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POST FLIGHT ANALYSIS
REPORT NO. 1207-5/74

POST FLIGHT ANALYSIS

REPORT

MISSION 1207-5

21 MARCH 1974

CDRL Item No. A057
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PUBLICATION REVIEW

This report has been reviewed and is approved.

William Howell Jr.
PFA Chairman

POST FLIGHT ANALYSIS
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FOREWORD

This report was prepared for and by direction of the Director, Office of Special Projects, and constitutes Volume III of the Final Mission Report.

The preparation, collection, and reduction of raw data in this report has been a joint effort of the Post Flight Analysis (PFA) Team comprised of the following organizations:

SPO

Stellar Terrain Subsystem Contractor

Processing and Reproduction Contractor

DMATC

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SUMMARY

1.1 INTRODUCTION

This report details the technical evaluation of ST System S/N 004 flown on mission 1207. Significant aspects of the ST test and integration, satellite vehicle performance, post-recovery handling, and mapping suitability of the product are also included.

Mission 1207 was launched on 10 November 1973 and recovered 7 January 1974. Camera data, mission statistics, and recovery data are summarized in Tables 1-1, 1-2, and 1-3.

1.2 CAMERA OPERATIONS AND PERFORMANCE

The third ST System was fully operational for 58 days on orbit, making it the longest mission flown to date. Two anomalies in the stellar camera were minor detractions to an otherwise excellent operational performance.

Post flight analyses conducted at the processing site, the Contractor's facility, and DMATC have shown that mission objectives were met with a high level of success.

The imagery acquired from both cameras was comparable to past missions. The terrain camera performed at expected levels based on acceptance test results and the stellar units recorded an adequate distribution of sixth magnitude stars.

Except for the stellar process marks, the ancillary data generated by both units were acceptable.

Weather conditions for the majority of the photography were fair to good with approximately 71 percent of the photography being 90 percent cloud free.

1.3 IMAGE QUALITY

The majority of the terrain photography was good and appeared consistent throughout the flight. The best imagery acquired was equal to the best of prior missions; however, there was less photography of cultured areas for comparison to prior flights.

This was the first ST system to use EK 3414 film in the terrain camera. Thirty feet of this film was "tagged on" for special engineering tests. Test objectives were accomplished and the results substantiate the optimism for using this film as the primary load for mission 1209.

Stellar imagery was good for both plus and minus Y, each unit recording between 50 and 100 images on evaluated frames.

TABLE 1-1

CAMERA STATISTICS

Camera Designations	Terrain			+Y		–Y		
Focal length, inches	12.0156			9.9800		9.9686		
Filter type	WR-21			None		None		
Reseau S/N	015			025		022		
Lens S/N	004			008		010		
Supply spool S/N	050				104			
Supply film weight, pounds	58.9				10.99			
Film data								
Type, terrain	3400	MCD	3414		MCD		3401	2403
Length, feet	3355	2.0	30		2.0		20	10
Type, stellar	3401		3400					
Length, feet	2000		100					

TABLE 1-2

MISSION STATISTICS

Mission number	1207
Launch date	10 November 1973
Launch time	2010 GMT
Satellite vehicle	SV-7
ST system	S/N 004
Orbit inclination	96.93 degrees
Initial perigee	88.673 nautical miles
Initial apogee	154.400 nautical miles
Argument of perigee	142.801 degrees
Initial period	88.883 minutes
Range of photo altitudes (approx)	87-119 nautical miles
Range of sun angles	1-85 degrees

TABLE 1-3

RECOVERY STATISTICS

Recovery date	7 January 1974
Recovery time	2245 GMT
Recovery rev	942
Comment	Routine air catch

1.4 EXPOSURE

Density measurements made at the processing facility indicated exposure levels for 1207 were correct and essentially the same as for mission 1206.

1.5 THERMAL PROFILE

There were no thermal control problems on this flight. Paint patterns, the same as those on 1206, provided excellent thermal distribution on the MISEA and EDAP assemblies.

1.6 PRESSURE PROFILE

Average chute pressure stabilized at 45 micrometers. This was an increase of approximately 15 micrometers from the average level of mission 1206. This increase was planned in order to supply pressure levels that were compatible to corona free pressures experienced during ground testing. A maximum of 55 micrometers and a minimum of 29 micrometers were recorded during the flight.

1.7 CALIBRATE MODE OPERATION

Two calibration operates were programmed beginning with rev 935. These operates were separated by 20 degrees to avert photographing the moon which was in the field of the Milky Way. EK 3401 film with special process and EK 2403 were used in the terrain camera for this operation. Usefulness of the terrain star imagery is uncertain at this time.

1.8 SUMMARY OF ANOMALIES

Table 1-4 is a summary of the more pertinent anomalies and their resulting impact during mission 1207.

TABLE 1-4

SUMMARY OF ANOMALIES

Time	Description	Impact
Pad	Vehicle main bus off while APSA AGE heater supplies were on; resulted in excessive chatter of relays K1 A and K1 B.	None—procedural problem has been corrected to prevent recurrence.
Rev 7	Health check/normal photo operate. Telemetry (S 203) on 2 frames of 11-cycle operate indicated spike at end of normal terrain press.	None—no degradation was noted on mission photography for any frames with terrain platen press telemetry anomalies.
Rev 24	S 203 indicated "No Press" on 1 frame and spikes on 2 additional frames of 29-frame operate.	None
Rev 265 Rev 281 Rev 284	Random telemetry indications of various terrain press conditions.	None
Rev 495 through Rev 720	No telemetry indications of terrain platen press.	None
Rev 722 through Rev 736	8 telemetry indications of S 203 for 55 cycles operated.	None
Rev 737 through Rev 934	One S 203 telemetry indication on rev 934.	None
Rev 88	Starting with frame 10 of 20-cycle operate +Y shutter monitor, S 212, intermittently indicated "Not Closed." Redundant monitor, S 285, indicated normal operation.	None
Rev 427	S 204 indicated capping shutter "Not Open" on frame 8 of 10-cycle operate. Capping shutter occurrence monitor, S 206, was normal for this frame.	None
Rev 444	S 204 intermittent to end of mission with S 206 continuing to indicate normal operation.	None
Rev 719	Temp. sensor, S 154, on terrain shutter/lens assembly indicated upper limit temp. of 81.5°F. All other sensors normal.	None

SECTION II

CAMERA OPERATION AND PERFORMANCE

2.1 PRELAUNCH OPERATIONS

This section briefly outlines the test and integration functions following shipment from the manufacturing facility.

2.1.1 Test and Integration Summary

Following customer acceptance at the manufacturing facility, the system was shipped to the celestial calibration site for starfield calibration. Calibration operations were conducted from 21 September 1972 through 30 September 1972. Upon completion of the calibration, the unit was shipped to the Integrating Contractor on 4 October 1972 for integration and test prior to flight.

Starting on 4 October 1972 and continuing through 16 November 1972, activities necessary to prepare the ST for mating with the APSA, recovery vehicle, and the doppler beacon system, were completed. During this time, preliminary functional tests were conducted, initial film tracking was established, and exposure levels of ancillary data were determined. On completion of this phase of integration, the camera system was installed in the APSA.

The light leak test results showed a leak in a stellar chute coupling section. A roller assembly, deleted by design change on all systems, required two open pinning holes for installation. These holes remained in all castings and are now covered with RTV in accordance with a service bulletin. On 22 March 1973, the stellar transport was returned to manufacturer to correct an uneven press condition. Due to a microswitch malfunction the minus Y shutter was replaced on 10 April 1973. By 12 April 1973 all anomalies were corrected and functional tests were completed.

The next major milestone encountered in the integration process was mating of the APSA with the satellite basic assembly. For satellite vehicle SV 7, this was accomplished in 20 weeks from the APSA installation. The mapping camera module (MCM) functional test, light leak tests, and film tracking and roller pinning were completed prior to SBA mating. For each major test conducted at the module level, pretest and post-test baselines were established and verified to serve as guides throughout the remainder of the integration cycle. Mating with the SBA was completed on 14 April 1973.

Performance and acoustic tests were completed without anomalies, and preparations were started for vacuum chamber tests.

The EDAP and terrain thermal shutter were replaced with units that were updated with the latest modifications and final preparations were completed for vacuum chamber tests.

Two vacuum chambers, designated A-1 and A-2 are used for vacuum testing of the ST system. The A-1 chamber test provides information critical to determining a corona-free pressure range for both the stellar and terrain units. The A-2 chamber test supplies the data necessary to evaluate film flatness. Module level testing (ST and APSA) can only be accomplished in the A-1 chamber.

Vacuum tests in the A-1 chamber were conducted from 23 May to 20 June 1973. These tests were aborted twice before completion to investigate vacuum leaks in the chamber and possible contamination of the chamber vacuum system. On completion of the A-1 test, the vehicle was moved into the A-2 chamber for further vacuum testing. This test was completed on 3 July 1973 and the film was retrieved for evaluation.

Evaluation of corona/pressure data showed a narrow and unacceptable pressure range (20 to 30 micrometers) that permitted corona free operation. The stellar transport was removed and returned to Boston for roller changes.

The reworked transport was returned and preparations were made to conduct another A-1 chamber test at the module level. The results of the second test were similar to the first vacuum test and the stellar transport was again removed.

The stellar transport, SN 005, was removed from SV-8 and installed on SV-7. A second module level vacuum test, which produced inconsistent data, was run. The transport was removed and inspection showed the platen press was not retracting fully, allowing the film to drag along the rubber press material. This transport was sent to manufacturer for repair.

A third module level vacuum test was conducted when the reworked transport was returned to the system. This test proved successful, showing a corona-free window up to 55 micrometers.

A fourth and final A-1 module test was conducted to troubleshoot terrain rotary shutter and the plus Y stellar shutter problems. This test was completed on 6 September 1973. The APSA was mated to the SBA and a system performance test was completed on 11 September 1973.

Flight loading took place on 21 September 1973. The vehicle was shipped to the launch base on 25 October 1973 following final preflight confidence tests.

The chronological occurrence of the important test milestones, covering activities at the integration facility, is indicated in Table 2-1.

The complete test history for SN 004 is detailed in the following reports:

1. Acceptance Test Report ST Subsystem, CEI System Assembly Number 152000G4, SN 004, 19 September 1972.
2. Addendum I, Acceptance Test Report (Flight Readiness Report), CEI System Assembly Number 152000G4, SN 004, 26 September 1973.
3. Addendum II, Acceptance Test Report (Flight Readiness Report), CEI System Assembly Number 152000G4, SN 004, 25 October 1973.

TABLE 2-1

INTEGRATION/TEST SUMMARY

Activity	Completed
Received system	4 October 1972
Completed receiving functional test	9 November 1972
Completed installation into APSA	16 November 1972
Completed film tracking test	15 December 1972
Completed pinning operation	15 December 1972
Removed U transport for use on SN 003	11 January 1973
Replaced D thermal shutter with updated unit	11 January 1973
Replaced 64 PC cards with updated units	11 January 1973
Returned D supply servo electronics to Boston to correct low torque condition	11 January 1973
Returned U transport to manufacturer for rework microswitch bracket on platen	15 January 1973
Replaced EDAP—relay suspect	20 January 1973
Installed U transport SN 003	20 January 1973
Installed D supply servo electronics	20 January 1973
Returned D transport to manufacturer for starwheel and shutter repair	22 January 1973
Relubed D platen press	29 January 1973
Installed D transport	29 January 1973
Returned D transport to manufacturer for roller alignment	30 January 1973
Installed D transport	2 February 1973
Repaired light leak (FSB 055)	3 February 1973
Completed special A1 chamber test to check D film positioning	9 February 1973
Replaced 10 PC cards in MISEA with updated units	14 February 1973
Replaced A35 card—suspected overstress	7 March 1973
Completed light leak test	14 March 1973
Completed MCM functional	20 March 1973
Cleaned D reseau	21 March 1973
Returned U transport to manufacturer to correct uneven press condition	22 March 1973
Installed U transport	2 April 1973
Removed U transport and reworked A3 and A5 PC cards on transport	3 April 1973
Replaced A35 card with updated unit	3 April 1973
Removed camera system from APSA	10 April 1973
Replaced −Y U shutter—microswitch malfunction	10 April 1973
Installed unit in APSA	11 April 1973
Completed MCM functional	12 April 1973
Mated to SBA	14 April 1973
Completed ADPAC performance test	16 April 1973
Replaced A14 card—relay suspect	20 April 1973
Completed acoustic test	20 April 1973
Completed post acoustic performance test	20 April 1973
Replaced EDAP with updated unit	9 May 1973
Replaced D thermal shutter with updated unit	11 May 1973

TABLE 2-1

INTEGRATION/TEST SUMMARY (CONT.)

Activity	Completed
Replaced 6 PC cards having suspect IC's	11 May 1973
Replaced 2 PC cards with updated units	11 May 1973
Removed D supply for APSA modification	14 May 1973
Completed APSA performance test	16 May 1973
Installed special temp sensor for vacuum chamber test	17 May 1973
Completed prevacuum chamber test	19 May 1973
Started first chamber pressure sweep	23 May 1973
Aborted test—chamber problem	24 May 1973
Investigated contamination problem	1 June 1973
Restarted vacuum test	12 June 1973
Stopped vacuum test—vacuum leak and contamination	13 June 1973
Completed vacuum test	20 June 1973
Replaced EDAP—relay suspect	26 June 1973
Replaced A22 card—original used on SN 005	26 June 1973
Completed vacuum chamber test (A2)	3 July 1973
Retrieved film from vacuum chamber tests	9 July 1973
Removed D supply from APSA modification	17 July 1973
Removed +Y baffle for installation of temp sensor	17 July 1973
Installed D supply	18 July 1973
Installed +Y baffle	19 July 1973
Returned U transport to manufacturer to correct corona marking problem	19 July 1973
Replaced A35 card with updated unit	27 July 1973
Demated for corona tests	3 August 1973
Inspected MISEA connections—D capping shutter anomaly	10 August 1973
Installed U transport SN 003	14 August 1973
Completed vacuum chamber retest (module level)	17 August 1973
Replace U transport (corona marking problem)	20 August 1973
Completed A1 retest (module level)	22 August 1973
Removed U transport (corona marking problem)	23 August 1973
Installed U transport SN 003, check MISEA	24 August 1973
Replaced A55 card with updated unit	25 August 1973
Installed U transport SN 005	28 August 1973
Completed vacuum chamber retest (module level)	30 August 1973
Repainted MISEA	31 August 1973
Completed special vacuum chamber test (module level) to check +Y shutter operation	6 September 1973
Mated unit to SBA	10 September 1973
Completed system performance test	11 September 1973
Completed special tests for reseau density	18 September 1973
Completed flight loading	21 September 1973
Unit shipped to base	25 October 1973

4. Addendum III, Acceptance Test Report (Flight Readiness Report), CEI System Assembly Number 152000G4, SN004, 27 November 1973.
5. Calibration Test Report Mapping Camera SN 004, 9 November 1972.
6. Acceptance Test Data, Mapping Camera SN 004, 8 December 1972.

2.1.2 Preflight Resolution Testing

The collimator arrangement test unit (CATU) and the resolution test unit (RTU) are special test equipment used in optical testing of the ST system.

The CATU is used to determine terrain lens resolution, distortion and distortion stability, and camera knee angle stability. Results of the collimator tests verify specification parameters of the ST for acceptance prior to delivery. The CATU is not intended to provide the accuracy or precision required for absolute metric calibration.

Test resolution data for acceptance of the ST system is collected in the resolution test unit. An aerial image of a tri-bar target with simulated ground motion is projected by a parabolic collimating system through an optical window in the side of the test chamber and folded by three mirrors to permit format sampling at the ±0.85- and 0-field positions.

Resolution data from the CATU and RTU for SN 004 are shown in Table 2-2.

2.1.3 Vacuum Testing

Results of tests conducted in the vacuum chamber at the integration site, and the thermal vacuum chamber located at the ST Contractor's facility are utilized to determine system pressures that can best provide corona free photography in flight.

Corona data is acquired empirically, during ground testing, by evaluating film that has been operated through various pressure sweeps. When it is determined that a corona-free pressure range is compatible for both stellar and terrain film loads, the gas orifice that produced this pressure is selected for flight. When selecting an orifice for the desired pressure range during flight, factors such as film outgassing, the amount of moisture in the supplies, and the length of time on orbit are some of the parameters that add to the uncertainty of achieving total success.

2.1.4 Preflight Calibration

To accomplish starfield calibration at the celestial calibration site, the camera system is installed in a vacuum tank, which is in turn mounted on a synchronous drive equatorial mount. The vacuum tank is fitted with three calibrated windows to allow simultaneous photography by all cameras. Throughout the calibration the camera is maintained in a vacuum which approaches the conditions of the operational environment. Approximately 50 exposures are made at various azimuth and elevation angles to optimize star image distributions for each calibration.

2.1.5 Major Configuration Differences

The following is a list of differences between SN 004 (SV-7) and SN 005 (SV-6).

1. A temp sensor was added between the terrain thermal shutter and the terrain lens for additional telemetry to indicate shutter opening.
2. Spare relay contacts on PC cards have been paralleled to provide additional redundancy.

2.2 ON-ORBIT OPERATIONS

Acquisition requirements of ST photography are generated by the user, based on priorities of selected mapping areas, ephemeris data, weather prediction, fixed camera parameters, and selection criteria contained in the orbital software data base.

The ST system was operated on 134 revs between rev 6 and rev 937. A total of 2,106 frames were exposed in the terrain camera and a corresponding number of frame pairs were exposed in the stellar unit. These exposures included 18 frames of EK 3414 exposed on the terrain camera and 19 frames from both units which were operated for in-flight stellar calibration. Film consumption versus rev and days on orbit is plotted in Fig. 2-1.

Thirty feet of EK 3414 was included in the terrain camera load to obtain empirical data of operational parameters. This data, combined with additional information from 1208, will be used for establishing exposure requirements for the terrain camera on mission 1209 which will carry 3414 as the primary load.

A special tag end of EK 3400 was loaded in the stellar supply for operation during the run-out sequence. This film and a special operation of the stellar unit to photograph the comet, Kohoutek, were not recovered.

This mission is the first occasion that the ST system did not transport all the film supply into the takeup. Following depletion of the terrain supply, the transport stalled making it necessary to cut the film at the recovery bucket seal. Table 2-3 is a summary of the cycles/film operated and the film recovered.

The ST flight configuration in relation to the satellite vehicle is shown in Figure 2-2. A single terrain footprint from a nominal altitude of 92.5 nautical miles covers 140 nautical miles along track and 70 nautical miles across track. The overlap of the terrain camera frames is controlled to provide contiguous stereo models along the flight path using every other (triple overlap) or every third (quadruple overlap) frame in combination, depending on the stereo separation desired (see Figure 2-3, and photographic example of a stereo pair, Figure 2-4). Measurements of star image locations on the stellar frames are used to accurately orient the terrain camera axis in space at the time of each exposure.

To accomplish the operations necessary to satisfy mission objectives, the ST response is controlled by generating a command load which is telemetered to the command system of the satellite vehicle. Through a network of ground control stations, the satellite vehicle is capable of receiving updated command loads and transmitting current telemetry data concerning the status of the ST system.

Several alternate operational modes of the ST camera are available to provide commands for specific events and to permit continuous operation under certain failure conditions. These operating modes are listed in Table 2-4.

TABLE 2-2

CATU AND RTU RESOLUTION IN C/MM

CATU			RTU		
–X/0.85	0	+X/0.85	–X/0.85	0	+X/0.85
41	52	45	50	65	50

TABLE 2-3

FILM RECOVERY SUMMARY

Rev	Operate	Frames Operated	Frames Recovered	Comments
918	146	2,069	2,069	3400 runout
932	147	6	6	3414 operates
933	148	5	5	
934	149	7	7	
935	150	7	7	3401-2403 calibrate
936	151	12	8.5	
938	152	4	0	Stellar only—Kohoutek

MISSION FILM CONSUMPTION

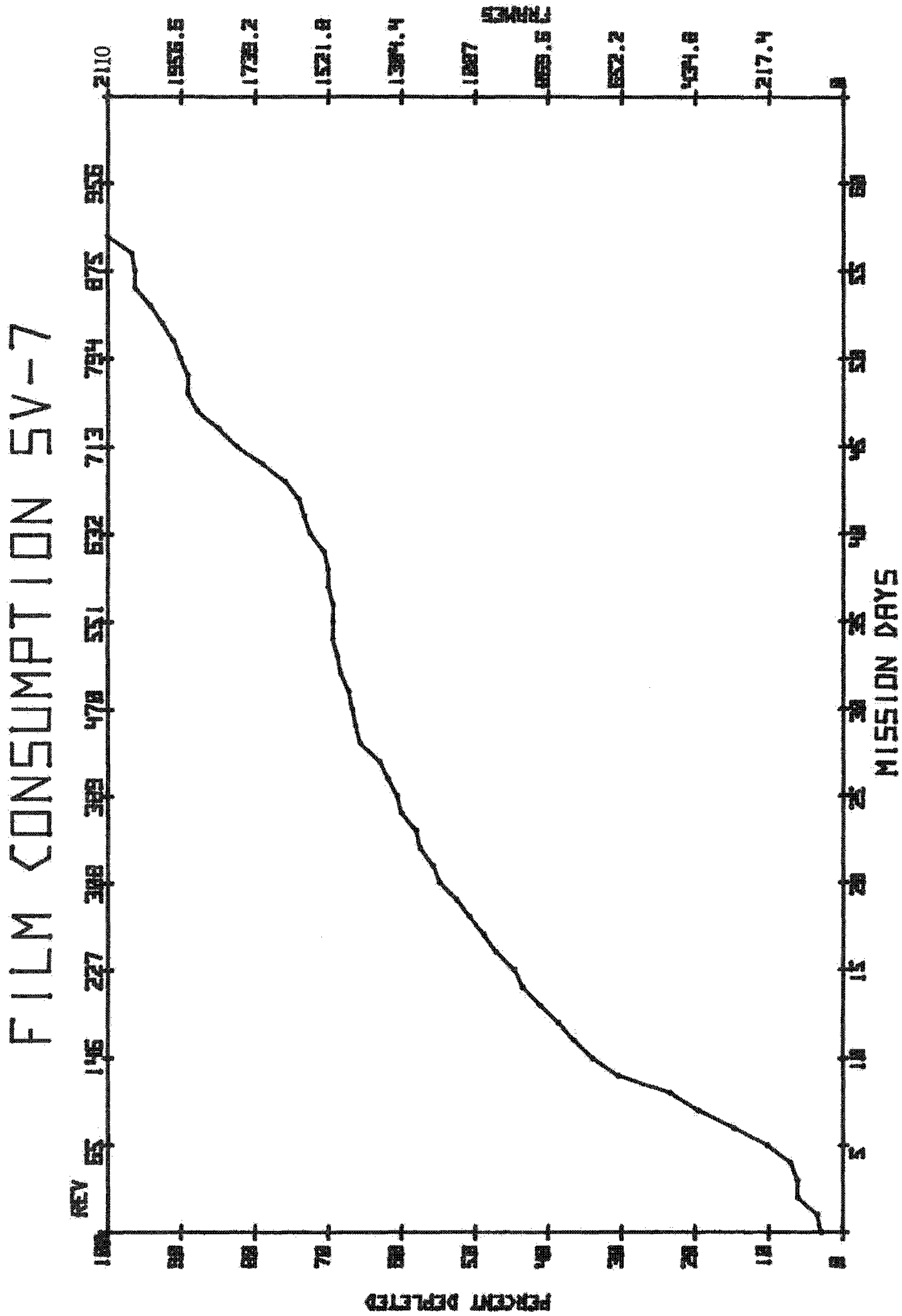


FIGURE 2-1

SATELLITE VEHICLE (92.5-NM NOMINAL ALTITUDE)

