HANDLE VIA TALENT-KEYHOLE CONTROL SYSTEM ONLY

Post Flight Analysis Report

MISSION 1208-5

ICL-TCS-2013-74

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POST FLIGHT ANALYSIS
REPORT NO. 1208-5/74

POST FLIGHT ANALYSIS REPORT

MISSION 1208-5

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ICL-TCS-2013-74
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PUBLICATION REVIEW

This report has been reviewed and is approved.

William Howell Jr.
PFA Chairman

FOREWORD

This report was prepared for and by direction of the Director, Program A, and constitutes Volume III of the Final Mission Report.

The preparation, collection, and reduction of 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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SECTION I

SUMMARY

1.1 INTRODUCTION

This report details the technical evaluation of Stellar Terrain (ST) system SN 006 launched on 10 April 1974 (mission 1208) and recovered 9 June 1974. Significant aspects of the ST test and integration, satellite vehicle performance, post-recovery handling, and mapping suitability of the product are also included. Camera data, mission statistics, and recovery data are summarized in Tables 1-1, 1-2, and 1-3.

1.2 CAMERA OPERATIONS AND PERFORMANCE

This ST System, the fourth flown, was fully operational and anomaly free for 60 days on orbit, making it the longest and most successful mission flown to date. Post flight analyses conducted at the processing site, the Contractor's facility, and Defense Mapping Agency Topographic Center have shown that mission objectives were met with a high level of success. The terrain imagery was comparable to the best of past missions and an adequate distribution of sixth magnitude stars was acquired on the stellar frames. The ancillary data generated by both units was acceptable.

As on mission 1207, a 30-foot length of EK 3414 was "tagged on" to the terrain film supply for special engineering tests. The results of these tests support the decision to use EK 3414 as the primary load on 1209.

Weather conditions for the first half of the mission were generally good. However, as the mission progressed, weather conditions deteriorated resulting in 30 percent or more cloud cover on approximately 25 percent of all terrain frames.

1.3 IMAGE QUALITY

The majority of the terrain photography was good and appeared consistent throughout the flight. The average resolution derived by VEM analysis was 60 l/mm. Stellar imagery was good for both plus and minus Y units. On evaluated frames, each camera recorded between 75 and 100 star images.

1.4 EXPOSURE

Density measurements made at the processing facility indicated exposure levels for 1208 were correct. Essentially, exposure levels were the same for missions 1206, 1207, and 1208.

1.5 THERMAL PROFILE

There were no thermal control problems. Paint patterns, the same as those on 1207, provided excellent thermal distribution on the MISEA and EDAP assemblies.

1.6 PRESSURE PROFILE

Average chute pressure stabilized at 22 micrometers, a decrease of approximately 20 micrometers from the average level of mission 1207. This decrease was planned in order to supply pressure levels that were compatible with corona-free pressures experienced during ground testing. A maximum of 47 micrometers and a minimum of 10 micrometers were recorded during the flight.

1.7 CALIBRATE MODE OPERATION

Calibration was conducted on revs 965/966. Four separate calibration operates were programmed at 20-degree intervals using 3401 film in the terrain camera. Analysis of the star imagery and calibration potential of this operation is in process.

1.8 SUMMARY OF ANOMALIES

There were no ST anomalies.

TABLE 1-1

CAMERA STATISTICS

Camera Designations	Terrain		+Y		-Y
Focal length, inches	12.0772		9.9784		9.9780
Filter type	WR-21		None		None
Reseau S/N	012		029		024
Lens S/N	006		012		005
Supply spool S/N	094			107	
Supply film weight, pounds	58.03			10.99	
Film data					
Type, terrain	3400	MCD	3414	MCD	3401
Length, feet	3301	2.0	30	2.0	30
Type, stellar	3401		3400		
Length, feet	1966		100		

TABLE 1-2

MISSION STATISTICS

Mission number	1208
Satellite Vehicle	SV-8
Launch date	10 April 1974
Launch time	2020 GMT
Orbit inclination	94.52 degrees
Initial perigee	85.55 nautical miles
Initial apogee	164.73 nautical miles
Argument of perigee	141.36 degrees
Initial period	89.01 minutes
Range of photo altitudes (approx)	86-117 nautical miles
Range of sun angles	16-86 degrees

TABLE 1-3

RECOVERY STATISTICS

Recovery date	9 June 1974
Recovery time	2231 GMT
Recovery rev	973
Comment	Routine air catch

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 3 April 1973 through 11 April 1973. Upon completion of the calibration, the unit was shipped to the Integrating Contractor on 12 April 1973 for integration and test prior to flight.

Starting on 13 April 1973 and continuing through 3 May 1973 activities necessary to prepare the ST for mating with the structural assembly, 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.

The light leak test results showed a leak in the vicinity of the terrain supply gasket. Light leak retest, to verify correction of the gasket leak, was completed successfully on 25 June 1973. On 27 June 1973 the stellar transport was returned to the manufacturer for investigation of a current anomaly in the press motor. The terrain thermal shutter, shutter cards and Electrical Distribution and Power (EDAP) assembly were replaced with updated, test qualified components.

Approximately 16 weeks were required to complete module level tests prior to mating the Mapping Camera Module (MCM) with the satellite basic assembly (SBA). The data from these tests serve as baselines throughout the remainder of the integration cycle. By 23 July 1973, all anomalies were corrected; functional tests, light leak tests, film tracking, and roller pinning were completed successfully. Mating of the MCM with the SBA was accomplished on 30 July 1973.

Performance and acoustic tests were completed without anomalies and preparations were started 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 cameras. 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 successfully from 11 October to 24 October 1973. On completion of the A-1 test, the vehicle was moved into the A-2 chamber for further vacuum testing. These tests were completed on 3 November 1973 and the film was retrieved for evaluation.

Evaluation of corona/pressure data showed a wide pressure range (10 to 50 micrometers) that permitted acceptable corona marking operation of the stellar and terrain units. An orifice was selected for the pressure range that exhibited minimal corona marking.

Following completion of the A-2 chamber tests, it was necessary to remove and/or replace a number of subassemblies and Main Instrument System Electronics Assembly (MISEA) cards. MISEA cards A-37 and A-46 were replaced due to potential problems related to end cap installation on the 10K-ohm resistors. Cards A-31, A-32, and A-33 (terrain platen press) were returned to the manufacturer for modification. The terrain platen press was removed to replace the press switch and adjust the platen travel/return spring for correct press operation. An occasional phase lock drop out of the rotary shutter, while changing commands during operation, required demating of the camera unit from the structural assembly and removing the rotary shutter for investigation. An extensive analysis of the phase lock problem proved inconclusive and the original rotary shutter was reinstalled in the system. (There was no loss of rotary shutter phase lock during mission operations.) The stellar transport was removed to correct a sticking press condition and the terrain thermal door assembly was replaced due to worn drive gears.

Since extensive changes and repairs had been carried out following the chamber test, the decision was made to run a special vacuum test in the A-1 chamber. The chamber test and additional confidence tests were completed on 27 January 1974.

On 30 January 1974 the MCM was again mated to the SBA and flight loading was completed on 31 January 1974.

The vehicle was shipped to the launch base on 12 March 1974.

While at the base, it was necessary to remove the terrain supply on two occasions to allow work on the pressure makeup system (PMS). The final confidence run was conducted and launch occurred on 10 April 1974.

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 006 is detailed in the following reports:

1. Acceptance Test Report ST Subsystem, CEI System Assembly Number 152000G4, SN 006, 4 May 1973.
2. Addendum I, Acceptance Test Report (Flight Readiness Report), CEI System Assembly Number 152000G4, SN 006, 30 January 1974.
3. Addendum II, Acceptance Test Report (Flight Readiness Report), CEI System Assembly Number 152000G4, SN 006, 15 May 1974.
4. Calibration Test Report Mapping Camera SN 006, 30 May 1973.
5. Acceptance Test Data, Mapping Camera SN 006, 27 June 1973.

TABLE 2-1

INTEGRATION/TEST SUMMARY

Activity	Completed
Received system	12 April 1973
Reworked plus and minus Y shutter cams (FSB 098, 099)	13 April 1973
Reworked A-3, A-5 cards on U transport to correct broken terminals	16 April 1973
Received U/D supply and takeup	23 April 1973
Started receiving inspection and test	26 April 1973
Reworked W-11 TB-3 buss bar ass'y. (temp. sensors)	27 April 1973
Conducted confidence run	28 April 1973
Changed "select at test" resistor on D takeup servo amp	30 April 1973
Installed unit in structural assembly	3 May 1973
Tracking and alignment/roller pinning	15 May 1973
Changed A-52 card to updated configuration (FSB 114)	15 May 1973
Conducted confidence and live run	15 May 1973
Removed U supply and U servo electronics/out of spec torque conditions	21 May 1973
Cleaned U reseau	24 May 1973
Replaced EDAP with updated unit	6 June 1973
Installed U supply and U servo electronics	11 June 1973
Completed alpha test (light leak)	12 June 1973
Installed D thermal shutter and cards (FSB 124)	15 June 1973
Changed select at test resistor on A-31 card	19 June 1973
Reworked A-31 card to repair open trace	20 June 1973
Conducted confidence run	20 June 1973
Conducted MCM functional test	22 June 1973
Special alpha test to verify correction of light leak around D supply gasket	25 June 1973
Cleaned reseau	25 June 1973
Installed special temp sensor on D window (FSB 085, 126)	26 June 1973
Returned U transport to manufacturer for press motor investigation	27 June 1973
Received U transport and conducted evaluation (FSB 127)	20 July 1973
Conducted confidence run	23 July 1973
Mated MCM to SBA	30 July 1973
Removed U transport to be used temporarily on SV-7 during vacuum chamber test	20 August 1973

TABLE 2-1

INTEGRATION/TEST SUMMARY (CONT.)

Activity	Completed
Removed connections on RT-11 to eliminate 4K short	10 September 1973
Calibrated EDAP (FSB 030A)	10 September 1973
Installed U transport from SV-9 on SV-8 (temporary) (FSB 115, 139)	10 September 1973
Conducted SV performance test	12 September 1973
Completed acoustic test	21 September 1973
Selected resistors for U reseau illumination	24 September 1973
Conducted modified MCM performance test	4 October 1973
Conducted prechamber confidence test	10 October 1973
Completed vacuum chamber test (A-1)	24 October 1973
Completed vacuum chamber test (A-2)	3 November 1973
Demated MCM/SBA for SRV rework	5 November 1973
Applied thermal paint on MISEA (FSB 108)	8 November 1973
Installed A-37, A-46 to replace cards with suspect 10K resistors	12 November 1973
Demated SRV	13 November 1973
Replaced D platen press switch (FSB 144)	15 November 1973
Remated SRV	3 December 1973
Checked film alignment and system operation	3 December 1973
Completed alpha test	4 December 1973
Shipped D platen press, A-31, A-32, and A-33 cards to manufacturer for mods	4 December 1973
Shorted out failsafe switch on U transport	5 December 1973
Removed D supply for use with SV-10 (temporary)	11 December 1973
Reworked harness for D platen press pot telemetry (FSB 150)	13 December 1973
Installed D platen press, A-31, A-32, and A-33 cards	17 December 1973
Removed D transport to check operation of platen press	
Reinstalled D transport and performed confidence test	18 December 1973
Removed D transport to check D platen press return spring	
Changed resistors on A-69, A-72 for reseau illumination and fiducials	19 December 1973
Temporary installation of MISEA from SN 001 to investigate rotary shutter phase lock problem	2 January 1974
Returned original MISEA to system	5 January 1974
Demated system from structural assembly	

TABLE 2-1

INTEGRATION/TEST SUMMARY (CONT.)

Activity	Completed
Installed new rotary shutter assembly (temporary)	
Mated system to structural assembly	
Demated system from structural assembly	
Installed original rotary shutter	7 January 1974
Mated system to structural assembly	
Removed D transport and D platen press for D reseau cleaning	
Conducted modified functional test	
Replaced U transport with SN 002 (SV-10) for investigation of platen press problem on SN 006	8 January 1974
Mated MCM to SV-8	9 January 1974
Conducted vehicle performance test	10 January 1974
Replaced D thermal shutter to correct drive gear problem	19 January 1974
Reinstalled original U transport	19 January 1974
Calibrated D platen press pot telemetry	19 January 1974
Completed special vacuum chamber test (A-1) to test system changes	24 January 1974
Repeated special vacuum chamber test—first test aborted due to PMS malfunction	26 January 1974
Inspected D thermal shutter drive gears	27 January 1974
Conducted special light leak check of film chute	27 January 1974
Mated MCM to SBA	28 January 1974
Conducted modified performance test	30 January 1974
Completed flight loading	31 January 1974
Eliminated tripped heater zone 14	15 February 1974
Completed preship test of system and film load	
Shipped to launch base	12 March 1974
Removed D supply for PMS inspection	30 March 1974
Reinstalled D supply and conducted 14 frame confidence from T and C	1 April 1974
Conducted 2-frame confidence from PADPAC	1 April 1974
Removed D supply for PMS inspection	2 April 1974
Reinstalled supply and conducted confidence run from T and C	2 April 1974
Conducted confidence from PADPAC	3 April 1974
Conducted 2-frame OP (R-1)	7 April 1974
Launched	10 April 1974

2.1.2 Preflight Resolution Testing (Manufacturing Facility Only)

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/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 006 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. 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 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 006 (SV-8) and SN 004 (SV-7).

1. A telemetry potentiometer and redesigned microswitches were installed on the terrain platen press.
2. Redesigned gears and push rods were installed on the stellar platen press.
3. Redesigned microswitches were installed on the terrain thermal door.

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 predictions, fixed camera parameters, and selection criteria contained in the orbital software data base.

The ST system was operated on 171 revs between rev 2 and rev 966. A total of 2,045 frames were exposed in the terrain camera and a corresponding number of frame pairs were exposed in the stellar unit. Included were 18 frames of EK 3414 in the terrain camera for engineering purposes and 20 frames in each camera for in-flight stellar calibration. Film consumption versus rev and days on orbit is plotted in Figure 2-1.

The 18 frames of EK 3414 were included in the terrain camera load to obtain empirical exposure data. These data, combined with additional information from 1207, will be used to establish exposure requirements for the terrain camera on mission 1209 with 3414 as the primary load.

During the runout sequence, a special tag end of EK 3400 was exposed to judge this film's potential as the primary load in the stellar camera system. All the film was recovered successfully and evaluation of the imagery acquired on the 3400 film is in process. 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.

2.2.1 Launch and Orbital Conditions

The launch of 1208 took place on the first countdown attempt. Planned and achieved orbital parameters are listed in Table 2-5.

TABLE 2-2

CATU AND RTU RESOLUTION, C/MM

CATU			RTU		
-X/0.85	0	+X/0.85	-X/0.85	0	+X/0.85
42	57	47	48	59	46

TABLE 2-3

FILM RECOVERY SUMMARY

Rev	Operate	Frames Operated	Frames Recovered	Comments
1-948	197	2,005	2,100	Includes 95 frames operated prior to launch
954	198	6	6	3414 operates (includes MCD)
955	199	10	10	
958	200	4	4	
965	201	7	7	3401 calibrate (includes MCD)
	202	4	4	
966	203	5	5	
	204	4	4	
968	205	10	10	B mode to clear tag end of terrain film
969	206	210	210	Stellar only—runout

FILM CONSUMPTION/REVS

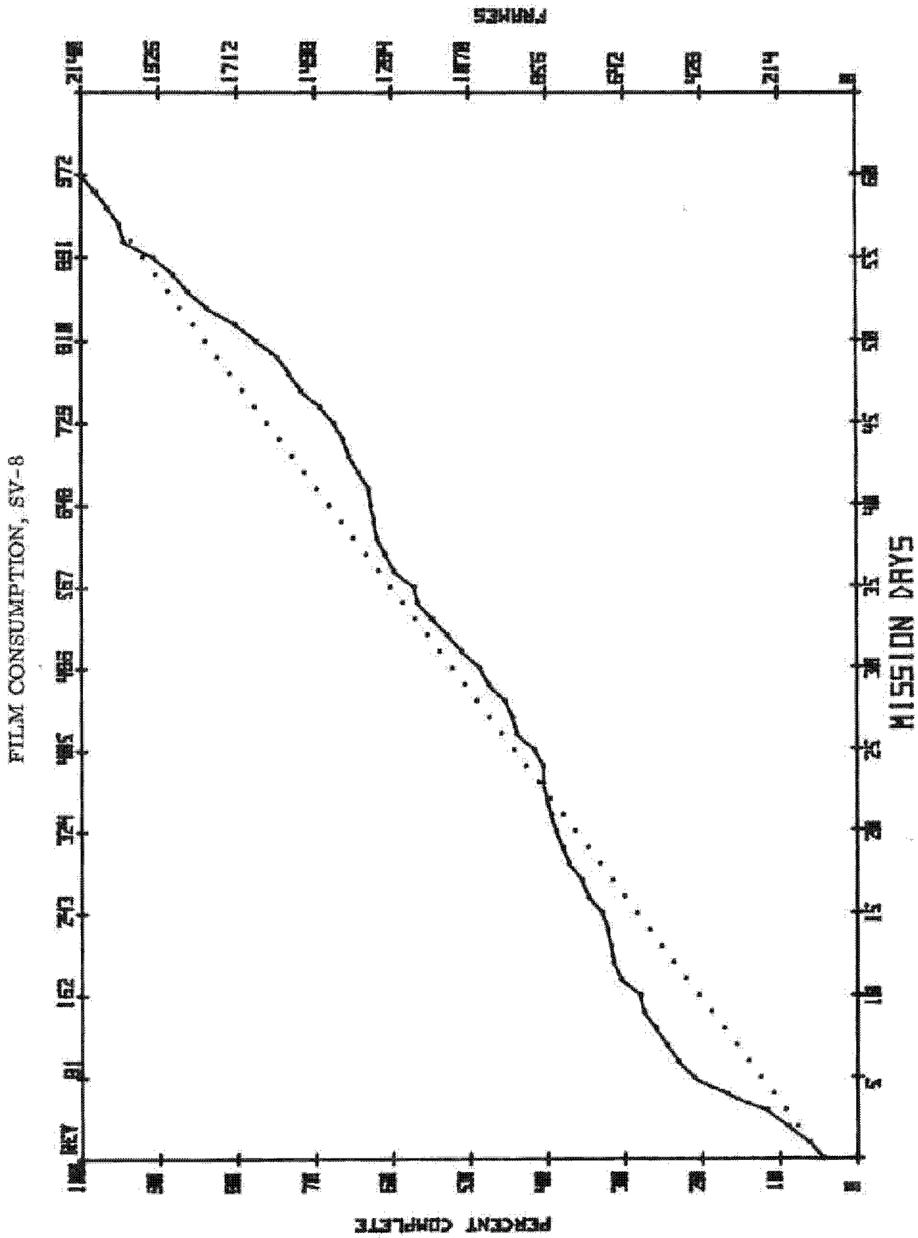


FIGURE 2-1

SATELLITE VEHICLE (92.5-NM NOMINAL ALTITUDE)

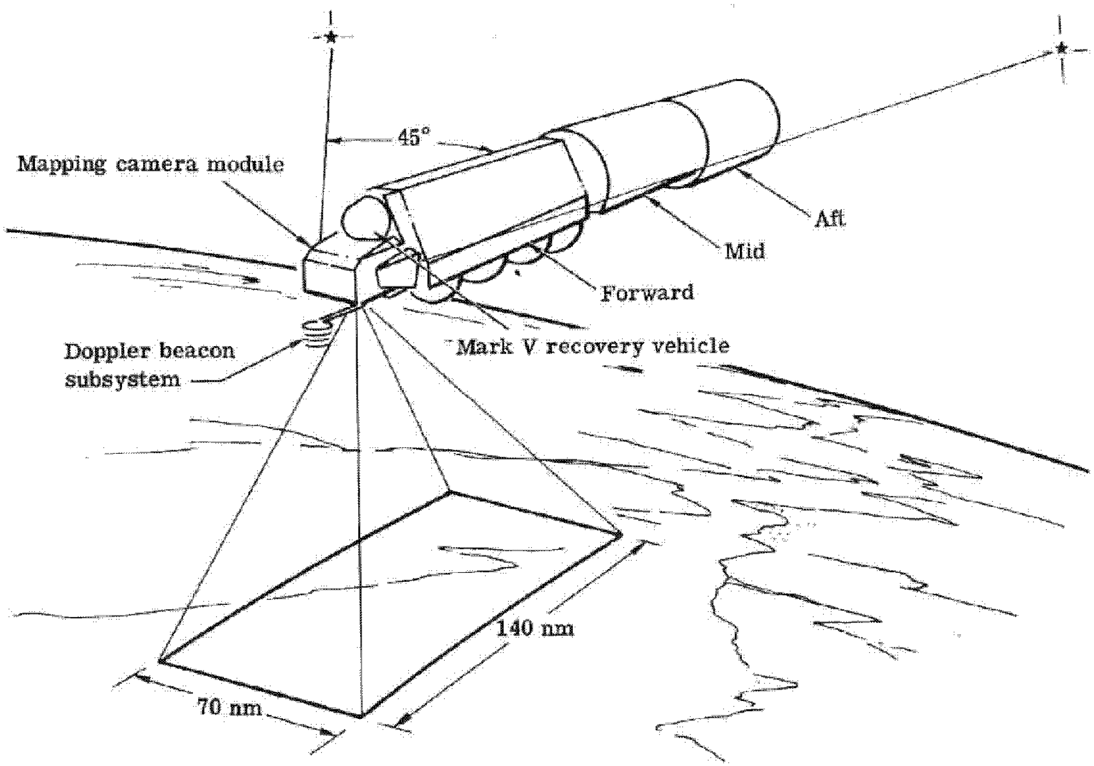
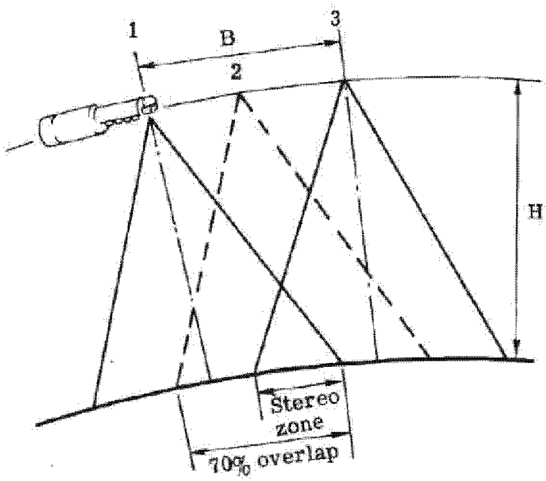


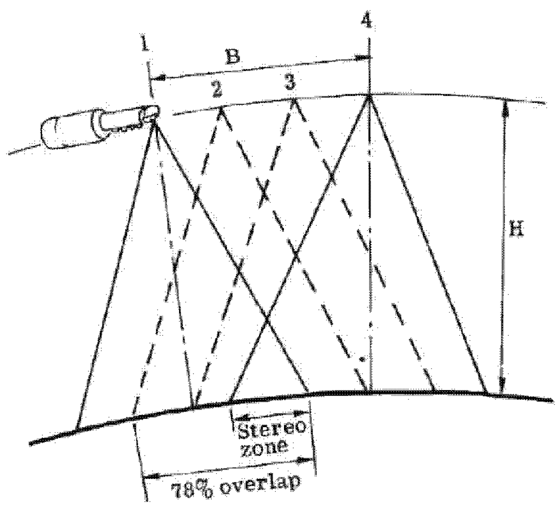
FIGURE 2-2

MAPPING CAMERA OVERLAP/STEREO



Triple overlap; B/H = 0.9

(80 < H < 240 nm)