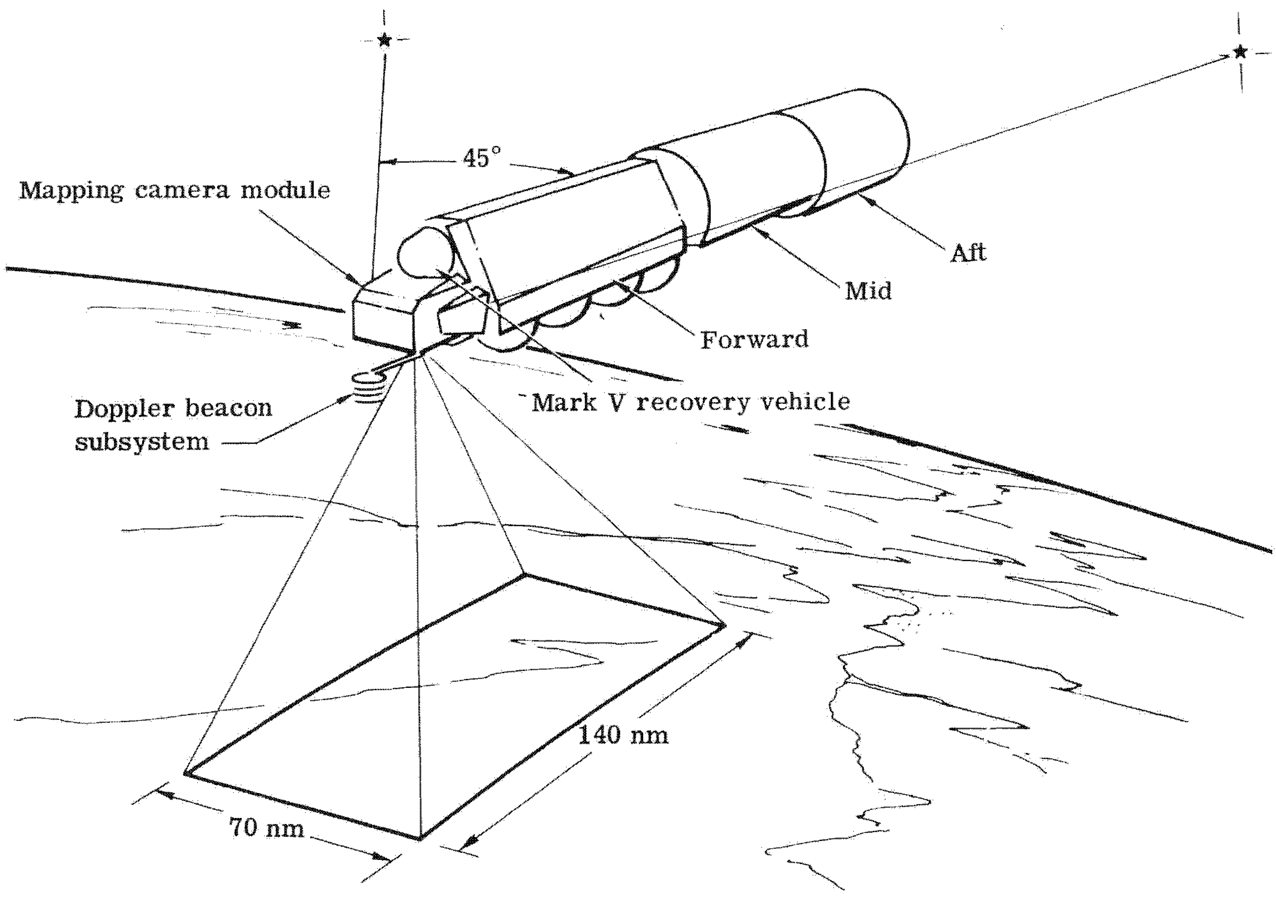
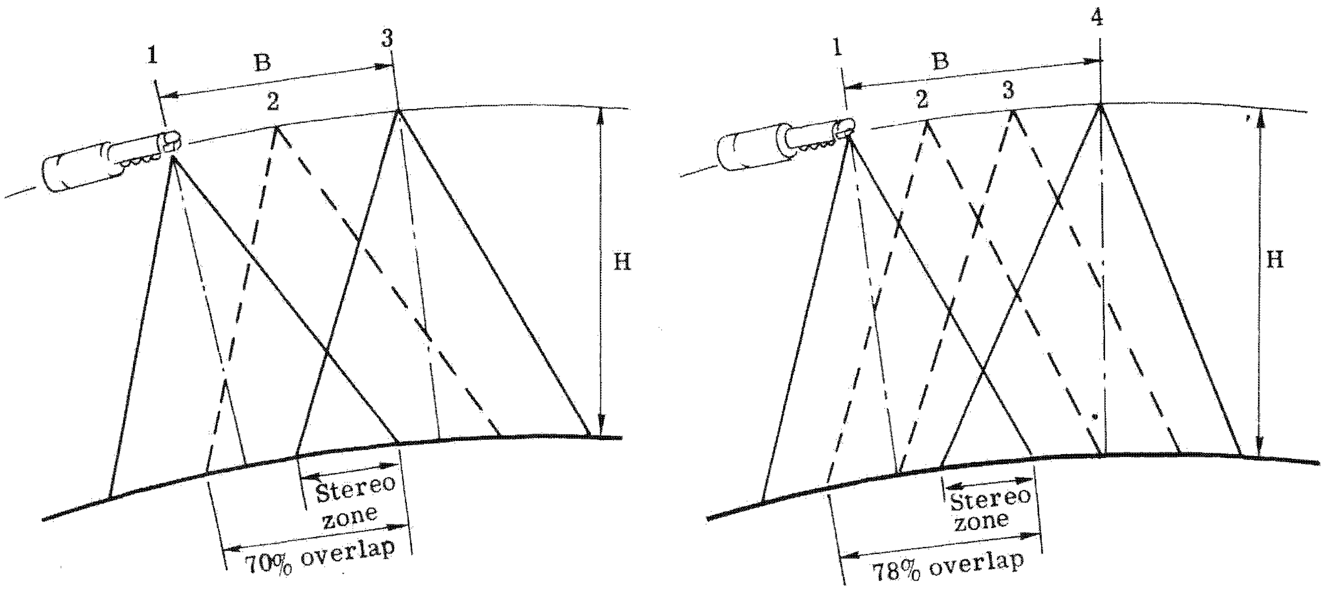


FIGURE 2-2

MAPPING CAMERA OVERLAP/STEREO



Triple overlap; B/H = 0.9

(80 < H < 240 nm)

Quadruple overlap; B/H = 1.0

(100 < H < 240 nm)

FIGURE 2-3

TABLE 2-4

MODES OF OPERATION

- Standby
  - Heaters powered only
- Ascent mode
  - Film path tensioned
  - Stellar and thermal shutters closed (ascent condition)
- Normal mode
  - Primary photographic mission
  - $0.0165 > V/h < 0.0565$
  - Terrain exposure: 3, 6, 12 milliseconds
  - Overlap: 78%, 70%, 10%
- Backup mode
  - Backup operating mode in the event of an electrical malfunction in the normal mode
  - Terrain exposure: 6.2 milliseconds } Fixed rate
  - FMC correct for nominal $V/h = 0.046$ } Fixed rate
  - Frame rate: 8.9 seconds } Fixed rate
  - 70 percent or greater overlap
- Calibrate mode
  - Calibration condition
  - Frame time: 20 seconds
  - Exposure: 2 seconds
  - FMC inhibited
- Redundant modes
  - Command selection of parallel control circuits for terrain capping shutter, thermal shutter, stellar platen press, stellar transport
  - Command terrain thermal shutter open/reset
- Failsafe modes
  - Capping of either stellar shutter (shutter open condition)

2.2.1 Launch and Orbital Conditions

The launch of 1207 took place on the first countdown attempt on 10 November 1973. Liftoff occurred at 2010 GMT near the opening of the launch window. Planned and achieved orbital parameters for this mission are listed in Table 2-5.

2.2.2 Sequence of Significant Events

A summary of all ST photographic operations is presented in Table 2-12. The summary includes engineering operates as well as mission photographic events. Table 2-6 lists a chronological description of the engineering operates in addition to other special nonphotographic events that occurred during mission 1207.

2.2.3 Thermal Profile

Thermal control for the mapping camera is achieved by a combination of passive and active techniques. Active methods are used where precise temperature levels are required; passive methods are used where rather broad limits suffice. Specifically, the main instrument temperature is maintained by thermostatically controlled heaters. The supply cassettes and the takeups are controlled by virtue of their location within the passively controlled APSA and RV. The MISEA and EDAP are controlled by proper selection of external thermal finishes; these are located exterior to the MCM.

The main instrument is surrounded by a thermostatically controlled heated structure that contains the heaters, temperature sensors, and a mylar laminated insulation (MLI) blanket to reduce heat losses. A number of different heater zones are used for both reliability and to ensure uniformity of temperature distribution.

The main instrument thermal requirement is to maintain the temperature at which the calibration was performed to within ±1 °F. The camera temperatures were very stable throughout the mission, showing only slight deviations.

Following on-orbit stabilization, the terrain camera average temperature was steady at 73.4 °F, while the stellar camera unit stabilized at 73.8 °F. Average temperatures for the MISEA and EDAP units were approximately 5° higher than those recorded on 1206.

Average operational temperatures for the total mission are shown in Figures 2-5 and 2-6. Tables 2-7 through 2-9 show once a day temperatures taken in rev segments approximately every 36 degrees.

2.2.4 Pressure Profile

Ground test data for SV 7 determined that the best operating pressure for minimized corona marking during flight was between 25 and 55 micrometers. Average pressure for mission 1207, following stabilization, was 45 micrometers. A high pressure of 60 micrometers for a single frame of an operate was recorded on rev 186. The lowest pressure recorded was 29 micrometers on rev 936. As mission life progressed, the difference between the lowest pressure, which typically occurred on the first frame of an operate, and the highest pressure decreased. As an example,

TABLE 2-5

PLANNED VERSUS ACTUAL ORBITAL PARAMETERS

	Planned	Actual
Launch time (GMT)	2009-2042	2010
Launch time (SVT)	—	72601.1
Inclination, degrees	96.90	96.93
Initial perigee, nautical miles	87.930	88.673
Initial apogee, nautical miles	154.060	154.400
Argument of perigee, degrees	156.050	142.801
Initial period, minutes	88.910	88.883
Beta angle control, degrees	+2 – (–)8	achieved

TABLE 2-6

SUMMARY OF SIGNIFICANT EVENTS

(SV 7 SN 004)

(For sequence number identification, see Appendix B)

Rev	Activity	Event	Comments
—	Ascent	A mode	No anomalies
7	Photography	Sequence 149	Health check with programmed photography
24	Photography	Sequence 149	First indication of D platen press TM anomaly
88	Photography	Sequence 149	+Y shutter TM (S212) indicated shutter "not closed"
113	Photography	Sequence 148	Bar XC acquisition
405	Photography	Sequence 148	Bar XC acquisition
427	Photography	Sequence 149	First indication of D capping shutter TM (S204) anomaly
632	Photography	Sequence 148	Bar XC acquisition
932	Photography	Sequence 149	3414 engineering
933	Photography	Sequence 149	3414 engineering
934	Photography	Sequence 149	3414 engineering
936	Photography	Sequence 380	ST in-flight calibration
938	Photography	Sequence 380	Attempt to photograph comet Kohoutek
939	Film runout	Sequence 149	Unsuccessful film runout event due to stalled terrain system
942	RV 5 recovery	—	Successful air recovery of RV 5

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MISSION 1207 AVERAGE SYSTEM TEMPERATURE

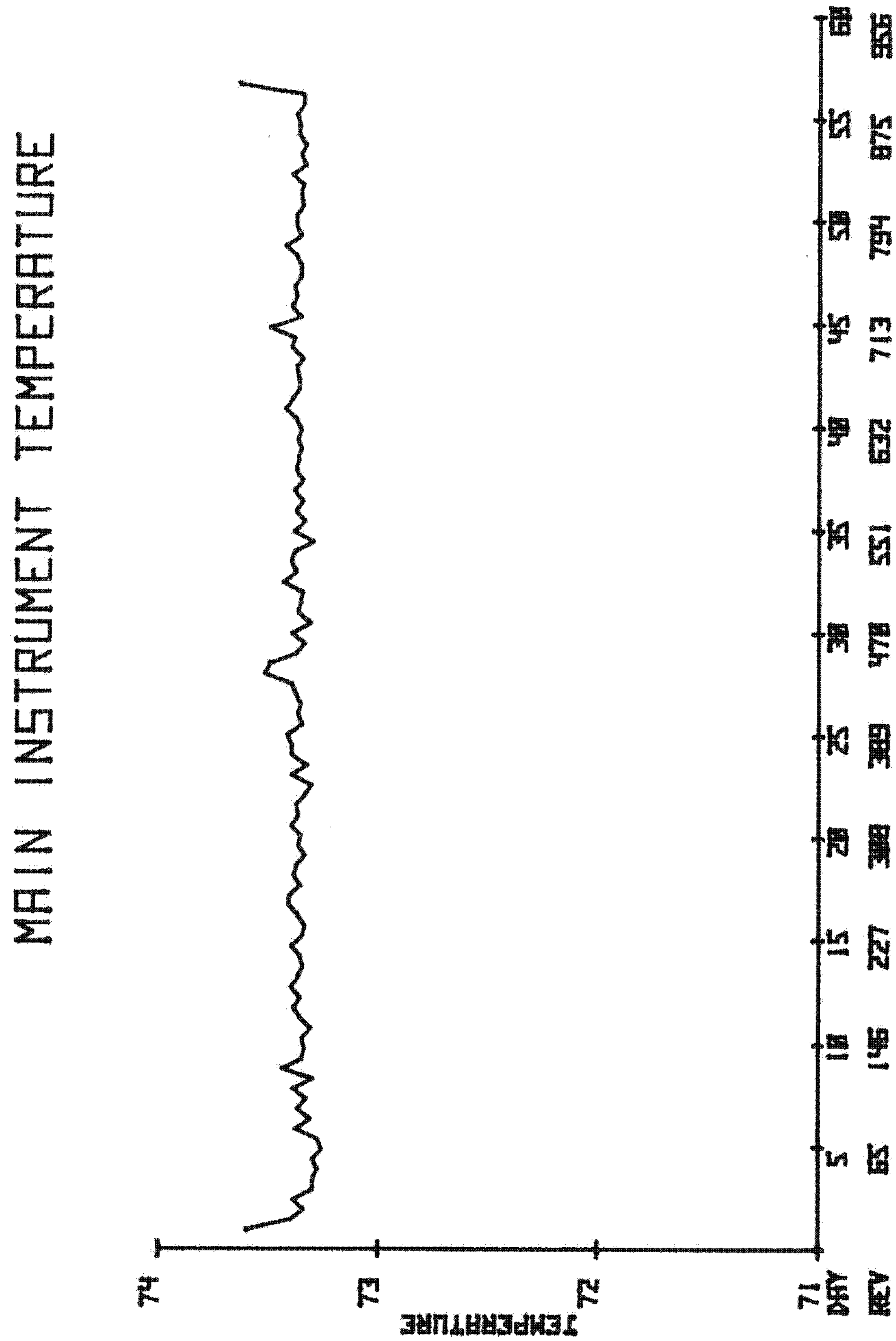

FIGURE 2-5

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MISSION 1207 TYPICAL TEMPERATURE DISTRIBUTION ON ORBIT

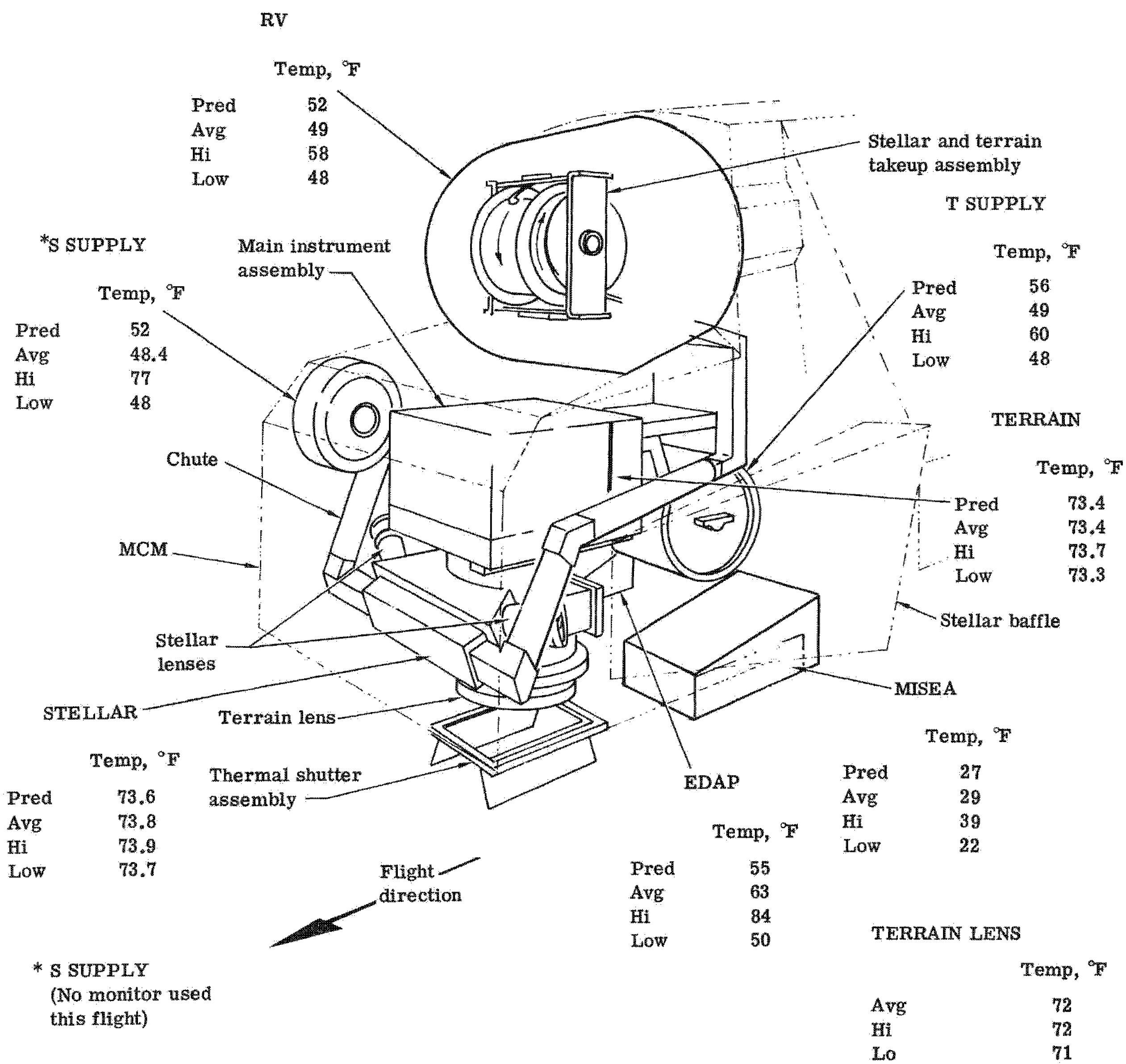


FIGURE 2-6

TABLE 2-7

SV-7 ORBIT TEMPERATURES (°F) REV 14

Rev Seg	Main Inst Avg	+Y Avg	-Y Avg	EDAP Avg	MISEA Avg	D Supply	D Wind.	T/U	Lat
14.4	73.4	73.9	73.8	62	26	54	72	58	39.3N
14.5	73.5	73.8	73.8	71	29	53	72	58	2.5N
14.6	73.4	73.8	73.8	78	34	53	72	58	34.5S
14.7	73.4	73.8	73.8	81	36	53	72	58	70.9S
14.8	73.4	73.8	73.8	84	37	53	72	58	74.7S
14.9	73.4	73.8	73.8	69	39	54	72	57	38.1S
15.0	73.4	73.8	73.9	64	35	54	72	57	2.2S
15.1	73.4	73.7	73.8	63	34	54	72	57	17.8N
Avg.	73.4	73.8	73.8	71.5	34	53	72	58	

TABLE 2-8

SV-7 ORBIT TEMPERATURES (°F) REV 296

Rev Seg	Main Inst Avg	+Y Avg	-Y Avg	EDAP Avg	MISEA Avg	D Supply	D Wind.	T/U	Lat
295.3	73.4	73.8	73.8	52	25	49	72	50	80.9 N
295.4	73.4	73.7	73.9	57	23	49	71	50	43.7 N
295.5	73.4	73.8	73.8	61	25	49	72	50	10.0 N
295.6	73.4	73.8	73.8	65	27	49	72	50	26.9 S
295.7	73.4	73.8	73.8	76	30	49	72	50	62.7 S
295.8	73.4	73.7	73.8	77	35	49	72	50	78.3 S
295.9	73.3	73.7	73.8	70	36	49	71	50	44.3 S
296.0	73.4	73.7	73.8	64	33	49	72	50	8.6 S
296.1	73.4	73.7	73.8	60	31	49	72	50	27.3 S
Avg	73.4	73.7	73.8	65.8	29.6	49	71.8	50	

TABLE 2-9

SV-7 ORBIT TEMPERATURES (°F) REV 749

Rev Seg	Main Inst Avg	+Y Avg	-Y Avg	EDAP Avg	MISEA Avg	D Supply	D Wind.	T/U	Lat
749.3	73.4	73.7	73.8	50	25	50	72	49	78.8 N
749.4	73.4	73.8	73.8	54	23	50	71	48	43.7 N
749.5	73.4	73.8	73.8	60	24	50	71	49	6.8 N
749.6	73.4	73.8	73.8	65	27	49	72	49	29.9 S
749.7	73.4	73.8	73.8	71	29	49	72	49	63.6 S
749.8	73.4	73.7	73.8	74	33	49	72	48	76.1 S
749.9	73.4	73.8	73.8	67	34	49	72	48	42.5 S
750.0	73.4	73.7	73.8	63	33	49	72	48	5.8 S
750.1	73.4	73.8	73.8	59	30	50	72	48	29.3 S
Avg	73.4	73.8	73.8	62.6	28.7	49.5	72	48.5	

the high and low pressures recorded on rev 108 were 51 and 41 micrometers, respectively, while no measurable difference was recorded on rev 853. On rev 853, the pressure for all frames was 46 micrometers. Table 2-10 indicates typical pressures recorded for this flight.

TABLE 2-10

PRESSURE SUMMARY/1207

Rev	Max	Min	Avg
7	55	49	50
151	49	45	48
380	47	41	46
640	46	41	46
800	47	41	46

Stellar corona-free window— <50 micrometers
Terrain corona-free window—> 20 micrometers

2.2.5 Image Quality

Using copies supplied by the processing facility, an extensive evaluation of all mission 1207 photography has been accomplished at DMATC and at the ST contractor's facility. This evaluation included, but was not limited to, the following:

1. Subjective image evaluation
2. Visual edge matching (terrain only)
3. Relative density measurements
4. Terrain overlap checks
5. Fiducials and reseau grids
6. Effects of corona
7. Flatness measurements
8. In-flight stellar calibration.

The imagery acquired on 1207 was comparable to pre-flight test quality. Figure 2-7 is a contact print and Figure 2-8 is a 10× enlargement which represents typical terrain imagery obtained on this mission.

There were no unusual variations in image quality across the format, or in comparison of photography acquired at the start and end of the mission.

This system was the first to use EK 3414 film in the terrain camera. A subjective evaluation of this film was conducted at the processing site by the PFA team and at the contractor's facility. The imagery on 3414 was judged to be significantly better than imagery on 3400. However, it is important to note that the sampling was small (30 feet of 3414) with limited cultural areas. A direct comparison of targets covered by 3400 and 3414 was not possible, nor was it possible to objectively analyze the 3414 performance.

Since SN 004 had been optimized for operation with 3400 film, a compromise to forward motion compensation had to be accepted to achieve the longer exposure times necessary for 3414. Programming and commands for the desired exposure times for 3414 caused an FMC error which resulted in detectable smear.

The results of this engineering test are considered highly successful and further perpetuates the optimistic response to using 3414 as the primary load on mission 1209. Figures 2-9 to 2-11 are examples of three different terrain scenes acquired on mission 1207 using 3414 film. A 20× enlargement taken from a segment of OP 148, frame 3 is shown in Figure 2-12, and a stereo pair is presented in Figure 2-13.

The stellar imagery from both units was considered good to excellent with an adequate distribution of sixth magnitude stars. Figure 2-14 is an example of a typical starfield on the stellar format.

Exposure

The exposure algorithm, essentially the same as used on 1206, resulted in correctly exposed imagery. The majority of photography was less than one third stop overexposed, and no changes are recommended for 1208.

Exposure times for the special engineering test with 3414 film were manually programmed, and produced properly exposed imagery. Table 2-11 lists exposure times versus sun angles that were used for this test.

TABLE 2-11

3414 EXPOSURE VALUES

Rev	Start Sun Angle	End Sun Angle	Exposure Time, ms
932	31	34	14.5
933	52	54	10.5
934	23	28	14.5

Image Analysis Using VEM

Data derived from the VEM analysis will not be included in this section. The duplicating film was changed from SO-467 to SO-284, and a matrix was not available to evaluate imagery on this film.

NOTE: FIGURE 2-9 ON PAGE 2-22 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

NOTE: FIGURE 2-10 ON PAGE 2-23 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

NOTE: FIGURE 2-11 ON PAGE 2-24 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

NOTE: FIGURE 2-12 ON PAGE 2-25 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

NOTE: FIGURE 2-13 ON PAGE 2-26 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

2.2.6 On-Orbit Calibration

In addition to the preflight calibration data, two additional calibration steps are conducted in flight. The two in-flight calibrations, range and stellar, are distinctly different operations.

Range calibration is conducted while operating the camera in the normal mode over a ground range containing accurately measured control points. A typical range is the Bar XC located in the Arizona/New Mexico area.

Stellar calibration was accomplished in two separate operations at the end of mission 1207. This calibration required the vehicle to be pitched to an attitude that pointed all three camera lenses at the stars. The camera system was then operated in the calibrate (C) mode to record star imagery on the terrain and stellar formats simultaneously. Special films used for this operation in the terrain camera were 3401 and 2403. Evaluation is currently in process to determine the calibration potential of the star imagery.

2.2.7 Anomalies—Telemetry

Anomaly

Terrain platen press telemetry, S-203.

Analysis

The first indication of the press telemetry anomaly occurred on operate 3, rev 24. Nine frames were operated during this rev with telemetry switch S203 indicating "No Press" on frame 1, "Normal Press" with a TM spike at the end on frame 2, and spikes at the beginning and end of a normal press on frame 3. Anomaly characteristics at this time were similar to those experienced on 1206. Since flatness measurements and image evaluation conducted during post-flight analysis of mission 1206 established that photography was not affected by this anomaly, normal programming was continued for 1207 operations. Correct T/M press indications were recorded until operate 55, rev 265, when 3 frames of a 29-frame operate indicated a TM spike on the end of a normal press. On operates 57 and 58, rev 281, and continuing through rev 479, S-203 indications were erratic.

There were no S-203 indications recorded from revs 495 through 720. On revs 722 through 736, during 55 frames operated, there were eight S-203 indications before the telemetry again went inactive. On the last operate there was one indication recorded for S-203.

A number of frames were selected for flatness measurements at DMATC. The selection included samples of all the different press conditions, including normal operation, that were recorded during the mission. Reduction of the flatness measurements produced a standard deviation of less than 10 micrometers on all frames measured. Rejection criterion for these measurements at DMATC is 12.9 micrometers.

Anomaly

Terrain capping shutter telemetry, S-204.

Analysis

On operate 78, rev 427, the terrain capping shutter monitor, S-204, indicated "Closed" for one frame. Capping shutter occurrence, S-206 indicated normal operation for this frame. A tracking station problem was reported for this rev and the anomaly was attributed to loss of sync in the telemetry transmission. No action was taken and normal flight programming continued.

On the second operate of rev 444, S-204 indicated the capping shutter remained closed for 4 frames of a 21-frame operate. Since the telemetry data for this rev was processed through a different tracking station, a telemetry transmission problem was ruled out and an analysis of the problem from a camera standpoint was continued.

S-204 is a microswitch TM monitor that indicates the capping shutter is starting to open. S-206, a rotary switch monitor, indicates capping shutter occurrence when the shutter approaches the full open position. For all "Closed" indications of S-204, S-206 reported normal operation. The problem was diagnosed as a telemetry microswitch malfunction and no further action was taken.

This anomaly occurred randomly throughout the remainder of the mission. In all cases, S-206 indicated normal operation of the capping shutter. Film evaluation performed during the PFA substantiated the conclusion that this was a telemetry problem.

Anomaly

Plus Y shutter telemetry, S-212.

Analysis

On rev 87 and continuing randomly to rev 136, S-212 indicated that the plus Y shutter was not closing for every frame. Redundant monitor S-285 continued to indicate normal operation.

This problem previously occurred during integration testing in the "B" mode and during "solo" operations on 1206. All information indicated that this was a telemetry microswitch problem and normal operations were continued.

Evaluation of photography taken during this time did not indicate any shutter malfunction.

2.2.8 Anomalies—System

2.2.8.1 Terrain Camera

Anomaly

At depletion of the terrain supply, the transport did not transfer all the film into the takeup.

Analysis

Figure 2-15 is a reconstruction of the data from selected telemetry monitors taken for the first four frames on rev 938 and two 1-frame operates conducted in the backup mode on rev

989 after recovery of RV-5. The terrain transport stalled on the fourth frame of rev 938. The system then operated normally, without takeup, for two frames on rev 989 and for one frame on rev 1054.

D supply torquer TM, S-101, showed a reduced level when the terrain film supply was depleted. The data from the one frame operate on rev 989 indicates the film was 6 to 9 inches from the input metering roller when the system stalled (DIR-1 and 2, S-107, S-108).

The ST system was not designed to operate without supply or takeup tension. Possible damage and/or lockup of the starwheel mechanism is a high probability failure mode. Also, loose film in the transport could easily jam in several gear meshes or close tolerance roller configurations.

Anomaly

Temperature sensor.

Analysis

On rev 719, temperature sensor S-154, located on the plus Y side of the upper terrain shutter/lens assembly, indicated 81.5 °F. Normal operating temperature for this sensor had been 73.4 °F. Sensors 148, 152, and 154 are all associated with the heater for thermal zone 2; sensors 148 and 152 continued to record normal operating temperatures and the problem was diagnosed as being sensor/circuit related.

2.2.8.2 Stellar Camera

Anomaly

A small light leak in the aft stellar chute resulted in a superimposed image (pinhole camera effect) on the tenth frame (toward the takeup) from the start of most operates. Pressure makeup equipment, located in the APSA, has been identified in the superimposed imagery. An example of this light leak is shown in Figure 2-16. Figure 2-17 shows the relationship of the PMS to the stellar chute.

Analysis

Illumination of this equipment was provided through the lightening holes located on the bottom aft face of the APSA and reflecting off the silvered chute sections.

Extensive analysis, which included simulated photography and pinhole viewing, has located the position of the hole in the aft chute, approximately 6 inches forward of the rivets which attach the grounding strap bracket to the chute section.

Observations

1. There are no attachments or rivets located in this area of the chute that are potential apertures for light leaks.

2. The position of the chute seam is limited by the length of the grounding strap to areas that are outside the view of the imagery acquired.
3. A hole of approximately 0.070 inch was necessary to produce this imagery.
4. Light leak tests conducted prior to flight did not indicate any signs of a leak.
5. The chute sections and PMS unit are installed in the APSA prior to light leak tests and mating with the vehicle. On completion of the light leak tests, no further work in this area is necessary by the camera contractor.

Conclusions

1. The location of this hole is in a position that precludes the possibility that loose, broken, or improperly installed hardware caused the leak.
2. The exact cause of the hole is uncertain at this time.

Anomaly

Stellar process marks.

Analysis

Stellar process marks were operational throughout this mission but were not of sufficient density to activate the optical titling device. This condition was a result of changing the stellar transport assembly during integration testing. The replacement transport from SV 8 had been updated with improved process markers that require higher current levels for proper illumination. Common circuitry controls the density levels of both the terrain and stellar process marks, making it difficult to optimize density levels for both cameras when unit designs are different.

2.2.9 System Functional Measurements

To assess the system functional performance, the mission material was subjected to various mechanical/optical measurements specified for:

Film tracking
Frame metering distance
Frame format size
Overlap
Data block
Image study.

Excluding the stellar process mark anomaly discussed previously, all measured items are within specified tolerances.

2.3 SOLO OPERATIONS

Following recovery of the RV, engineering and diagnostic operations are programmed for the ST system. These operates are designed to provide analysis data for anomalies occurring during the mission, exercise all commands not used during the mission, and to provide support data for maneuvers and operations considered for future flights. The more significant solo operations of mission 1207 are described in Section 2.3.1 and a summary of all solo activities is presented in Table 2-13.

2.3.1 Significant Solo Activities

Solo activities were programmed to provide support data for the following anomalies/conditions:

1. Terrain transport stall at film runout
2. Early system shutdown during calibrate operation
3. Rotary shutter phase lock dropout when changing exposure times during operation. This condition was not noted in flight but has been observed during ground testing on other ST systems.
4. Terrain thermal door "emergency open."

Terrain Transport Stall During Runout

Following recovery of RV-5, three 1-frame operates were programmed in the backup mode. These operates were designed to provide additional data for analyses of the stalled transport and possibly free the terrain transport for further diagnostic operations. The three single-frame operates were completed with no TM indications of a stalled condition. However, two frames later during a calibrate mode operation, the stellar transport stalled and was inoperative for the remainder of the solo operations. The terrain transport continued to operate throughout the solo programming.

Early Shutdown in Calibrate Mode

Three calibration operates were programmed to evaluate the early shutdown which occurred during the in-flight stellar calibration for 1207. The early shutdown was repeated and an analysis is in process to determine the possible causes of this anomaly.

Rotary Shutter Phase Lock Dropout

Rotary shutter phase lock dropout had been observed during ground testing of ST system when exposure changes were made during operation. To observe the effects of a vacuum environment and a zero-g condition, 40 exposure changes were programmed during a continuous 88-frame operate. There were no indications of rotary shutter phase lock dropout during this test.

Terrain Thermal Door "Emergency Open"

During operation of the solo activities, the terrain thermal door did not open when the "emergency open" function was commanded. Two unsuccessful attempts were made using the standard sequence for this command. A third attempt, using a modified sequence which pulsed the door 20 times, was also unsuccessful and the thermal door circuitry was reset to allow normal operations. This problem occurred only during the emergency open sequence and is currently under investigation to determine possible causes for the anomaly.

TABLE 2-12

MISSION SUMMARY

Revs Successful Operates		Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs/Ops		Comments
		1-6			6		
7	Op 1				1	1	11 fr
		8-21			14		
22	Op 2				1	1	18 fr
		23			1		
24	Op 3					1	9 fr first platen press anomaly indication
25	Op 4				1	1	20 fr
		26			1		
27	Op 5				1	1	11 fr
		28-53			26		
54	Op 6				1	1	9 fr
55	Op 7				1	1	12 fr
		56-60			5		
61	Op 8				1	1	11 fr
		62-72			11		
73	Op 9				1	2	15 fr
	Op 10						17 fr
		74			1		
75	Op 11				1	1	25 fr
		76-86			11		
87	Op 12				1	1	32 fr
88	Op 13				1	1	20 fr +Y shutter TM S212 not closed
		89-90			2		
91	Op 14				1	2	27 fr
	OP 15						10 fr
92	Op 16				1	1	9 fr
		93-102			10		
103	Op 17				1	1	13 fr
104	Op 18				1	1	11 fr
		105			1		
106	Op 19				1	1	44 fr (44.4E-39.1E 26.7N-1.4S)
		107			1		
108	Op 20				1	2	29 fr
108	Op 21						8 fr
		109-112			4		
113	Op 22				1	1	7 fr $\overline{XC}$
		114-116			3		
117	Op 23				1	1	8 fr
		118			1		
119	Op 24				1	1	13 fr
		120			1		
121	Op 25				1	1	23 fr
		122			1		
123	Op 26				1	1	25 fr
124	Op 27				1	1	7 fr
		125-134			10		
135	Op 28				1	1	41 fr (137.01E-124.3E/67.76N-40.9N)

TABLE 2-12

MISSION SUMMARY (CONT.)

Revs Successful Operates	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs/Ops		Comments
136 Op 29				1	1	14 fr
137 Op 30				1	1	47 fr (80.14E-73.7E/ 42.06N-12.5N)
138 Op 31				1	1	18 fr
139 Op 32				1	1	34 fr
	140-150			11		
151 Op 33				1	1	33 fr
152 Op 34				1	1	24 fr
153 Op 35				1	1	18 fr
	154-167			14		
168 Op 36				1	1	11 fr
169 Op 37				1	2	21 fr
Op 38						23 fr
	170-183			14		
184 Op 34				1	1	24 fr
	185			1		
186 Op 40				1	2	12 fr
Op 41						11 fr
	187-199			13		
200 Op 42				1	1	15 fr
201 Op 43				1	1	13 fr
202 Op 44				1	2	14 fr
Op 45						11 fr
	203-216			14		
217 Op 46				1	1	29 fr
218 Op 47				1	1	24 fr
	219-231			13		
232 Op 48				1	1	13 fr
233 Op 49				1	1	12 fr
	234-246			13		
247 Op 50				1	1	6 fr
248 Op 51				1	1	11 fr
249 Op 52				1	2	13 fr
Op 53						16 fr
250 Op 54				1	1	8 fr
	251-264			14		
265 Op 55				1	1	29 fr
	266-267			2		
268 Op 56				1	1	9 fr
	269-280			12		
281 Op 57				1	2	8 fr
Op 58						7 fr
	282-283			2		
284 Op 59				1	1	25 fr
	285-296			12		
297 Op 60				1	1	12 fr
298 Op 61				1	1	14 fr
299 Op 62				1	1	13 fr
	300-312			13		
313 Op 63				1	1	17 fr

TABLE 2-12

MISSION SUMMARY (CONT.)

Revs Successful Operates		Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs/Ops		Comments
314	Op 64				1	2	13 fr
	Op 65						13 fr
		315			1		
316	Op 66				1	1	7 fr
		317-329			13		
330	Op 67				1	1	10 fr
		331			1		
332	Op 68				1	1	9 fr
		333-346			14		
347	Op 69				1	1	39 fr
		348-361			14		
362	Op 70				1	1	12 fr
		363-378			16		
379	Op 71				1	1	11 fr
380	Op 72				1	1	18 fr
		381			1		
382	Op 73				1	1	13 fr
		383-394			12		
395	Op 74				1	1	13 fr
		396-403			8		
404	Op 75				1	1	7 fr
405	Op 76				1	1	10 fr $\overline{XC}$
		406-412			7		
413	Op 77				1	1	10 fr
		414-426			13		
427	Op 78				1	2	10 fr
	Op 79						15 fr
		428-442			15		
443	Op 80				1	1	23 fr
444	Op 81				1	2	6 fr
	Op 82						21 fr
445	Op 83				1	1	7 fr
		446-460			15		
461	Op 84				1	1	14 fr
		462-478			17		
479	Op 85				1	1	10 fr
		480-494			15		
495	Op 86				1	1	10 fr
		496-507			12		
508	Op 87				1	1	11 fr
509	Op 88				1	1	14 fr
		510-523			14		
524	Op 89				1	1	9 fr
		525-541			17		
542	Op 90				1	1	14 fr
		543-588			46		
589	Op 91				1	1	14 fr
		590-620			31		
621	Op 92				1	1	6 fr
622	Op 93				1	1	6 fr
		623-631			9		

TABLE 2-12

MISSION SUMMARY (CONT.)

Revs Successful Operates	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Total Ops	Comments
632 Op 94				1	1	11 fr $\overline{XC}$
	633-637			5		
638 Op 95				1	1	15 fr
639 Op 96				1	1	9 fr
640 Op 97				1	1	7 fr
	641-654			14		
655 Op 98				1	1	7 fr
656 Op 99				1	1	10 fr
	657-669			13		
670 Op 100				1	1	10 fr
	671			1		
672 Op 101				1	1	7 fr
	673-686			14		
687 Op 102				1	1	14 fr
	688-689			2		
690 Op 103				1	1	25 fr
	691-700			10		
701 Op 104				1	1	7 fr
702 Op 105				1	1	8 fr
703 Op 106				1	1	25 fr
704 Op 107				1	2	12 fr
Op 108						15 fr
	705-718			14		
719 Op 109				1	1	36 fr
Op 110					2	7 fr
720 Op 111				1		24 fr
	721			1		
722 Op 112				1	1	8 fr
	723-734			12		
735 Op 113				1	1	26 fr
736 Op 114				1	2	9 fr
Op 115						12 fr
	737			1		
738 Op 116				1	1	7 fr
	739-750			12		
751 Op 117				1	1	14 fr
752 Op 118				1	2	9 fr
Op 119						13 fr
753 Op 120				1	1	4 fr
754 Op 121				1	2	7 fr
Op 122						8 fr
755 Op 123				1	1	8 fr
	756-767			12		
768 Op 124				1	1	9 fr
	769					
770 Op 125				1	1	19 fr
	771-799			29		
800 Op 126				1	1	7 fr
801 Op 127				1	1	15 fr
	802-816			15		

TABLE 2-12

MISSION SUMMARY (CONT.)

Revs Successful Operates	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Total Ops	Comments
817 Op 128				1	1	14 fr
	818-821			4		
822 Op 129				1	1	6 fr
	823-831			9		
832 Op 130				1	1	7 fr
833 Op 131				1	1	12 fr
	834			1		
835 Op 132				1	1	7 fr
	836-837			2		
838 Op 133				1	1	6 fr
	839-846			8		
847 Op 134				1	1	8 fr
	848			1		
849 Op 135				1	1	13 fr
850 Op 136				1	1	9 fr
	851-852			2		
853 Op 137				1	1	8 fr
	854-864			11		
865 Op 138				1	1	13 fr
866 Op 139				1	1	7 fr
	867-868			2		
869 Op 140				1	2	17 fr
Op 141						8 fr
	870-899			20		
900 Op 142				1	1	3 fr
901 Op 143				1	1	7 fr
	902-912			11		
913 Op 144				1	2	9 fr
Op 145						6 fr
	914-917			4		
918 Op 146				1	1	16 fr
	919-931			13		
932 Op 147				1	1	6 fr } 3414
933 Op 148				1	1	5 fr } 3414
934 Op 149				1	1	7 fr } 3414

935-936 CAL OP 150-151 7 fr and 12 fr
Rev 938 COMET—4 frames

TABLE 2-13

SOLO OPERATIONS SUMMARY

Rev	Mode	Cycles	Comments
989 and 1054	Backup	3	Three 1-frame operates, terrain transport operational.
1638 and 1662	—	0	Command terrain thermal shutter "emergency open." Thermal door did not respond.
1638	—	0	Command stellar safety shutters "closed."
1660	Calibrate	7	Programmed three separate operates in calibrate mode to evaluate early shutdown characteristics.
1660	—	—	Transferred to redundant electronics.
1687	Normal	88	Checked rotary shutter phase lock when changing exposure during operation.
1701	Normal	1	Used "pulsing" method in an attempt to open terrain thermal door with "emergency open" sequence.
1703 and 1704	Normal	1025	Continuous operation for 2 revs (11,000 sec) at 2.5-msec exposure. No anomalies observed.

SECTION III

PROCESSING AND REPRODUCTION

3.1 INTRODUCTION

This section, prepared by the Processing Facility, discusses defilming, processing, titling, and reproduction of the mission 1207 Stellar Terrain System original films.

3.2 RECEIVING AND DEFILMING

The RV arrived at the processing site in good condition at 1500 hours GMT, 8 January 1974. The cut/seal mechanism was closed and the temperature tabs located on the lip of the RV were intact and appeared normal. A high probability existed that the extreme tag ends of both the terrain and stellar records would be securely entrapped in the cutter assembly. However, the film was found to be free of the cutter assembly and clean serrated cuts on both records were noted.

Approximately 15 feet of the terrain record was over the spool flange. The antibackup solenoid was not operating on the terrain takeup.

The stellar record was approximately 1/8 inch below the top of the spool flange. No static discharges were noted during the despooling operation. The total weight of both records was 67 pounds.

3.3 PROCESSING AND OPTICAL TITLING

3.3.1 Processing

All camera records were processed on 8 and 9 January 1974. The stellar record was cut after processing 252 feet because the op marks could not be detected at the infrared viewing station. The cut was made in Frame 6, of Op 17. Plus density lines and creases associated with the cut/handling operation were noted on the film 3.5 feet from where the cut was made. These marks caused the loss of two pairs of stellar frames. The emulsion side of the stellar film has a drying pattern "beauty defect" which is characteristic of some batches of 3401. The terrain record was processed without incident. Processing data are presented in Tables 3-1 and 3-2 with corresponding curves in Figures 3-1 through 3-4.

3.3.2 Optical Titling of Operational Film

The stellar record was not optically titled because the density of the exposed frame and op marks was too light to produce a detectable signal. The terrain record was not optically titled due to a problem in the optical titling software. Post-mission simulations have recreated the problem and the software is being modified appropriately.

TABLE 3-1

PROCESSOR AND DEVELOPER DATA

Camera	Film Segment	Processor	Developer
Stellar	3401	Yardleigh 5	17DN
Terrain	3400	Yardleigh 5	20DN
	3414	Yardleigh 6	19DN
	3401	Versamat	MX-689

TABLE 3-2

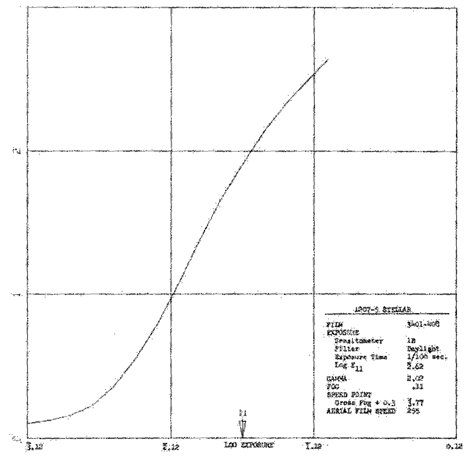
FRAME AND FOOTAGE DATA

	Stellar Camera	Terrain Camera
Operational frames	2,069 (pairs)	2,069
3414		18
3401		11
Footage		
Pre-flight	15 ft*	30 ft*
Operational ftg.	1,886 ft	3,320 ft
3414		30 ft
3401		18 ft

*LDR and prelaunch test film are removed prior to processing.

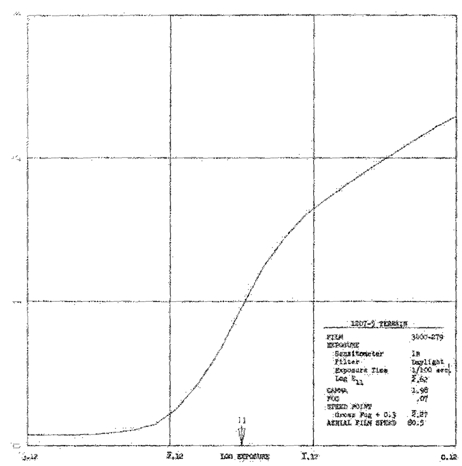
PROCESSING CURVE, STELLAR, 3401 FILM

FIGURE 3-1



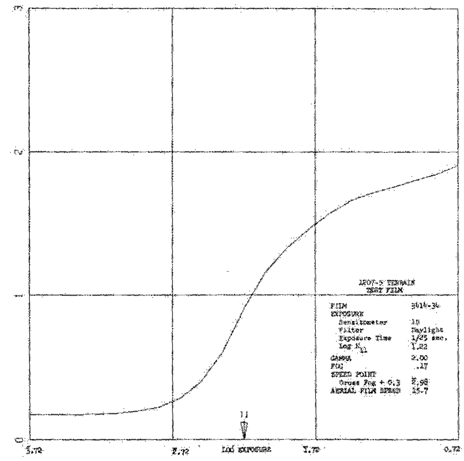
PROCESSING CURVE, TERRAIN, 3400 FILM

FIGURE 3-2



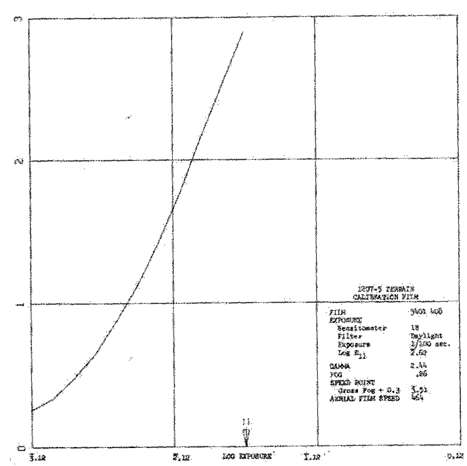
PROCESSING CURVE, TERRAIN, 3414 TAG-ON

FIGURE 3-3



PROCESSING CURVE, TERRAIN CALIBRATION, 3401 FILM

FIGURE 3-4



3.4 SENSITOMETRY

Sensitometric exposures are used to establish and maintain process control. In the case of the original films, flight roll film samples or other film samples of the same emulsion batch are evaluated prior to mission arrival so that process conditions can be adjusted, if necessary, to obtain the optimum sensitometry for the particular batch of flight film involved. The flight records are then processed under these adjusted conditions with additional flight roll sensitometric strips attached. Sensitometric curves from these strips are shown in Figures 3-1 through 3-4 and are most representative of the sensitometry of the flight film.

3.5 REPRODUCTION

3.5.1 Breakdown

After processing, the original negatives were "broken down" into lengths not exceeding 325 feet on the terrain and 240 feet on the stellar. The ops were left in sequential order, with corresponding parts of the two records containing the same ops.

3.5.2 Printing

All duplicate copies were printed on the Kingston printer. Duplicate positives of the terrain 3400 and 3401 films were prepared using Kodak Aerial Duplicating Film (Estar base) SO-284 and those for the 3414 film were prepared using Kodak High Resolution Aerial Duplicating Film (Estar base) SO-192. Duplicate positives of the stellar record were prepared using Kodak Aerographic Duplicating Film (Estar base) 2420. All duplicate negatives were prepared using Kodak Direct Duplicating Aerial Film (Estar base) 2422. Viscous Dalton processors were utilized for all duplicate processing. The system reproduction curves for these applications are shown in Figures 3-5 through 3-8.

3.6 TERRAIN CAMERA EXPOSURE ANALYSIS

Exposure analysis of density measurements of urban scenes with vegetation surround indicates correct exposure was attained on 3400 film. No exposure changes are recommended for subsequent missions. Limited analysis using density measurement and subjective judgment indicated the 3414 to be correctly exposed.

3.6.1 Basic Exposure Recommendation

The 1207 terrain camera exposure recommendation, based on 3400 film exposed through a W-21 equivalent filter, is a three-step function of solar altitude (see Figure 3-9). In actual operation, the effective exposure time may vary from the nominal due to a V/h change.

The KSCOPE computer program generated recommendation for the terrain camera is the same as that for 1206 and includes several exposure biases explained in the 1206 PFA report. The recommendations for this mission are depicted graphically in Figure 3-9 and in Table 3-3.