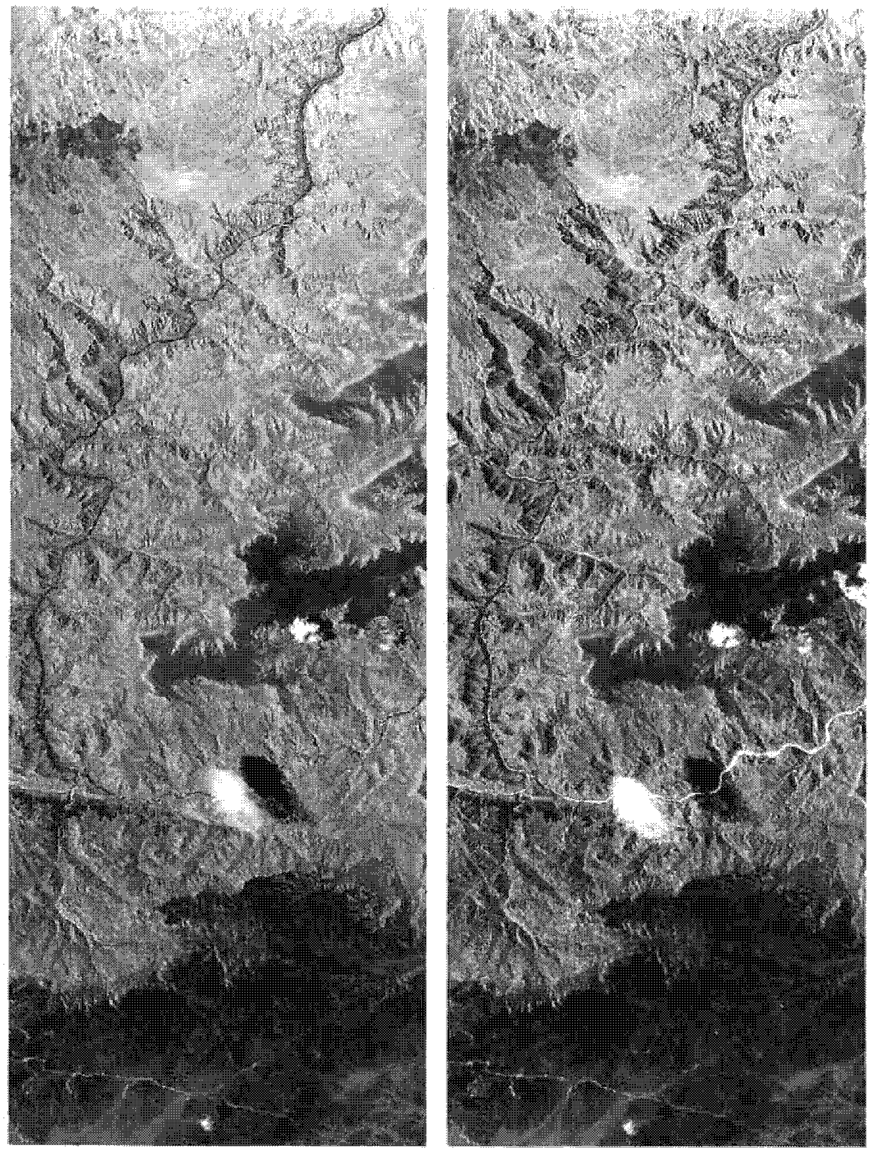


Quadruple overlap; B/H = 1.0

(100 < H < 240 nm)

FIGURE 2-3

EXAMPLE OF STEREO PAIR



Terrain camera: Op 061; frames 003 and 004; Colorado River, Lake Mead National Park, Arizona; contact print

FIGURE 2-4

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)

TABLE 2-5

PLANNED VERSUS ACTUAL ORBITAL PARAMETERS

	Planned	Actual
Launch time (GMT)	2020-2040	2020
Launch time (SVT)	—	73200.7
Inclination, degrees	94.51	94.52
Initial perigee, nautical miles	84.94	85.55
Initial apogee, nautical miles	162.22	164.73
Argument of perigee, degrees	149.7	141.36
Initial period, minutes	89.0	89.01
Beta angle control, degrees	+30 – (–) 8	Achieved

TABLE 2-6

SUMMARY OF SIGNIFICANT EVENTS

(SV-8, SN 006)

For sequence number identification, see Appendix

Rev	Activity	Event	Comments
—	Ascent	A mode	No anomalies
2	Photography	Sequence 149	Health check with programmed ocean photography
48	Photography	Sequence 148	Bar XC acquisition
129	Photography	Sequence 148	Bar XC acquisition
388	Photography	Sequence 148	Bar XC acquisition
566	Photography	Sequence 148	Bar XC acquisition
954	Photography	Sequence 149	3414 engineering
955	Photography	Sequence 149	3414 engineering
958	Photography	Sequence 149	3414 engineering
965	Photography	Sequence 380	ST in-flight calibration (4 operates)
969	Film runout	Sequence 149	Successful stellar film runout event
973	RV 5 recovery	—	Successful air recovery of RV 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 and special nonphotographic events that occurred during the mission.

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, while the supply cassettes and the take-ups are controlled by virtue of their location within the passively controlled MCM and RV. The MISEA and EDAP are controlled by proper selection of external thermal finishes 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 blanket to reduce heat losses. A number of different heater zones are used for 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 stable throughout the mission, showing only slight deviations.

Following on-orbit stabilization, the terrain camera average temperature was steady at 73.3°F, while the stellar camera unit stabilized at 73.8°F. Average temperatures for the MISEA and EDAP units were approximately 2 degrees and 3 degrees, respectively, lower than those recorded on 1207.

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

It was determined from ground test data that the best operating pressure to minimize corona marking during flight was between 10 and 30 micrometers. Average operational pressure following stabilization was 22 micrometers. A high pressure of 47 micrometers for a single frame of an operate was recorded on rev 7, while the lowest pressure recorded was 10 micrometers on rev 965. As mission life progressed, the difference between the lowest pressure, which typically occurs on the first frame of an operate, and the highest pressure, decreased. Table 2-10 indicates typical pressures recorded for this flight.

MISSION 1208 AVERAGE SYSTEM TEMPERATURE

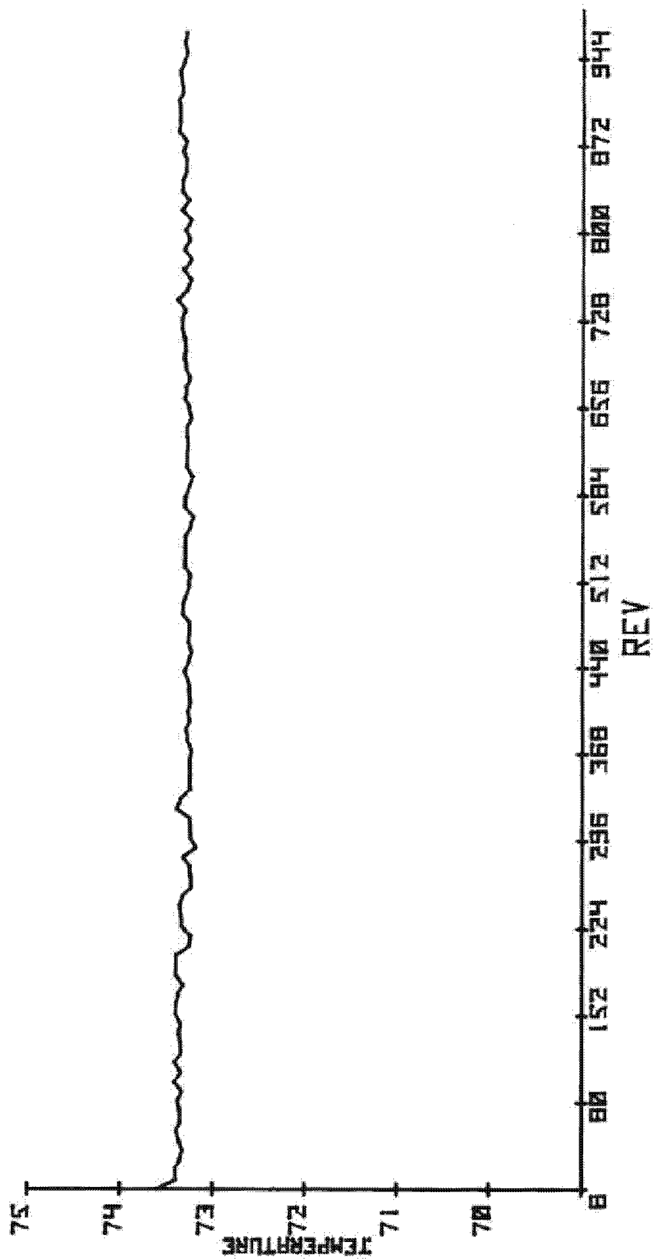


FIGURE 2-5

MISSION 1208 TYPICAL TEMPERATURE DISTRIBUTION ON ORBIT

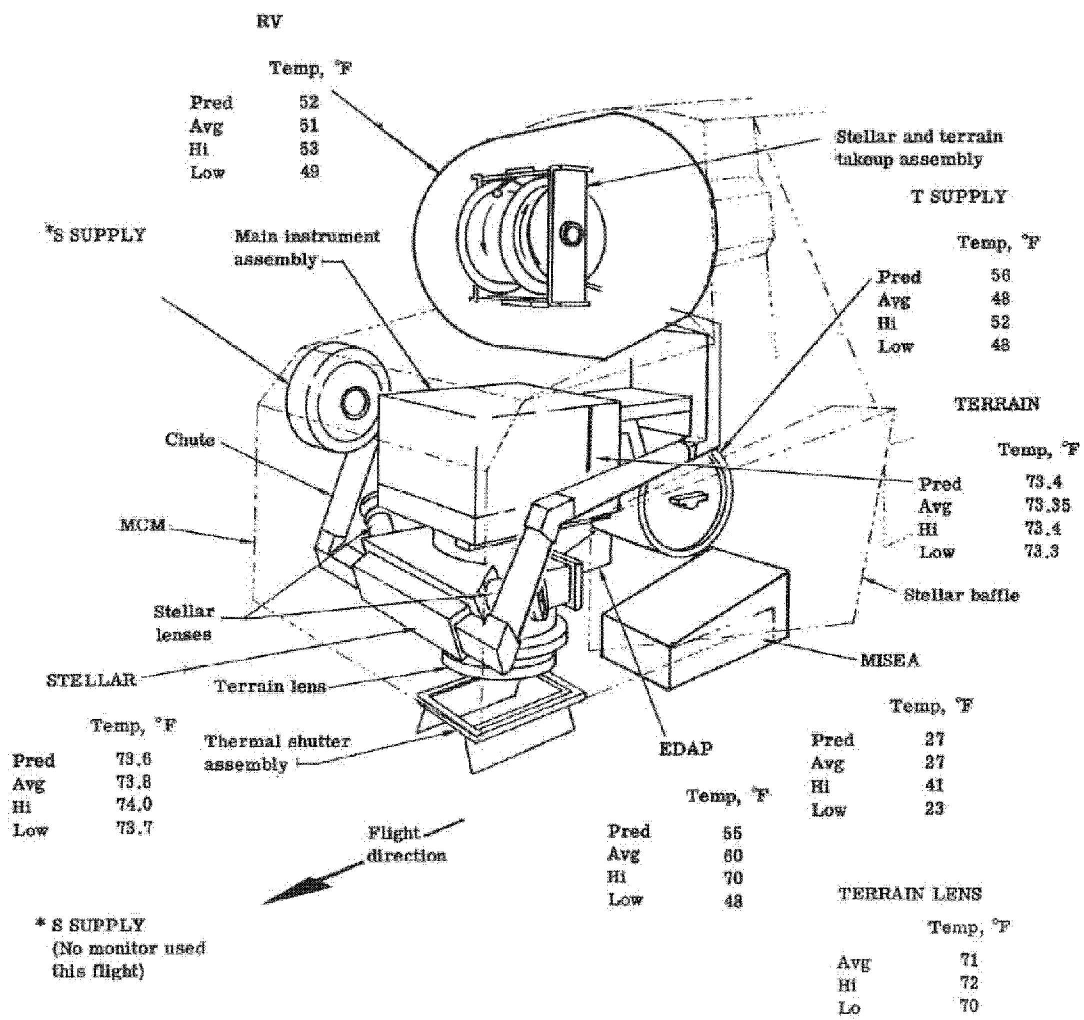


FIGURE 2-6

TABLE 2-7

SV-8 ORBIT TEMPERATURES (°F) REV 132-POGO

Rev Seg.	Main Inst. Avg.	+Y Avg.	-Y Avg.	EDAP Avg.	MISEA Avg.	D Supply	D Wind.	T/U	Lat.
132.3	73.4	73.8	73.8	57	23	48	71	53	73.9N
132.4	73.4	73.8	73.8	66	24	48	71	53	43.5N
132.5	73.3	73.8	73.7	67	26.5	48	71	53	12.5N
132.6	73.3	73.8	73.8	68	29	48	71	53	18.4S
132.7	73.3	73.8	73.8	70	30	48	71	53	59.0S
132.8	73.3	73.8	73.7	60	30	48	71	53	85.4S
132.9	73.4	73.8	73.8	55	29.5	48	71	53	50.8S
133.0	73.4	73.8	73.7	55	27	48	71	53	11.1S
133.1	73.4	73.8	73.8	52	25	48	71	53	18.9N
133.2	73.4	73.8	73.8	48	23	48	71	53	59.1N
Avg.	73.4	73.8	73.8	60	27	48	71	53	

TABLE 2-8

SV-8 ORBIT TEMPERATURES (°F) REV 457-POGO

Rev Seg.	Main Inst. Avg.	+Y Avg.	-Y Avg.	EDAP Avg.	MISEA Avg.	D Supply	D Wind.	T/U	Lat.
456.3	73.3	73.8	73.7	62	24	48	70	51	47.8N
456.4	73.3	73.8	73.8	63	24	48	70	51	45.0N
456.5	73.3	73.8	73.7	65	27	48	71	51	10.4N
456.6	73.3	73.8	73.7	67	30	48	71	51	26.7S
456.7	73.3	73.8	73.7	66	31	48	71	51	62.9S
456.8	73.3	73.8	73.7	56	31	48	71	51	77.9S
456.9	73.3	73.8	73.7	53	30	48	71	51	42.9S
457.0	73.3	73.8	73.7	53	27	48	70	51	8.2S
457.1	73.3	73.8	73.7	51	26	48	70	51	27.1N
457.2	73.3	73.8	73.7	52	24	48	70	51	63.8N
Avg.	73.3	73.8	73.7	58.8	27.4	48	70.5	51	

TABLE 2-9

SV-8 ORBIT TEMPERATURES (°F) REV 910-POGO

Rev Seg.	Main Inst. Avg.	+Y Avg.	−Y Avg.	EDAP Avg.	MISEA Avg.	D Supply	D Wind.	T/U	Lat.
909.5	73.4	73.9	73.8	70	37	52	71	50	10.7N
909.6	73.4	74.0	73.8	71	38	52	71	50	26.3S
909.7	73.4	73.9	73.8	67	39	52	71	50	62.4S
909.8	73.4	73.9	73.8	58	41	52	71	50	80.4S
909.9	73.4	74.0	73.8	54	38	52	71	50	45.8S
910.0	73.4	74.0	73.8	54	36	52	71	50	10.0S
910.1	73.4	74.0	73.8	52	34	52	70	50	26.2N
910.2	73.4	74.0	73.9	52	32	52	70	50	62.6N
Avg.	73.4	74.0	73.8	60	37	52	71	50	

TABLE 2-10

PRESSURE SUMMARY/1208
(Micrometers)

Rev	Max	Min	Avg
7	47	22	35
240	25	24	24
480	23	19	23
718	23	19	22
958	23	19	22
965	22	10	21

Stellar corona-free window—<30 micrometers
Terrain corona-free window—<70 micrometers

2.2.5 Image Quality

Using copies supplied by the processing facility, an extensive evaluation of all mission 1208 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 1208 was comparable to preflight test in quality. Composites of 10× imagery from missions 1205/1206 and 1207/1208 are shown in Figures 2-7 and 2-8, respectively. There were no unusual variations in image quality across the format, or in photography acquired at the start and at the end of the mission. Figure 2-9 is a contact print of typical 3400 film imagery.

A subjective evaluation of the 3414 engineering test, conducted at the processing site by the PFA team and at the contractor's facility, showed the test to be highly successful. The imagery on 3414 was judged to be significantly better than imagery on 3400. A level of performance of approximately 90 to 100 1/mm was achieved; however, it is important to note that the sampling was small (18 frames) 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.

Data acquired from 3414 engineering tests during missions 1207 and 1208 provide empirical support for using 3414 as the primary load on 1209 and subsequent missions.

Figure 2-10 is a contact print and Figures 2-11 through 2-13 are prints at 20× and 40× magnification taken from a segment of frame 004, Op 199.

The stellar imagery from both units was considered good to excellent with an adequate distribution of sixth magnitude starts. Figures 2-14 and 2-15 show examples of variations in star images acquired on a stellar format.

Exposure

The exposure algorithm, essentially the same as used on 1206 and 1207, resulted in correct exposure of the majority of operational photography. 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. These data will be used to adjust the exposure algorithm for 3414 film and a WR-12 filter which will be used on mission 1209.

~~TOP SECRET RUFF NOFORN~~

POST FLIGHT ANALYSIS
REPORT NO. 1208-5/74

COMPOSITE OF MISSIONS 1205-5 AND 1206-5

Terrain camera: 1205-5—Op 152; frame 004/1206-5—Op 054; frame 003;
Luke AFB, Phoenix, Arizona; 10× enlargement*

*Image size is a function of altitude.

FIGURE 2-7

~~TOP SECRET RUFF NOFORN~~

ICL-TCS-2013-74

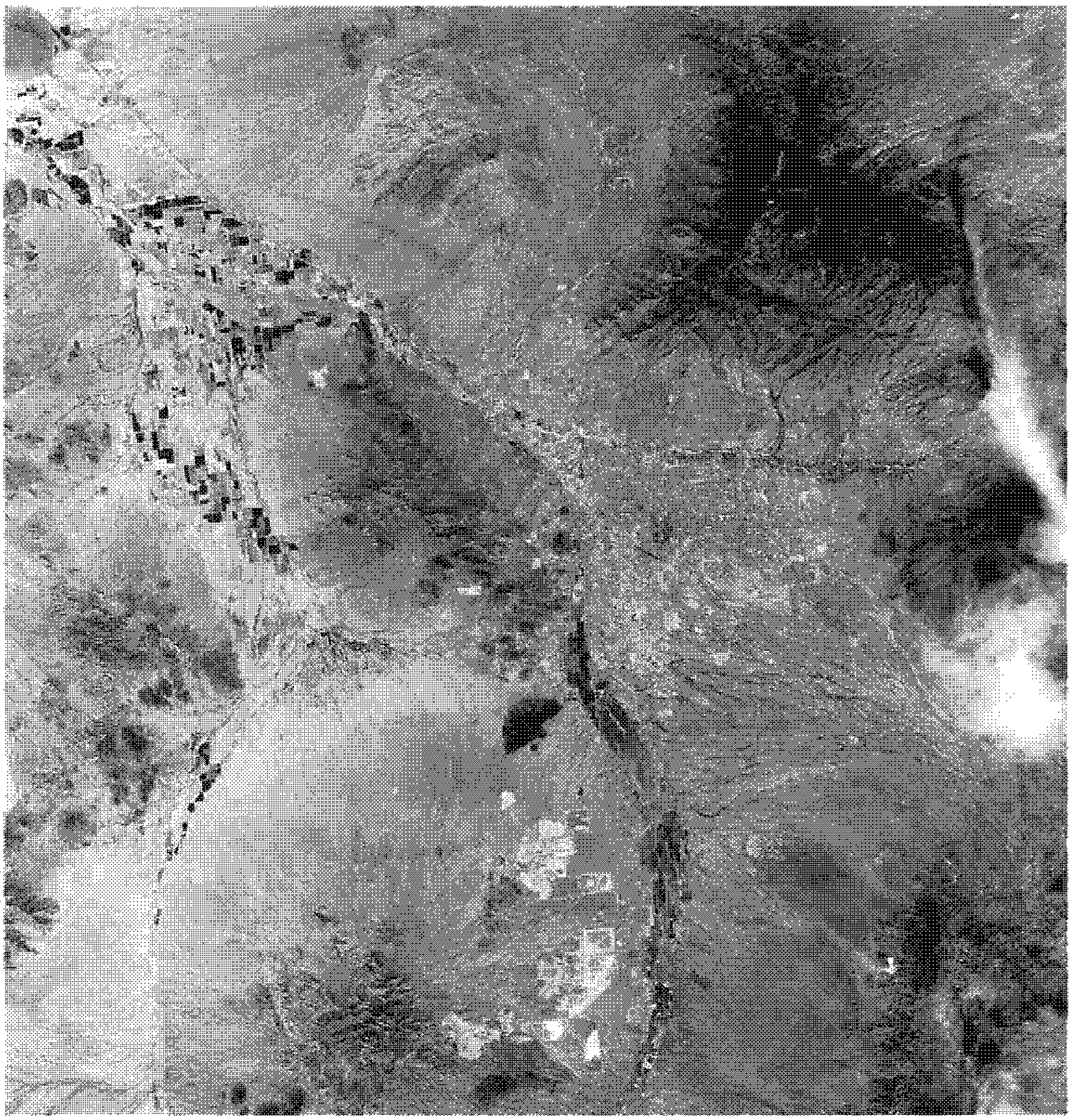
HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

COMPOSITE OF MISSIONS 1207-5 AND 1208-5

Terrain camera: 1207-5—Op 076; frame 006/1208-5—Op 037; frame 006;
Davis Monthan AFB, Tuscon, Arizona; 10× enlargement*
*Image size is a function of altitude.