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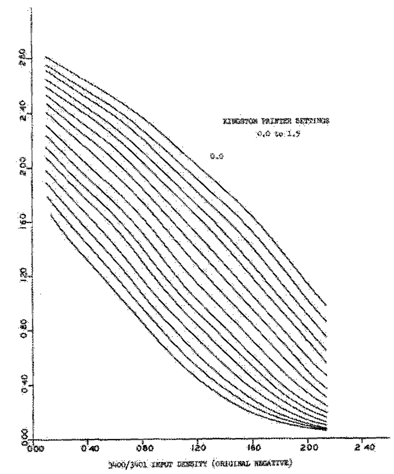
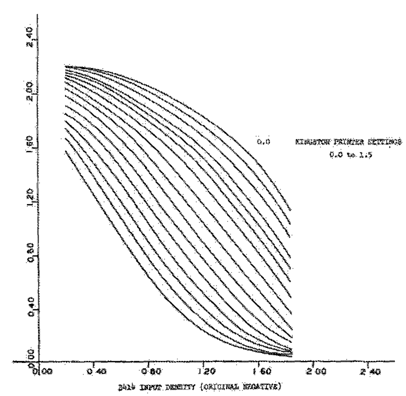


REPRODUCTION CURVES, KINGSTON PRINTER,
SO-284 FILM

FIGURE 3-5



REPRODUCTION CURVES, KINGSTON PRINTER,
SO-192 FILM

FIGURE 3-6

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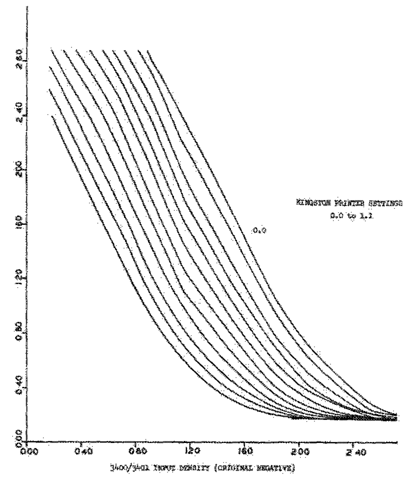
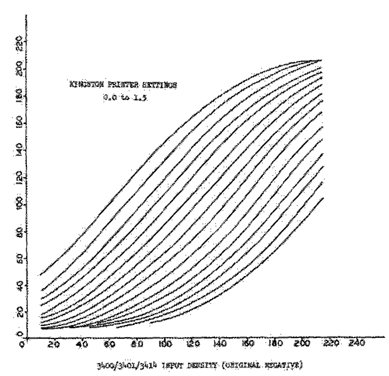
REPRODUCTION CURVES, KINGSTON PRINTER, 2420 FILM

FIGURE 3-7



REPRODUCTION CURVES, KINGSTON PRINTER, 2422 FILM

FIGURE 3-8



TERRAIN CAMERA EXPOSURE RECOMMENDATION

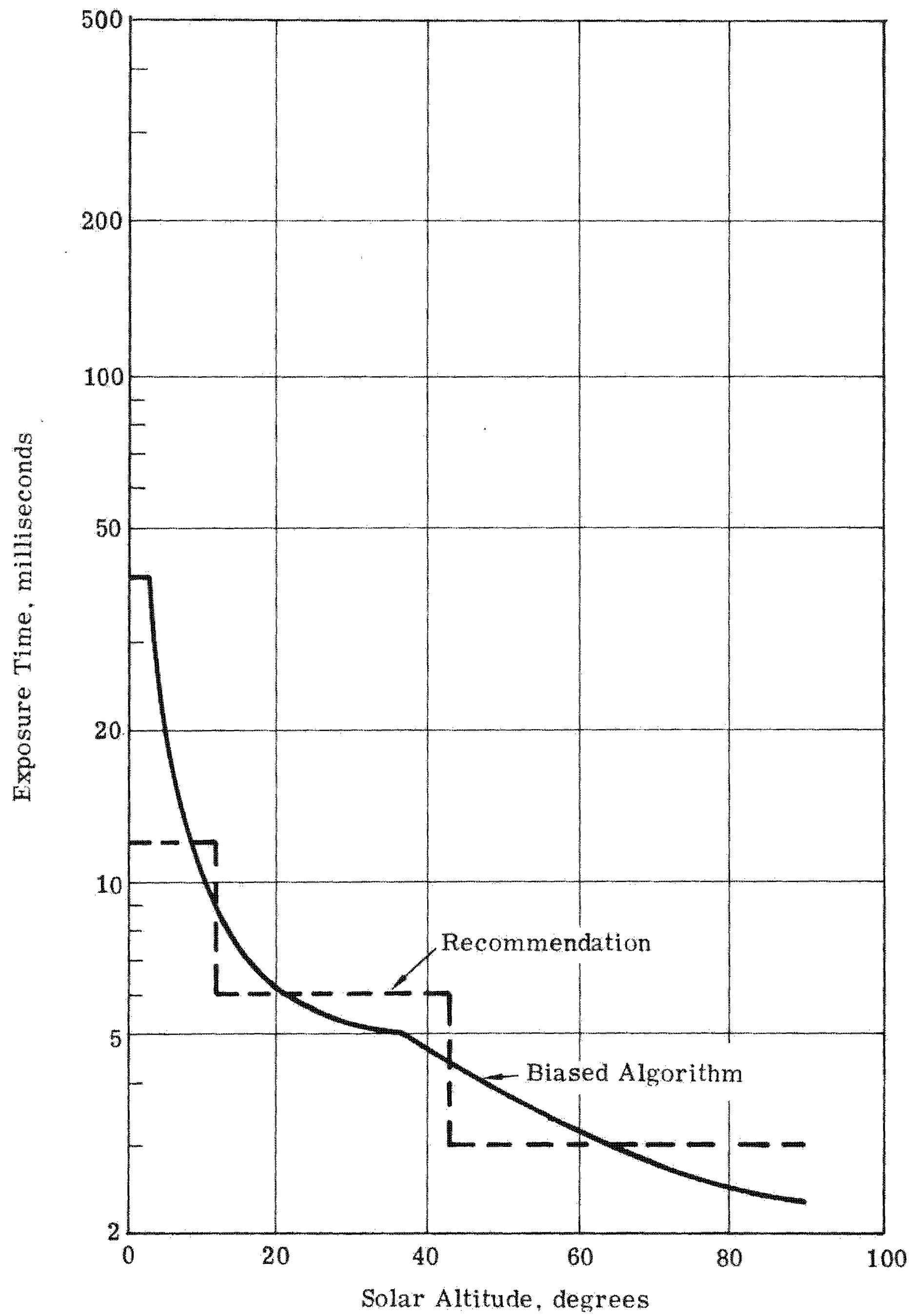


FIGURE 3-9

TABLE 3-3

EXPOSURE RECOMMENDATIONS

Solar Altitude, degrees	Exposure Time for 3400 Film, milliseconds
0 to 14	12
15 to 45	6
Greater than 45	3

3.6.2 Method of Analysis

Frame Selection for Microdensitometry

Terrain camera 3400 imagery of four vegetation surround areas were selected for microdensitometer measurement and subsequent analysis. Only one frame of 3414 imagery was selected for microdensitometer measurement and analysis. Raster scanning of all imagery selected was performed on the GAF-650, with a 23-micrometer aperture. Calibration of the microdensitometer was achieved with the macrocharacteristic curve exposed on the 1B sensitometer using the terrain camera record of the mission. Program HISTO was then used to analyze the scan data in terms of parameters meaningful to exposure analysis.

Density Profiles

Density profiles of each of the scanned urban scenes were generated which highlight important density statistics of each scene. The important density statistics from measured density distribution of each acquisition are presented as a vertical line whose extremes represent the 95 percent and 5 percent cumulative points of the distribution. (Refer to Figure 3-10.) The dot represents the mean density of the scene. To the right is the appropriate film process curve to relate measured density to relative log exposure.

Log E Analysis

The exposure of each terrain camera acquisition was rated on its log E deviation (total delta log E) from the aim criteria of 1.0 mean scene density. The "total delta log E" can be considered to have been caused by two factors. The first is deviation from recommended exposure time called "camera delta log E." The camera delta log E was the exposure time deviation from that of the KSCOPE generated exposure recommendation curve.

The second factor in the total delta log E is the possible error in the exposure algorithm itself. This error is called "algorithm delta log E" and is the arithmetic difference between total delta log E and camera delta log E. The algorithm delta log E was computed for each acquisition, a positive value signifying overexposure and a negative value indicating underexposure. The algorithm delta log E is the indicator of the correctness of the exposure recommendation.

3.6.3 Exposure Evaluation

As Table 3-4 indicates, a residual overexposure was observed for vegetation surround scenes on the 3400 film. This one-third stop error is not significant considering the large exposure increments of the terrain camera and the small sample size from which the error was estimated. Since analysis of 1206 had indicated no exposure recommendation error when using the same three-step function as used for 1207, no changes are appropriate at this time.

The profiles shown in Figure 3-10 are the raw density profiles obtained from microdensitometry of the four frames listed in Table 3-4. The departure of the scene means (indicated by the circles) from 1.0 density corresponds to the total delta log E column of Table 3-4.

A subjective appraisal of the 3414 film exposure was made and indicated that adequate exposure was achieved. One frame was scanned, Op 148 Frame 004, to confirm the subjective evaluation.

TABLE 3-4

LOG EXPOSURE ERRORS OF VEGETATION SURROUND SCENES

Op/Frame	Total Delta Log E	Camera Delta Log E	Algorithm Delta Log E
014/023	0.14	0.00	0.14
024/008	0.24	0.08	0.16
030/026	0.27	0.14	0.13
030/027	0.20	0.14	0.06
	Average exposure algorithm error =		0.13

TERRAIN CAMERA DENSITY PROFILE (3400 FILM)

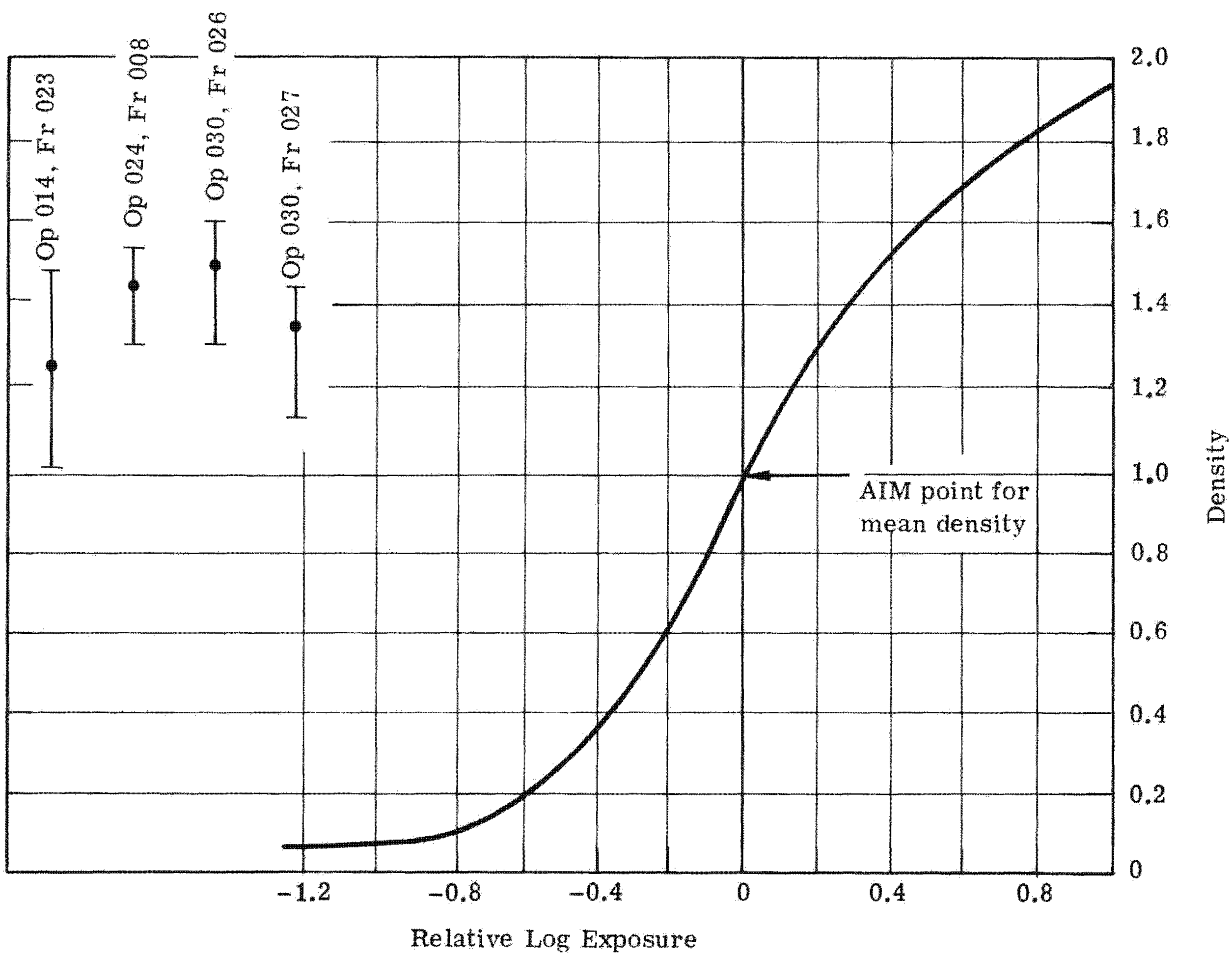


FIGURE 3-10

SECTION IV

DMA EVALUATION

4.1 INTRODUCTION

This section details the technical analysis of the mission 1207 material by the DMA Post Flight Analysis Team.

Comparison of the photography with the system specifications indicates that the system provided the necessary data and that all critical performance requirements were met.

Data collection began with the tabulation of fiducial positions obtained during preflight calibration. During the orbital phase, mission performance report (MPR) data were accumulated and added to the post flight analysis (PFA) data file in preparation for the film analysis at the Processing Facility.

During analysis of the mission photography, numerous instrument measurements and various metric evaluations were made. The results of the system specification check are provided in the form of discussions, tables of metric results, and illustrations (figures, photographs, and graphs). Also presented as deemed appropriate under the various subheadings are data on specifications, data acquisition procedures and evaluation results, discussions of anomalies, and conclusions.

4.2 MENSURATION

4.2.1 Film Deformation

Specification

For the film deformation evaluation, 30 terrain frames and 60 stellar frames (coincident to the above terrain frames) are required. The frames are selected by a random number correlation to the mission material with seven frames chosen from each quarter and one frame from both the first and last usable operates. The deformation rejection criterion for a six-parameter, least-squares fit of the terrain reseau measurements to the calibrated reseau system is a 12.9-micrometer standard deviation. As a result of the mission 1205 analysis, a tolerance of 6.0-micrometer standard deviation is used as a rejection guide for the stellar frames.

Procedure

Telemetry information indicated a possible malfunctioning of the platen press mechanism for the terrain camera. Nine of the 30 selected frames had telemetry data indicating no platen press during exposure (terrain frame deformation anomalies).

In addition to the 30 frames, two frames were selected to include the 3414 film and 3401 calibration mode film.

The following steps outline the film deformation evaluation.

1. Frame selection
2. Mensuration
3. Six-parameter transformation
4. Computer run analysis
5. Plotting of residual vectors
6. Data results analysis
7. Anomaly study (if appropriate)
8. Data tabulation and reporting.

Evaluation Results

Terrain Frames

All terrain frame mensuration was performed on duplicate positives. Each frame was read at one sitting by one reader, performing one reading per intersection with no frame rotation. All terrain frames fell within the specified tolerance of 12.9 micrometers. The data acquired from these measurements are presented in Tables 4-1 and 4-3 and a typical plot is shown in Figure 4-1. The results for the evaluation are shown in Table 4-1.

Stellar Frames

Stellar frame mensuration followed the same procedures as used for the terrain frames. Table 4-2 lists the results for the stellar evaluation and a typical plot is shown in Figure 4-2.

Terrain Frame Deformation Anomalies

Nine of the selected deformation frames (Table 4-3) were correlated directly to telemetry information that indicated a possible no press condition for the platen press mechanism. All of the frames that were evaluated for deformation indicate that the platen press functioned as required.

Stellar Frame Anomalies

Underexposed operate/frame marks prevented the normal optical titling of the entire stellar record (Figure 4-16). Consequently, pen and ink titling corrections were made to the first frame of each operate and every fifth frame within an operate.

A "pinhole" size opening occurred in the stellar film chute (ref 2.2.8.2). As a result of this anomaly, 479 frames (11 percent of the operational frames) were affected. Of the 479 individual port and starboard frames, 260 were considered totally unusable including 101 simultaneously exposed pairs (Table 4-4). Consequently, stellar derived terrain attitudes cannot be directly determined for 101 terrain frames but must be obtained either by the use of well distributed quality ground control points or some other means.

TABLE 4-1

TERRAIN FILM DEFORMATION

	Standard Deviation, micrometers
Tolerance	12.9
Averages of 30 terrain frames, Mission 1207-5(DPs)*	7.1
Averages of 30 terrain frames, Mission 1206-5(DPs)	7.9
Averages of 30 terrain frames, Mission 1205-5(DPs)	8.3

*DP = duplicate positive

TABLE 4-2

STELLAR FILM DEFORMATION

	Standard Deviation, micrometers
Tolerance	6.0
Averages of 30 port (-y) frames, Mission 1207-5(DPs)	4.0
Averages of 30 starboard (+y) frames, Mission 1207-5(DPs)	4.2
Average of 30 port (-y) frames, Mission 1206-5(DPs)	3.4
Average of 30 port (-y) frames, Mission 1205-5(DPs)	4.7
Average of 30 starboard (+y) frames, Mission 1206-5(DPs)	4.2
Average of 30 starboard (+y) frames, Mission 1205-5(DPs)	4.6

TABLE 4-3

FILM DEFORMATION STATISTICS

Rev	Op	Frame	Standard Deviations (micrometers)		
			Terrain	Port (-y)	Starboard (+y)
7	1	1	11.070	5.711	3.728
75	11	19	4.436	4.376	4.816
87	12	15	5.188	4.470	5.320
88	13	5	5.629	4.041	5.468
106	19	2	6.555	4.553	4.979
121	25	22	5.426	3.700	NR*
135	28	29	8.330	3.462	3.138
136	29	13	3.974	3.414	2.844
169	37	11	5.753	4.314	4.160
169	38	12	5.744	3.730	3.536
169	39	7	8.203	NR	NR
186	40	11	8.339	4.388	5.413
218	47	5		4.348	3.098
218	47	12	6.632	3.678	5.018
233	49	4	7.224	3.551	4.754
265	55	12		4.285	3.305
314	65	2	4.711	3.064	3.665
330	67	7	7.967	3.498	4.906
330	68	5	6.684	5.422	5.092
380	72	16	8.204	3.461	5.593
427	78	1	10.520	3.379	3.768
479	85	1	7.648	NR	NR
479	85	10	NR	3.961	5.199
622†	93	2	9.534	4.090	3.543
701†	104	7	8.863	4.099	5.394
719†	109	9	3.485	NR	NR
719†	109	19	NR	3.548	NR
736†	115	4		4.302	4.775
768†	124	6	6.494	4.308	3.988
817†	128	9	7.138	5.759	2.984
849†	135	9	6.846	NR	2.887
865†	138	9	6.367	2.705	2.816
918†	146	16	11.080	2.532	4.832
933	148	2	6.178	3.360	2.828
936	150	7	7.524		4.282

*Not read
†No platen press telemetry signal—terrain camera

TERRAIN FILM DEFORMATION PLOT, OPERATE 012, FRAME 015

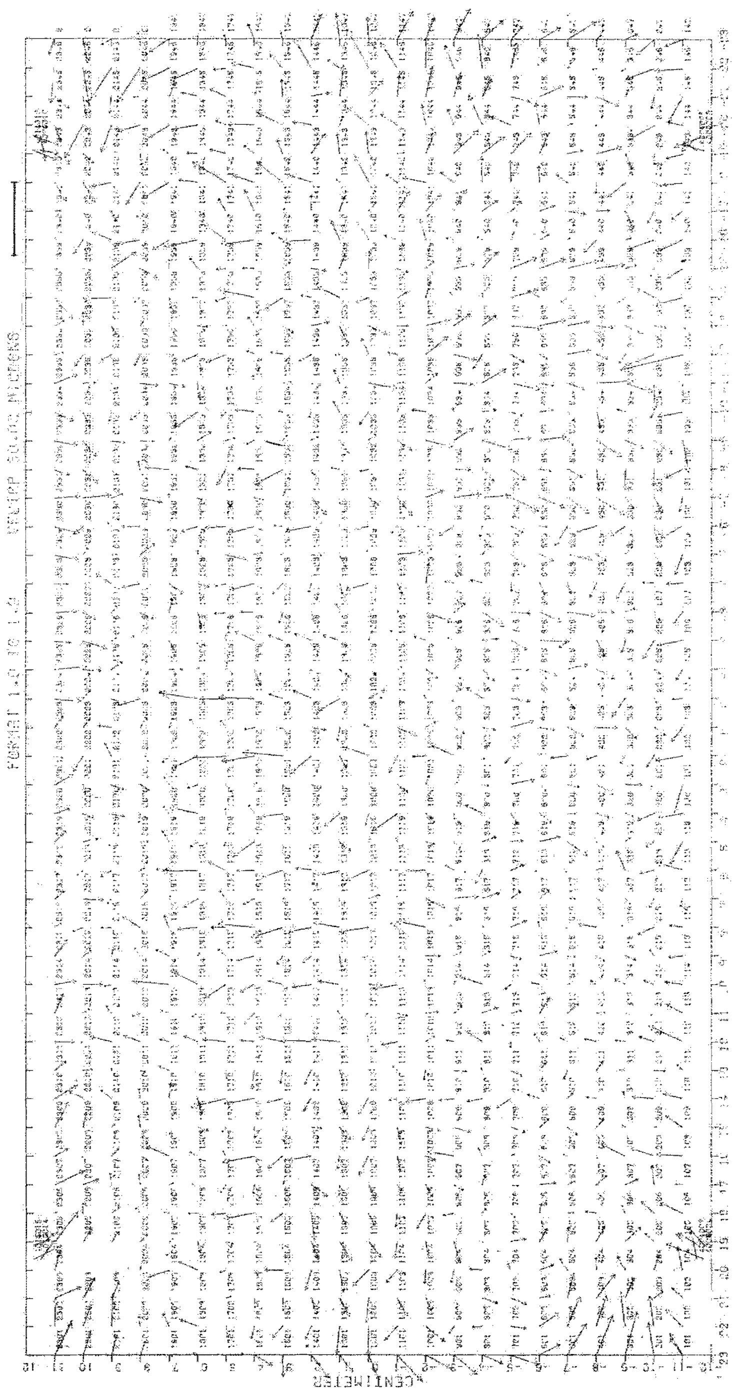


FIGURE 4-1

~~TOP SECRET-HEXAGON~~

STELLAR FILM DEFORMATION PLOT, OPERATE 019, FRAME 002P

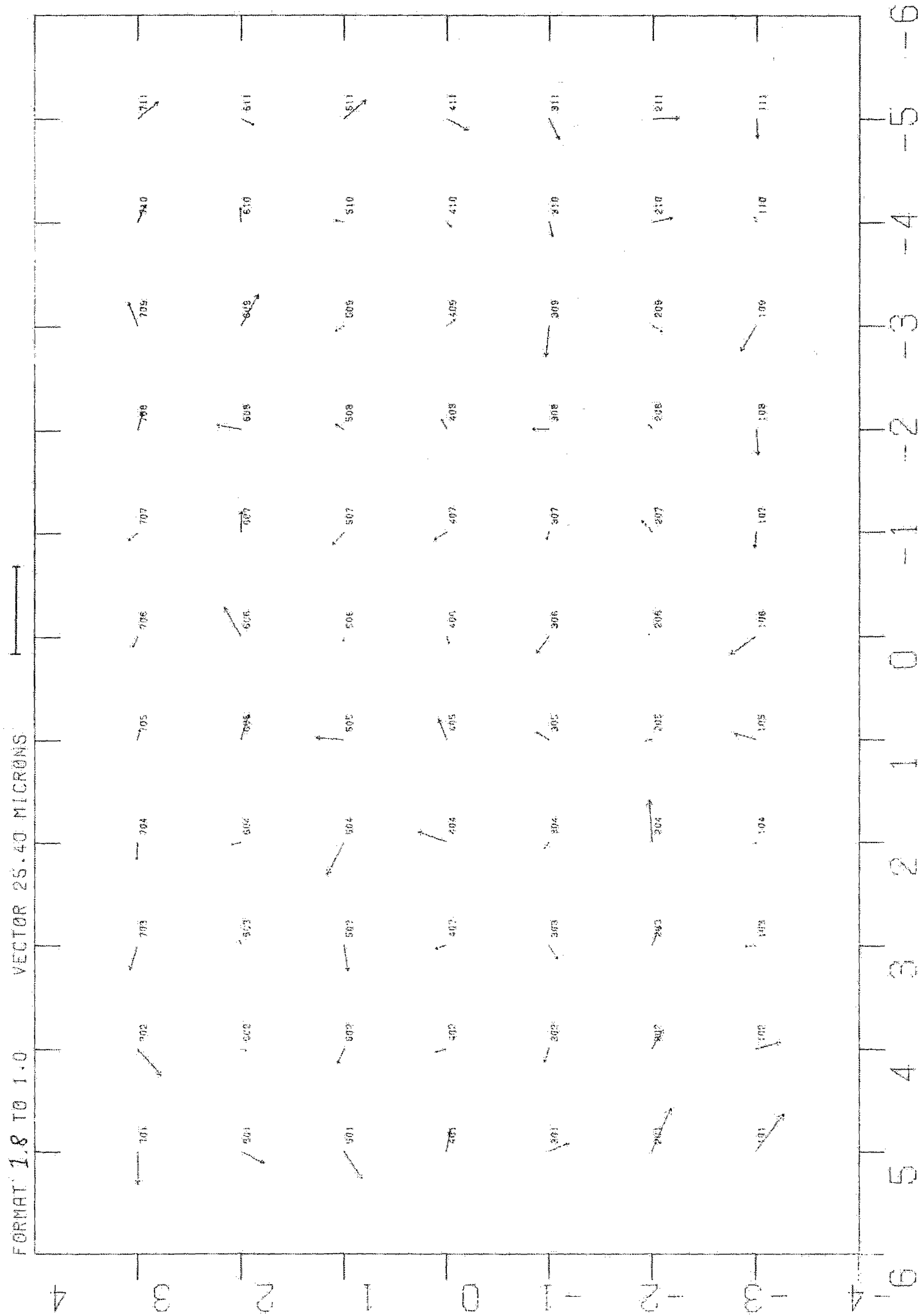


FIGURE 4-2

~~TOP SECRET-HEXAGON~~

BIF-059W-5048-74

Handle via Byeman
Controls Only

TABLE 4-4

LOCATION OF REJECTED STELLAR FRAME PAIRS
(LIGHT LEAK ANOMALY)

OP	FRM PAIR*	OP	FRM PAIR	OP	FRM PAIR
1	2	51	2	96	7
2	9,18	53	7,15	99	1
4	11	55	20,29	100	1,18
5	2	57	6	102	5
7	3	59	16	103	16
8	2	60	3	104	6
10	8	61	5	108	6
11	16	62	4	109	34
17	4	63	8	111	23
18	2	65	4,11	113	17
19	35	67	1,10	115	10
20	28	69	30	117	5
21	6	70	3	121	6
22	6	71	2	122	7
24	4	73	4	123	8
25	14	74	4	125	10
31	9	75	1	127	6
32	25	77	1	128	5,11
34	15	79	6	131	3,10
35	9	82	12,19	132	4
38	14	84	5,15	133	5
39	15	86	1	135	13
41	2	87	2	136	8
43	4	88	5,14	138	4,11
45	2	90	5	140	16
46	20	91	5	142	1
47	15	92	3	144	6
48	4	94	2	147	2
49	3,9	95	6,15	148	3

*Simultaneously exposed port (-y) and starboard (+y) frames.

The 3401 stellar film was found to be of less quality than noted on previous missions. Although some degradation exists on the duplicate positives obtained, the film is still considered usable. Current evidence indicates this condition is a characteristic of the particular batch of 3401 film.

Additional stellar film anomalies that occurred on this mission are:

a. 6 frames creased during processing or despooling
b. Corona spots along Op/Frm Mark film edge
c. Direct or reflected lunar light
d. Foreign particles in platen press area

4.2.2 Fiducial Stability Evaluation

Specifications

Due to the importance of the fiducial system to data reduction, this evaluation has been added as an addition to the original requirement to determine the "yardstick" distances between the four terrain frame fiducials. The fiducial "calibration" approach verifies the stability of the fiducial system and provides transformed values to satisfy the measurement requirement. Specifications for the distance measurements between fiducials are as follows:

X axis	386.600 to 388.100 mm
Y axis	232.000 to 233.200 mm

Fiducials are routinely read on each terrain frame used for the film deformation study.

Procedure

The following steps outline the fiducial stability evaluation procedure:

1. Frame selection
2. Mensuration (three readings per intersection-fiducial)
3. Mensuration (180-degree rotation)
4. Six-parameter transformations
5. Data analysis
6. Average transformed values (0- to 180-degree rotation)
7. Select "best" transformed frame
8. Three-parameter transformation (remaining frames into "best" frame)
9. Mean resulting fiducial sets
10. Correct four fiducials to zero x/zero y center
11. Three-parameter transformation (in-flight into pre-flight fiducial values)
12. Comparison analysis
13. Anomaly study (if appropriate)
14. Data tabulation and reporting.

Evaluation Results

All measured values were found to be within the tolerance criteria. A comparison of the fiducial spacing for particular frames is displayed in Table 4-5. The same procedures used for the pre-flight fiducial calibration were followed to generate an in-flight set of "calibrated" fiducials. The two sets were then compared to verify the stability of the fiducial system. The tabulated results are displayed on the appropriate statistics data sheets (Tables 4-6 and 4-7).

Conclusions

It is concluded from the data results, that the fiducial system remained stable throughout the mission. The total standard deviation value of 0.0011 for the three-parameter fit of the in-flight calibrated fiducial set to the pre-flight calibrated fiducial set is a reasonably good indication of the fiducial systems stability.

As with previous missions, fiducials are difficult to read in areas of high reflectance such as sand and snow. The fiducial image blends in with the background imagery and pointing precision is greatly reduced or totally lost. Corrective action taken by the camera contractor will be effective on 1209 and subsequent missions.

4.2.3 Macrodensitometry

Specifications

The requirements for macrodensitometry are two minimum density and two maximum density readings for two terrain frames. The frames are to be located near each end of the mission. Also, two stellar sets are to be sampled. All densitometry is to be performed on original negative material.

Procedure

All readings were performed on a Macbeth Model TD 404 macrodensitometer.

Evaluation Results

Nine frames in addition to the required sampling were evaluated for format areas of typical maximum and minimum densities (Table 4-8).

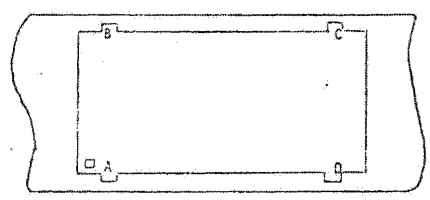
Calibration mode frames were also measured with the results illustrated in Table 4-9. Minor corona marking across the format was noted on the C-mode material.

The stellar frames were evaluated as required including several frames apparently fogged by radiation. A pattern similar to that noted on mission 1205 is visable on groups of frames (Table 4-10). However, density levels were minimal and no frames were rejected due to radiation fogging.

TABLE 4-5

FIDUCIAL DISTANCES

		X	Y				
OP 031 FR 021	A	193.440	-116.899	|A(Y) - B(Y)|	232.439	232.464	Width
	B	193.423	116.839	|C(Y) - D(Y)|	232.489		
	C	-193.882	115.977	|B(X) - C(X)|	387.311	387.382	Length
	D	-194.014	-116.512	|A(X) - D(X)|	387.454		
OP 029 FR 25	A	193.372	-116.621	|A(Y) - B(Y)|	232.459	232.478	Width
	B	193.338	115.848	|C(Y) - D(Y)|	232.486		
	C	-193.989	115.967	|B(X) - C(X)|	387.327	387.383	Length
	D	-194.057	-116.519	|A(X) - D(X)|	387.439		
OP 047 FR 12	A	193.404	-116.619	|A(Y) - B(Y)|	232.471	232.476	Width
	B	193.414	115.952	|C(Y) - D(Y)|	232.480		
	C	-193.909	115.959	|B(X) - C(X)|	387.323	387.370	Length
	D	-194.012	-116.521	|A(X) - D(X)|	387.416		
OP 003 FR 01	A	193.435	-116.621	|A(Y) - B(Y)|	232.473	232.481	Width
	B	193.445	115.852	|C(Y) - D(Y)|	232.479		
	C	-193.831	115.962	|B(X) - C(X)|	387.226	387.379	Length
	D	-193.993	-116.527	|A(X) - D(X)|	387.432		
OP 085 FR 01	A	193.383	-116.613	|A(Y) - B(Y)|	232.452	232.464	Width
	B	193.415	115.839	|C(Y) - D(Y)|	232.475		
	C	-193.902	115.955	|B(X) - C(X)|	387.317	387.367	Length
	D	-194.034	-116.520	|A(X) - D(X)|	387.417		
OP 124 FR 06	A	193.417	-116.621	|A(Y) - B(Y)|	232.451	232.466	Width
	B	193.463	115.830	|C(Y) - D(Y)|	232.480		
	C	-193.893	115.949	|B(X) - C(X)|	387.361	387.378	Length
	D	-193.978	-116.531	|A(X) - D(X)|	387.395		
OP 104 FR 07	A	193.364	-116.606	|A(Y) - B(Y)|	232.451	232.462	Width
	B	193.400	115.845	|C(Y) - D(Y)|	232.472		
	C	-193.931	115.950	|B(X) - C(X)|	387.331	387.360	Length
	D	-194.024	-116.522	|A(X) - D(X)|	387.388		
OP 146 FR 16	A	193.436	-116.615	|A(Y) - B(Y)|	232.451	232.448	Width
	B	193.420	115.846	|C(Y) - D(Y)|	232.436		
	C	-193.897	115.934	|B(X) - C(X)|	387.317	387.379	Length
	D	-194.065	-116.502	|A(X) - D(X)|	387.441		



Specifications: Width 233.200 - 232.000mm Length 388.100 - 386.600mm

TABLE 4-6

IN-FLIGHT TO PRE-FLIGHT FIDUCIAL TRANSFORMATION

	X	Y
5001	193.6706	-116.2798
5002	193.7076	116.1775
5003	-193.6448	116.2903
5004	-193.7332	-116.1881

Total Standard Deviation in X = 0.0015

Total Standard Deviation in Y = 0.0006

Standard Deviation of Total Fit = 0.0011

TABLE 4-7

TERRAIN FIDUCIAL STABILITY EVALUATION

Preflight

TOTAL STD DEV 0.0012
X STD DEV 0.0014
Y STD DEV 0.0009

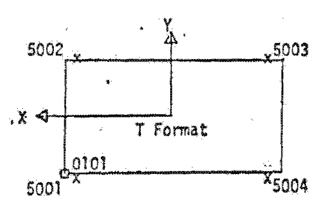
FRAME ID OP	FRAME ID NO	STD DEV
PREFLIGHT	1	0.0019
	2	0.0010
	9	0.0011
	10	0.0008
	20	0.0011
	21	0.0017
	25	0.0012
	27	0.0027
	31	0.0020
	32	0.0021

Inflight

TOTAL STD DEV 0.0026
X STD DEV 0.0028
Y STD DEV 0.0024

FRAME ID OP	FRAME ID NO	STD DEV
12	15	0.0010
37	11	0.0027
55	12	0.0084
67	7	0.0028
72	16	0.0021
124	6	0.0038
135	9	0.0045

Fiducial Locations



(All values in millimeters.)

	5001	5002	5003	5004
X Pre-	193.6724	193.7074	-193.6456	-193.7340
X Inflight	193.6688	193.7080	-193.6440	-193.7326
Delta Xs	0.0036	-0.0006	0.0006	0.0014

	5001	5002	5003	5004
Y Pre-	-116.2798	116.1769	116.2908	-116.1879
Y Inflight	-116.2797	116.1782	116.2898	-116.1883
Delta Ys	0.0001	-0.0013	0.0010	-0.0004

TABLE 4-8

FORMAT DENSITY STATISTICS, TERRAIN FRAMES

Op	Frame	Maximum Density	Minimum Density	Base + Fog
1	1	1.43* 1.35	.75 1.03	0.13
50	1	1.27 1.28	.59 .67	0.13
52	1	.97 1.09	.65 .56	0.13
55	4	1.58 1.53	.91 1.03	0.13
55	5	1.31 1.29	.52 .58	0.13
76	8	1.48 1.37	.70 .50	0.14
107	7	1.48 1.49	.61 .39	0.14
107	8	1.53 1.49	.54 .51	0.14
146	16	1.55 1.52	.61 .64	0.12
147	4	1.16 1.13	.50 .52	0.18†
147	5	1.15 1.17	.59 .66	0.18†

*Transmission Density Units

† 3414 Film

TABLE 4-9

FORMAT DENSITY STATISTICS, CALIBRATION MODE TERRAIN FRAMES

Op	Frame	Format edge			Center		Format edge		Base + Fog
150	6	1.47*	1.87	2.07	2.14	1.97	1.71	1.46	.73
151	3	1.42	1.86	2.08	2.14	2.10	1.73	1.42	.71

*Transmission Density Units

TABLE 4-10

FORMAT DENSITY STATISTICS, STELLAR FRAMES

Op	Frame	Format Corner				Center			Format Corner		Base + Fog
1	1(-y)P	.47†	.65	.74	.77	.79	.78	.76	.68	.52	.27
	1(+y)S	.57	.69	.83	.90	.93	.92	.88	.87	.29	
146	16(-y)P	.56	.71	.83	.88	.90	.88	.83	.75	.55	.27
	16(+y)S	.67	.78	.88	.94	.96	.93	.88	.80	.62	
107	10(-y)P		.71			.90			.71		.26
	10(+y)S		.76			.92			.69		
108*	11(-y)P		.83			1.02			.89		.49
	11(+y)S		.90			.93			.73		
	13(-y)P		.76			.96			.80		.41
	13(+y)S		.76			.97			.69		
109*	3(-y)P		.72			.98			.78		.41
	3(+y)S		.84			.95			.74		
	5(-y)P		.90			1.07			.89		.48
	5(+y)S		.90			1.01			.83		
122*	8(-y)P		.82			1.01			.89		.47
	8(+y)S		.93			.97			.78		
124*	5(-y)P		.89			1.07			.92		.51
	5(+y)S		.93			1.03			.84		

*Transmission Density Units
†Radiation fogging - Note Base + Fog Value

4.2.4 Microdensitometry

4.2.4.1 Reseau Intersections

Specifications

To satisfy PFA requirements, four intersections per frame on two frame sets (terrain, port, starboard), selected from the first and last operates of the total mission, are to be scanned on the microdensitometer. The reseau intersection, illustrated in Figure 4-3, displays dimensions for the intersection found on the camera reseau plate. In previous reports, this figure erroneously presented values expected on the film material. No specifications are available for the dimensions determined from microdensitometric readings on the film. Figure 4-3 remains for reference with the dimension values being reported only for relative mission-to-mission comparisons or as an anomaly diagnostic device.

Procedure

Microdensitometry was performed on original negative material. All data measurements are made on a GAF microdensitometer with chart recorder and analyzed in the following manner:

1. Background density is obtained from the graph.
2. Depth of curve is determined from the background line.
3. One-third of the depth value is measured from the background line into the curve throat.
4. A parallel line (parallel to the background line) is then drawn through the curve at the one-third distance.
5. The distance between the two intersections of the curve and the parallel line is determined.
6. From the microdensitometer table speed and chart speed, a speed factor is obtained.
7. This speed factor multiplied by the intersection distance gives the final image width.

Evaluation Results

Sample graphs of microdensitometer scans across reseau intersection lines (Figures 4-4 and 4-5), and the resulting statistical values (illustrated in Table 4-11) are provided for relative comparison to previous mission results. Also included for convenience are reseau format diagrams (Figures 4-6 and 4-7).

Conclusions

All intersections evaluated were found to be usable. The results of this evaluation are considered representative of the 1207 camera system.

STELLAR TERRAIN RESEAU INTERSECTION

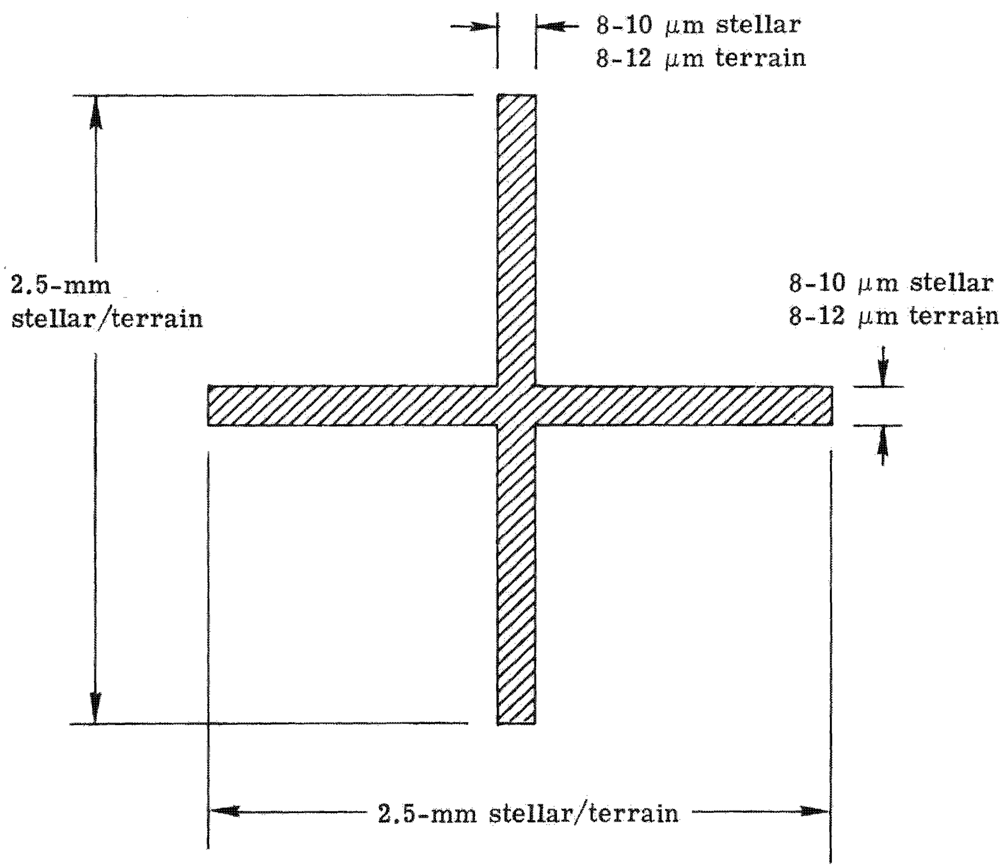


FIGURE 4-3

MICRODENSITOMETER PLOT, TERRAIN RESEAU INTERSECT

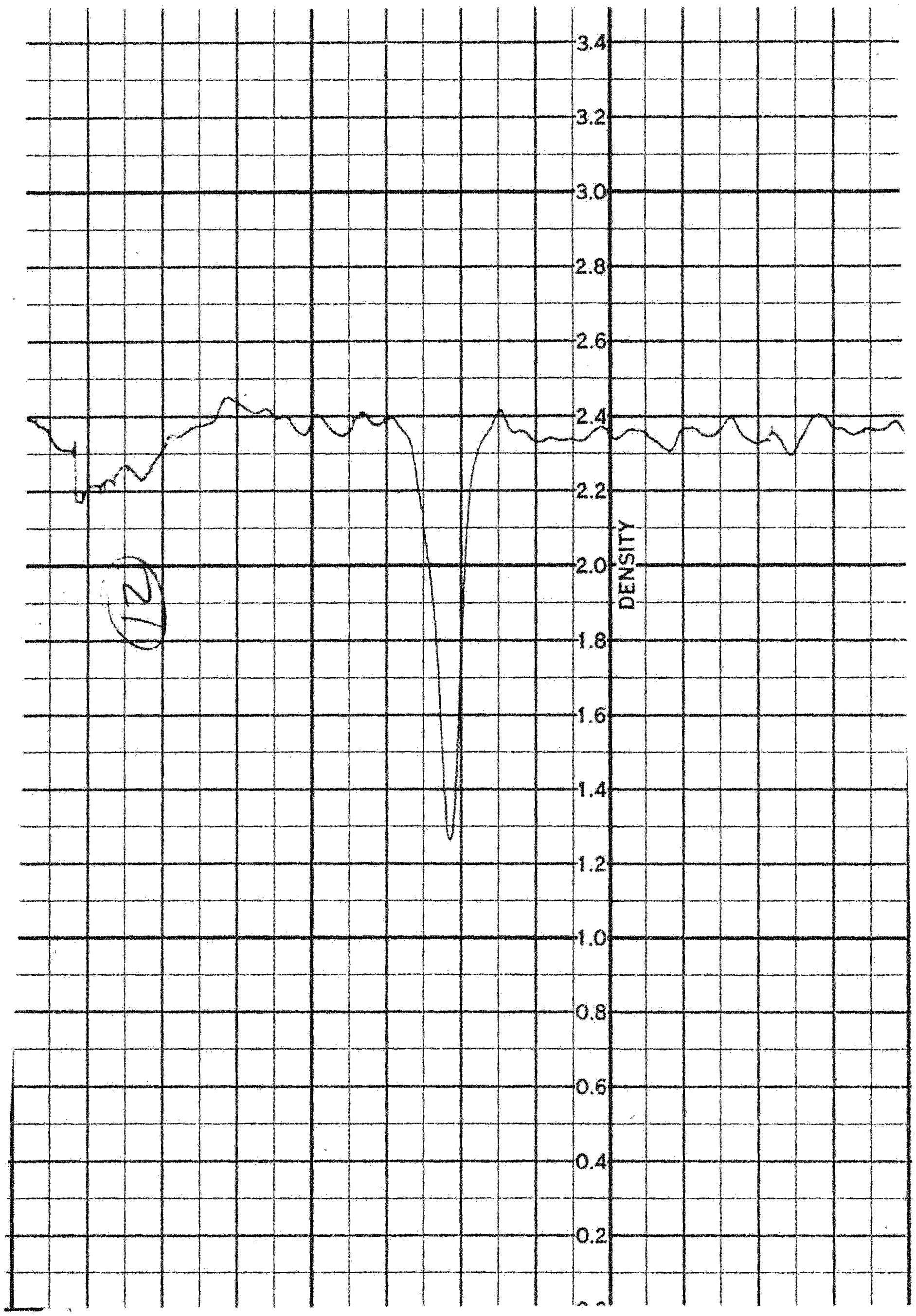


FIGURE 4-4

MICRODENSITOMETER PLOT, STELLAR RESEAU INTERSECT

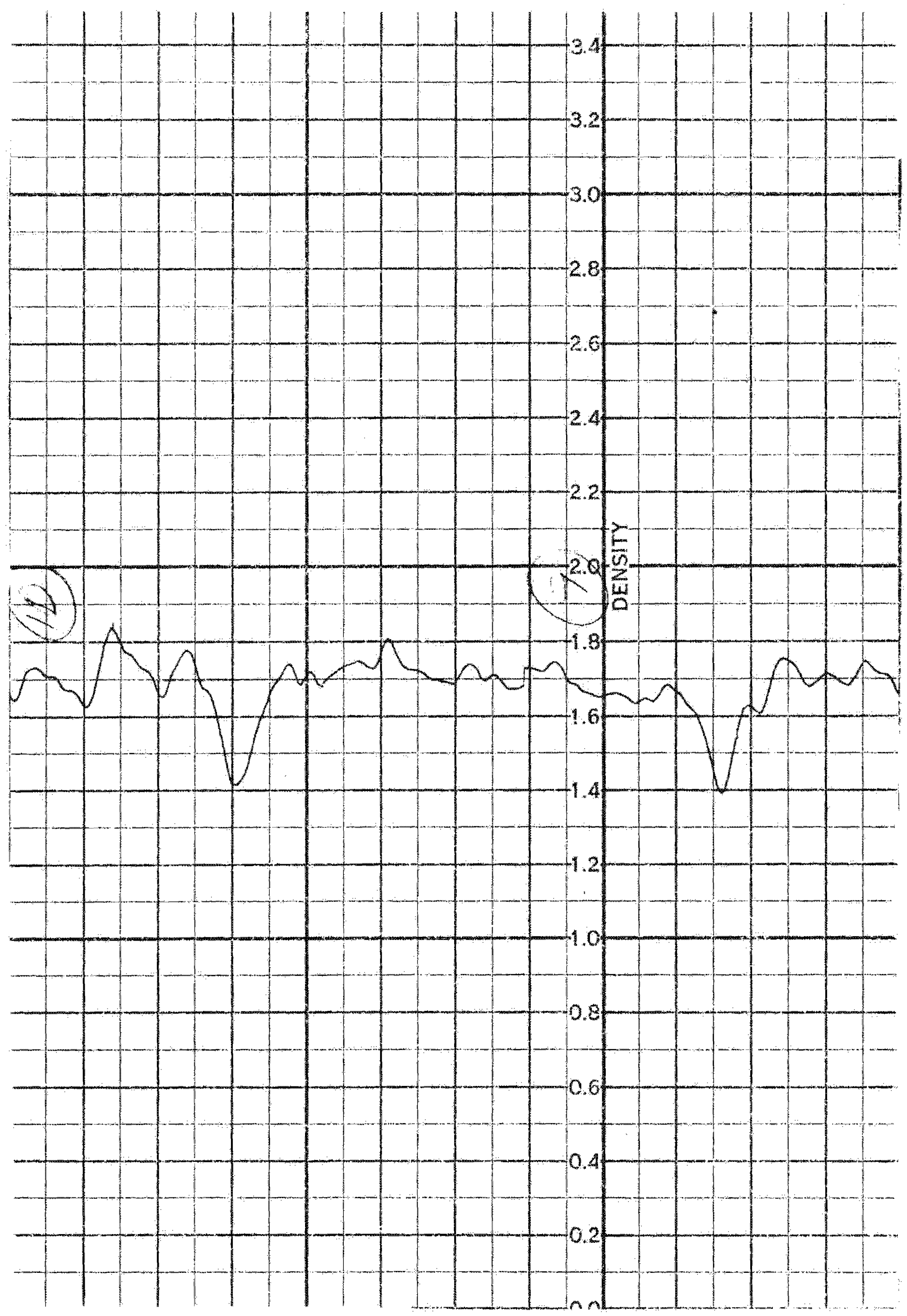


FIGURE 4-5

TABLE 4-11

STELLAR TERRAIN, RESEAU INTERSECTION STATISTICS

Op	Frame	Camera	Background Density	Peak Density	Width (micrometers)
1	1	Terrain	2.40	1.26	15.62*
			2.30	1.14	17.19
			2.40	1.30	15.62
			2.50	1.53	15.62
			2.60	1.62	18.75
146	16	Terrain	1.70	1.00	23.44
			2.40	1.44	18.75
			1.00	0.64	28.12
			2.55	1.72	18.75
			2.40	1.26	15.62
146	16	(+y)S	1.50	1.08	21.87
		(+y)S	1.74	1.28	20.31
		(+y)S	1.56	1.06	25.00
		(-y)P	1.50	1.12	25.00
		(-y)P	1.70	1.14	21.87
		(-y)P	1.40	1.00	21.87

*Microdensitometer is calibrated for absolute density and against a calibrated line width as a standard operating procedure.