FIGURE 2-8

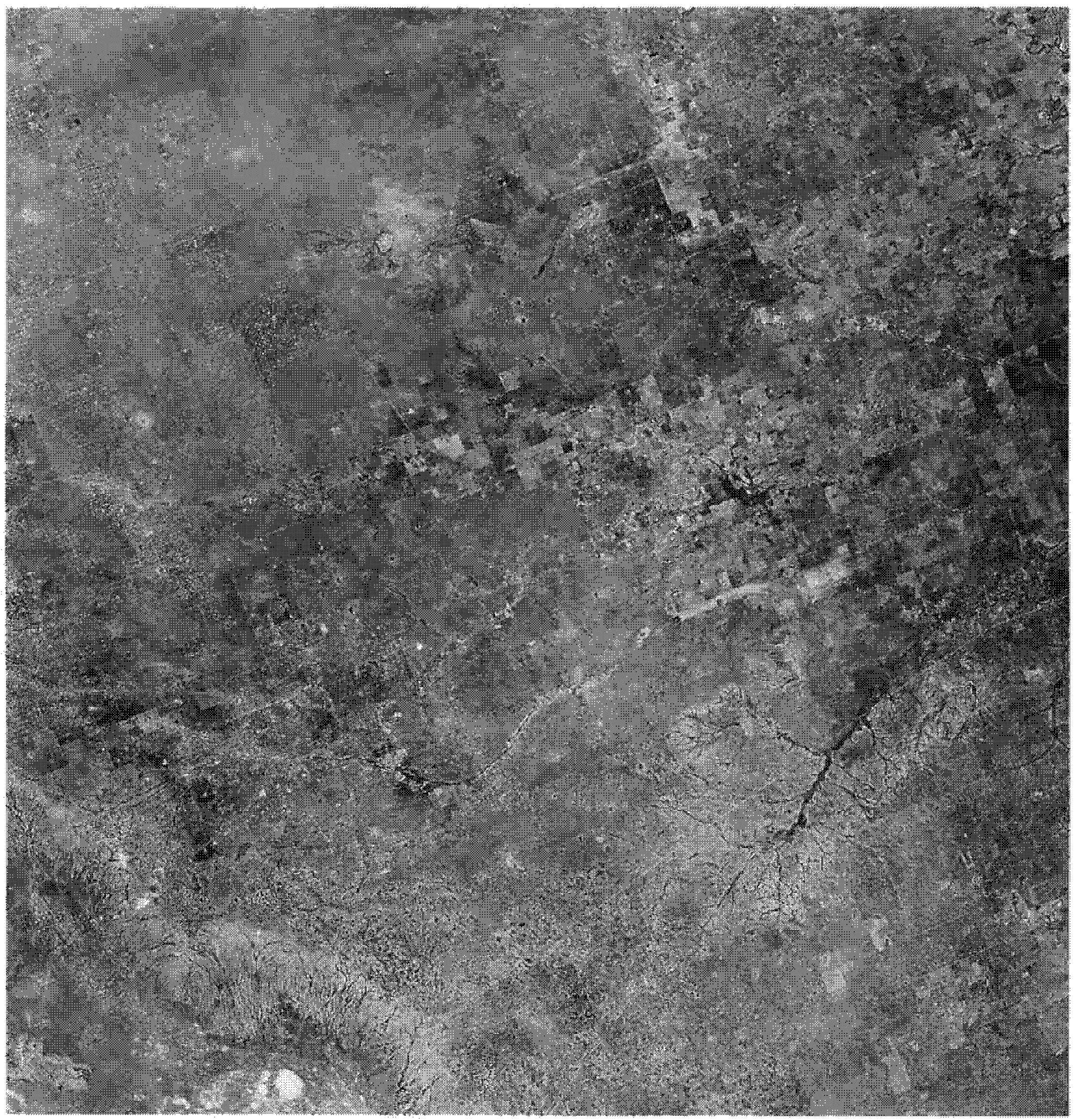
TYPICAL TERRAIN IMAGERY — MISSION 1208



Terrain camera; Op 037; frame 006; Tucson, Arizona; contact print

FIGURE 2-9

EXAMPLE OF 3414 TERRAIN PHOTOGRAPHY



Terrain camera: Op 199; frame 004; Midland/Odessa, Texas; contact print

FIGURE 2-10

~~TOP SECRET-RUFF NOFORN~~

POST FLIGHT ANALYSIS
REPORT NO. 1208-5/74

EXAMPLE OF 3414 TERRAIN PHOTOGRAPHY

Terrain camera: Op 199; frame 004; Midland, Texas; 20× enlargement

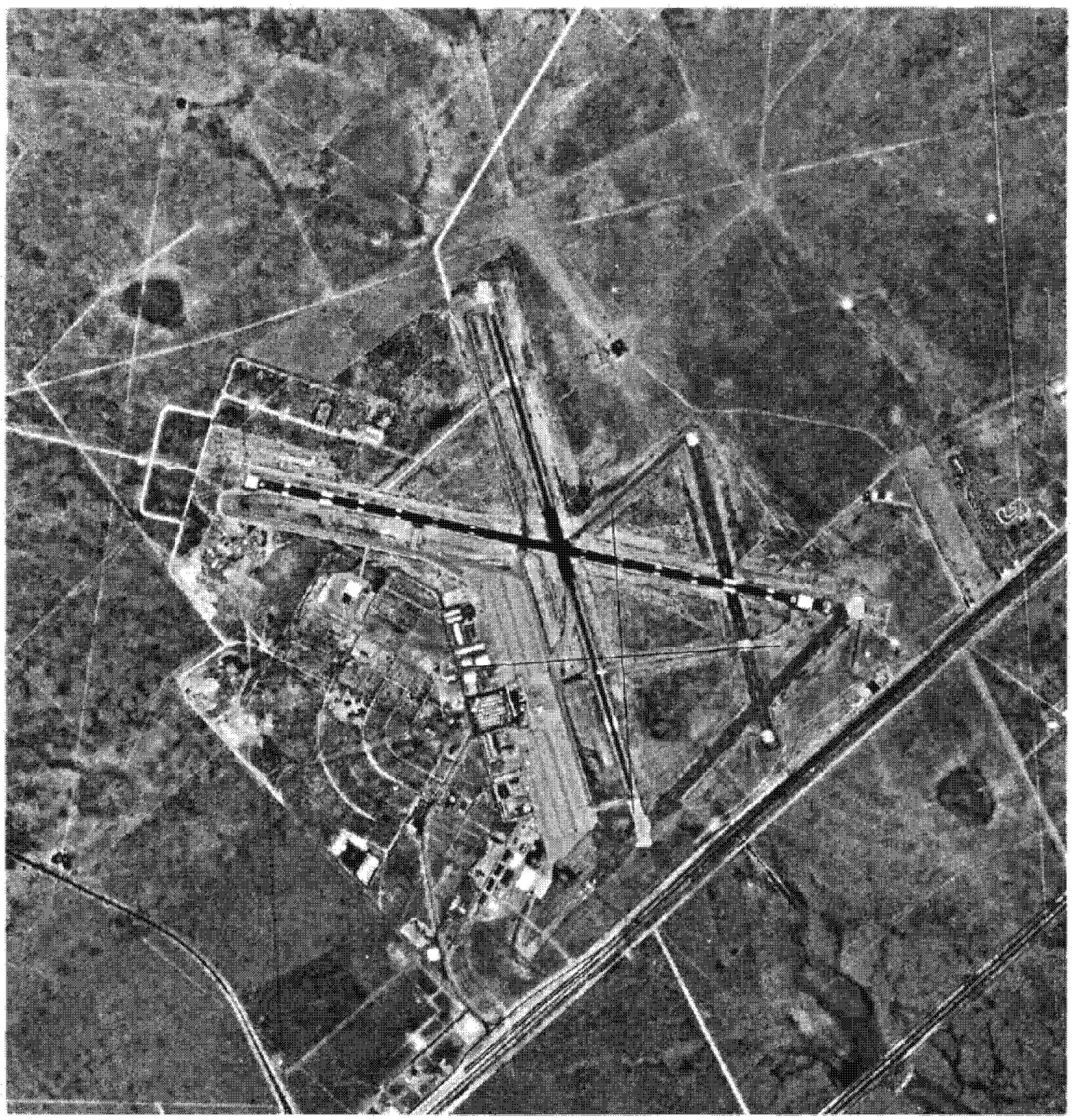
FIGURE 2-11

~~TOP SECRET-RUFF NOFORN~~

ICL-TCS-2013-74
HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

~~TOP SECRET-RUFF NOFORN~~

EXAMPLE OF 3414 TERRAIN PHOTOGRAPHY



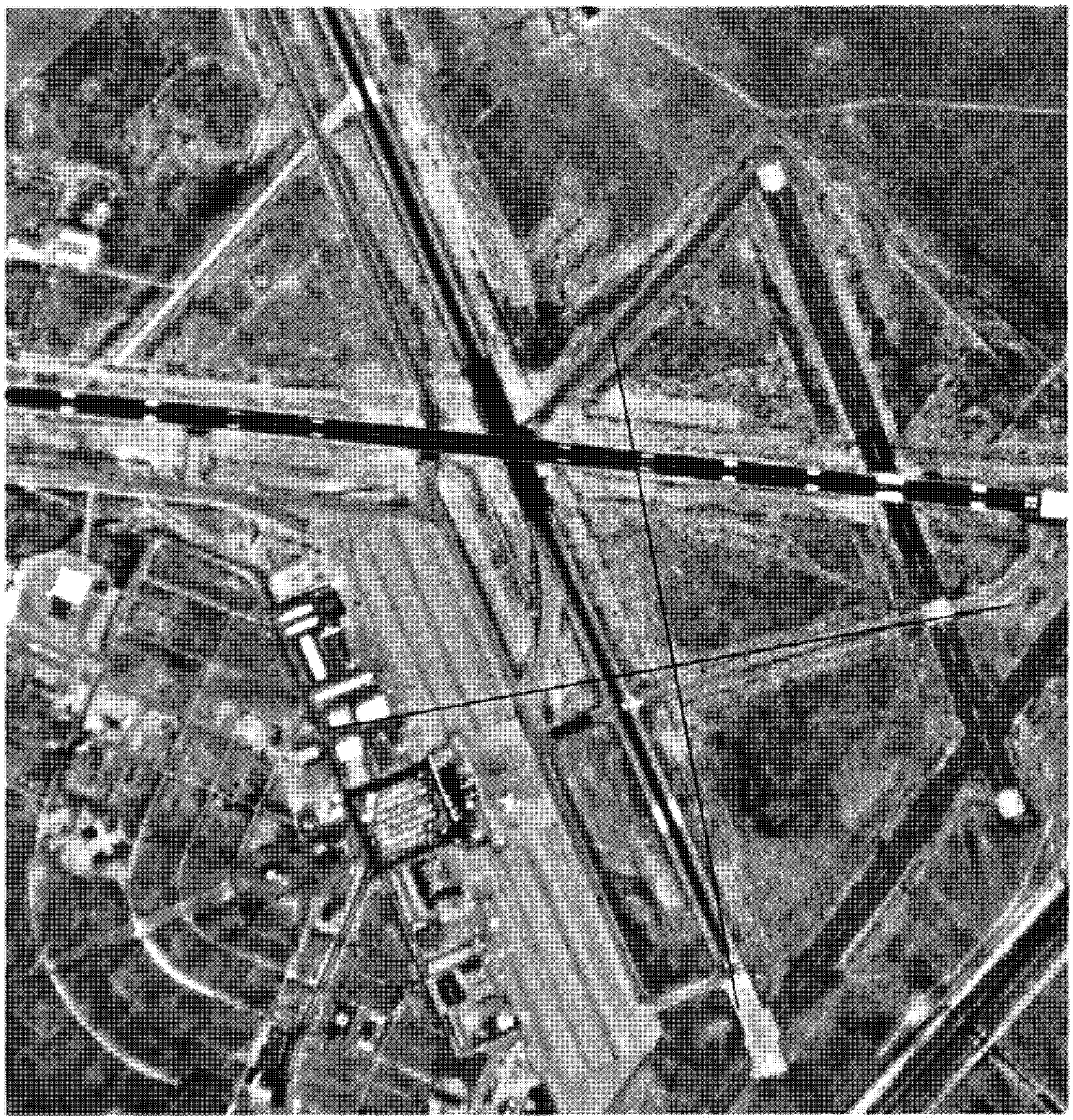
Terrain camera: Op 199; frame 004; Midland Air Terminal, Texas; 20× enlargement

FIGURE 2-12

~~TOP SECRET-RUFF NOFORN~~

HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

EXAMPLE OF 3414 TERRAIN PHOTOGRAPHY



Terrain camera: Op 199; frame 004; Midland Air Terminal, Texas; 40× enlargement

FIGURE 2-13

TABLE 2-11

3414 EXPOSURE VALUES

Rev	Start Sun Angle	End Sun Angle	Exposure Time, ms
954	75	71	5.7
955	69	73	6.5/11.6
958	46	48	12.6

Image Analysis Using VEM

VEM analysis was conducted using a matrix calibrated for duplicating film type SO-467. Terrain camera film from missions 1207 and 1208 was duplicated on SO-284. The processing facility has shown only minor differences in the characteristics of these two materials that should not invalidate the VEM analysis. The average VEM resolution read by PFA Team members (Contractor and DMATC personnel) was 60 l/mm.

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 four separate operations at the end of mission 1208. 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. Evaluation is currently in process to determine the calibration potential of the star imagery.

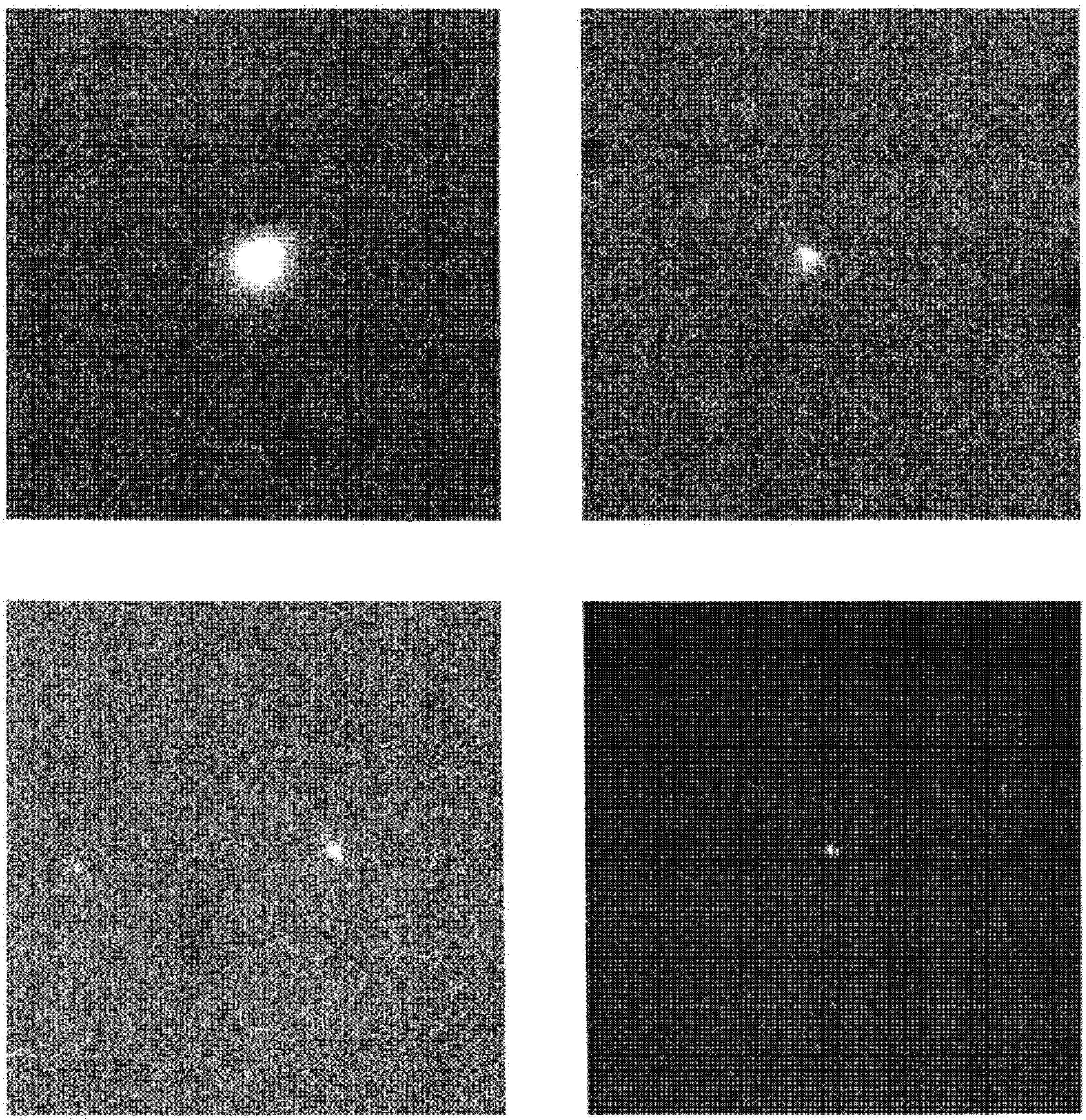
2.2.7 Anomalies—Telemetry

There were no telemetry anomalies.

2.2.8 Anomalies—System

There were no system anomalies.

EXAMPLE OF STELLAR PHOTOGRAPHY

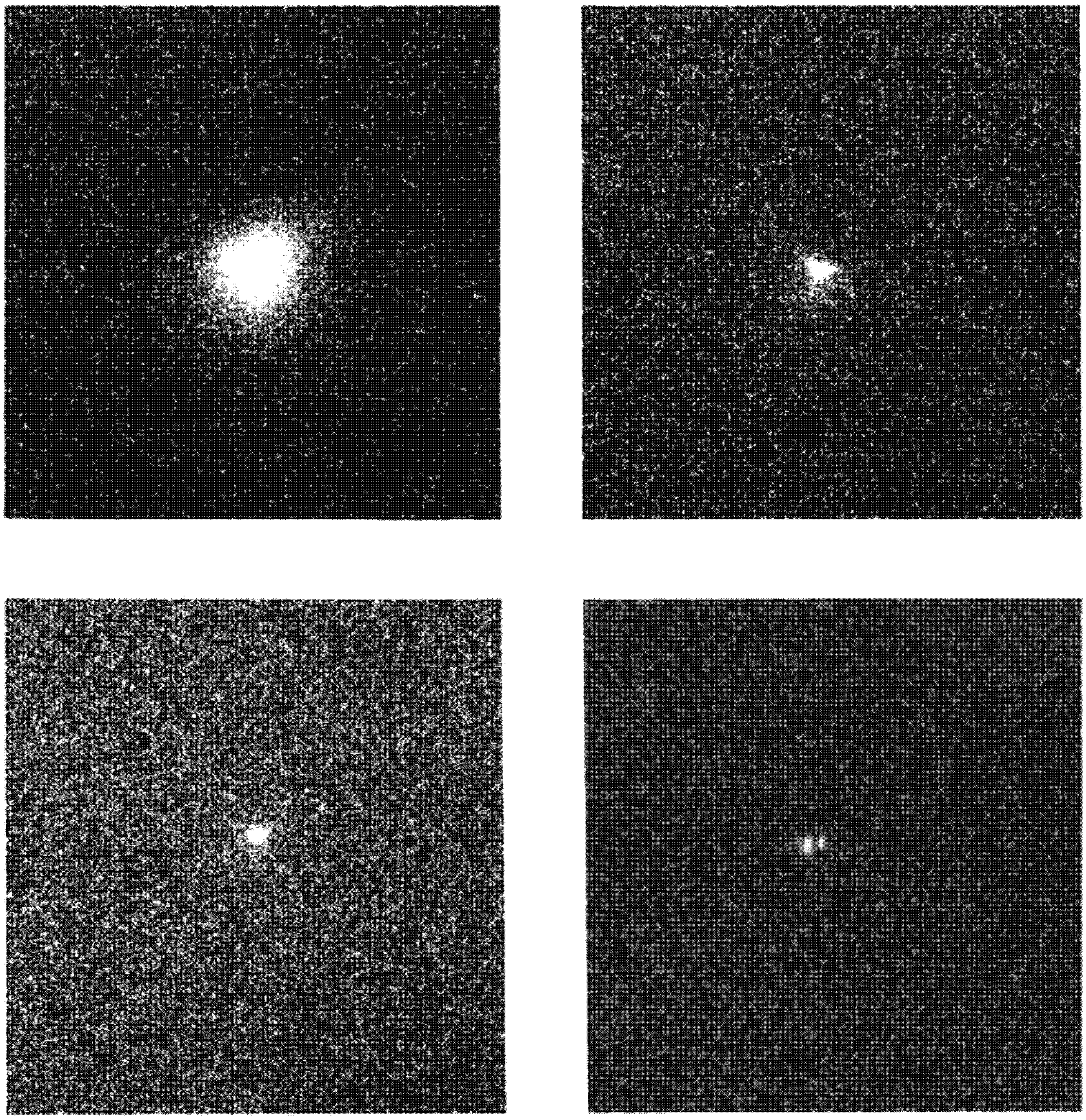


Stellar camera: 20x enlargements of stellar images

FIGURE 2-14

POST FLIGHT ANALYSIS
REPORT NO. 1208-5/74

EXAMPLE OF STELLAR PHOTOGRAPHY



Stellar camera: 40× enlargements of stellar images

FIGURE 2-15

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.

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 analytical 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 solo operations scheduled for mission 1208 were programmed to verify the contingency capabilities and exercise the 10 percent and 78 percent overlap options. A summary of all solo activities is presented in Table 2-13.

2.3.1 Significant Solo Activities

On three occasions the terrain thermal door failed to respond to an emergency open command during solo operations. The first two commands were given with a standard emergency sequence while the third command was pulsed twenty times. Thermal door functions in the normal mode continued to execute properly. This failure is similar to the emergency command failure during solo operations of mission 1207 and both are under investigation. The remainder of the solo activities programmed for this operation were completed successfully.

TABLE 2-12

MISSION SUMMARY

Revs Successful Operate		Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
		1			1	
2	Op 1					2 fr op—Health check
		3-5			3	
6	Op 2					19 fr
7	Op 3					16 fr
		8-9			2	
10	Op 4					18 fr
		11-18			8	
19	Op 5					6 fr
20	Op 6					17 fr
21	Op 7					10 fr
22	Op 8					8 fr
		23-35			13	
36	Op 9					15 fr
		37			1	
38	Op 10					7 fr
	Op 11					6 fr
		39-41			3	
42	Op 12					30 fr
43	Op 13					14 fr
		44-47			4	
48	Op 14					9 fr—Bar XC
		49-51			3	
52	Op 15					10 fr
53	Op 16					16 fr
54	Op 17					20 fr
55	Op 18					16 fr
		56-57			2	
58	Op 19					25 fr
59	Op 20					15 fr
	Op 21					13 fr
		60-68			9	
69	Op 22					20 fr
		70			1	

TABLE 2-12

MISSION SUMMARY (CONT.)

Revs Successful Operate		Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
71	Op 23					14 fr
	Op 24					15 fr
		72			1	
73	Op 25					15 fr
		74-75			2	
76	Op 26					7 fr
		77-84			8	
85	Op 27					12 fr
		86			1	
87	Op 28					10 fr
		88			1	
89	Op 29					13 fr
		90-104			15	
105	Op 30					7 fr
106	Op 31					14 fr
		107			1	
108	Op 32					6 fr
	Op 33					6 fr
		109-116			8	
117	Op 34					17 fr
		118-119			2	
120	Op 35					12 fr
		121-127			7	
128	Op 36					6 fr
129	Op 37					9 fr
		130-132			3	
133	Op 38					4 fr
		134-135			2	
136	Op 39					15 fr
		137-148			12	
149	Op 40					8 fr
		150-165			16	
166	Op 41					15 fr
		167			1	
168	Op 42					17 fr

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
169 Op 43					14 fr
170 Op 44					9 fr
	171-180			10	
181 Op 45					7 fr
182 Op 46					5 fr
	183-186			4	
187 Op 47					8 fr
	188-199			12	
200 Op 48					7 fr
	201-217			17	
218 Op 49					9 fr
	219-229			11	
230 Op 50					7 fr
	231			1	
232 Op 51					7 fr
	233-239			7	
240 Op 52					7 fr
	241-247			7	
248 Op 53					5 fr
Op 54					8 fr
	249			1	
250 Op 55					8 fr
Op 56					11 fr
	251-262			12	
263 Op 57					7 fr
	264-265			2	
266 Op 58					10 fr
	267-280			14	
281 Op 59					21 fr
282 Op 60					17 fr
	283-290			8	
291 Op 61					5 fr
	292-300			9	
301 Op 62					12 fr
	302-312			11	

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
313 Op 63					13 fr
	314-315			2	
316 Op 64					5 fr
	317-330			14	
331 Op 65					14 fr
	332-342			11	
343 Op 66					12 fr
	344-362			19	
363 Op 67					9 fr
	364-387			24	
388 Op 68					9 fr—Bar XC
	389-393			5	
394 Op 69					7 fr
395 Op 70					9 fr
	396-411			16	
412 Op 71					5 fr
Op 72					24 fr
413 Op 73					10 fr
414 Op 74					10 fr
	415-428			14	
429 Op 75					11 fr
	430-442			13	
443 Op 76					9 fr
	444			1	
445 Op 77					11 fr
	446-459			14	
460 Op 78					15 fr
461 Op 79					12 fr
Op 80					9 fr
462 Op 81					9 fr
	463-476			14	
477 Op 82					8 fr
478 Op 83					12 fr
	479			1	

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
480 Op 84					5 fr
	481-486			6	
487 Op 85					8 fr
	488-490			3	
491 Op 86					16 fr
	492			1	
493 Op 87					15 fr
494 Op 88					10 fr
	495			1	
496 Op 89					11 fr
	497-509			13	
510 Op 90					18 fr
511 Op 91					6 fr
Op 92					6 fr
512 Op 93					5 fr
	513-523			11	
524 Op 94					8 fr
Op 95					9 fr
525 Op 96					10 fr
	526			1	
527 Op 97					10 fr
	528-540			13	
541 Op 98					8 fr
542 Op 99					6 fr
Op 100					6 fr
543 Op 101					11 fr
544 Op 102					10 fr
	545-558			14	
559 Op 103					8 fr
	560			1	
561 Op 104					7 fr
	562-565			4	
566 Op 105					12 fr—Bar XC
	567-570			4	
571 Op 106					6 fr
	572-573			2	

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
574 Op 107					15 fr
575 Op 108					8 fr
Op 109					9 fr
	576			1	
577 Op 110					13 fr
	578-589			12	
590 Op 111					9 fr
	591-596			6	
597 Op 112					10 fr
	598-606			9	
607 Op 113					6 fr
608 Op 114					9 fr
	609-624			16	
625 Op 115					7 fr
	626-636			11	
637 Op 116					10 fr
	638-656			19	
657 Op 117					6 fr
	658-668			11	
669 Op 118					9 fr
670 Op 119					9 fr
671 Op 120					8 fr
	672-684			13	
685 Op 121					7 fr
686 Op 122					6 fr
Op 123					9 fr
	687-688			2	
689 Op 124					6 fr
	690-691			2	
692 Op 125					8 fr
	693-700			8	
701 Op 126					8 fr
	702-713			12	
714 Op 127					5 fr
	715-717			3	

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
718 Op 128					20 fr
	719-733			15	
734 Op 129					18 fr
	735			1	
736 Op 130					9 fr
Op 131					6 fr
737 Op 132					6 fr
	738			1	
739 Op 133					8 fr
	740-747			8	
748 Op 134					7 fr
	749			1	
750 Op 135					10 fr
	751			1	
752 Op 136					10 fr
753 Op 137					9 fr
754 Op 138					8 fr
	755-766			12	
767 Op 139					9 fr
768 Op 140					7 fr
Op 141					7 fr
	769			1	
770 Op 142					9 fr
	771-778			8	
779 Op 143					8 fr
	780-783			4	
784 Op 144					13
	785			1	
786 Op 145					11 fr
	787-794			8	
795 Op 146					8 fr
	796-798			3	
799 Op 147					15 fr
800 Op 148					16 fr

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
801 Op 149					19 fr
	802-813			12	
814 Op 150					9 fr
815 Op 151					13 fr
816 Op 152					8 fr
Op 153					10 fr
	817			1	
818 Op 154					12 fr
Op 155					6 fr
819 Op 156					7 fr
Op 157					10 fr
	820-828			9	
829 Op 158					8 fr
	830			1	
831 Op 159					17 fr
Op 160					4 fr
832 Op 161					4 fr
833 Op 162					6 fr
	834			1	
835 Op 163					7 fr
Op 164					5 fr
Op 165					11 fr
	836-840			5	
841 Op 166					7 fr
	842-845			4	
846 Op 167					4 fr
847 Op 168					9 fr
	848			1	
849 Op 169					10 fr
	850			1	
851 Op 170					5 fr
Op 171					7 fr
Op 172					10 fr
	852-862			11	

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
863 Op 173					4 fr
	864-866			3	
867 Op 174					8 fr
Op 175					5 fr
868 Op 176					13 fr
Op 177					10 fr
	869			1	
870 Op 178					15 fr
	871-880			10	
881 Op 179					23 fr
	882-883			2	
884 Op 180					5 fr
Op 181					10 fr
	885-896			2	
897 Op 182					6 fr
	898			1	
899 Op 183					13 fr
Op 184					10 fr
Op 185					19 fr
900 Op 186					11 fr
Op 187					18 fr
Op 188					10 fr
	901-902			2	
903 Op 189					10 fr
	904-915			12	
916 Op 190					5 fr
Op 191					3 fr
	917-927			11	
928 Op 192					5 fr
929 Op 193					6 fr
	930-931			2	
932 Op 194					12 fr
	933-943			11	
944 Op 195					5 fr
	945			1	

TABLE 2-12
MISSION SUMMARY (CONT.)