STELLAR RESEAU FORMAT

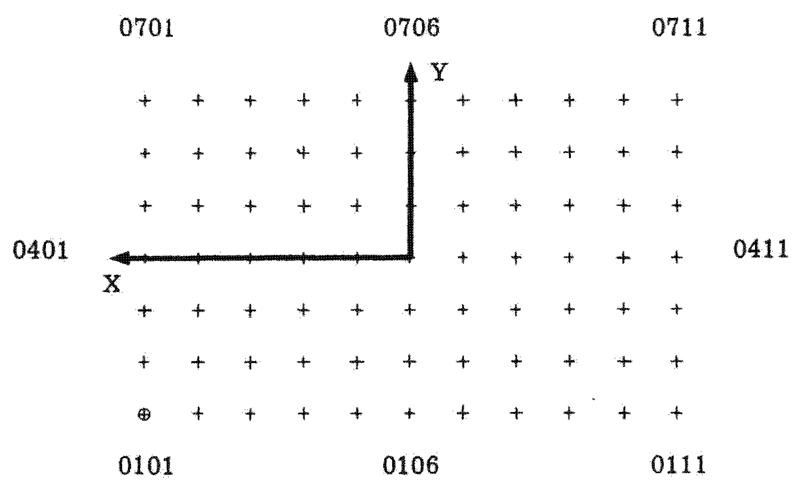


FIGURE 4-6

TERRAIN RESEAU FORMAT

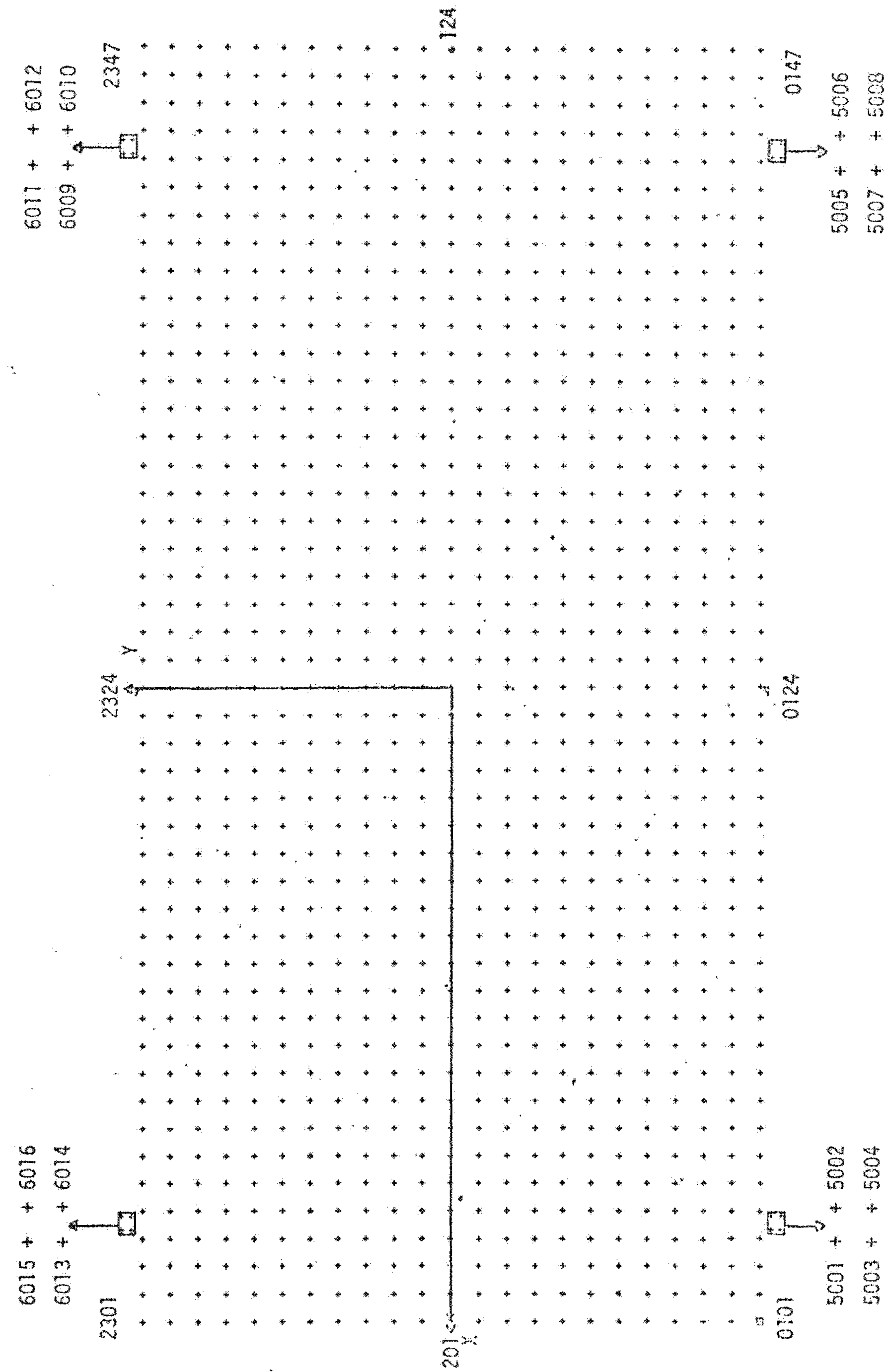


FIGURE 4-7

4.2.4.2 Fiducials

Specifications

The fiducial specifications are similar to the reseau intersection specifications in that four fiducials are to be measured per frame for two frames, one frame at each end of the mission. The dimension values (blueprint) are illustrated in the fiducial diagram (Figure 4-8).

Procedure

The data reduction procedure for reseau intersections applies for all microdensitometric measuring and curve analysis (Figure 4-9).

Evaluation Results

The fiducial line widths and densities are listed in Table 4-12. Mission 1207 fiducial images appear well defined with visible center dots for all four fiducials. The fiducial stability evaluation verifies readability of the fiducials.

Conclusion

Results of this evaluation indicate that the fiducials meet specifications.

4.2.4.3 Data Block

Specifications

The following list presents the criteria for the data block evaluation.

1. Two frame sets are to be scanned.
2. The terrain data block and the stellar data block for each set.
3. Tolerances are as follows:

   Peak density of each dot with respect to background fog must be greater than 0.6 of a density unit.

   Density between dots with respect to the background fog must be less than 0.25 of a density unit.

   Dot diameter of the 0.3 density level must fall between 152.0 and 254.0 micrometers.

Procedure

Typical microdensitometry procedures discussed in the reseau section were followed.

TERRAIN FIDUCIAL DIAGRAM

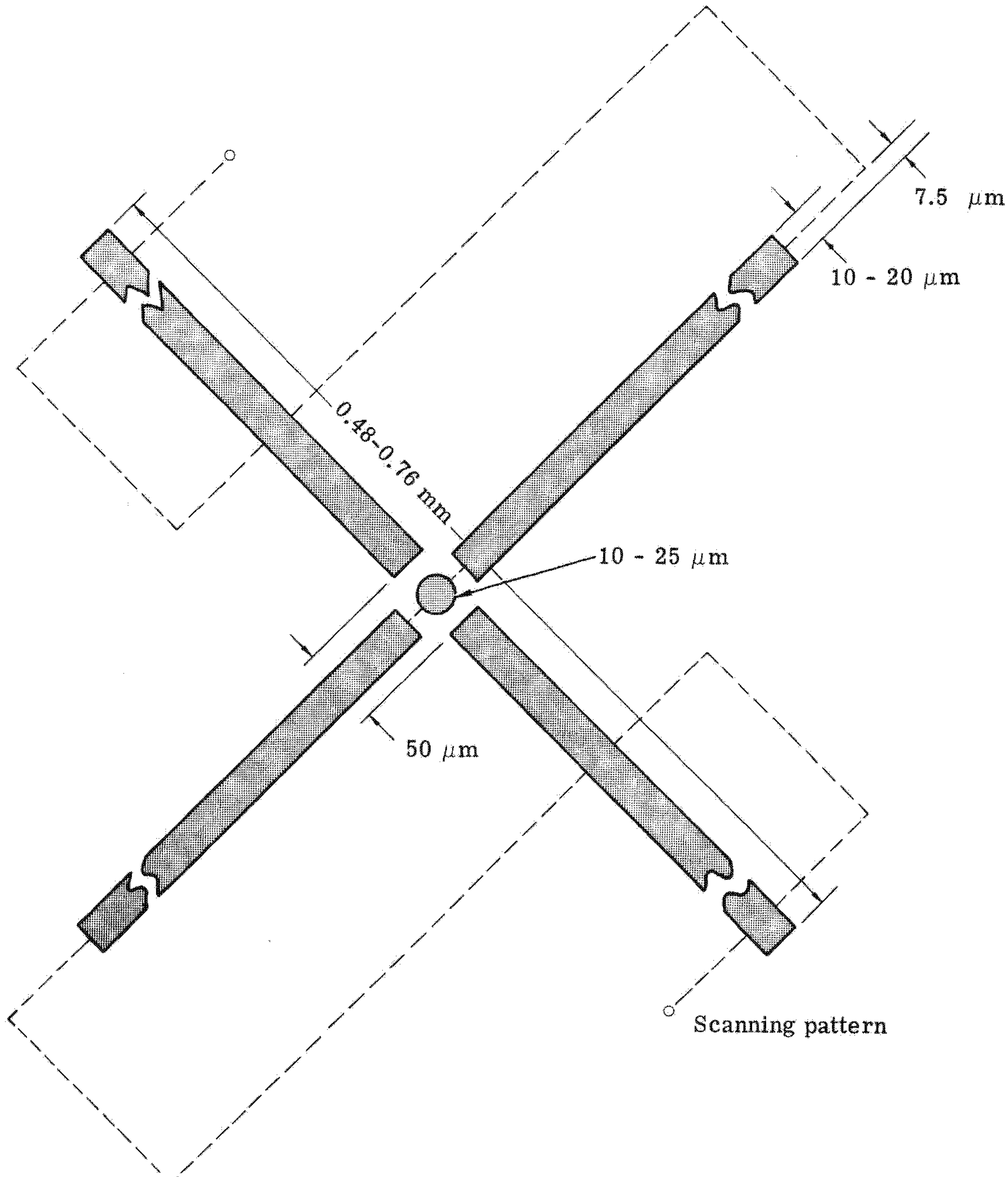


FIGURE 4-8

MICRODENSITOMETER PLOT, FIDUCIAL

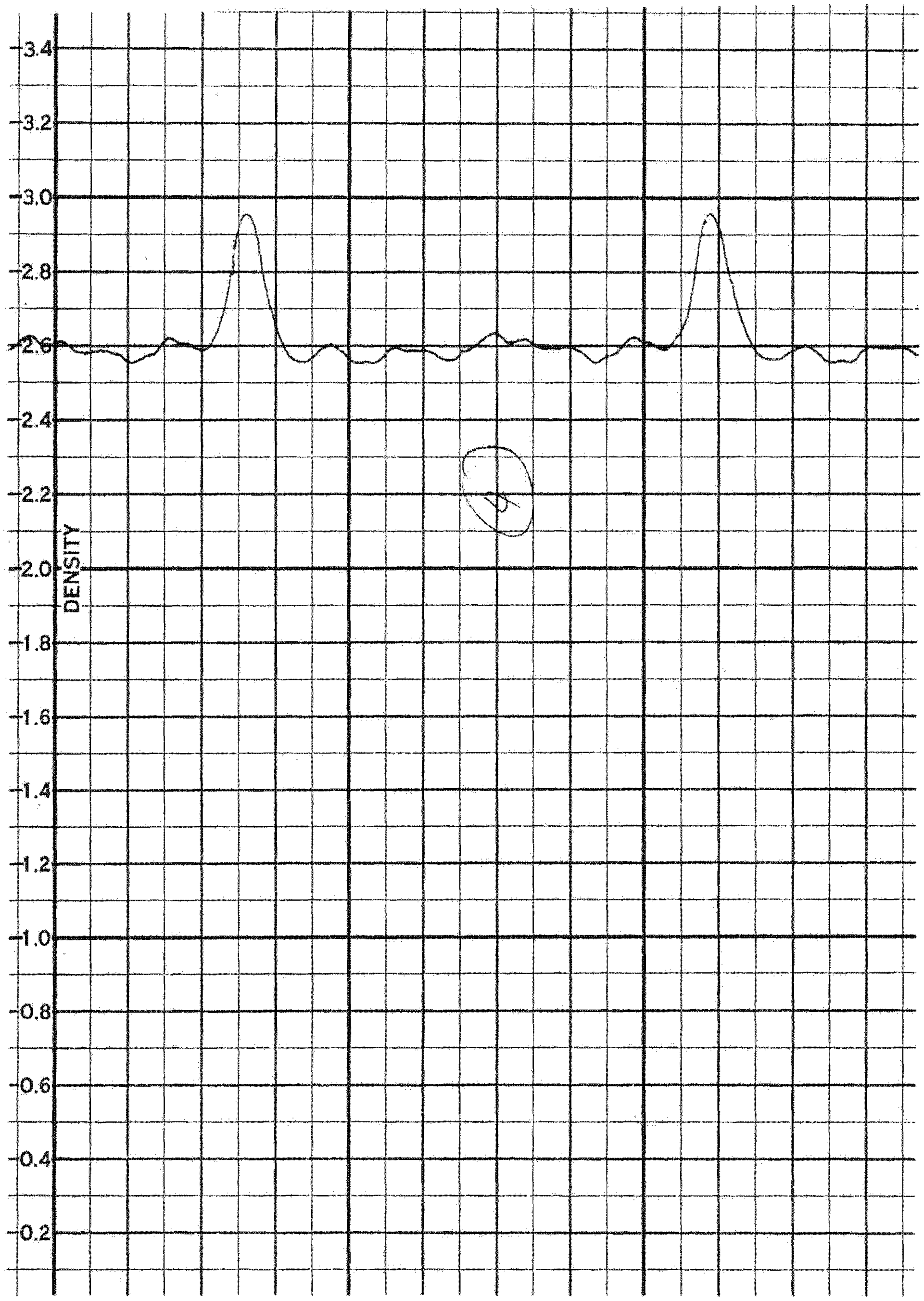


FIGURE 4-9

TABLE 4-12

TERRAIN, FIDUCIAL MARK STATISTICS

Op	Frame	Background Density	Peak Density	Width(micrometers)
1	1	2.60	2.94	18.75
		2.60	2.80	18.75
		2.64	2.94	17.18
		2.60	2.94	18.75
146	16	2.40	2.82	17.18
		2.30	2.60	25.00
		2.40	2.70	18.75
		1.44	2.48	40.62

Evaluation Results

The required data blocks were scanned and all peak densities exceeded the background fog values thus satisfying requirements. Density between dots exceeded the 0.25 density unit specification for operate 1, frame 1 (1.33 of a density unit). All dot diameters fell within the 152.0 to 254.0-micrometer specification.

Figures 4-10 through 4-15 are provided for a convenient reference.

4.2.4.4 Operate and Frame Marks

Specifications

Operate and frame mark dimensions shall be as shown in Fig. 4-16. For titling, mark densities must exceed the format background densities by a minimum of 1.0 density unit.

Procedure

Typical microdensitometry procedures discussed in the reseau section were followed.

Evaluation Results

The dimensions of the frame marks were found to exceed the specifications (Table 4-13, Figure 4-17).

Conclusions

The operate and frame mark density requirement was satisfied for the terrain. However, for the stellar record this requirement was not met and no optical titling was achieved. The average densities are listed in Table 4-13.

4.2.5 Measurements

4.2.5.1 Film Tracking

Specifications

The following blueprint tolerance values specify the distance from each frame's usable format edge to the film base edge (blueprints: frame format, D instrument, 154532; frame format, U instrument, 152070).

Tolerances: Terrains—5.08 to 6.60 millimeters
Stellars—usable format extends out to film edge.

For both terrains and stellars, 30 consecutive frames are to be measured.

STELLAR DATA BLOCK ORIENTATION

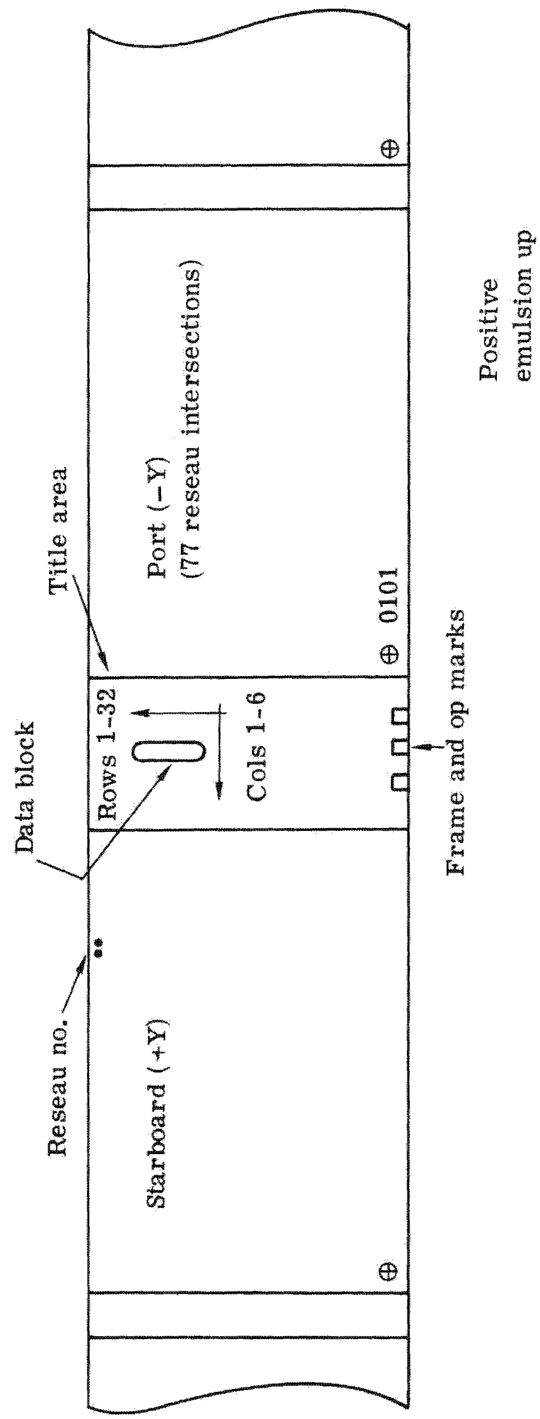


FIGURE 4-11

TERRAIN DATA BLOCK ORIENTATION

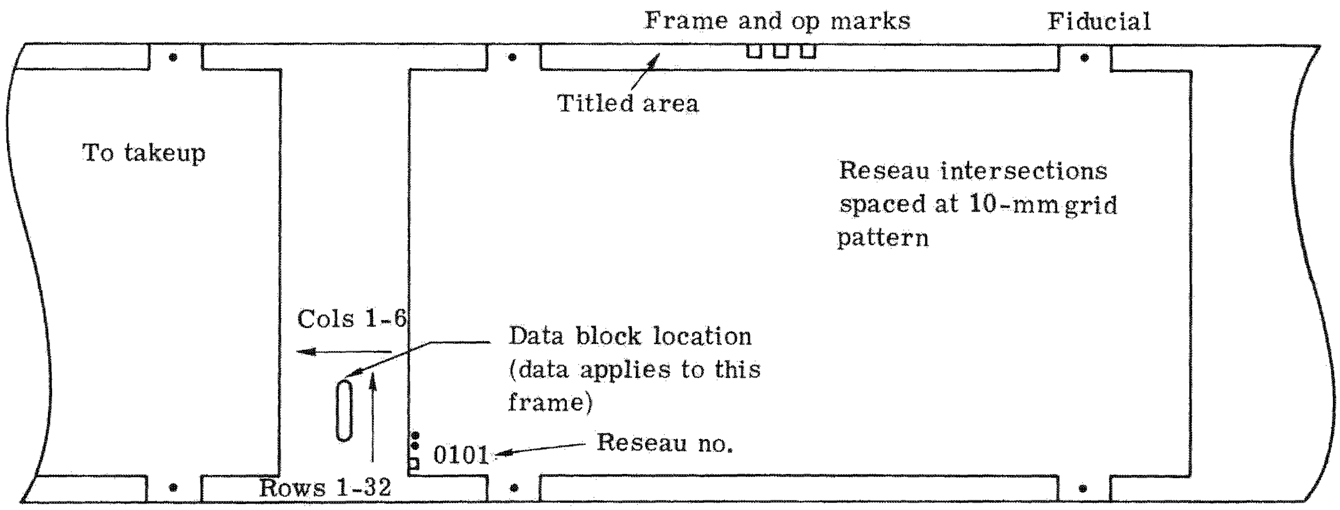
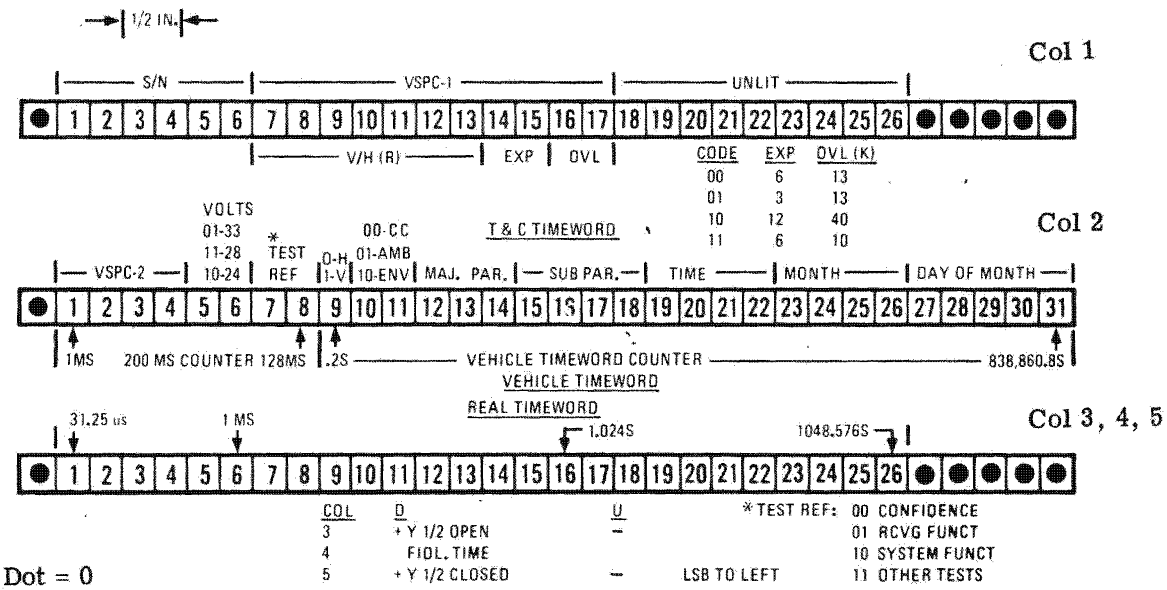


FIGURE 4-12

DATA BLOCK GUIDE



Note: Dot = 0
Blank space = 1

The above guide matches the special reading devices (10× Lupes with guide) necessary to effectively interpret the data blocks.

FIGURE 4-13

MICRODENSITOMETER PLOT, TERRAIN DATA BLOCK

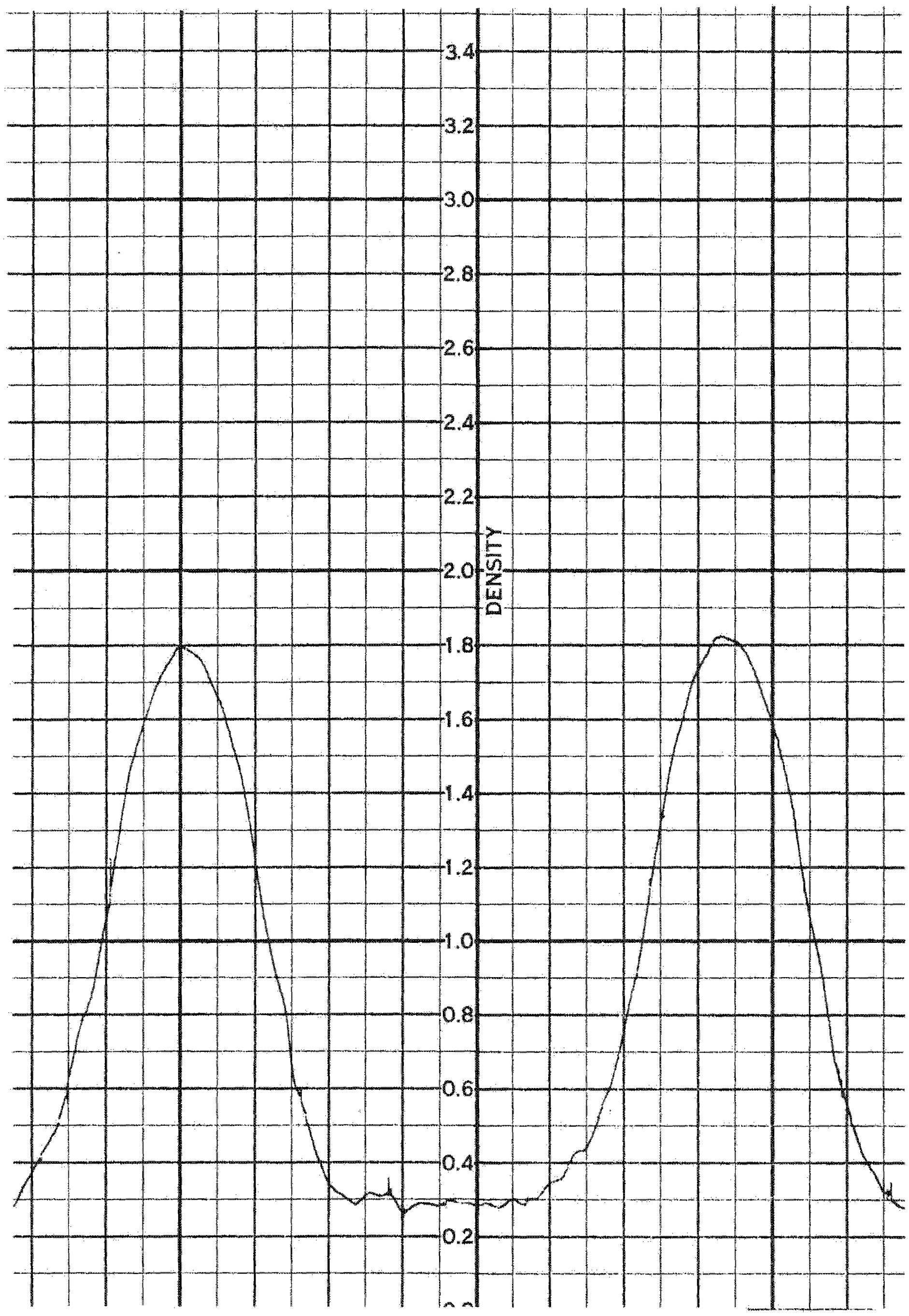


FIGURE 4-14

Approved for Release: 2025/06/18 C05137295

POST FLIGHT ANALYSIS
REPORT NO. 1207-5/74

MICRODENSITOMETER PLOT, STELLAR DATA BLOCK

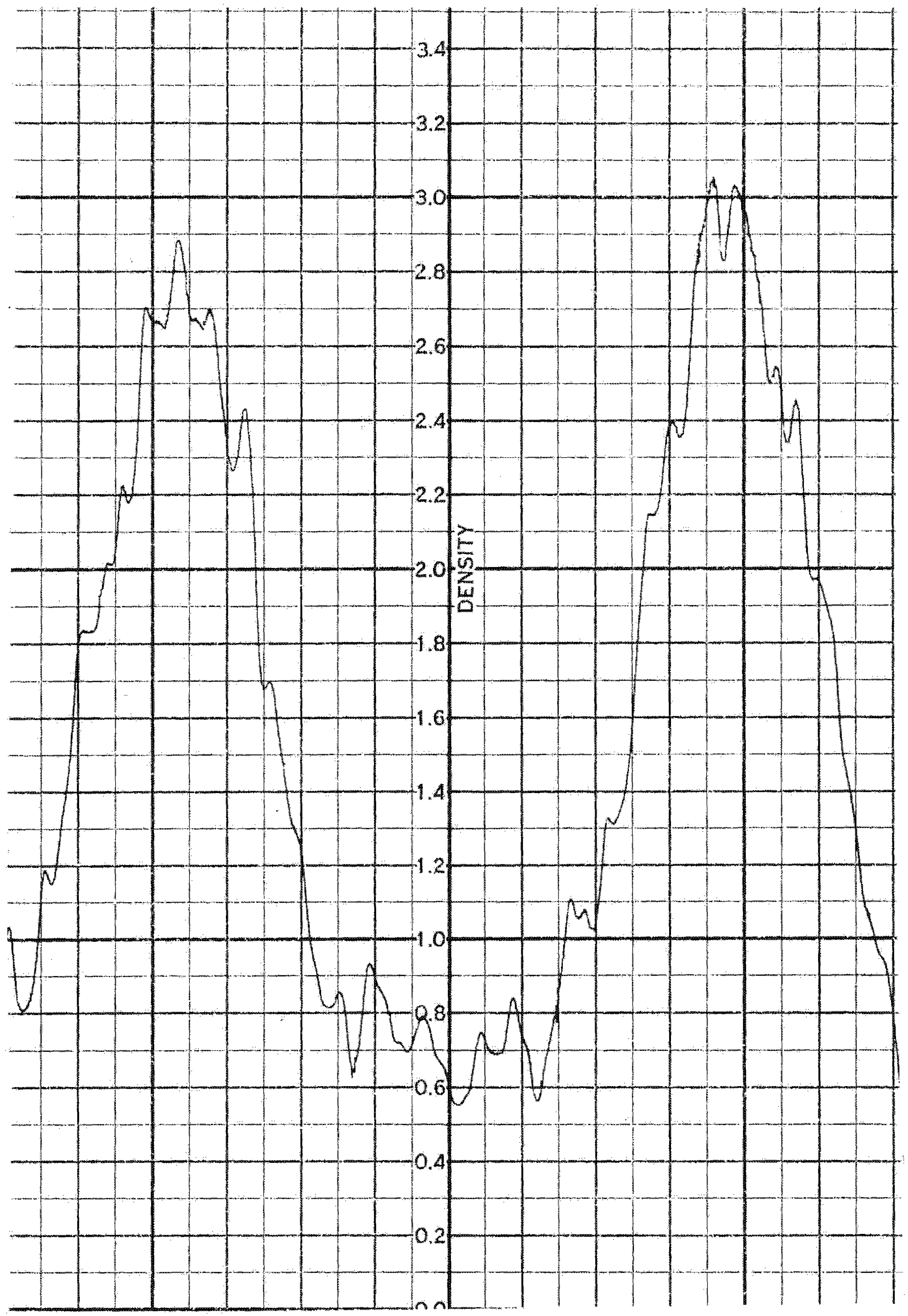


FIGURE 4-15

STELLAR TERRAIN OPERATE/FRAME MARKS

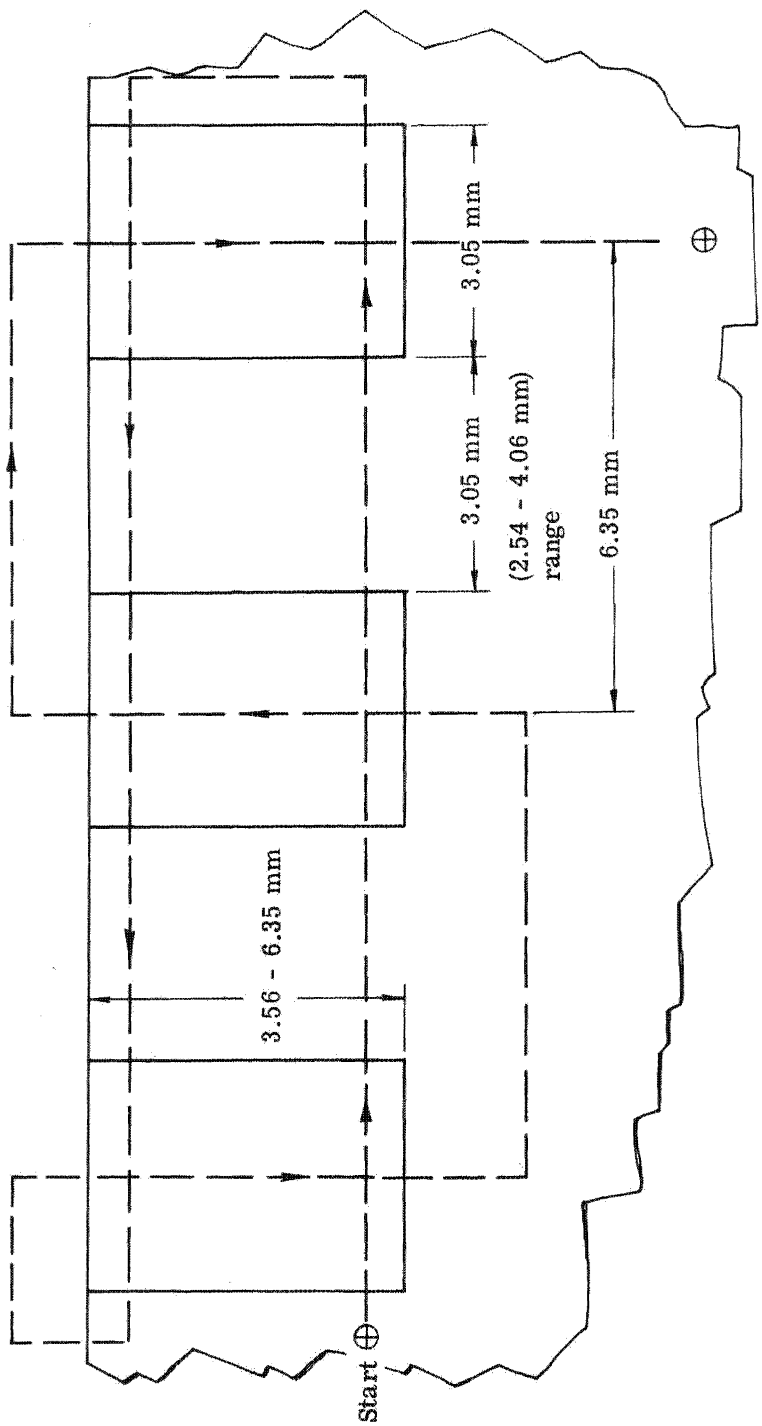


FIGURE 4-16

MICRODENSITOMETER PLOT, TERRAIN FRAME MARKS

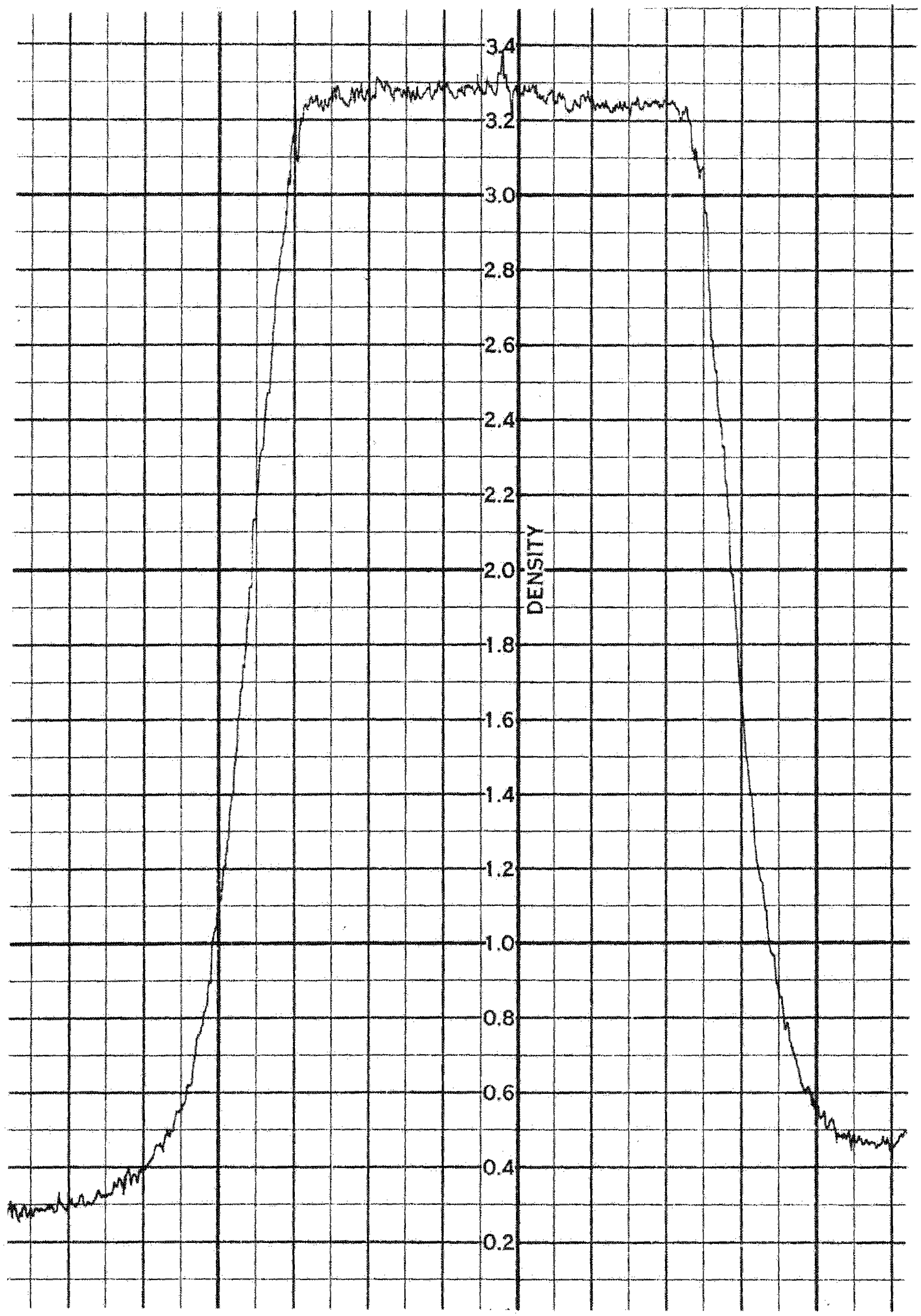


FIGURE 4-17

TABLE 4-13

STELLAR TERRAIN, OPERATE AND FRAME MARKS STATISTICS

Op	Frame	Camera	Background Density	Peak Density	X Axis Direction Width (mm)	Y Axis Direction Length (mm)	Average* Density
1	1	Terrain	0.30	3.40	4.6875		2.22
			0.30	3.40	4.5000		
146	16	Terrain	0.40	3.30	4.3125		2.16
			0.40	3.30	4.2500		
			0.40	3.30	3.9375		
1	1	Stellar	0.60	2.40		5.5000	1.23
			0.60	2.40		5.5000	
			0.60	2.00		5.3125	
			0.60	2.10	3.1875		
			0.60	2.30	3.1875		
146	16	Stellar	0.56	1.60		4.0625	0.89
			0.50	1.50		5.3125	
			0.50	1.05	3.1250		
			0.50	1.40	3.1250		

*Macrodensitometer value (Transmission density measurements)

Procedure

All measurements were made using 10× magnifiers with millimeter scales.

Evaluation Results

1. Tracking measurements were taken from three areas of the total film load (operates 2-4; 40-42; 144-146).
2. Measurements were made on original negative material at the processing site.
3. Operates 2-4 were found out of tolerance (Table 4-14).
4. Stellar frames were inspected to ensure usable format to the film base edge. No frames were found shifted on the base to indicate any tracking difficulties.

Conclusion

There were no problems due to tracking on any material inspected.

4.2.5.2 Frame Metering Distances

Specifications

Frame spacing requirements are in three parts:

1. Terrain frame-to-frame distance.
   Tolerance (blueprint): 19.81 to 32.51 millimeters.
2. Stellar frame-pair to frame-pair distance.
   Tolerance (blueprint): 3.56 to 8.64 millimeters.
3. Stellar frame port (–y) to simultaneously exposed starboard (+y) distance.
   Tolerance (blueprint): 46.99 to 49.53 millimeters.

Thirty frames and frame pairs are required for the frame to frame measurements. Two stellar sets are required to satisfy the port-to-starboard measurement specifications.

Procedure

1. All of the listed measurements were made on a monocomparator. (Table 4-15).

Points located along the appropriate usable format sides were read and carried in solution to provide transformed values.

Evaluation Results

1. The distances between terrain frames were found to be within specifications.
2. The distances between stellar frame pairs were found to be within specifications.
3. Port (–y) to starboard (+y) distances were also found to be within specifications.

Conclusion

Measurements indicate nominal conditions for the metering phase of system operation.

4.2.5.3 Frame Format Size

Specifications

The following values were taken from the format blueprints:

Terrain frame: 228.600 × 642.788 millimeters
Stellar frame: 70 × 110 millimeters

Two frame sets located at each end of the mission material are to be designated for measurment.

Procedure

All data were obtained from monocomparator readings.

Evaluation Results

The required data are presented in Table 4-16.

Conclusion

Measurements indicate no anomalies.

4.2.5.4 Fiducial Positioning With Respect to Surrounding Reseau Intersections

Specifications

Figure 4-18 shows a typical fiducial and the tolerances for fiducial positioning with respect to the reseau system.

Procedure

All values were derived from the results of the film deformation six-parameter transformation runs.

Evaluation Results

Figures 4-19 through 4-22 illustrate the grouping of fiducials and the position of each grouping to the reseau system (four surrounding reseau intersections).

Conclusion

All frames evaluated are within the specified tolerance.

TABLE 4-14

TERRAIN, FILM TRACKING STATISTICS

Operate No.	0101 Frm Corner*
2-4	4.7-5.5
40-42	5.1-5.3
144-146	5.1-5.3

*Usable Format to Film Base Edge (Range - mm)

TABLE 4-15

STELLAR TERRAIN, METERING DISTANCES

Location	Actual Range (mm)	Tolerance (mm)
Terrain/Terrain	22.359-29.972	19.81-32.51
Stellar Pair/Stellar Pair	5.812- 6.016	3.56- 8.64
Port (-y)/Starboard (+y)	47.556-47.610	46.99-49.53

TABLE 4-16

STELLAR TERRAIN, USABLE FORMAT DIMENSIONS

Frame	Average Size (mm)
Terrain	228.629 x 462.463
Port (-y)	69.259 x 110.113
Starboard (+y)	69.279 x 110.097

FIDUCIAL ORIENTATION

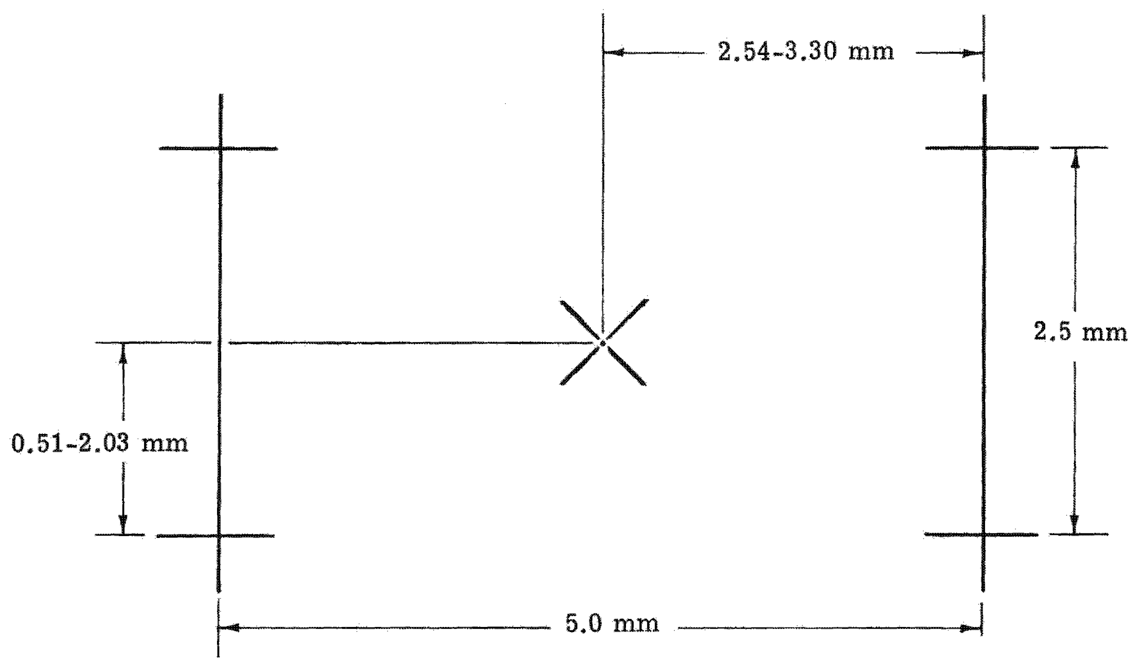


FIGURE 4-18

FIDUCIAL ORIENTATION PLOT (1)

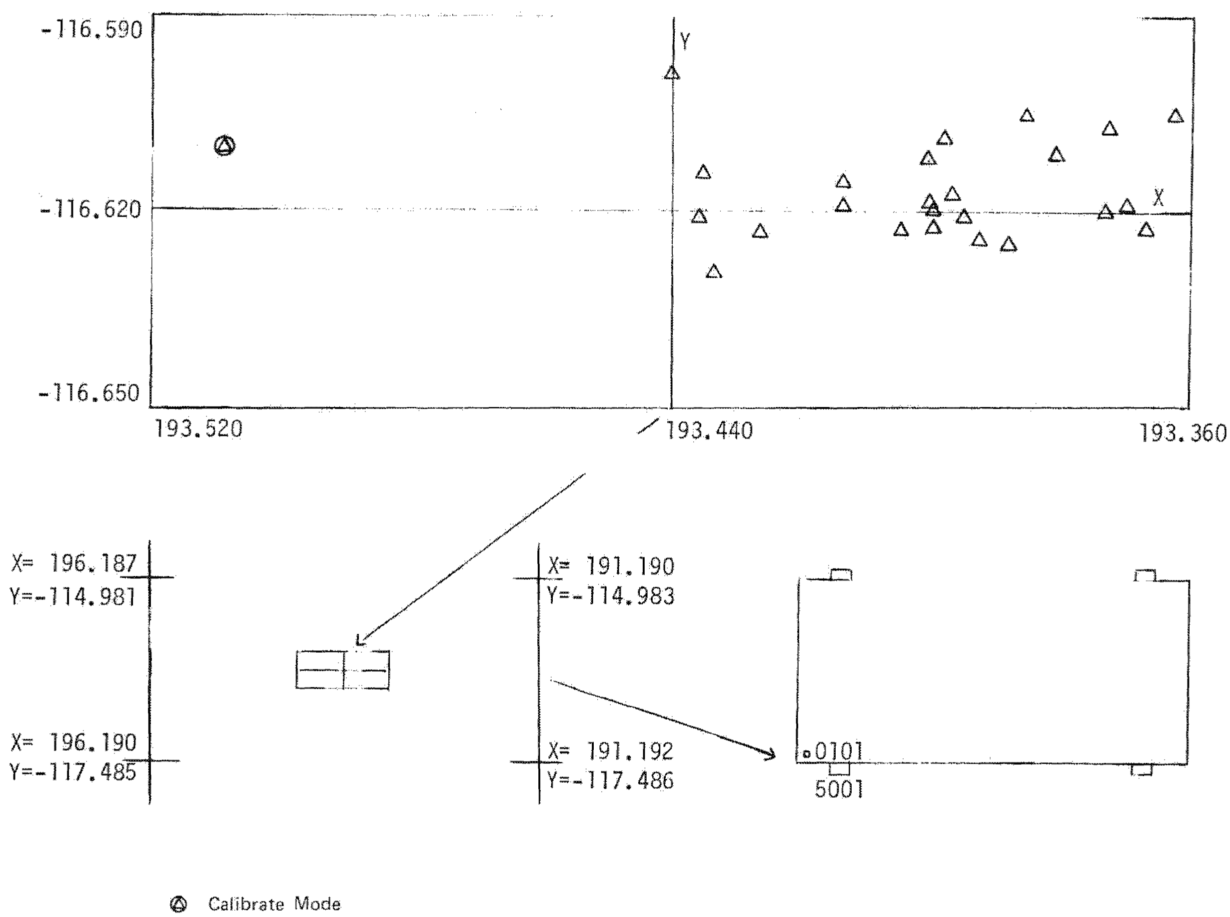


FIGURE 4-19

FIDUCIAL ORIENTATION PLOT (2)

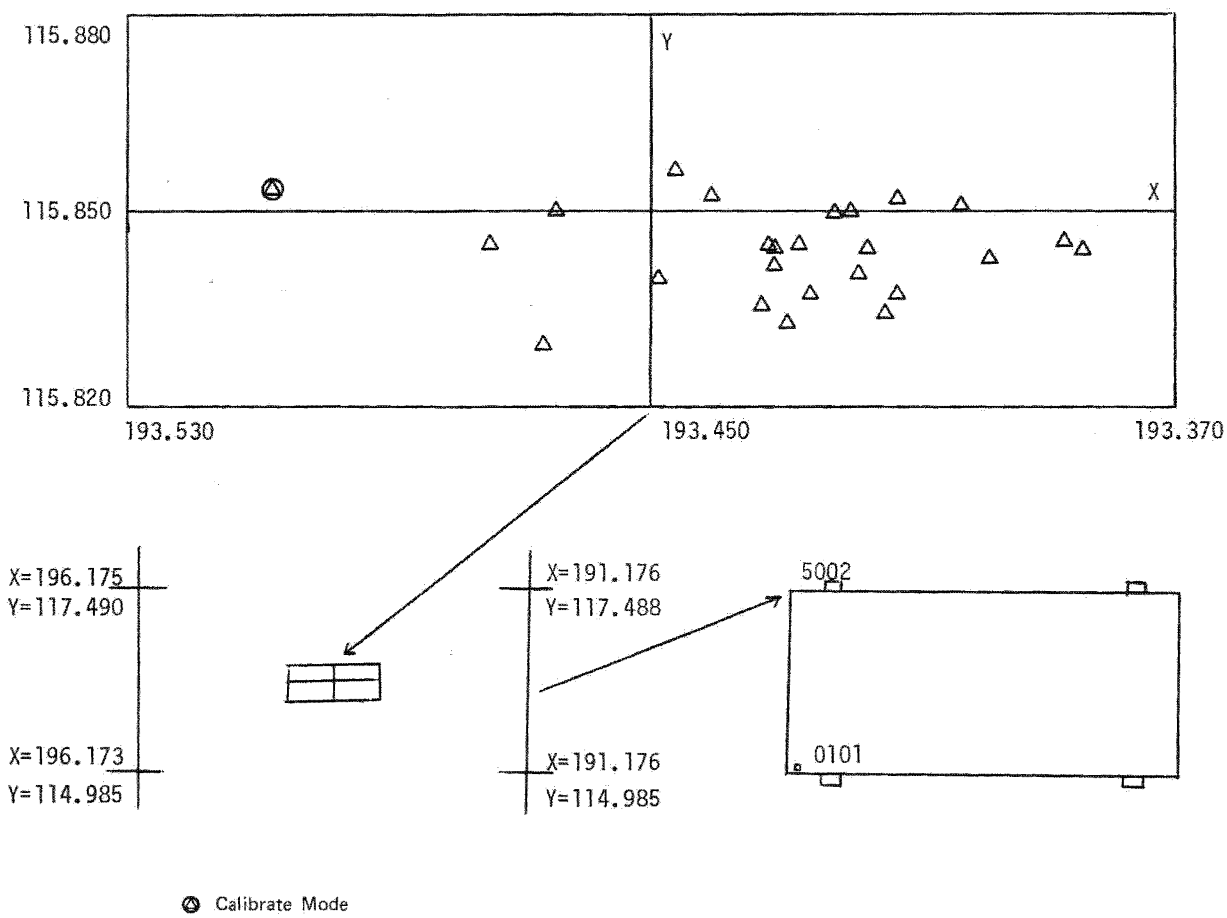


FIGURE 4-20

FIDUCIAL ORIENTATION PLOT (3)