Revs Successful Operate	Revs Able But No Operates	Revs/w Anom.	Revs Inhibit	Total Revs	Comments
946 Op 196					8 fr
	947			1	
948 Op 197					20 fr
	949			1	
	950-953			4	
954 Op 198					6 fr 3414 film
955 Op 199					10 fr 3414 film
	956-957			2	
958 Op 200					4 fr 3414 film
	959-964			6	
965 Op 201					7 fr } Calibrate mode
Op 202					4 fr } Calibrate mode
966 Op 203					5 fr } Calibrate mode
Op 204					4 fr } Calibrate mode
Op 205					12 fr Clear terrain film end
	967			1	
968 Op 206					10 fr } Run out
969 Op 207					215 fr } Run out

TABLE 2-13

SOLO OPERATIONS SUMMARY

Rev	Mode	Cycles	Comments
1327	Normal	4	Operation with redundant electronics
1344	Backup	5	Operations with converter 2 off
1345	Backup	5	Operations with converter 1 off
1345	Normal	4	Operation with converter 2 off
1345	Normal	4	Operation with converter 1 off
1361	Normal	4 & 18	Operations with terrain thermal shutter emergency open at the start and reset at the end
1458			Terrain thermal shutter emergency open
1477			Terrain thermal shutter emergency open-pulsing technique

SECTION III

PROCESSING AND REPRODUCTION

3.1 INTRODUCTION

This section, prepared by the Processing Facility, discusses defilming, processing, titling and reproduction of the mission 1208 Stellar and Terrain Camera original films.

3.2 RECEIVING AND DEFILMING

The RV arrived at the processing site in good condition at 1120 hours EDT, 10 June 1974. The antibackup solenoids on both the terrain and stellar takeups functioned properly. No static discharges were noted at any time and there were no problems during despooling. The total weight of the terrain and stellar payloads was 69 pounds.

3.3 PROCESSING AND OPTICAL TITLING

3.3.1 Processing

All operational camera records were processed on 10 and 11 June 1974. The 3400 terrain record was cut at the head of the processor on frame 4, Op 65 because of the inability of the titling equipment to maintain synchronization. After the problem was resolved, processing proceeded without incident. High base plus fog densities occurred on the Type 3401 stellar flight material (see Section 3.3.3). The 100 feet of Type 3400 film on the stellar roll was cut into four 25-foot sections for experiments in "forced" processing.

Processing data are presented in Tables 3-1 and 3-2 with corresponding sensitometric curves in Figures 3-1 through 3-7.

3.3.2 Optical Titling of Operational Film

71.8 percent of the terrain 3400 film was optically titled. The majority of the frames not optically titled were contained in the first 1,200 feet of imagery (Ops 1-64). The titling problem was caused by an electrical malfunction in the connection to the amplifier which interfaces with the frame mark detector in the optical titling hardware.

The stellar 3401 was not optically titled because of the inability to read frame marks at the point of detection (film $\approx 1/4$ processed). It appears that the delta density between the base plus fog and frame mark density was insufficient for detection by the optical titling equipment. The processing facility has taken the action to investigate the optical titling of 3401 film with high base plus fog densities.

TABLE 3-1

PROCESSOR AND DEVELOPER DATA

Camera	Film Segment	Processor	Developer
Stellar	3401	Yardleigh 6	17DN
	3400 (part 1)	Held unprocessed	
	3400 (part 2)	Dundee	27DN
	3400 (part 3)	Dundee	27DN
	3400 (part 4)	Dundee	17DN
Terrain	3400	Yardleigh 6	20DN
	3414	Viscous Fultron	19DN
	3401	Versamat	MX-689

TABLE 3-2

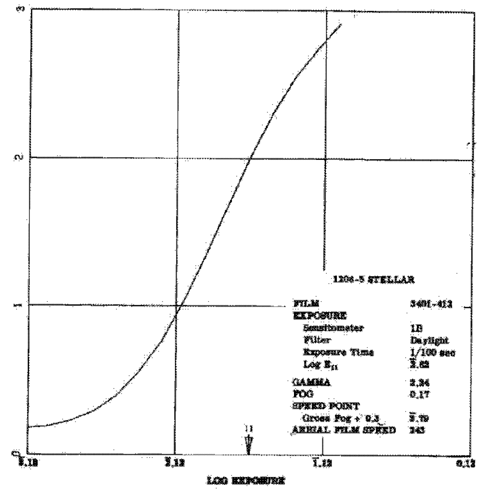
FRAME AND FOOTAGE DATA

	Stellar Camera	Terrain Camera
Operational frames	2,005 (pairs)	2,005
Other frames		
3400	85 (est.)	—
3401	135 (est.)	19
3414	—	18
MCD	—	3 (est.)
Footage		
Pre/post flight	N/A	N/A*
Operational		
3400	100	3,315
3401	1,980	30
3414	—	30

*Hand-made prelaunch splices were removed and not processed.

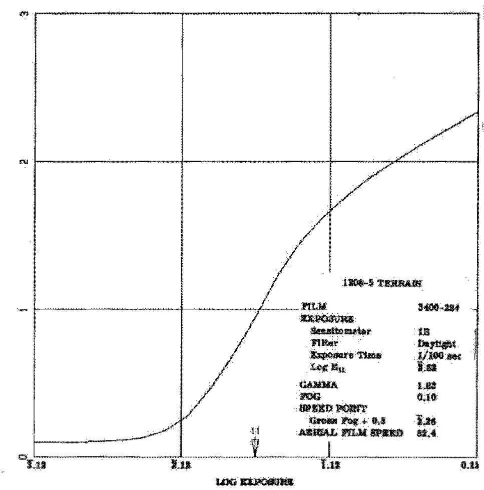
PROCESSING CURVE, STELLAR 3401 FILM

FIGURE 3-1



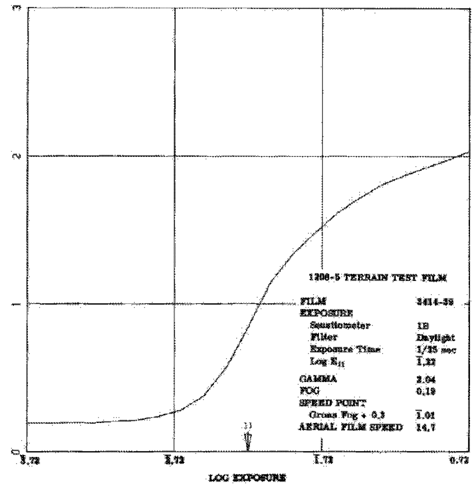
PROCESSING CURVE, TERRAIN, 3400 FILM

FIGURE 3-2



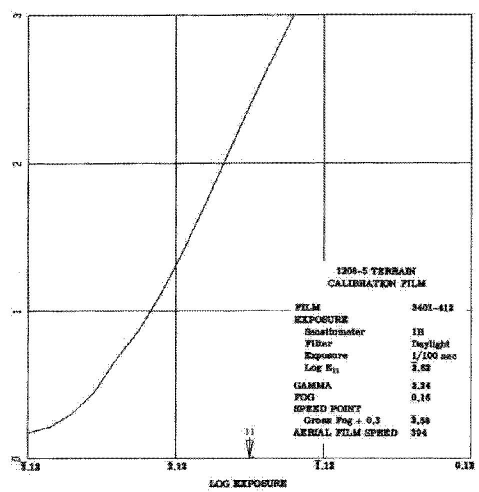
PROCESSING CURVE, TERRAIN, 3414 TAG-ON

FIGURE 3-3



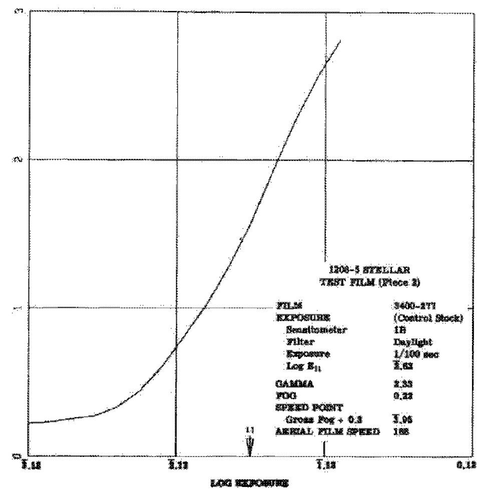
PROCESSING CURVE, TERRAIN,
CALIBRATION 3401 FILM

FIGURE 3-4



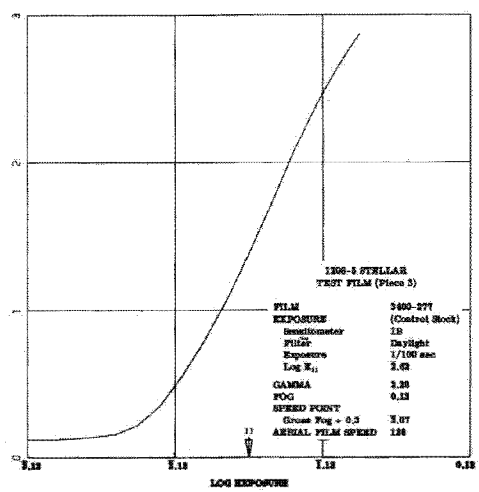
PROCESSING CURVE, STELLAR, 3400 TEST CONTROL NO. 2

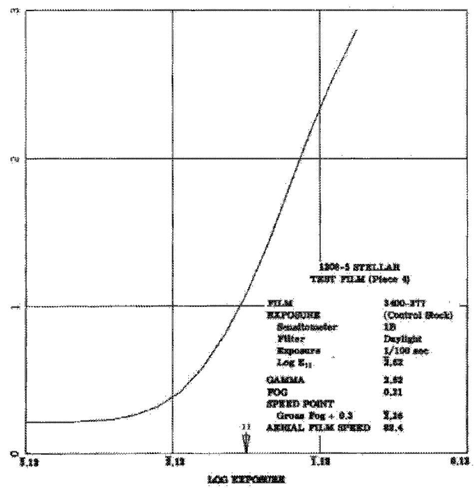
FIGURE 3-5



PROCESSING CURVE, STELLAR, 3400 TEST CONTROL NO. 3

FIGURE 3-6





PROCESSING CURVE, STELLAR,
3400 TEST CONTROL NO. 4

FIGURE 3-7

3.3.3 Stellar Base Plus Fog

High and variable base plus fog levels were noted on the stellar film. Figure 3-8 shows the base plus fog densities measured on the 3401 original negative between the frame mark and data block of the first and last frame of each op. However, as these measurements were being made, several instances of still higher fog levels were noted within ops. These are represented in Table 3-3.

TABLE 3-3

STELLAR BASE PLUS FOG

Op	Frame	B&F
48	003	1.03
48	005	0.87
49	005	1.13
50	005	0.80
52	005	0.84
57	005	0.68
58	011	0.69
62	006	0.70

3.4 SENSITOMETRY

Sensitometric exposures are used to establish and maintain process control. In the case of the original camera films, flight roll film samples 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 mission 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 films.

Figures 3-5 through 3-7 show the sensitometry of the process control film used for the experimental 3400 on the stellar. Sensitometric data on this flight film is not available.

3.5 REPRODUCTION

3.5.1 Breakdown

After processing, the operational 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.

~~TOP SECRET-RUFF NOFORN~~

BASE PLUS FOG DENSITIES, 3401 ON

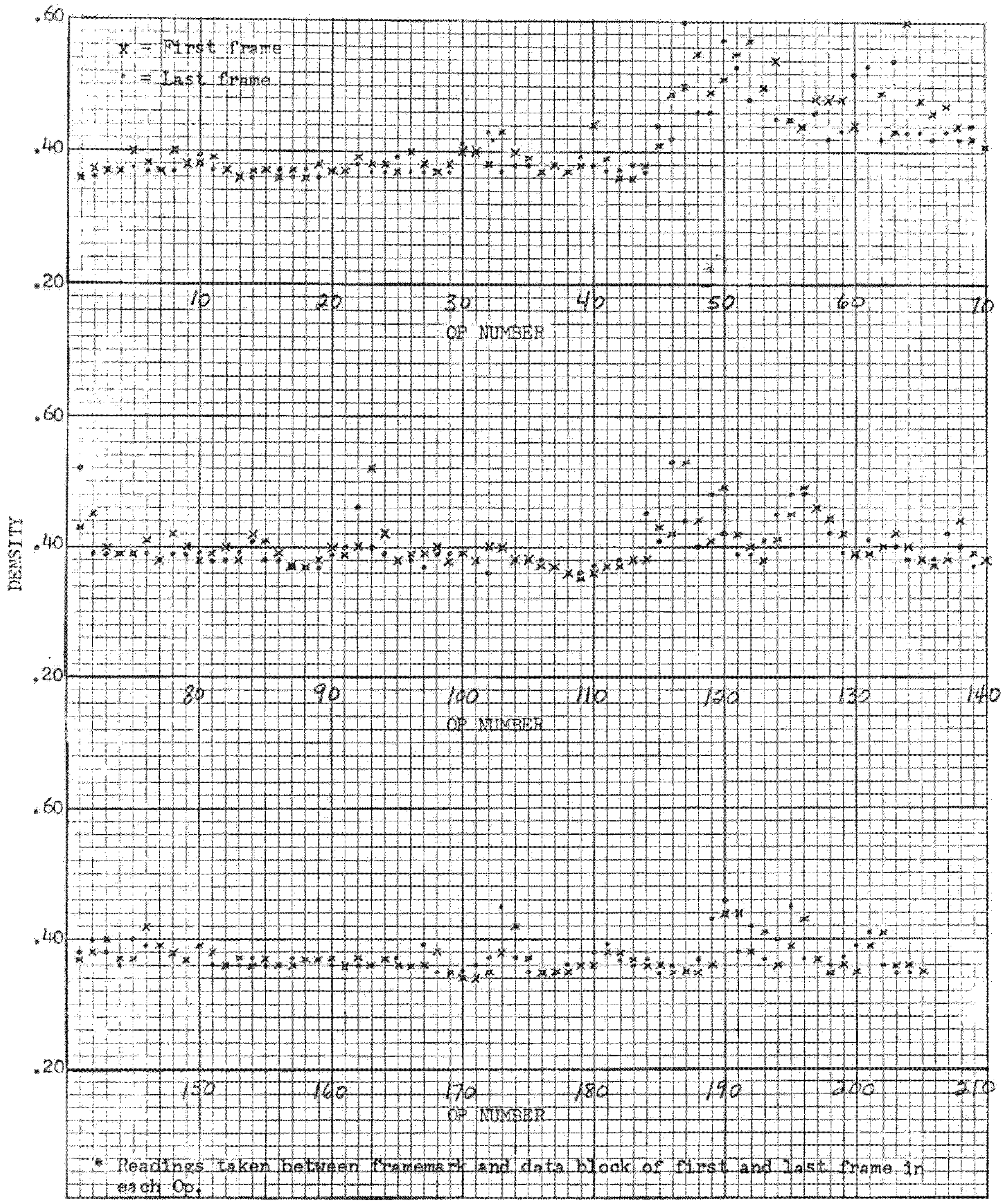


FIGURE 3-8

~~TOP SECRET-RUFF NOFORN~~

ICL-TCS-2013-74
HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

3.5.2 Printing

All duplicate copies were printed on the Kingston printer. Duplicate positives of the terrain record 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 3-9 through 3-12.

3.6 TERRAIN CAMERA EXPOSURE ANALYSIS

Microdensitometer analysis of vegetation surround urban area imagery indicated correct exposure of the 3400 film. Subjective analysis of these scenes concurred with the measurements. No exposure change is recommended for 3400 film on future missions with equivalent optics.

Limited analysis of the 3414 film indicated correct exposure for frames exposed at solar altitudes of over 70 degrees using a one-stop increase from the 3400 recommendation. No urban area imagery at lower solar altitudes was available on this mission for analysis.

3.6.1 Basic Exposure Recommendation

The 1208 terrain camera exposure algorithm for 3400 film, through a W-21 equivalent filter, is basically a KSCOPE generated curve biased by the factors explained in the 1206 PFA report. The actual recommendation for the system is a three-step function of solar altitude approximating this curve (Figure 3-13). In actual operation, the effective exposure time may vary from the nominal due to a V/h change.

The exposure recommendation for the 3414 film was a two-step recommendation of one-stop exposure increase over 3400. Current system limitations prevented the one-stop increase at low solar altitudes for mission 1208. System SN 007 (mission 1209) and subsequent systems will have the capability to expose 3414 film at the lower sun angles. The exposure recommendations for 3400 and 3414 films are shown in tabular form in Table 3-4.

TABLE 3-4

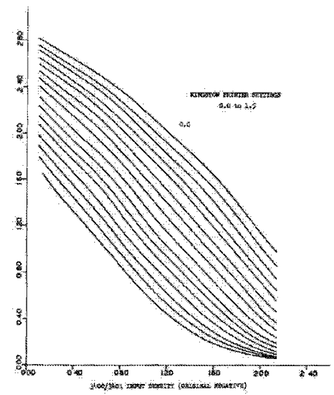
TERRAIN CAMERA EXPOSURE RECOMMENDATIONS

	Exposure Time, milliseconds	
Solar Altitude	3400	3414
0° to 14°	12	12*
15° to 46°	6	12
47° to 90°	3	6

* System limited.

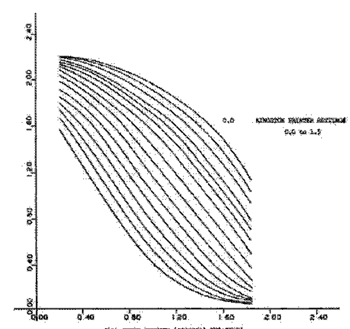
REPRODUCTION CURVES, KINGSTON PRINTER, SO-284 FILM

FIGURE 3-9



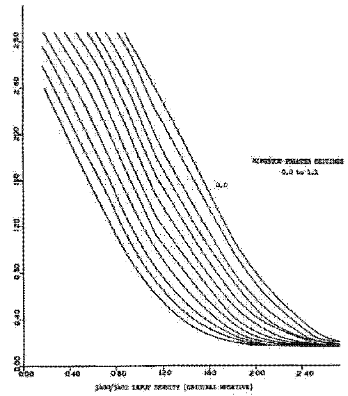
REPRODUCTION CURVES, KINGSTON PRINTER, SO-192 FILM

FIGURE 3-10



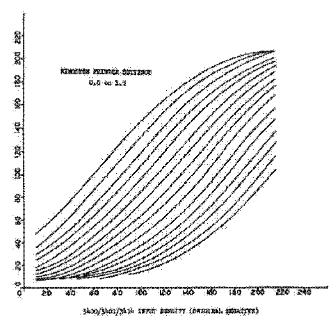
REPRODUCTION CURVES, KINGSTON PRINTER, 2420 FILM

FIGURE 3-11



REPRODUCTION CURVES, KINGSTON PRINTER, 2422 FILM

FIGURE 3-12



TERRAIN CAMERA EXPOSURE RECOMMENDATION (3400 FILM)

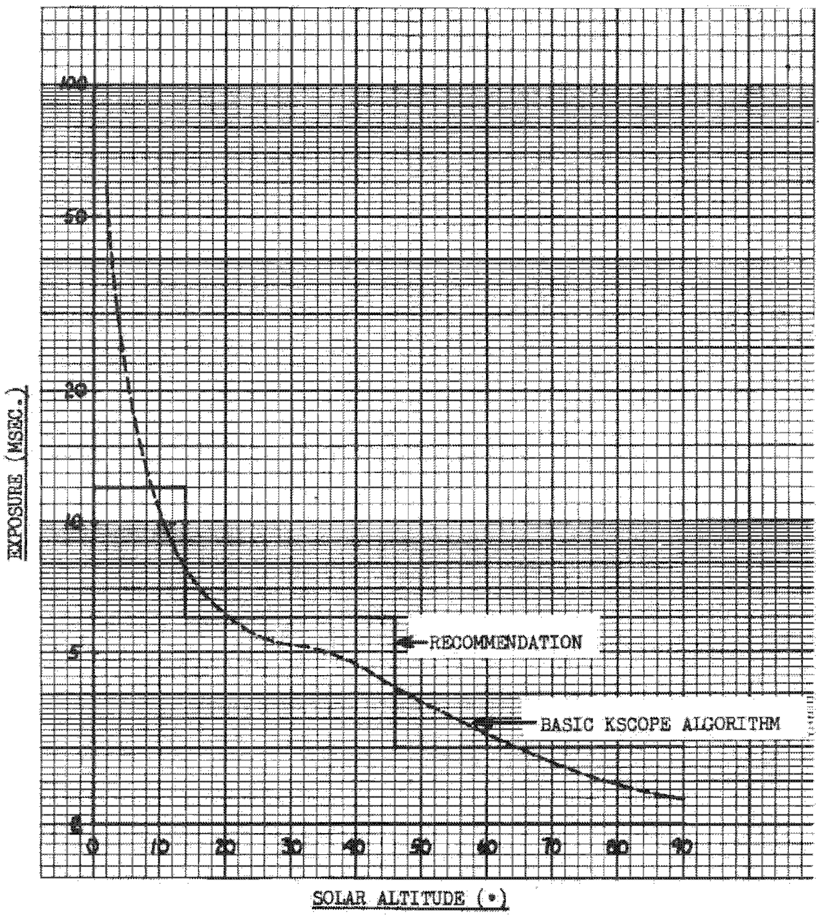


FIGURE 3-13

3.6.2 Method of Analysis

Frame Selection for Microdensitometry

Terrain camera 3400 imagery of nine vegetation surround areas was selected for microdensitometer measurement and subsequent analysis. Only three frames of 3414 imagery were 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 and processed with the terrain camera record of the mission. Program HISTO was then used to analyze the scan data in terms of parameters meaningful with exposure analysis.

Density Profiles

Density profiles of each of the scanned urban area scenes were generated highlighting 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 Figures 3-14 and 3-15). 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 1.1 mean scene density (formerly considered to be 1.0 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 is the exposure time deviation from that of the KSCOPE generated exposure algorithm 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

The exposure of the 3400 film was concluded to be satisfactory as evidenced by the data presented in Table 3-5 and by visual inspection of the imagery. The −0.02 total delta log E shows that the actual exposure was virtually at the aim density while the 0.02 delta algorithm log E indicates the accuracy of the algorithm used to formulate the recommendation. Thus, no exposure change is required.

The limited analysis of 3414 film (Ops 198 and 199) indicated correct exposure at solar altitudes of 70 degrees and above. No vegetation surround imagery was available at lower sun angles. The only other 3414 op (Op 200) was snow covered and contained no urban area. Although the algorithm delta log E indicates 0.06 log E underexposure, the limited data and relatively large

TERRAIN CAMERA DENSITY PROFILE (3400 FILM)

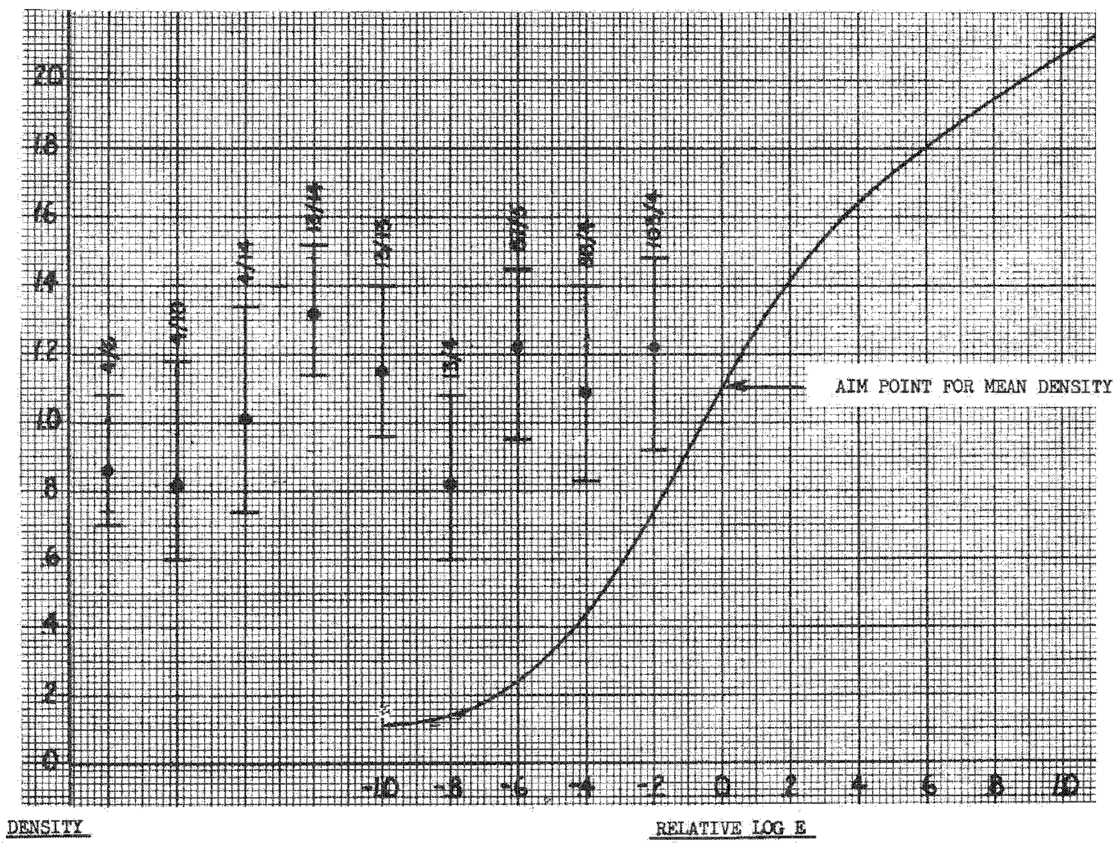


FIGURE 3-14

TERRAIN CAMERA DENSITY PROFILE (3414 FILM)

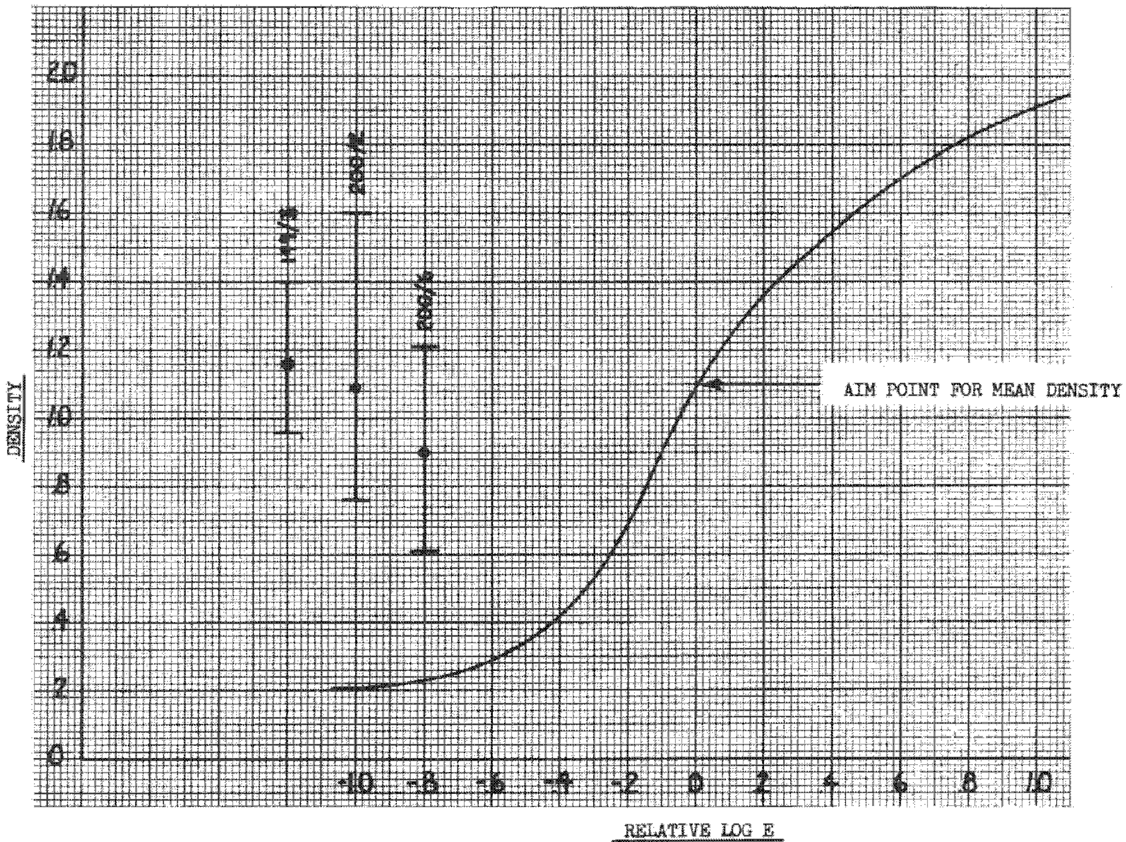


FIGURE 3-15

exposure increments of the system makes this insignificant. Despite the absence of data at low solar altitudes, extrapolation of available data implies that the addition of a nominal 24-millisecond exposure at very low solar altitudes would appear advisable if resolution loss due to smear does not become excessive.

TABLE 3-5

LOG EXPOSURE ERRORS OF VEGETATION SURROUND URBAN/INDUSTRIAL SCENES

Film Type	No. of Samples	Average Total Delta Log E	Average Camera Delta Log E	Average Algorithm Delta Log E
3400	9	−0.02	−0.04	0.02
3414	3	−0.02	0.04*	−0.06*

*Based on an assumed algorithm of one-stop exposure increase of 3414 over 3400 film.

SECTION IV

DMA EVALUATION

4.1 INTRODUCTION

This section details the technical analysis of the mission 1208 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 under the various subheadings are data on specifications, data acquisition procedures and evaluation results, discussions of anomalies, and conclusions.

4.2 FILM EVALUATION/ANOMALIES

Terrain Frame Anomalies

Due to a broken cable in the operate/frame mark detecting device, approximately 1,200 feet of the terrain record was not optically titled. The Processing Facility repaired the cable connector and proceeded to title the remaining record without further difficulties.

Minor "cosmetic" blemishes were noted throughout the terrain record. However, these are considered of minor consequence in the use of the terrain material.

Stellar Frame Anomalies

Although the operate/frame marks were exposed to specifications, the relatively high base plus fog combined with a restricted detection device to prevent the optical titling of the stellar record.

Relatively numerous "cosmetic" blemishes were noted on the stellar film. Blemishes noted consisted of the following:

1. Foreign particles in platen press area
2. Direct or reflected lunar light
3. Frame edges wrinkled on ON's during duplication
4. "Cosmetic" marks resulting from processing.

4.3 MENSURATION

4.3.1 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. A tolerance of 6.0-micrometer standard deviation is used as a rejection criteria for the stellar frames mensuration results.

Procedure

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.

All terrain and stellar 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.

Evaluation Results

The mensuration results indicated no significant deformation anomalies on this mission material. All terrain mensuration results fell within the specified tolerance of 12.9 micrometers. The stellar mensuration data was within the 6.0 micrometers tolerance. A deformation summary is presented in Table 4-1 and the deformation statistics for this mission are listed in Table 4-2. Typical plots of terrain and stellar deformation values are presented in Figures 4-1 and 4-2, respectively.

TABLE 4-1

FILM DEFORMATION STATISTICS (SUMMARY)
(Average Values, Micrometers)*

Mission	Terrain	Port (-y)	Starboard (+y)
1205-5	8.3	4.7	4.6
1206-5	7.9	3.4	4.2
1207-5	7.1	4.0	4.2
1208-5	7.1	3.9	3.8
(Tolerance)	12.9	6.0	6.0

* Values represent averages of standard deviations for 30 frames for each camera per mission.

4.3.2 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.

TABLE 4-2

FILM DEFORMATION STATISTICS

Rev	Op	Frame	Standard Deviations, micrometers Terrain	Port (−y)	Starboard (+y)
2	1	1	5.544	3.375	3.614
10	4	5	7.707	3.755	NR
42	12	4	7.023	3.166	5.321
42	12	7	6.846	NR	5.962
42	12	16	5.977	3.913	3.706
69	22	4	NR	4.070	3.933
85	27	3	6.359	5.891	4.024
136	39	7	4.945	3.061	3.278
166	41	3	4.992	5.027	2.969
181	45	3	5.655	5.152	3.180
281	59	5	NR	4.878	3.449
281	59	10	5.404	NR	NR
331	65	11	NR	3.239	3.382
363	67	3	12.810	3.418	3.950
394	69	4	9.100	2.245	2.856
443	76	9	10.650	NR	3.434
561	104	7	12.73	NR	3.214
566	105	3	NR	3.422	4.868
566	105	4	NR	4.045	NR
608	114	2	8.848	3.716	NR
674	120	8	6.235	3.509	5.651
689	124	4	5.385	3.992	NR
718	128	1	6.660	3.801	4.407
736	130	8	6.980	3.753	3.979
753	137	5	NR	2.247	2.287
801	149	18	NR	4.075	3.120
816	152	2	8.082	4.006	4.744
816	152	3	6.466	5.26	3.662
829	158	3	6.507	5.401	3.735
831	159	8	6.002	2.946	2.957
916	190	5	7.211	3.744	4.772
946	196	4	5.860	NR	3.539
948	197	20	4.657	3.852	3.477
954	199	5	NR	NR	2.878
955	200	9	6.930	3.145	5.115
958	201	3	10.280	5.188	NR
965	202	6	6.790	NR	NR
965	203	3	5.256	NR	NR

TERRAIN, FILM DEFORMATION PLOT

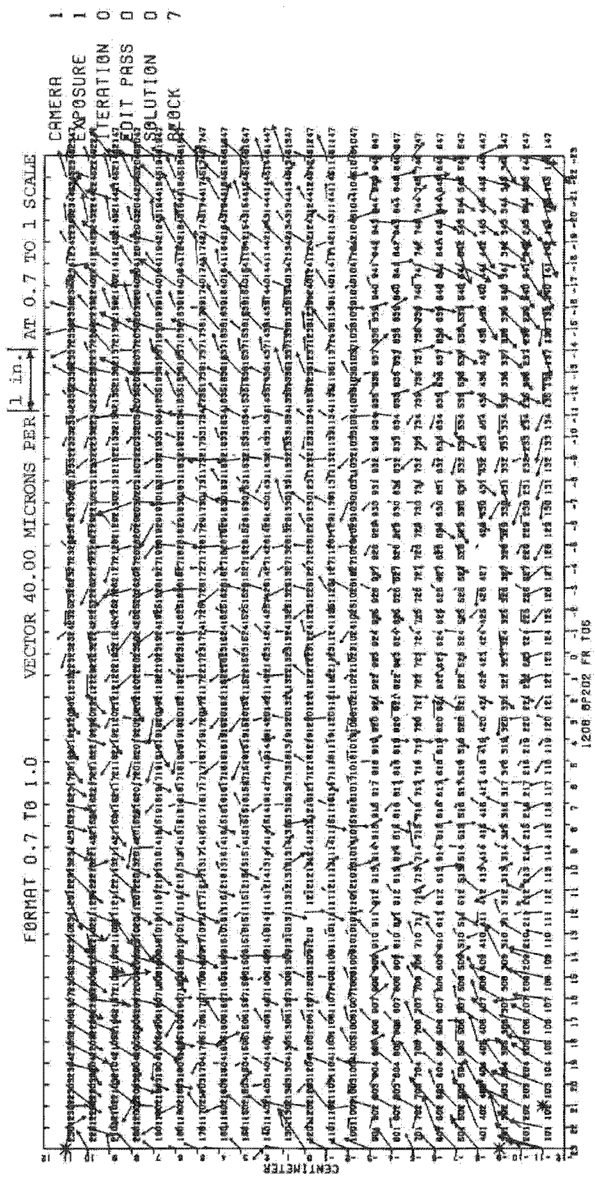


FIGURE 4-1

PORT (-Y), FILM DEFORMATION PLOT

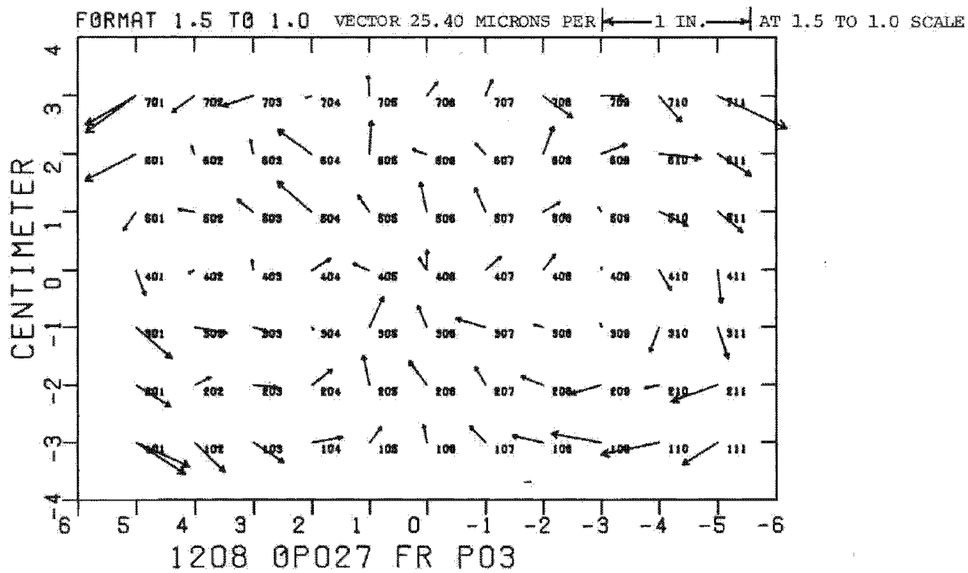


FIGURE 4-2

Evaluation Results

All measured values were found well within the tolerance values. A comparison of the fiducial spacing for particular frames is displayed in Table 4-3. The same procedures used for the preflight 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 presented in Tables 4-4 and 4-5.

Conclusions

It is concluded from the results, that the fiducial system remained stable throughout the mission. The total standard deviation value of 0.0016 for the three-parameter fit of the in-flight calibrated fiducial set to the preflight calibrated fiducial set is a reasonably good indication of the fiducial system's stability.

Quality of the fiducials on this mission is excellent with the center dot readily visible. As with previous missions, fiducials were found difficult to read in areas of high reflectance such as sand and snow. The fiducial image blends in with the background imagery and pointing accuracy and precision is greatly reduced or totally lost. Corrective action was taken by the camera contractor following mission 1205; however, due to lead time mission 1209 will be the first system with the imagery shaded from the area where the fiducial will be exposed. With mission 1208, the number of frames affected by fiducials not measurable was felt to be significantly high. This prompted an evaluation by the PFA Team to determine the extent of the problem. Table 4-6 presents the results of the visual evaluation, indicating the frames involved and the number of fiducials considered not measurable. This evaluation is the combined results of inspections on ON's, DN's, and DP's by two agencies. Two fiducials will allow measured points in the reseau system to be oriented to the optical axis of the camera system. Section 4.3.5.4 provides data illustrating the grouping of fiducials to the reseau system which further illustrates the difficulty involved in photogrammetrically reducing terrain frame data if three or four fiducials are not measurable.

4.3.3 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

In addition to the required sampling, a number of frames were selected randomly and were evaluated for typical maximum and minimum densities in the format area (Table 4-7).

TABLE 4-3

FIDUCIAL DISTANCES

Op	Frm	Width		Length	
		A	B	C	D
001	01	232.824	232.864	387.866	387.820
004	05	232.837	232.892	387.862	387.888
059	10	232.853	232.894	387.915	387.911
069	04	232.890	232.935	387.985	387.935
076	09	232.889	232.956	387.992	387.925
104	07	232.899	232.943	387.981	387.972
114	02	232.930	232.951	387.975	388.038
124	04	232.911	232.935	387.947	387.968
159	08	232.893	232.934	387.953	387.984
190	05	232.904	232.952	387.933	387.993

Specifications: Width 232.000-233.200mm

Length 386.600-388.100mm

TABLE 4-4

IN-FLIGHT TO PRE-FLIGHT FIDUCIAL TRANSFORMATION

	X	Y
5001	193.3634	-116.6745
5002	193.9359	115.7754
5003	-193.3651	116.6924
5004	-193.9342	-115.7932

Total Standard Deviation in X = 0.0020

Total Standard Deviation in Y = 0.0010

Standard Deviation of Total Fit = 0.0016

TABLE 4-5

TERRAIN FIDUCIAL STABILITY EVALUATION

Preflight

FRAME ID OP	FRAME ID NO	STD DEV
	7	.00130
	8	.00146
	10	.00073
	17	.00656
	18	.00557
	19	.00528
	21	.00473
	48	.00046
	51	.00108

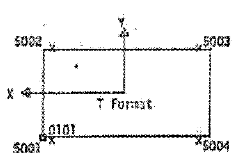
TOTAL STD DEV .00241
X STD DEV .00273
Y STD DEV .00205

Inflight

TOTAL STD DEV .00201
X STD DEV .00213
Y STD DEV .00188

FRAME ID OP	FRAME ID NO	STD DEV
1	1	.00234
4	5	.00166
59	10	.00159
69	4	.00264
76	9	.00420
104	7	.00273
114	2	.00121
159	8	.00243
190	5	.00406

Fiducial Locations



(All values in millimeters.)

	5001	5002	5003	5004			5001	5002	5003	5004
X Pre-	193.3626	193.9340	-193.3635	-193.9331		Y Pre-	-116.6740	115.7748	116.6916	-115.7922
X Inflight	193.3646	193.9374	-193.3672	-193.9350		Y Inflight	-116.6743	115.7767	116.6926	-115.7948
Delta Xs	.0020	.0034	-.0037	-.0019		Delta Ys	-.0003	.0019	.0010	-.0026

TABLE 4-6

FRAME SUMMARY OF REFLECTANCE IMPACT ON FIDUCIALS

Number of Fiducials Per Frame Considered Not Measurable

Op/Frame no.	1	2	3	4
2	18,19	16,17	3,14,15	1,2,4-13
4	1,15	16	17,18	
5		4		1-3,5,6
6	15,16	12-14	17	1-11
7				1-10
8	1,2,4,5,7	6	3	8
9			12-15	
10			1,6,7	2-5
11	2,3	4-6		
15				1-10
16			5	1-4,6-16
17	20	15-17	12-14	1-11
18				1-16
22			16	1-15,1720
23				1-14
27		12	3,10,11	1,2,4-9
32		1-6		
34			5,6,8,9,12,13,16,17	1-4,7,10,11,14,15
35			12	1-7,11
38			4	1-3
39			8-10	1-7
40				1-8
41			9,11	1-8,10,12-15
45		7	5,6	1-4
46				1-5
47				1-5
49				1-9
50		5-7	4	1-3
55			5,6	1-4,7,8
57				1-7
58			5,7-10	
60	10	8,11,13	7,9,14,15	1-6,17
62		2,3	1	
65				1-14
66			11,12	1-10
67	6,7,9			
69	6			
70				1-9

FRAME SUMMARY OF REFLECTANCE IMPACT ON FIDUCIALS (Continued)

Number of Fiducials Per Frame Considered Not Measurable

Op/Frame no.	1	2	3	4
76	1-4			
80	1			
81	1			
83	1			
84	2,3,5			
85	5,7,8	3,4,6		1,2
89	8,10,11	2,5-7	1,3	4
91	2,4,6	3,5		1
92	1			
94	7			
96	3,6			
98	2,3	1		
101		1,2		
106				1-6
111	6,8			
112				1-10
120				1-8
122				1-6
127			1	
129	18			
130	9			
131	3,4			
133	1,2			
134				1-7
136	8	10		
140	6	7		
143	4	2,3,5	1	
144			7,9	1-6,8
146	5	3	1,2,4	
148		16		1-11
149			11	1-10
152				1-8
153	3			
156		7		
163	7			
164	1-3			
167		2		
168	1,4			
169				1-10
170	1			
172	1,2			

FRAME SUMMARY OF REFLECTANCE IMPACT ON FIDUCIALS (Continued)

Number of Fiducials Per Frame Considered Not Measurable

Op/Frame no.	1	2	3	4
174		7,8		
186	2-4,7-9,11	6,10		
187	3,4			
192	1	2		
196	6	7		

TABLE 4-7

FORMAT DENSITY STATISTICS, TERRAIN FRAMES

OP	FRAME	MAXIMUM DENSITY	MINIMUM DENSITY	BASE + FOG
2	5	*1.91	1.74	0.22
	15	2.03	1.78	0.23
15	2	2.06	1.80	0.23
	10	2.02	1.64	0.22
28	1	1.27	0.65	0.20
	9	1.26	0.67	0.20
41	1	2.01	1.99	0.21
	5	2.00	1.96	0.21
55	2	2.02	1.86	0.23
	8	1.98	1.58	0.23
68	3	1.58	0.76	0.24
	7	1.56	1.27	0.24
81	1	1.99	0.67	0.23
	9	1.95	0.58	0.23
95	3	1.62	1.25	0.23
	7	1.66	1.06	0.23
108	2	1.22	0.53	0.24
	8	1.32	0.64	0.24
121	1	1.52	1.07	0.23
	7	1.52	0.85	0.23

TABLE 4-7 (CONTD)

FROMAT DENSITY STATISTICS, TERRAIN FRAMES

OP	FRAME	MAXIMUM DENSITY	MINIMUM DENSITY	BASE + FOG
134	1	2.11	1.62	0.23
	5	2.13	1.91	0.23
147	6	1.50	0.87	0.21
	15	1.47	1.07	0.21
161	1	1.68	0.89	0.21
	4	1.65	1.04	0.21
174	2	1.57	0.49	0.21
	8	1.42	0.85	0.21
188	4	1.82	1.56	0.22
	10	1.79	1.63	0.22
199	1	1.80	1.71	0.19
	2	1.86	1.75	0.19

*Transmission density units

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. However, density levels were minimal and no frames were rejected due to radiation fogging (Table 4-8).

4.3.4 Microdensitometry

4.3.4.1 Reseau Intersections

Specifications

Typically, four intersections per frame on two frame sets (terrain, port, starboard), selected from the first and last operates of the mission, are scanned on the microdensitometer. The reseau intersection illustrated in Figure 4-3 displays dimensions for the intersection found on the camera reseau plate. The dimensions determined from microdensitometry are film dependent, consequently no specification is provided. The dimension values are reported for relative mission to mission comparisons or as an anomaly diagnostic device.

Procedures

Microdensitometry was performed on original negative material. All data measurements are made on a GAF microdensitometer with chart recorder. The microdensitometer is calibrated for absolute density and against a calibrated line width as a standard operating procedure. Once an image trace is recorded on the graph paper, it is further 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 entitled "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 profiles across reseau intersection lines (Figures 4-4 and 4-5), and the resulting statistical values (Table 4-9), are provided for relative comparison to previous mission results. Also included for convenience are reseau format diagrams (Figures 4-6 and 4-7).