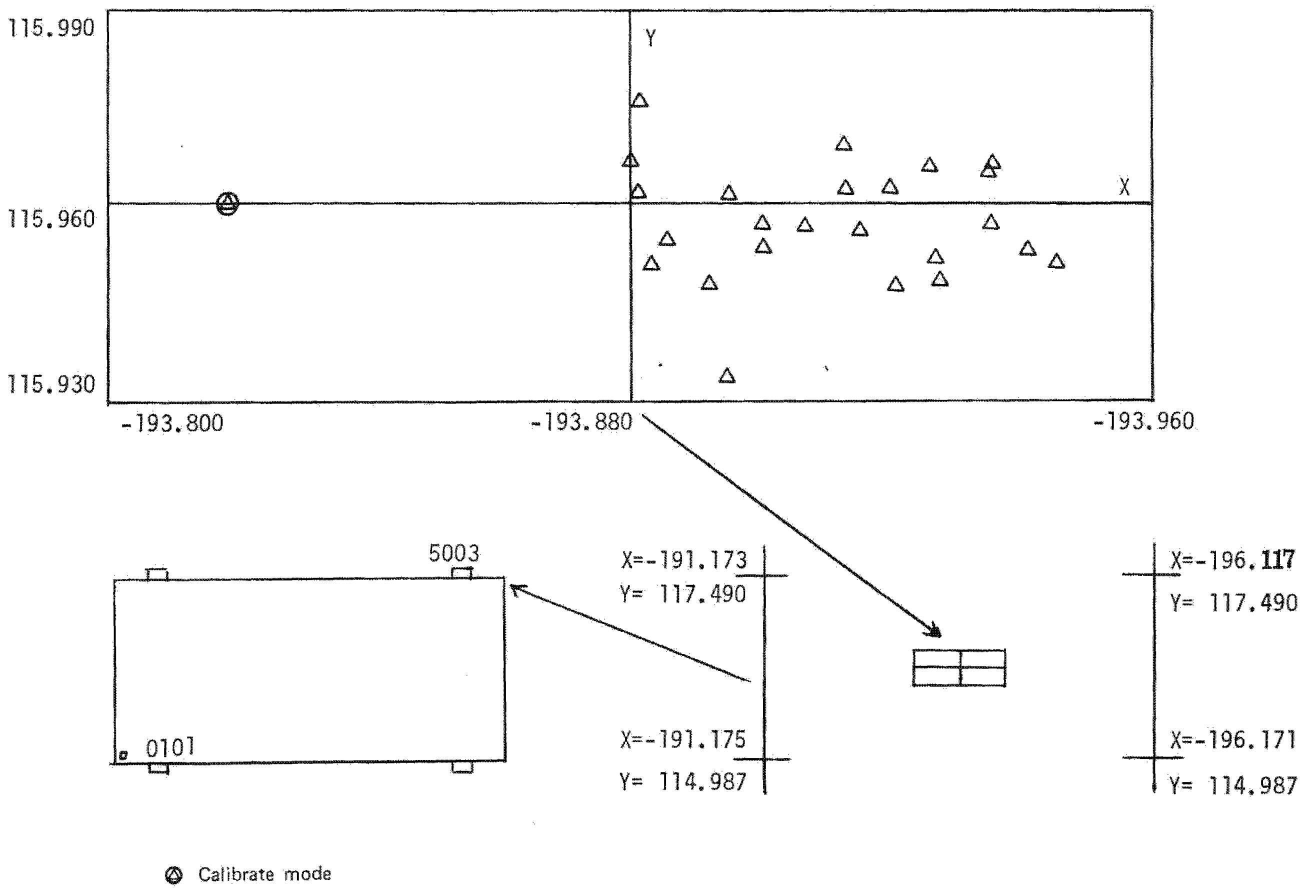


FIGURE 4-21

FIDUCIAL ORIENTATION PLOT (4)

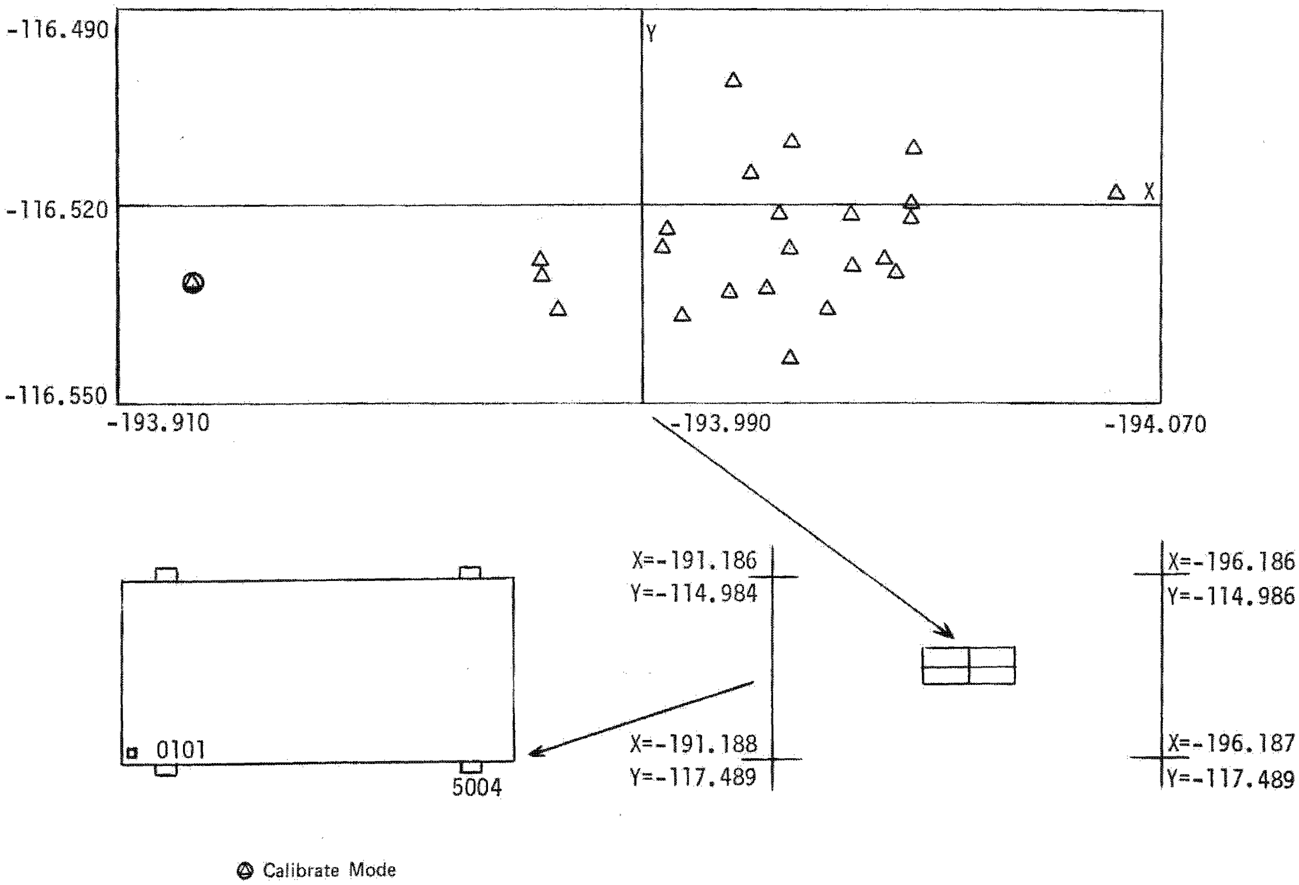


FIGURE 4-22

4.2.5.5 Overlap Study

Specifications

For the overlap evaluation, it was required to compare the actual overlap of 30 pairs of terrain frames against the commanded overlap. Mission Performance Report (MPR) and actual overlap values should agree to within 2 percent.

Procedure

Measurements made with a master template on randomly selected frames were used for the overlap evaluation.

Evaluation Results

The overlap percentage values are listed on the overlap data sheet (Table 4-17). Three values for the operational frames exceeded the 2 percent requirement. Frames 2 and 3 of operate 148 were part of the special engineering cycles using 3414 for which overlap and IMC values were compromised to allow maximum exposure times. The frames measured from operates 1 and 78 are only 0.1 percent out of tolerance, which may be variations attributed to measuring technique.

4.2.6 Terrain Image Study

Specifications

Objective resolution measurements for a given system would require the detection of targets comparable to ground testing results. However, because of scale, ground targets are not available . The visual edge matching (VEM) instrument is used to acquire VEM numbers and associated resolution values for a given film/lens system. The measured film values, presented in Table 4-18, have not been correlated to ground test results and should not be construed as directly representing ground resolution. The main importance and use for these VEM resolution values is a relative mission-to-mission comparison.

Procedure

An SO-467 matrix was used to evaluate imagery on SO-284 duplicating film. Since an SO-284 matrix was not available, it was decided by the PFA chairman to present the available data with an explanation. The film manufacturer indicated that SO-284 and SO-467 are nearly identical films with D-log E curve characteristics differing by no more than that expected between batches of a given film type. However, the conditions involved should be recognized when interpreting the results.

Evaluation Results

The results of the VEM analysis are presented in Table 4-17. Figure 4-23 is a format area locater that relates the VEM measurements to the terrain format.

TABLE 4-17

TERRAIN, OVERLAP PERCENT COMPARISONS

Op	1st Frame	2nd Frame	Percent Overlap	MPR/Title Overlap
1	10	11	72.1	70
11	6	7	71.9	70
12	29	30	69.4	70
13	10	11	70.5	70
19	15	16	71.6	70
25	8	9	70.8	70
28	15	16	70.8	70
29	6	7	70.8	70
37	18	19	71.3	70
38	1	2	70.5	70
40	3	4	71.3	70
47	20	21	71.0	70
49	9	10	71.3	70
55	26	27	70.5	70
65	7	8	71.0	70
67	3	4	71.6	70
68	8	9	71.6	70
72	5	6	71.6	70
78	9	10	72.1	70
85	7	8	71.6	70
93	4	5	71.6	70
104	2	3	71.0	70
109	35	36	71.3	70
115	8	9	71.0	70
124	1	2	71.4	70
135	5	6	71.0	70
138	3	4	71.3	70
146	8	9	71.6	70
148*	2	3	74.6	70

*3414 Film, Forced V/h value to get 14.5 msec exposure time.

TABLE 4-18

TERRAIN, VEM STATISTICS

Op	Frm	Area	VEM Number	Resolution C/mm	Edge Orientation	Reader
1	11	15	8	40.0	-	1
1	11	15	9	33.5	-	2
2	5	14	8	40.0	I	1
2	5	14	8	40.0	I	2
4	15	26	7	48.5	-	2
5	5	18	6	58.0	I	2
6	8	22	6	58.0	-	2
6	8	28	8	40.0	I	2
24	3	4	9	33.5	-	1
24	3	8	7	48.5	-	1
42	5	2	9	33.5	-	1
42	5	2	6	58.0	I	1
42	7	5	6	58.0	-	1
42	7	9	5.5*	64.0	-	1
42	10	16	7	48.5	I	1
56	2	18	6	58.0	-	2
56	2	29	7	48.5	-	2
56	5	9	6	58.0	/	2
61	4	10	6	58.0	-	2
61	12	19	6	58.0	I	2
61	13	11	6	58.0	-	2
63	1	15	6	58.0	I	2
64	4	7	5*	70.0	I	2
75	7	31	8	40.0	-	1
75	7	31	6	58.0	-	2
76	6	6	9	33.5	I	1
76	6	6	10	27.5	I	2
76	6	23	5*	70.0	I	1
76	6	23	6	58.0	I	2
76	6	23	5*	70.0	/	1
76	6	23	5*	70.0	-	2
76	7	19	5*	70.0	-	1
76	10	10	5*	70.0	-	2
76	10	10	6	58.0	-	1
78	7	28	9	33.5	/	1
78	8	14	8	40.0	-	1
78	8	14	8	40.0	-	1
78	9	26	8	40.0	-	1
78	10	26	5*	70.0	-	1
78	10	26	5*	70.0	-	2

*Extrapolated value - beyond scale of VEM Matrix SO-467

TABLE 4-18 (CONT.)

TERRAIN, VEM STATISTICS

Op	Frm	Area	Number	Resolution C/mm	Edge Orientation	Reader
78	10	19	7	48.5	-	1
78	10	19	8	40.0	-	2
136	2	26	8	40.0	-	1
136	2	26	7	48.5	I	1
136	2	26	7	48.5	I	2
136	2	26	7	48.5	-	2
136	5	23	6	58.0	I	1
146	4	27	7	48.5	-	1
146	4	27	8	40.0	I	1
146	4	27	7	48.5	I	2

Average of 50 readings 51.1 C/mm

TERRAIN FORMAT AREAS

4	8	12	16	20	24	28	32
3	7	11	15	19	23	27	31
2	6	10	14	18	22	26	30
1	5	9	13	17	21	25	29

FIGURE 4-23

Figures 4-24 through 4-28 are provided as examples of this particular mission's image quality.

4.2.7 Stellar Image Study

Specifications

In order to satisfy the design specifications, stellar frames must contain a relatively large number of sixth magnitude star images. Sixty stellar frames are to be visually evaluated against star charts for sixth magnitude images, star distribution, and quantity of images.

Procedure

The randomly selected frames are overlaid with a vellum sheet to "pull up" the film images. The vellum overlay is then matched to an appropriate star chart of the same scale. MPR camera axis data provides a star chart "window" in which the overlay is visually positioned to the star field. Once located, an approximate count is made of sixth magnitude images. Not all images marked on the overlay or measured during data reduction are star images but may be images of foreign material caught in the duplication process.

Evaluation Results

All sixty frames evaluated indicate an adequate number of sixth magnitude images.

Terrain Calibration Mode Imagery

Calibration mode terrain exposures indicate 75 to 100 possible images. During C-mode, the vehicle is in an "inertial" orientation that would cause the same star field to be viewed for each frame of an operate. An overlay is used to "pull up" images from each frame isolating usable star images for field identification. When this operation was performed, approximately 10 to 13 "star" images were detected. Using the located stellar frame exposures, an orientation of the terrain frame to the star chart was determined. A possible field identification has been made and the frames are currently in the mensuration process for data reduction.

If the field is correct, an insufficient number of star images are available for determination of interior camera parameters. Also, it is questionable that reasonable relative orientation angles can be determined.

It is felt that an increased terrain exposure time for in-flight stellar calibration frames should be considered to provide a more extensive distribution of star images.

4.2.8 Time Word Study

Specifications

Five data block times (vehicle time) are to be compared to the associated telemetry vehicle times printed in the MPR. Comparable values must agree to within 1 millisecond. For a sequence

NOTE: FIGURE 4-24 ON PAGE 4-48 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

NOTE: FIGURE 4-25 ON PAGE 4-49 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

NOTE: FIGURE 4-26 ON PAGE 4-50 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

NOTE: FIGURE 4-27 ON PAGE 4-51 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT.

of exposures having a common ground point, the variation in elapsed time between the terrain camera fiducial exposure times (internal clock times) should be less than 0.10 millisecond.

The midpoint of the terrain fiducial exposure and the stellar exposures should compare to ±4 milliseconds (internal clock times). This comparison is to be made on five frame sets.

Procedure

All data blocks for the PFA evaluation were read manually using a 10× reading device.

Evaluation Results

a. The terrain and stellar data block vehicle time words, when compared to the appropriate MPR VEH TIME values, were found to be identical for all frames evaluated from the following operates:

Operate	Frames
22	1-7
27	1-7
38	2-5
76	1-10
77	1-10
94	1-11
139	1-7
148	1-5

b. The variation in elapsed time between terrain camera fiducial exposure times is less than 0.10 millisecond for frames having a common V/h value. When the V/h value changes within an operate, usually the first frame to be affected does not numerically agree with the remaining frames for that V/h value. This frame would, however, still have a common ground point with associated tri-lap frames. In the above case, the specification is not satisfied. The following table for operate 94, frames 1-11, illustrates the described condition (Table 4-19).

c. Table 4-20 illustrates the differences between the stellar frames mid-exposure times and the terrain fiducial exposure times.

Calibration Mode Time Words

Table 4-21 illustrates the time values derived from the terrain and stellar data blocks for the calibration frames.

MPR Time Correlation Parameter Correction

For the rev span of 907-922, the MPR CFC term of the time correlation parameters should be corrected to read 850132.707275391 vice 850133.707275391.

TABLE 4-19

FIDUCIAL EXPOSURE ELAPSE TIME STATISTICS
Operate 94 Frames 1-11

Frame No.	Elapse Time Interval*	V/h
1		.0459
2	9.59950	.0459
3	9.59956	.0459
4	9.59956	.0459
5	9.59956	.0462
6	9.53759	.0462
7	9.53244	.0462
8	9.53250	.0462
9	9.53237	.0462
10	9.53244	.0462
11	9.53241	.0462

*Data Block Column #4 - Internal Clock Time

TABLE 4-20

MID-EXPOSURE TIME COMPARISON
(All Times in Secs)

Op	Frm	Mid-Exposure Differences (+y)S/Fiducial	Mid-Exposure Differences (-y)P/Fiducial	Total Exposure Time (+y)S	Total Exposure Time (-y)P
22	1	.00034	.00091	.20018750	.20100000
	2	.00038	.00089	.20018750	.20096875
	3	.00031	.00086	.20018750	.20096875
	4	.00031	.00088	.20018750	.20093750
	5	.00030	.00087	.20021875	.20093750
	6	.00031	.00086	.20018750	.20096875
	7	.00033	.00089	.20021875	.20096875
76	1	.00038	.00089	.20025000	.20103125
	2	.00034	.00088	.20025000	.20106250
	3	.00031	.00083	.20025000	.20103125
	4	.00033	.00086	.20028125	.20109375
	5	.00033	.00088	.20034375	.20106250
	6	.00031	.00086	.20031250	.20109375
	7	.00028	.00084	.20031250	.20106250
	8	.00031	.00087	.20025000	.20112500
	9	.00033	.00084	.20028125	.20112500
	10	.00030	.00083	.20028125	.20109375
27	1	.00072	.00122	.20018750	.20100000
	2	.00063	.00117	.20018750	.20096875
	3	.00066	.00120	.20018750	.20096875
	4	.00066	.00120	.20018750	.20096875
	5	.00064	.00120	.20021875	.20096875
	6	.00064	.00119	.20021875	.20100000
	7	.00061	.00117	.20021875	.20096875
139	1	-.00103	-.00058	.20031250	.20103125
	2	-.00100	-.00056	.20031250	.20106250
	3	-.00102	-.00058	.20028125	.20103125
	4	-.00106	-.00061	.20037500	.20103125
	5	-.00103	-.00062	.20031250	.20106250
	6	.00172	.00214	.20031250	.20103125
	7	.00173	.00216	.20028125	.20100000
148	1	.00033	.00075	.20034375	.20112500
	2	.00034	.00073	.20037500	.20109375
	3	.00033	.00075	.20034375	.20112500
	4	.00033	.00078	.20034375	.20106250
	5	.00033	.00077	.20034375	.20109375

TABLE 4-21

C-MODE TIME WORD STATISTICS
(Times in Secs)

Op	Frm	Fiducial Exposure Time	Starboard (+y) Shutter Times 1/2 Open	1/2 Closed	Total	Port (-y) Shutter Times 1/2 Open	1/2 Closed	Total
150	1	28.99259				29.02463	31.28266	2.25803
	2	49.03878				49.07081	51.32881	2.25800
	3	69.08494				69.11697	71.37500	2.25803
	4	89.13109				89.16312	91.42116	2.25804
	5	109.17728				109.20931	111.46734	2.25803
	6	129.22347	129.25550	131.51366	2.25816	129.25550	131.51350	2.25800
	7	149.26963	149.30166	151.55981	2.25815	149.30166	151.55966	2.25800
151	1	21.28291	21.31494	23.57303	2.25809	21.31494	23.57294	2.25800
	2	41.32906	41.36109	43.61922	2.25813			
	3	61.37522	61.40725	63.66538	2.25813			
	4	81.42138	81.45341	83.71156	2.25815			
	5	101.46756	101.49959	103.75772	2.25813			
	6	121.51372	121.54575	123.80388	2.25813			
	7	141.55991	141.59194	143.85006	2.25812			
	8	161.60606	161.63809	163.89622	2.25813			

4.3 MISSION FRAME COVERAGE AND STATISTICS

In order to provide a more comprehensive data package for each mission of the mapping camera system, illustrations of the mapping, charting, and geodetic (MC&G) requirements, the 90 to 100 percent clear trilap frame coverage, and a historical record of frame coverage are presented in Table 4-22 and on Figures 4-29 to 4-31.

TABLE 4-22

MISSION FRAME COVERAGE STATISTICS

Mission Number	1205-5	1206-5	1207-5
Unique Trilap MC&G Coverage (Acceptable)	2,700*	2,400	2,600
Unique Mono or Bilap MC&G Coverage (Unacceptable)	1,400	1,300	
Redundant Coverage Within a Mission	70	150	
Redundant Mission to Mission Coverage		160	

*Thousands of Square Nautical Miles

NOTE: FIGURE 4-29 ON PAGE 4-59 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT

NOTE: FIGURE 4-30 ON PAGE 4-60 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT

NOTE: FIGURE 4-31 ON PAGE 4-61 HAS BEEN INTENTIONALLY WITHDRAWN FROM THIS REPORT

SECTION V

CONCLUSIONS, RECOMMENDATIONS, AND ACTION ITEMS

5.1 CONCLUSIONS

5.1.1 Operations

Mission 1207, utilizing camera system SN 004, was operational for the total mission time of 58 days. The performance of both stellar and terrain units was comparable to past missions and satisfied the requirements for mensuration. The stellar light leak was the only anomaly affecting mission objectives. The successful engineering operation using 3414 film has extended the capability and versatility of the ST system.

Subjective and objective analyses of exposure levels acquired on terrain 3400 film have shown that exposure times were correct and are within the camera/algorithm accuracies. Exposure times used for 3414 photography were also judged to be correct.

The data generated for the 1207 mission performance report (MPR) represented the most accurate and complete compilation to date.

5.2 RECOMMENDATIONS

5.2.1 Mission 1208 Exposure

Exposure recommendations applied to 1207 should also be used for mission 1208.

5.2.2 "Forced" Process of 3401

The advantages observed from increasing the sensitivity of 3401 film, used for terrain starfield calibration, warrants continued use of this special process.

5.2.3 Extended Terrain Exposure Time for In-flight Starfield Calibration

An increase in exposure time by approximately one stop combined with the increased transmission gained by using a W-12 (equivalent) filter (effective mission 1209) should result in an adequate display of stars up to and including 5th magnitude images.

5.2.4 2403 Film (Terrain Calibrate Mode)

Since the results of this film have been unsatisfactory, 2403 will be eliminated from future flight loads (1209 and subsequent).

5.3 ACTION ITEMS

5.3.1 Mission 1206 and 1207 Calibration

Evaluate and compare the terrain star imagery acquired on these flights and determine for each:

a. The total number and magnitude of star images acquired on a typical frame.

b. That distribution and number of stars is adequate for distortion and/or knee angle calibration; if not, what distribution is required.

5.3.2 1207 ST Anomalies

Telemetry and operational problems encountered during this mission are addressed in individual failure reports and are currently under investigation and analysis under the program failure report system.

5.4 USE OF OTHER FILMS

5.4.1 3414 Film for Terrain Load

Useful data was obtained from the special test conducted on mission 1207. Additional data that will be acquired on 1208 should support the present conclusion that using 3414 film with a W-12 (equiv.) filter and extended operational exposure times on mission 1209 will improve terrain camera performance.

5.4.2 3400 Film for Primary Load on Stellar Camera

The 3400 tag-on used on 1207 was not recovered. Additional tests should be continued to provide the exposure information that is necessary before committing this film as the primary load for the stellar unit.

APPENDIX A

LIST OF ABBREVIATIONS

A mode	Ascent operation
APSA	Auxiliary payload structure assembly
AWAR	Area weighted average resolution
B mode	Backup operation
C mode	Calibrate operation
C/MM	Cycles per millimeter
C&S	Control and synchronization
DBS	Doppler beacon system
D-log E curve	Sensitometric response of film to light. Plot of density to log exposure
DMA	Defense Mapping Agency
DN	Duplicate negative
DP	Duplicate positive
EDAP	Electrical distribution and power
FMC	Forward motion compensation
FPA	Flight profile addendum
GMT/Z	Greenwich mean time
GRD	Ground resolved distance
IMC	Image motion compensation
LDR	Leader
MC	Mapping camera
MCD	Material change detector
MISEA	Main instrument system electronics assembly
MOP	Manual operation
MPR	Mission performance report
ON	Original negative
PFA	Post flight analysis
PMS	Pressure makeup system
REV	Orbital revolution
RTC	Real time command
RV	Recovery vehicle
SBA	Satellite basic assembly
SEQ	Sequence
SOLO	System engineering tests after last RV recovery
ST	Stellar terrain camera
SV	Satellite vehicle
SVT	Satellite vehicle time
TM	Telemetry
TU	Takeup unit
USGS	United States Geological Survey
VEM	Visual edge match

APPENDIX B

COMMAND SEQUENCE DEFINITIONS

Sequence Number	Descriptive Title	Purpose
148	Backup off command	For operations over real time station (RTS). Automatically calls seq. 150.
149	Instrumentation on Redundant off	Primary sequence for operations not over RTS. Includes instrumentation, tape recorder, and redundant off commands. Automatically calls seq. 150.
150	Normal operating sequence	Redundant seq. that controls ST operations.
151	V/H update	Update exposure and V/H during an ST operation.
152	B mode backup off	Used over RTS. Same as seq. 148 except it automatically calls seq. 153 when B mode is required.
153	Operation — B mode	Replaces seq. 150 when operating in B mode.
380	ST calibration	Used for in-flight starfield calibration.