TABLE 4-8

FORMAT DENSITY STATISTICS, STELLAR FRAMES

OP	FRAME	FORMAT CORNER		CENTER	FORMAT CORNER		BASE + FOG
1	1(-y)P	.90*	1.06	1.08	1.01	.82	.38
	1(+y)S	.81	.98	.99	.89	.66	
1	2(-y)P	.82	1.06	1.10	1.03	.81	.37
	2(+y)S	.82	.98	1.03	.94	.74	
11	2(-y)P	.85	1.03	1.07	1.01	.89	.45
	2(+y)S	.84	.95	.96	.88	.72	
11	6(-y)P	.83	1.00	1.03	.95	.80	.38
	6(+y)S	.80	.91	.94	.88	.72	
67†	5(-y)P	1.16	1.31	1.40	1.34	1.17	.80
	5(+y)S	1.10	1.20	1.22	1.13	.94	
67	9(-y)P	.94	1.10	1.14	1.04	.88	.45
	9(+y)S	.88	1.03	1.05	.97	.82	
82	2(-y)P	.93	1.07	1.15	1.07	.86	.38
	2(+y)S	.85	1.01	1.04	.94	.78	
82	8(-y)P	.90	1.08	1.13	1.06	.90	.39
	8(+y)S	.86	1.05	1.06	.96	.82	
104	1(-y)P	.94	1.14	1.19	1.12	.94	.41
	1(+y)S	.88	1.06	1.08	.98	.79	
104	7(-y)P	.93	1.12	1.17	1.06	.88	.41
	7(+y)S	.87	1.06	1.10	1.01	.80	
122	1(-y)P	.93	1.13	1.22	1.14	1.00	.43
	1(+y)S	.98	1.09	1.13	1.04	.84	
122	5(-y)P	.98	1.18	1.24	1.18	.97	.44
	5(+y)S	.97	1.11	1.14	1.06	.90	
186	3(-y)P	.99	1.20	1.27	1.21	1.02	.39
	3(+y)S	.93	1.12	1.16	1.08	.91	
186	11(-y)P	1.02	1.22	1.28	1.19	.96	.37
	11(+y)S	.92	1.11	1.16	1.09	.88	
204	3(-y)P	1.07	1.24	1.31	1.25	.96	.37
	3(+y)S	.87	1.13	1.17	1.09	.90	

*Transmission density units
†Radiation fogging, note base + fog value

STELLAR/TERRAIN, RESEAU INTERSECTION

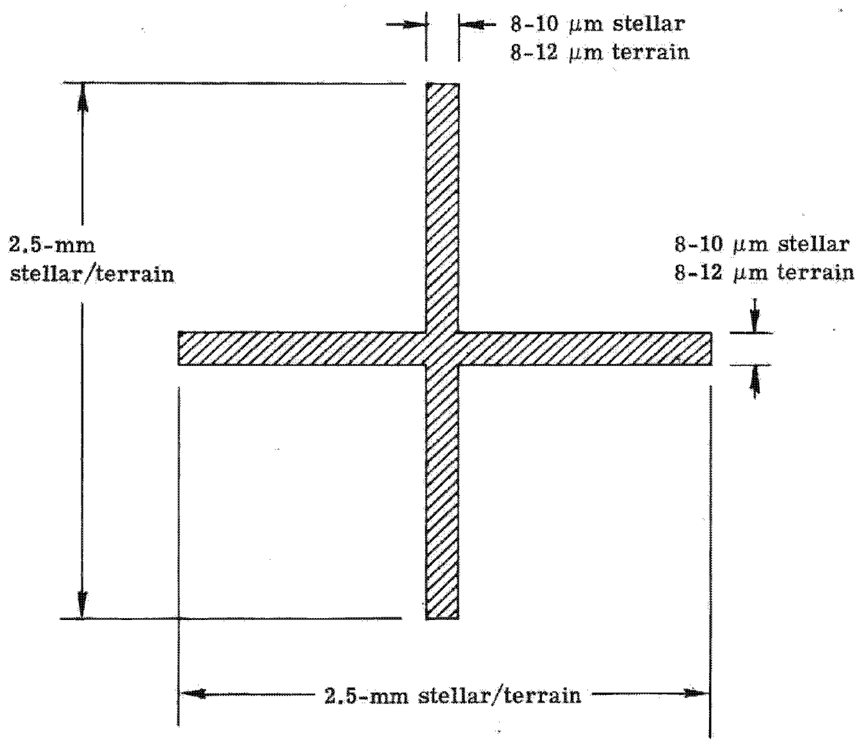


FIGURE 4-3

TERRAIN, MICRODENSITOMETER PROFILE (RESEAU INTERSECTION LINE), OPERATE 197, FRAME 18

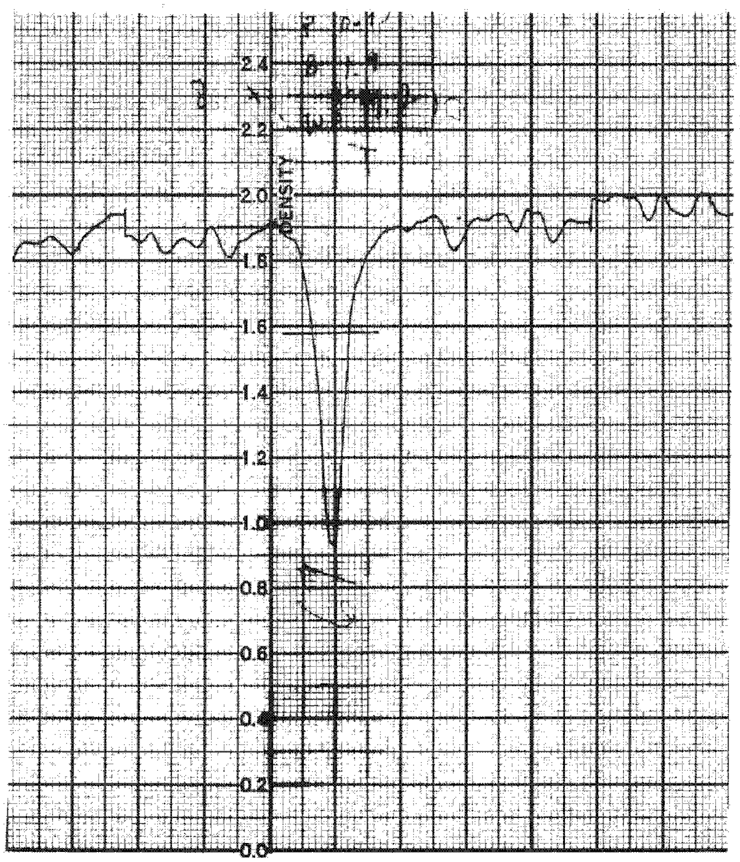


FIGURE 4-4

STELLAR, MICRODENSITOMETRIC PROFILE (RESEAU INTERSECTION LINE), OPERATE 001, FRAME 01

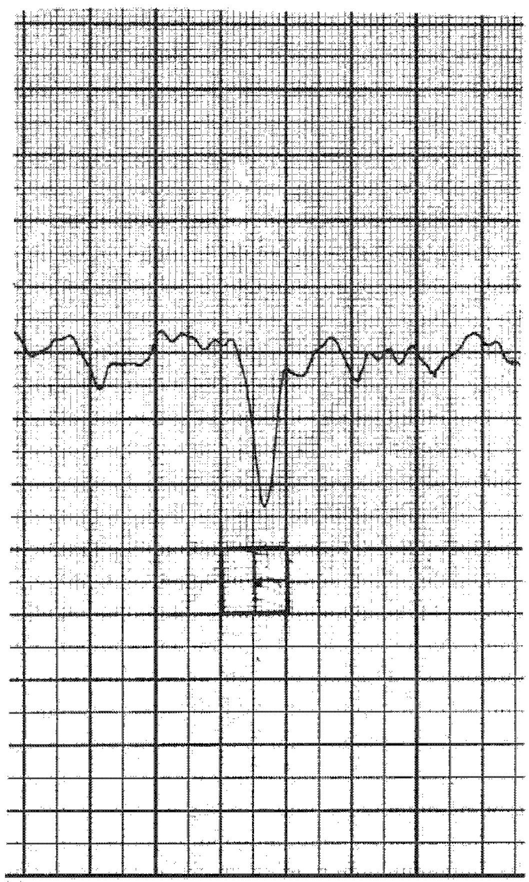


FIGURE 4-5

STELLAR, RESEAU FORMAT

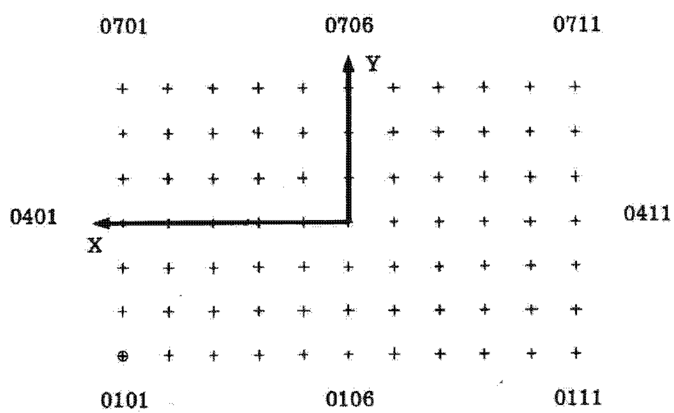


FIGURE 4-6

TERRAIN, RESEAU FORMAT

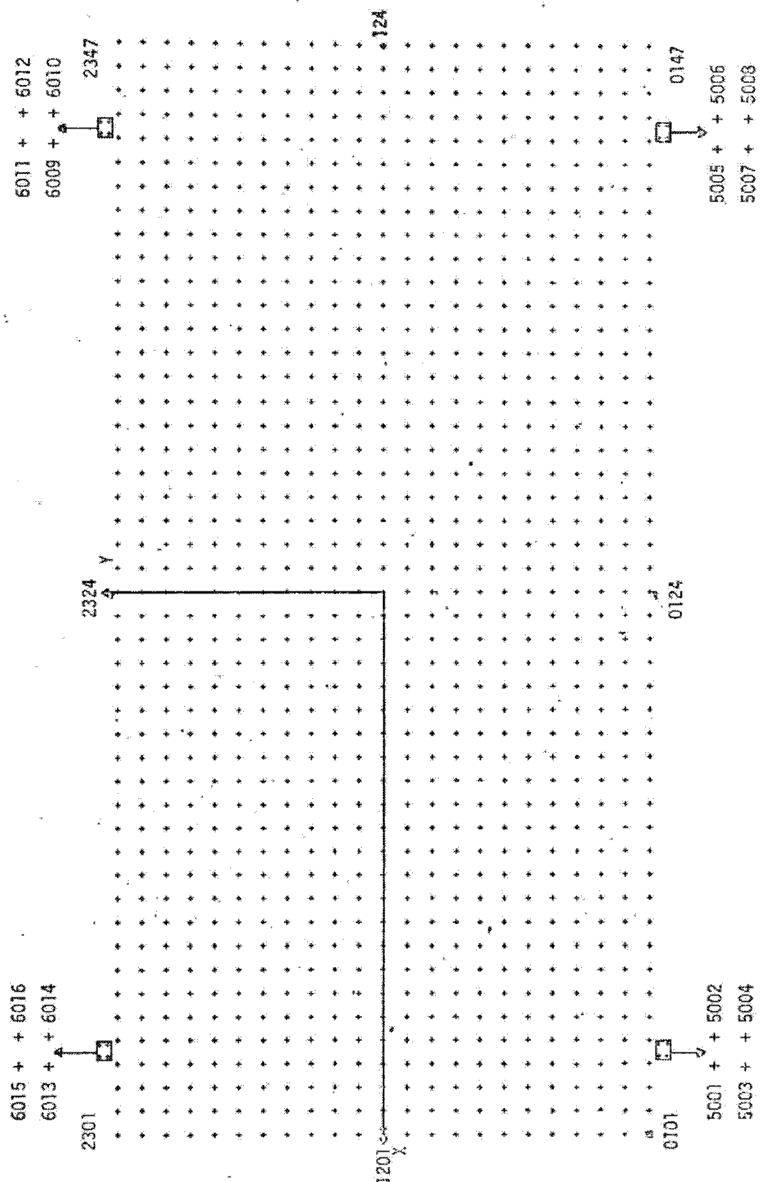


FIGURE 4-7

Conclusions

All intersections evaluated or visually inspected were considered to be usable. The results of this evaluation are considered representative of the SN 006 camera system.

To place the density values of the microdensitometer and the macrodensitometer in proper perspective, a graph has been included which illustrates density range comparison of a calibrated step tablet made with the microdensitometer and macrodensitometer (Figure 4-8).

4.3.4.2 Fiducials

Specifications

The fiducial measurement requirements are similar to those for reseau intersection measurements in that four fiducials are to be measured per frame for one frame at each end of the mission. The dimension values (blueprint) are illustrated in the fiducial diagram (Figure 4-9).

Procedures

The data reduction procedures are the same as for reseau intersection measurements. A microdensitometer profile is shown in Figure 4-10.

Evaluation Results

The fiducial line widths and densities are listed in Table 4-10. The fiducial images appear nicely defined with visible center dots for all four fiducials (Figure 4-11 and Table 4-11). The fiducial stability evaluation indicates the readability of the fiducials for this material. As stated previously, quality mensuration is difficult when the density of surrounding imagery approaches the fiducial density.

Conclusion

Results of this evaluation indicate that fiducial densities were within specifications. Figure 4-12 provides examples where fiducials were unusable due to snow/cloud imagery approaching the density of the fiducial. Figure 4-13 illustrates a microdensitometric profile across the center dot of a typical fiducial image.

4.3.4.3 Data Block

Specifications

The following list presents the measurement requirement and design criteria tolerances for the data block evaluation:

1. Two frame sets are to be scanned.
    a. The terrain data block and the stellar data block for each set
    b. Sets located near each end of mission material.

2. 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.

Procedures

Microdensitometry procedures as discussed in the reseau section were followed.

Evaluation Results

The required data blocks were scanned and results of the evaluation are presented in Table 4-12. Typical densitometric profiles are shown in Figures 4-14 and 4-15.

All peak densities were within specifications. One of the measured dot diameters fell outside the 152.0 to 254.0 micrometer specification.

Figures 4-16 through 4-19 are provided for convenient reference.

4.3.4.4 Operate and Frame Marks

Specifications

Determinations of dimensions and densities are required for evaluation of the operate and frame marks.

Procedures

Microdensitometry procedures as discussed in the reseau section were followed.

Evaluation Results

The measurements of the operate and frame marks for both the terrain and stellar record were within specifications (Table 4-13, Figure 4-20).

TABLE 4-9

STELLAR/TERRAIN, RESEAU INTERSECTION STATISTICS

Op	Frame	Camera	Location	Background Density	Peak Density	Width (micrometers)
1	1	Port	Format	1.75	1.32	*17.2
			Center	1.70	1.36	15.6
				1.70	1.30	14.1
				1.70	1.30	12.5
				1.60	1.13	14.1
				1.60	1.14	17.2
				1.60	1.20	20.3
				1.60	1.20	17.2
			Format	1.30	1.10	12.5
			Corner	1.35	1.00	15.6
1	1	Port	(0101)	1.35	1.08	15.6
				1.35	1.10	20.3
1	1	Starboard	Format	1.25	1.02	15.6
			Corner	1.25	0.98	15.6
			(0111)	1.20	0.98	12.5
				1.30	1.00	17.2
				1.50	1.20	18.8
				1.50	1.20	17.2
				1.50	1.16	18.8
				1.50	1.15	17.2
1	1	Starboard	Format	1.55	1.22	17.2
			Center	1.55	1.20	17.2
				1.55	1.20	17.2
				1.60	1.26	20.3
185	1	Port	Format	2.10	1.72	21.9
			Center	2.05	1.54	15.6
				2.05	1.65	15.6
				2.00	1.64	18.8
				1.90	1.48	14.1
				1.90	1.50	14.1
				1.90	1.53	15.6
				1.90	1.47	20.3
				1.60	1.22	15.6
				1.60	1.24	18.8
185	1	Port	Format	1.60	1.30	17.2
			Corner	1.60	1.20	18.8
			(0101)			

TABLE 4-9 (CONTD.)

STELLAR/TERRAIN, RESEAU INTERSECTION STATISTICS

Op	Frame	Camera	Location	Background Density	Peak Density	Width (micrometers)
185	1	Starboard	Format Corner (0111)	1.15	1.18	20.3
				1.50	1.12	18.8
				1.50	1.22	15.6
				1.50	1.20	18.8
				1.80	1.38	15.6
				1.80	1.42	17.2
				1.80	1.40	17.2
				1.80	1.36	17.2
185	1	Starboard	Format Center	1.90	1.46	20.3
				1.90	1.46	17.2
				1.90	1.50	18.7
				1.90	1.54	17.2
1	1	Terrain	Format Center	1.66	0.86	15.6
				1.40	0.64	17.2
				1.70	0.88	17.2
				1.80	0.92	14.7
				1.40	0.66	15.6
				1.40	0.64	17.2
				1.34	0.62	14.1
				1.36	0.60	14.1
				1.20	0.52	15.6
				1.20	0.58	15.6
				1.20	0.60	15.6
				1.20	0.52	15.6
1	1	Terrain	Format Corner (0101)	1.18	0.62	20.3
				1.18	0.66	20.3
				1.16	0.64	18.8
				1.16	0.64	21.9
197	18	Terrain	Format Center	1.26	0.62	15.6
				1.20	0.58	15.6
				1.40	0.72	15.6
				1.36	0.62	15.6

TABLE 4-9 (CONTD.)

STELLAR/TERRAIN, RESEAU INTERSECTION STATISTICS

Op	Frame	Camera	Location	Background Density	Peak Density	Width (micrometers)
				1.46	0.72	15.6
				1.60	0.85	15.6
				1.60	0.76	15.6
				1.50	0.76	17.2
				1.60	0.84	17.2
				1.40	0.60	15.6
				1.30	0.60	15.6
				1.50	0.73	17.2
197	18	Terrain	Format	2.00	0.95	17.2
			Corner	1.90	0.90	15.6
			(0101)	2.00	1.06	17.2
				1.90	0.93	17.2

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

~~TOP SECRET-RUFF NOFORN~~

DENSITY RANGE COMPARISON FOR
MICRO/MACRODENSITOMETERS

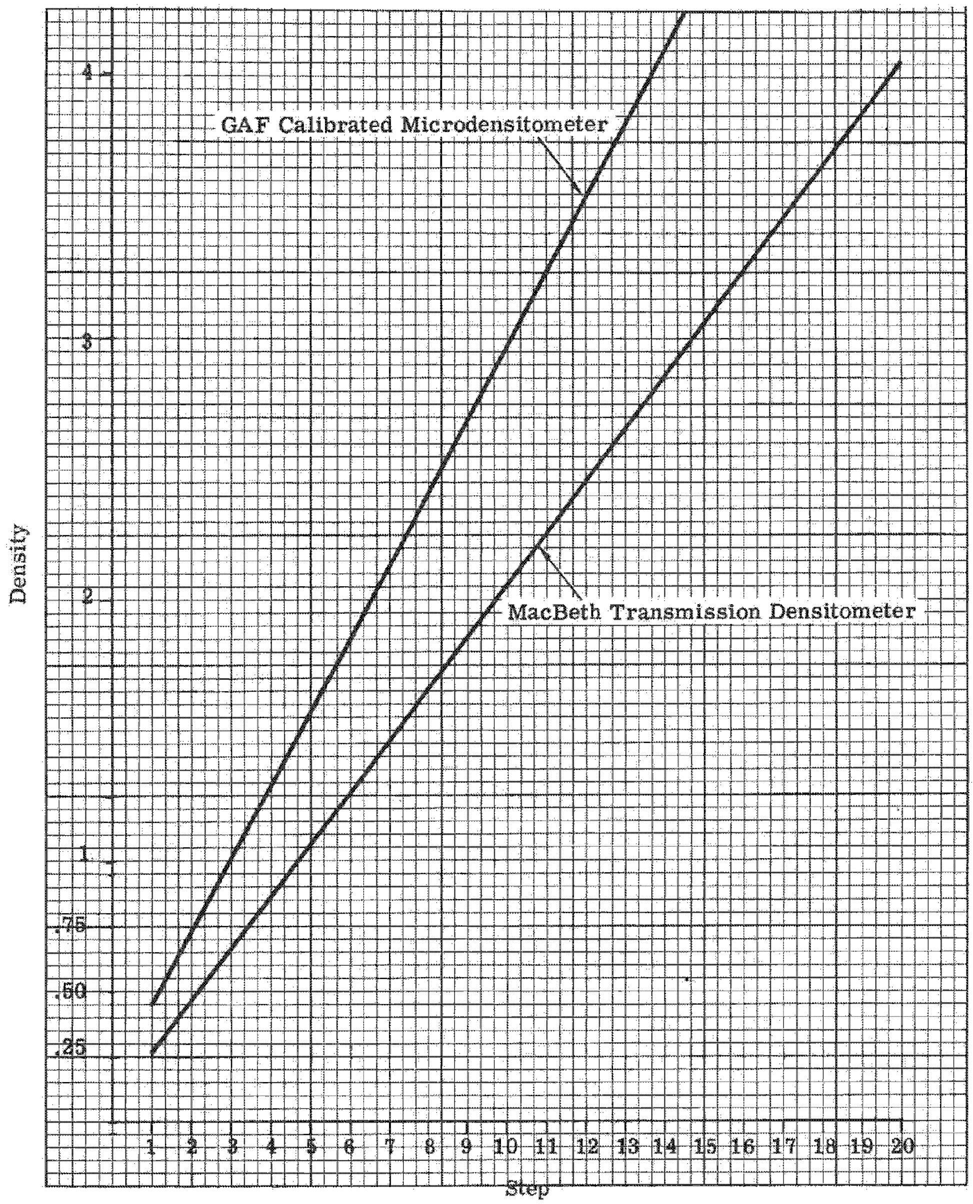


FIGURE 4-8

~~TOP SECRET-RUFF NOFORN~~

ICL-TCS-2013-74
HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

TERRAIN, FIDUCIAL DIAGRAM

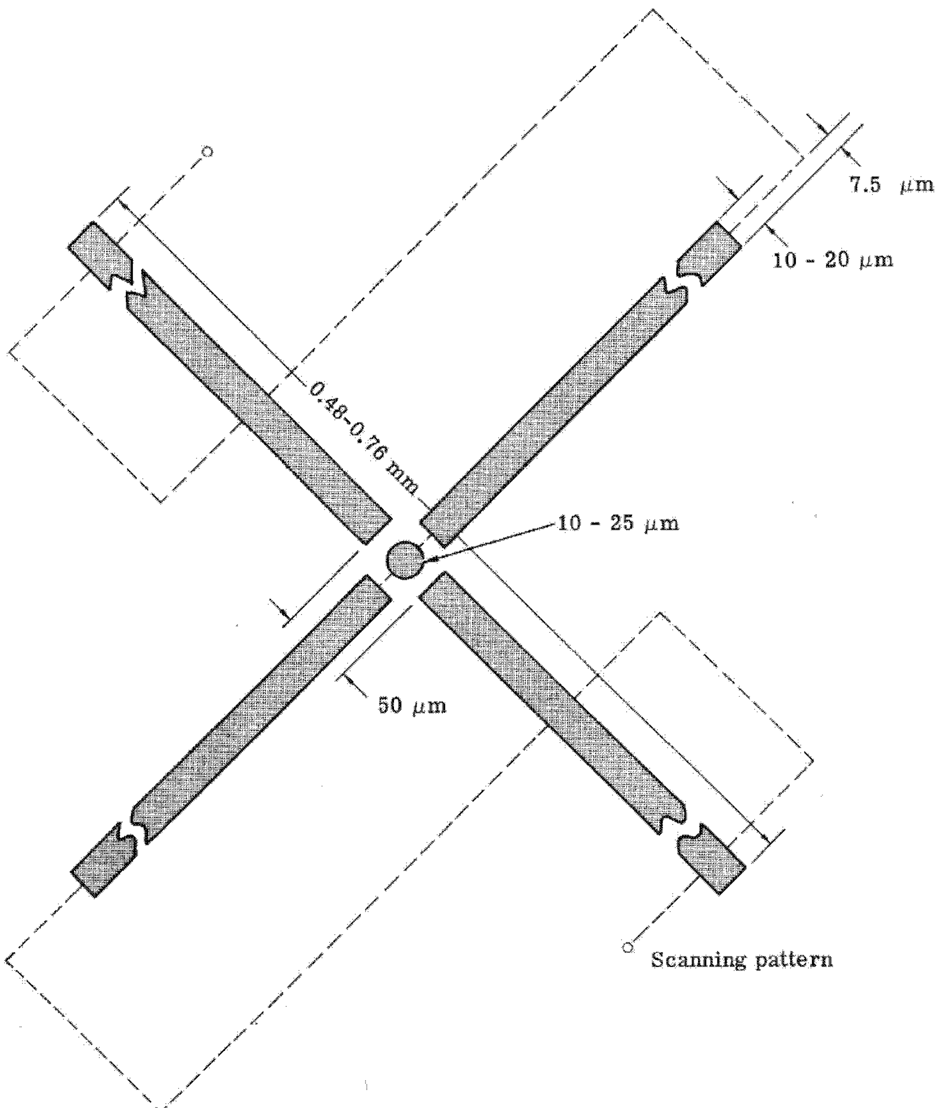


FIGURE 4-9

TERRAIN, MICRODENSITOMETRIC PROFILE
(ACROSS FIDUCIAL LINE), OPERATE 1, FRAME 1

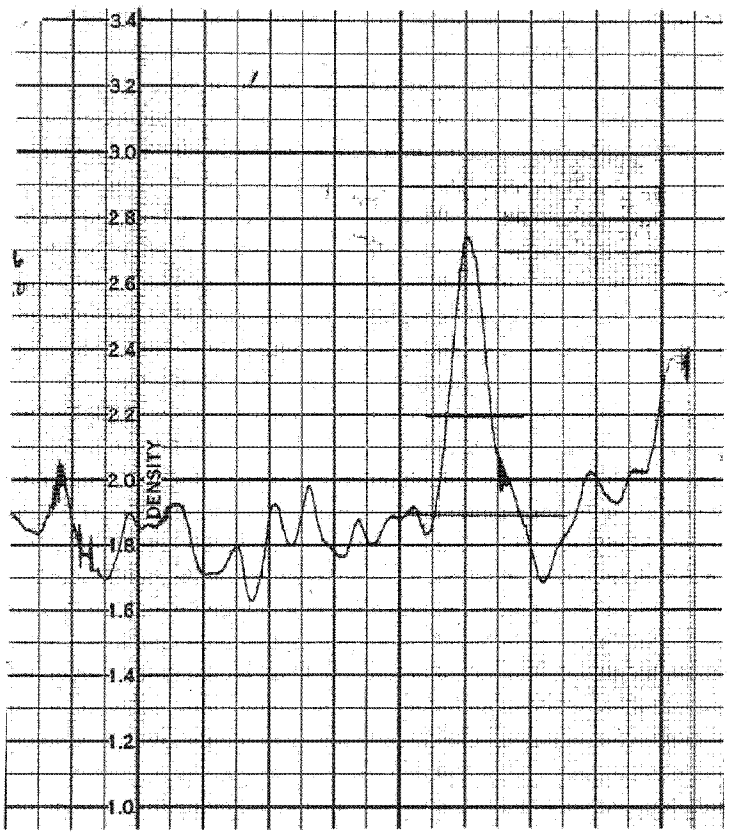


FIGURE 4-10

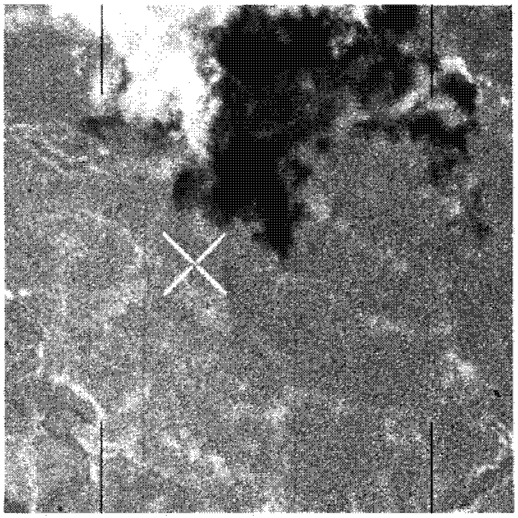
TABLE 4-10

TERRAIN, FIDUCIAL MARK STATISTICS (LINES)

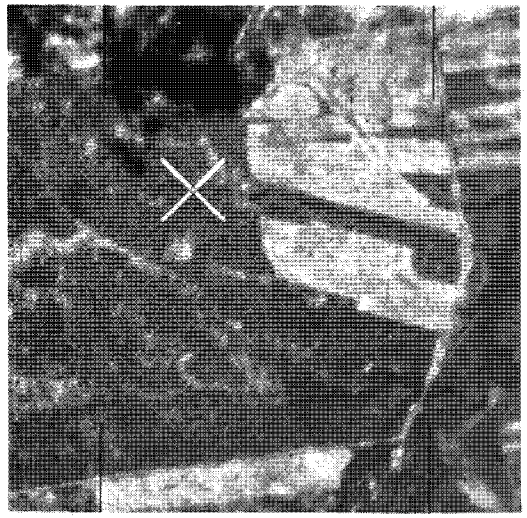
Op	Frame	Fiducial (Corner Intersection)	Background Density	Peak Density	Width (micrometers)
1	1	1(0101)	1.50	2.36	28.1
			1.46	2.48	29.7
			1.46	2.46	23.4
		2(2301)	1.80	2.64	21.9
			1.90	2.74	21.9
			1.80	2.56	25.0
			1.90	2.62	25.0
		3(2347)	1.80	2.72	31.2
			1.60	2.66	25.0
			1.70	2.60	23.4
			1.70	2.72	28.1
		4(0147)	2.58	2.82	18.8
			2.56	2.84	17.2
			2.60	2.80	26.6
			1.50	2.54	32.0
197	18	1(0101)	2.00	2.77	31.2
			2.00	2.65	23.4
			2.00	2.75	23.4
			2.00	2.62	23.4
		2(2301)	1.70	2.60	25.0
			1.80	2.44	21.9
			1.80	2.52	28.1
		3(2347)	1.70	2.76	28.1
			1.70	2.50	31.1
			1.70	2.74	25.0
			1.70	2.50	28.1
		4(0147)	0.90	2.00	26.6
			0.90	2.12	31.2
			1.00	2.06	29.7
			1.70	2.74	31.2

~~TOP SECRET-RUFF NOFORN~~

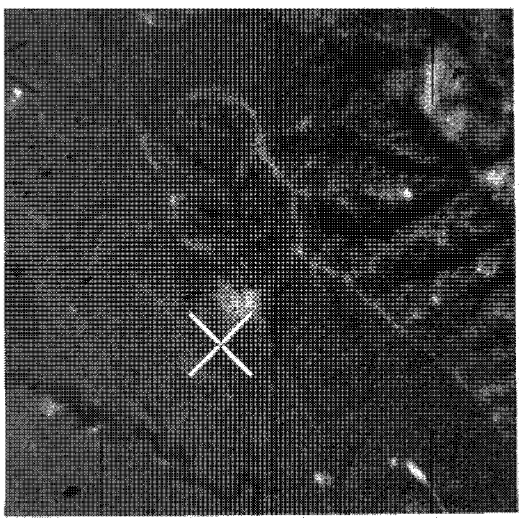
TERRAIN, ACCEPTABLE FIDUCIAL IMAGERY



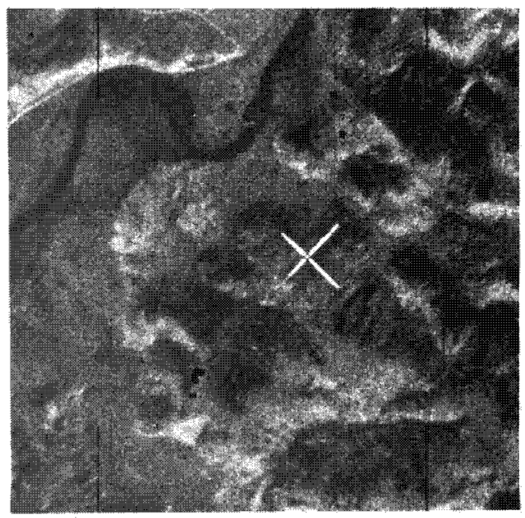
Fiducial No. 1



Fiducial No. 2



Fiducial No. 3



Fiducial No. 4

Terrain camera: Op 166; frame 006; 20× enlargements

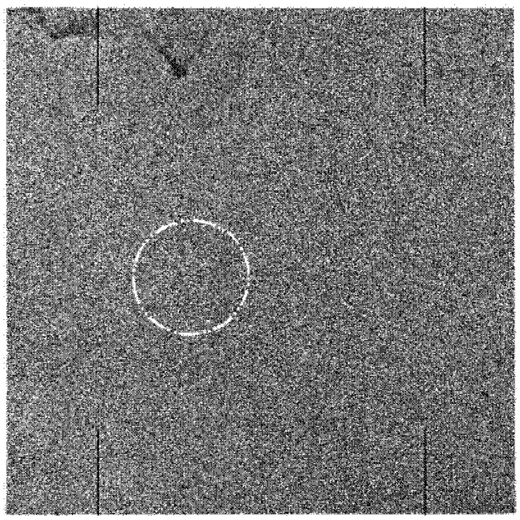
FIGURE 4-11

TABLE 4-11

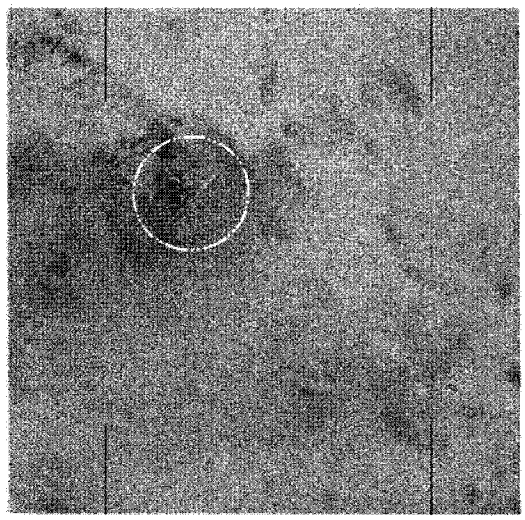
TERRAIN, FIDUCIAL MARK STATISTICS (CENTER DOTS)

Op	Frame	Fiducial (Corner Intersection)	Background Density	Peak Density	Diameter (micrometers)
1	1	1(0101)	1.72	2.00	18.8
		2(2301)	2.10	2.28	14.1
		3(2347)	1.90	2.26	12.5
		4(0147)	2.56	2.76	20.3
197	18	1(0101)	2.16	2.42	17.2
		2(2301)	1.94	2.18	15.6
		3(2347)	1.94	2.20	18.8
		4(0147)	1.48	1.94	20.3

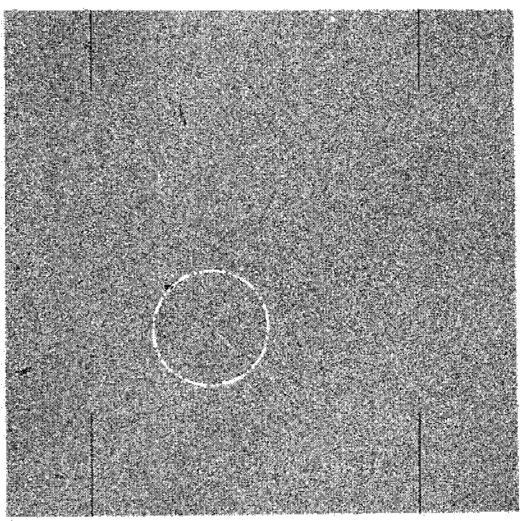
TERRAIN, REJECTED FIDUCIAL IMAGERY



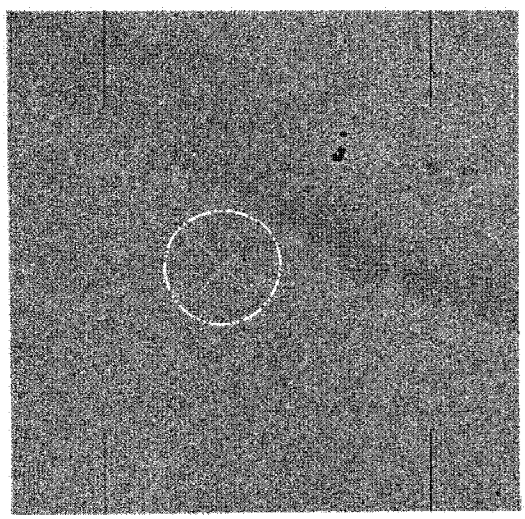
Fiducial No. 1



Fiducial No. 2



Fiducial No. 3



Fiducial No. 4

Terrain camera: Op 169; frame 005; 20× enlargements

Note: Encircled area (added in reproduction) shows location of fiducials.

FIGURE 4-12

TERRAIN, MICRODENSITOMETRIC PROFILE FIDUCIAL NO. 2
(ACROSS CENTER DOT), OPERATE 197, FRAME 18

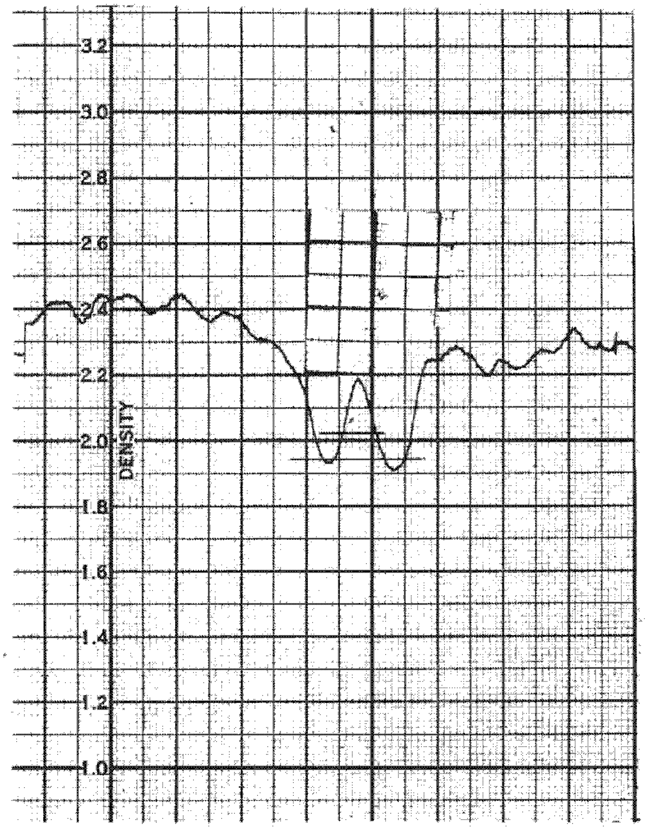


FIGURE 4-13

TABLE 4-12

STELLAR/TERRAIN, DATA BLOCK STATISTICS

Op	Frame	Camera	Row	Column	Background Density Between Dots	Peak Density	Diameter (micrometers)
1	1	Terrain	12	1	0.30	1.85	187.50
				2	0.30	1.84	190.60
				3	0.30	1.82	193.80
				4	0.30	1.88	168.80
185	2	Terrain	14	1	0.30	1.94	178.00
				2	0.30	1.90	187.50
				3	0.30	1.96	187.50
				4	0.30	1.98	200.00
1	1	Stellar	15	5	0.60	1.60	200.00
				4	0.60	1.50	206.20
				3	0.60	1.30	200.00
				2	0.70	1.40	150.00
				1	0.70	1.10	206.20
185	1	Stellar		5	0.60	2.24	212.5
				4	0.60	2.36	212.5
				3	0.60	2.20	212.5
				2	0.60	2.00	206.2

DENSITOMETRIC PROFILES (STELLAR DATA BLOCK),
OPERATE 185, FRAME 1

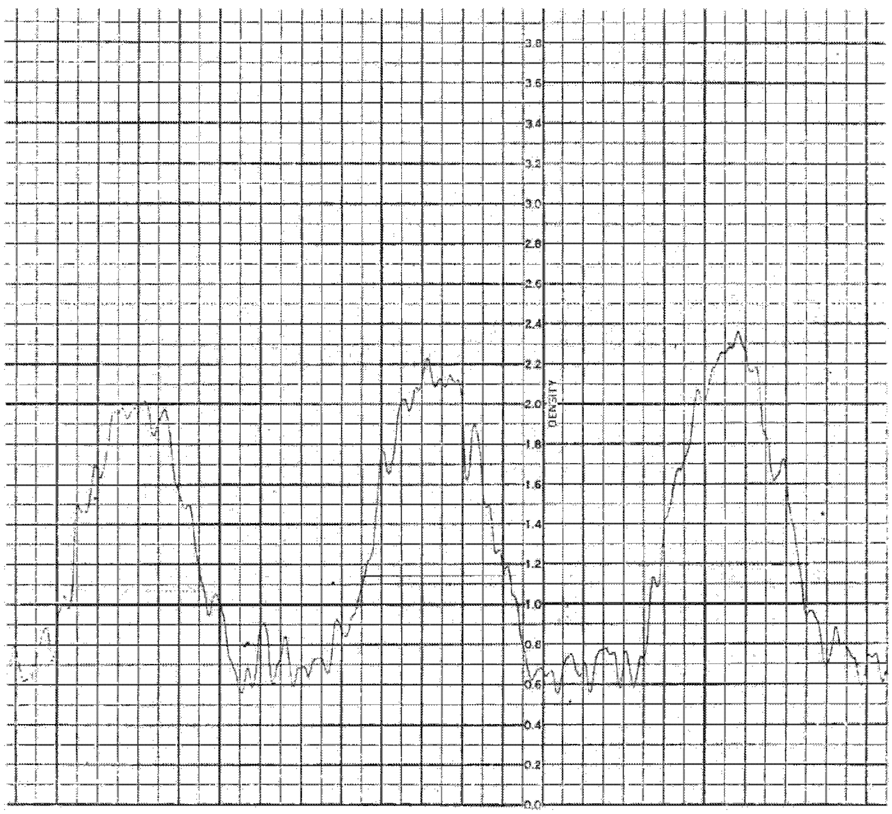


FIGURE 4-14

MICRODENSITOMETRIC PROFILE (TERRAIN DATA BLOCK),
OPERATE 185, FRAME 2

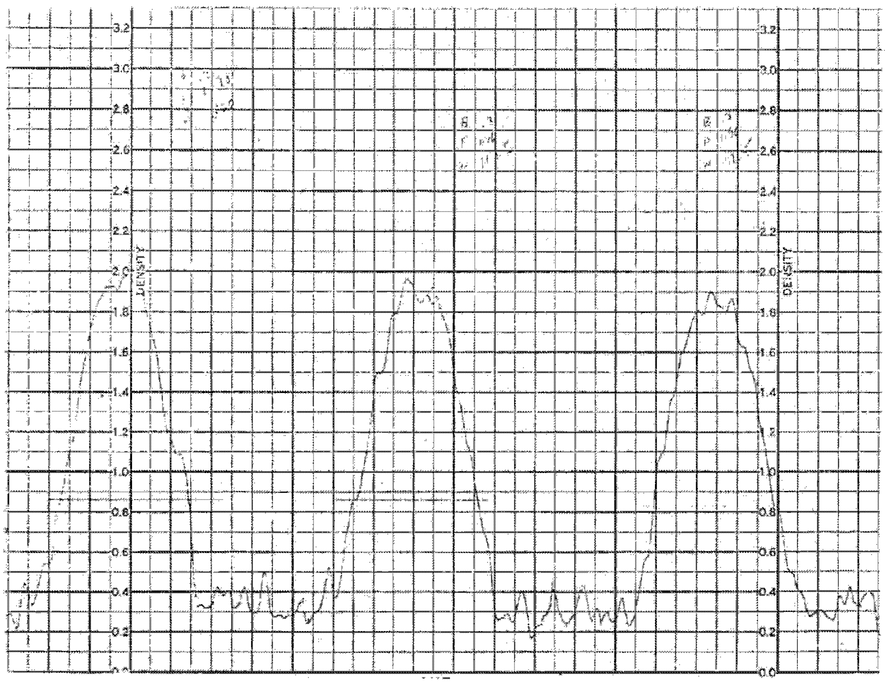


FIGURE 4-15

STELLAR/TERRAIN TYPICAL DATA BLOCKS

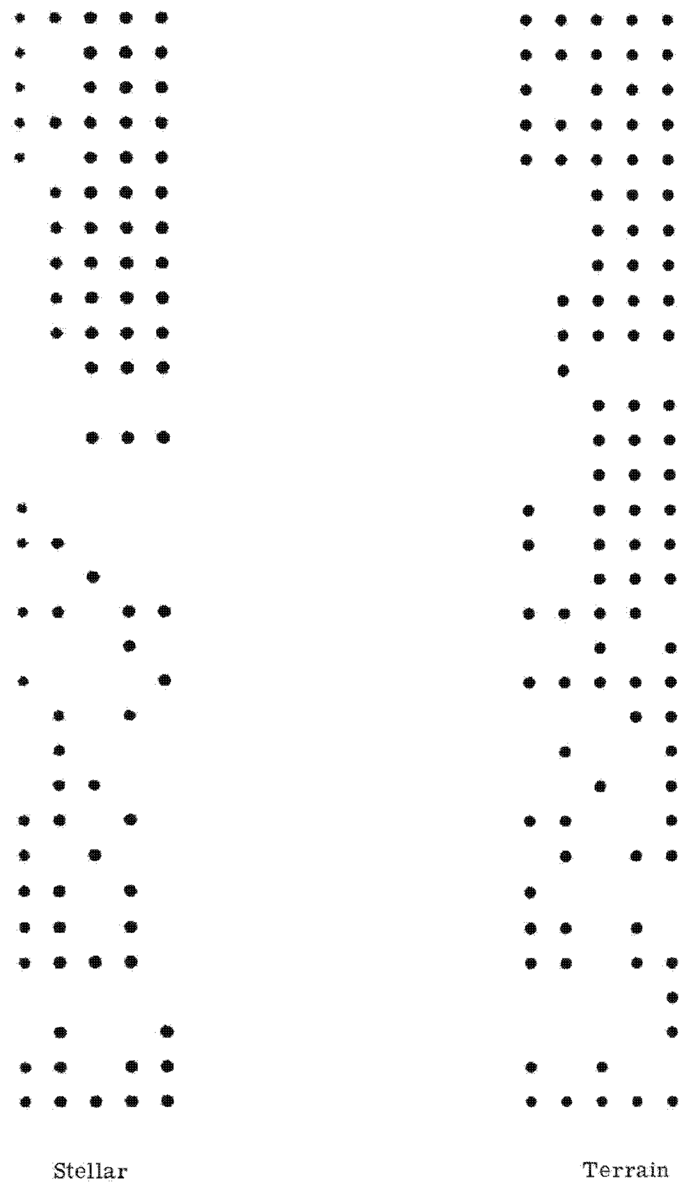
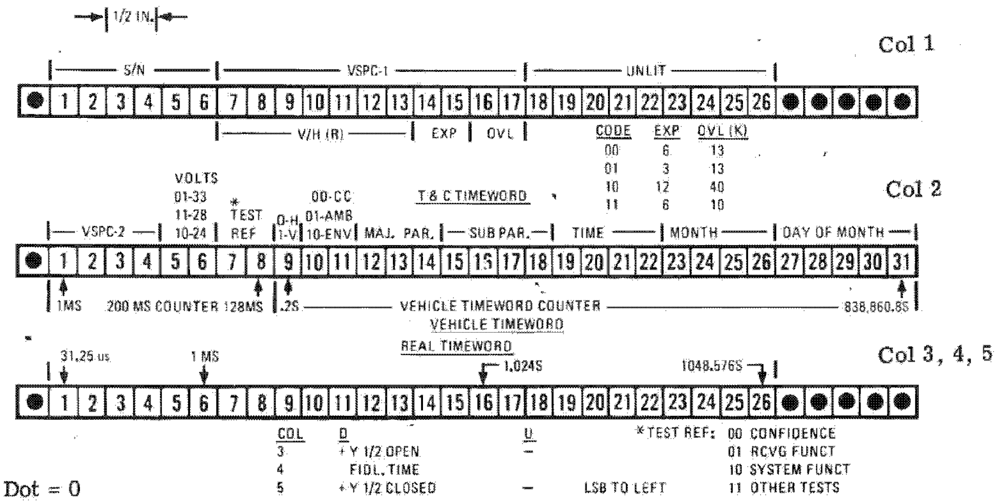


FIGURE 4-16

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 4-17

STELLAR, DATA BLOCK ORIENTATION

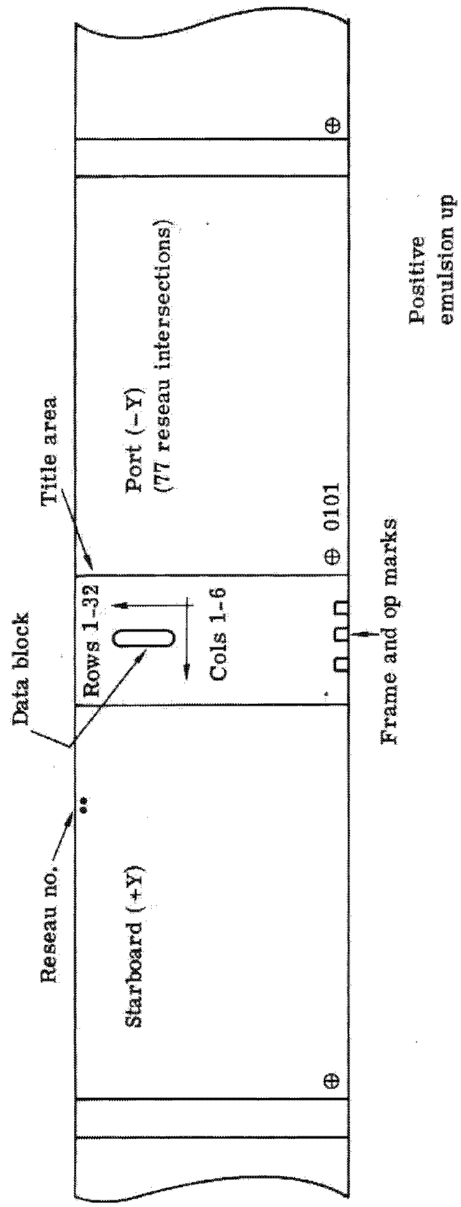


FIGURE 4-18

TERRAIN, DATA BLOCK ORIENTATION

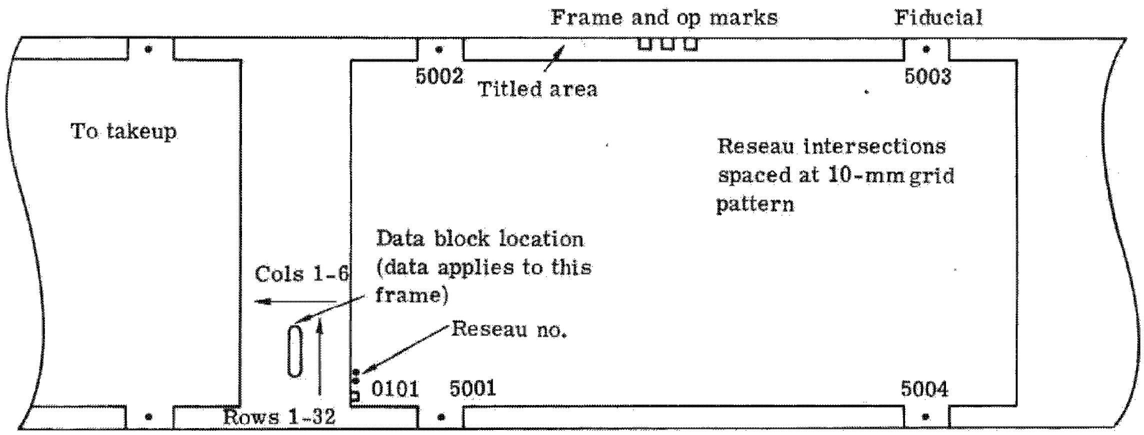


FIGURE 4-19

TABLE 4-13

STELLAR/TERRAIN, OPERATE/FRAME MARK STATISTICS

Op	Frame	Camera	Background Density	Peak Density	Width (mm)
1	1	Terrain	0.3	2.4	3.188
			0.3	2.4	3.250
185	2	Terrain	0.3	2.4	3.250
			0.3	2.6	3.250
1	1	Stellar	0.6	2.8	3.188
			0.5	3.0	3.156
			0.5	3.0	3.250
185	1	Stellar	0.6	2.5	3.125
			0.6	2.9	3.250
			0.6	3.0	3.250

STELLAR/TERRAIN, FRAME MARKS DIAGRAM

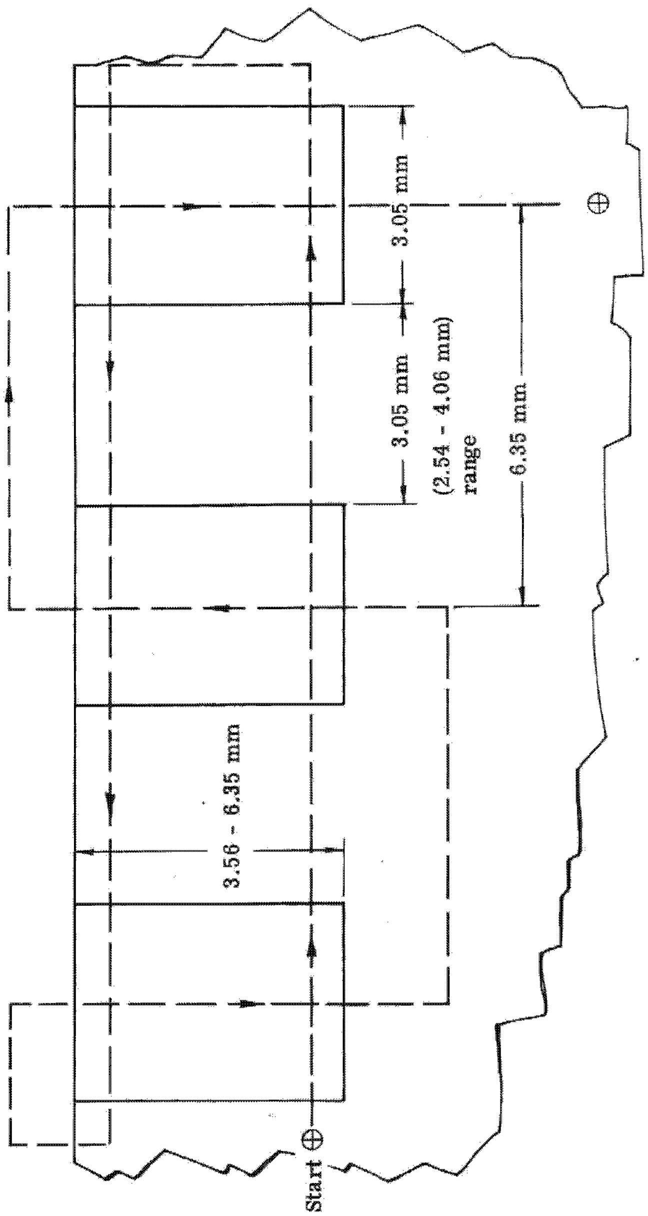


FIGURE 4-20

4.3.5 Measurements

4.3.5.1 Film Tracking

Specifications

The following are blueprint tolerance values of 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: terrain: 5.08 to 6.60 millimeters
stellars: usable format extends out to film edge.

Thirty consecutive frames are to be measured from both stellar and terrain cameras.

Procedures

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.
2. Measurements were made on the original negative material at the processing site.
3. All measurements were within tolerance.
4. Stellar frames were inspected to ensure usable format to the film base edge. There were no indications of any tracking difficulties.

Conclusions

From all material inspected, no problems due to tracking have been detected.

4.3.5.2 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 terrain frames and thirty stellar frame pairs are required for the frame to frame measurements. Two stellar pairs are required to satisfy the port to starboard measurement specifications.

Procedures

All of the measurements were made on a monocomparator during the film deformation determination phase of the PFA.

Evaluation Results

1. The distances between terrain frames were within the operational specifications.
2. The distances between stellar frame pairs were within specifications.
3. Port (−y) to starboard (+y) distances were within specifications.

Conclusions

Measurements indicate nominal condition for the metering phase of the camera's operations (Table 4-14).

4.3.5.3 Frame Format Size

Specifications

The following values were taken from the format blueprints.

Terrain frame: 228.600 × 462.788 millimeters
Stellar frame: 70 × 110 millimeters.

Two frame sets located at each end of the mission material were designated for the measurements.

Procedures

All data were obtained from monocomparator readings.

Evaluation Results

The data are presented in Table 4-15.

Conclusions

Measurements indicate no anomalies.

4.3.5.4 Fiducial Positioning With Respect to Surrounding Reseau Intersections

Specifications

Figure 4-21 shows the required tolerances for fiducial positioning with respect to the reseau system.

TABLE 4-14

STELLAR/TERRAIN, METERING DISTANCE STATISTICS

Location	Actual Range mm	Tolerance mm
Terrain/Terrain	22.863-30.094	19.81-32.51
Stellar Pair/Stellar Pair	5.662-7.52	3.56-8.64
Port (-y)/Starboard (+y)	47.538-47.589	46.99-49.53

TABLE 4-15

STELLAR/TERRAIN, USABLE FORMAT DIMENSIONS

Frame	Average Size (mm)
Terrain	229.001 x 463.152
Port (-y)	69.710 x 110.242
Starboard (+y)	69.538 x 110.270

TERRAIN, FIDUCIAL ORIENTATION TO RESEAU SYSTEM

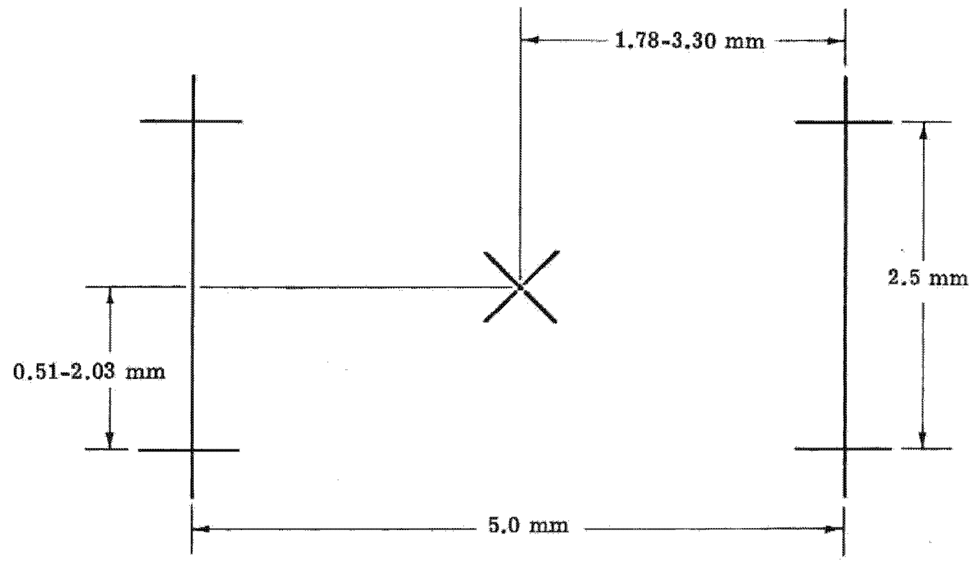


FIGURE 4-21

Procedures

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

Evaluation Results

Figures 4-22 through 4-25 illustrate the grouping of fiducials and the position of each grouping to the reseau system. (Four surrounding reseau intersections.)

Conclusions

All frames evaluated are within the specified tolerance.

4.3.5.5 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.

Procedures

Film measurements were used for the overlap evaluation on randomly selected frames.

The overlap percentage values are listed on the overlap data sheet (Table 4-16).

Evaluation Results

All frames evaluated are within the required overlap values.

4.3.6 Terrain Image Study

Specifications

Resolution specifications for a given system would logically require the detection of values comparable to ground testing results. However, because of scale, CORN targets or alternate methods are not available that will give satisfactory ground resolution information comparable to ground testing results. The visual edge matching (VEM) instrument is used to acquire VEM numbers and associated resolution values. The measured film values have not been correlated to ground resolution and should not be misconstrued as directly representing ground resolution. The main importance and use for these VEM resolution values is a relative mission to mission comparison.

Procedures

An SO-284 matrix was used in the VEM instrument to evaluate the film for this mission.

TERRAIN, FIDUCIAL ORIENTATION PLOT (1)

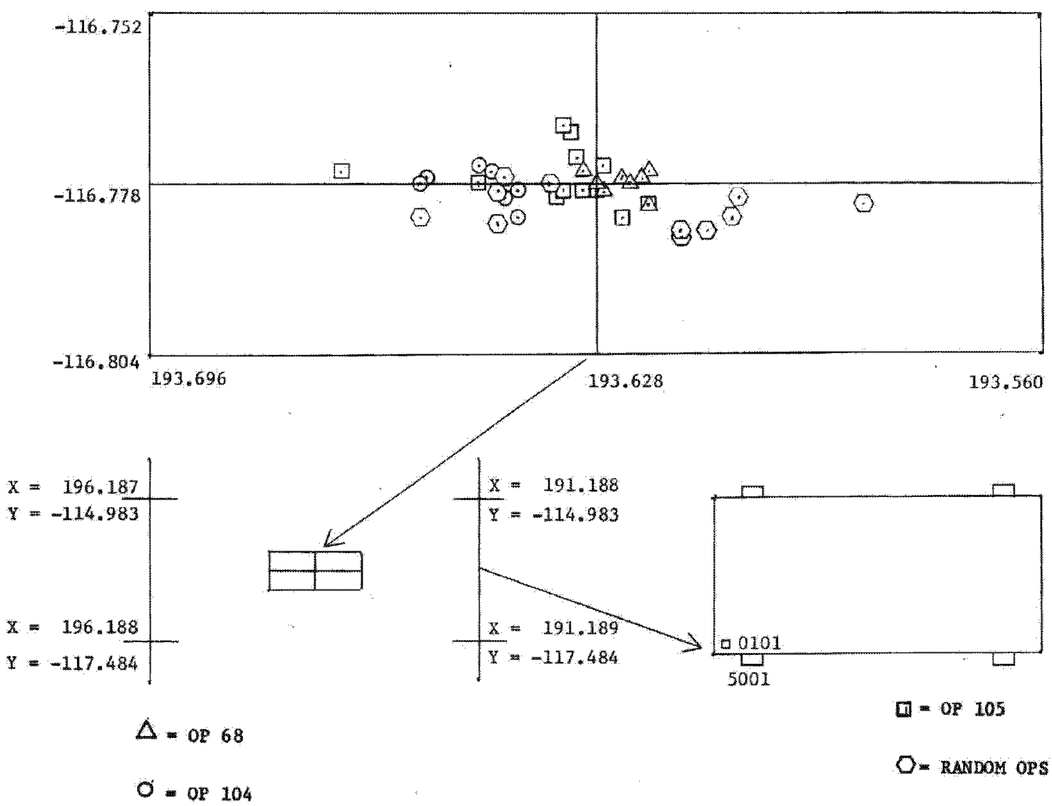


FIGURE 4-22

TERRAIN, FIDUCIAL ORIENTATION PLOT (2)

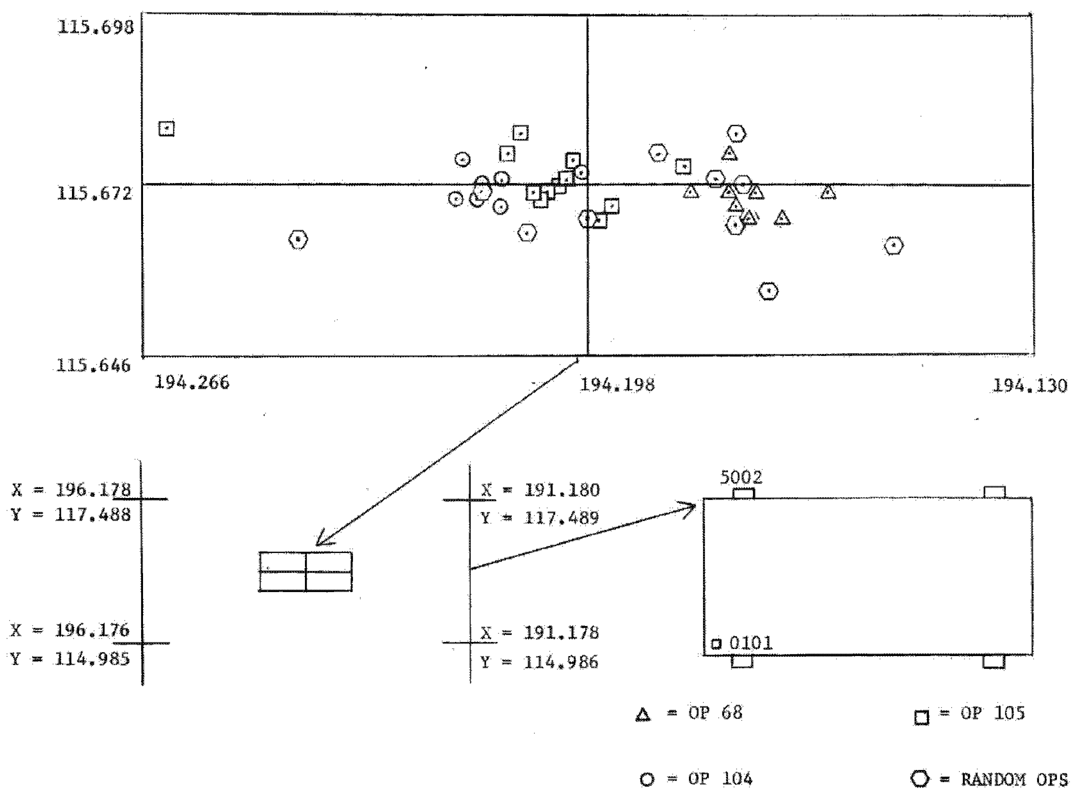


FIGURE 4-23

TERRAIN, FIDUCIAL ORIENTATION PLOT (3)

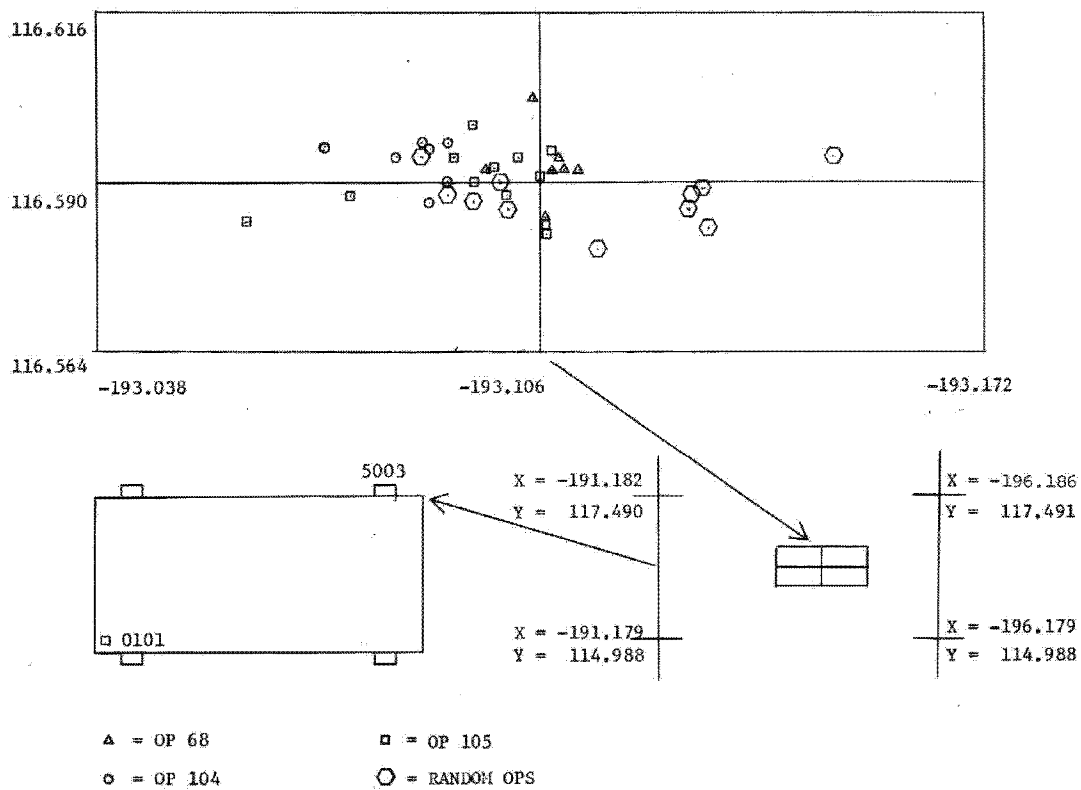


FIGURE 4-24

TERRAIN, FIDUCIAL ORIENTATION PLOT (4)

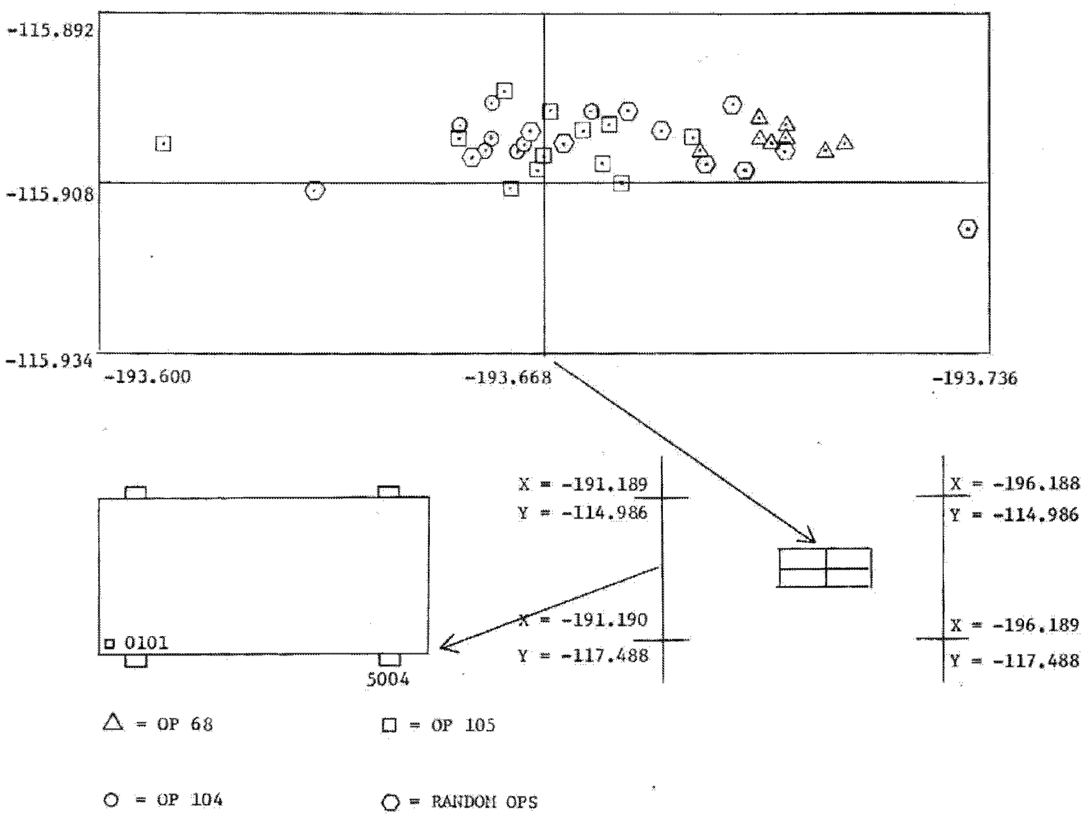


FIGURE 4-25

TABLE 4-16

TERRAIN, OVERLAP PERCENT COMPARISONS

Op	1st Frame	2nd Frame	Percent Overlap	MPR/Title Overlap
2	1	2	70.5	70
4	5	6	70.5	70
12	4	5	70.6	70
12	7	8	70.7	70
12	16	17	70.7	70
22	4	5	70.5	70
27	3	4	70.7	70
39	7	8	70.6	70
41	3	4	70.6	70
45	3	4	70.7	70
59	5	6	70.7	70
59	10	11	70.7	70
65	11	12	70.4	70
67	3	4	70.6	70
69	4	5	70.6	70
76	8	9	70.5	70
104	6	7	70.5	70
114	2	3	70.6	70
120	7	8	70.7	70
124	4	5	70.6	70
128	1	2	70.7	70
134	5	6	70.6	70
137	5	6	70.6	70
149	18	19	70.5	70
152	2	3	70.6	70
153	3	4	70.7	70
158	3	4	70.5	70
159	8	9	70.5	70
190	4	5	70.7	70

Evaluation Results

Table 4-17 displays the results of the VEM analysis performed by DMATC personnel during the Breakout phase of the PFA. Figure 4-26 is the format area locater that relates the VEM measurements to the terrain format.

Lens resolution statistics derived during preflight testing from standard resolution targets are shown in Table 4-18.

Figures 4-27 through 4-34 are provided as examples of this mission's image quality.

4.3.7 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 visually evaluated against star charts for sixth magnitude images, star distribution and quantity of images.

Procedures

The randomly selected frames are overlaid with a Duratrace sheet to "pull up" the film images. The Duratrace 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 60 frames evaluated indicate a comparable number of sixth magnitude images as found on previous missions.

Calibration Mode Imagery

The mission 1208 calibration mode essentially is a duplication of the mission 1207 conditions with the exception of a reduced overall density for the terrain frames (reduced artificial illumination exposure). The terrain exposures readily indicate 75 to 100 images very similar to mission 1207. A full in-flight calibration effort using the first three operates of the C-mode material is currently underway. At this writing, all stellar frames are measured and the computer data processing is in progress. Six frames of each camera, two from each operate are to be used in the reduction. Terrain frames are located to the stellar field and mensuration is in progress. Results of this calibration effort will be published, when available, as a separate report.

TABLE 4-17

TERRAIN, VEM STATISTICS

Op	Frm	Area	VEM No.	Resolution c/mm
56	11	1	5	51
36	1	2	4	63
56	8	2	6	42
59	18	3	5	51
167	3	3	5	51
158	2	4	5	51
34	7	5	5	51
197	7	5	7	34
56	8	6	7	34
56	8	6	5	51
37	8	7	4	63
62	5	7	6	42
56	11	8	6	42
20	6	9	4	63
166	4	9	4	63
155	6	10	7	34
157	3	10	4	63
63	10	11	5	51
166	4	11	3	77
185	11	12	4	63
187	12	12	5	51
52	6	13	4	63
59	18	13	6	42
63	4	14	6	42
166	4	14	2	*89
25	9	15	4	63
16	16	15	5	51
55	5	16	5	51
25	4	17	5	51
36	1	17	4	63
42	4	18	5	51
166	4	18	2	*89
37	9	19	6	42

*Extrapolated value - beyond scale of VEM Matrix.

TABLE 4-17 (CONTD.)

TERRAIN, VEM STATISTICS

Op	Frm	Area	VEM No.	Resolution c/mm
42	5	19	4	63
187	10	19	3	77
33	4	20	4	63
58	2	20	5	51
62	11	21	6	42
31	1	22	3	77
47	4	22	5	51
59	17	22	4	63
37	6	23	4	63
63	8	23	6	42
58	1	24	5	51
42	3	25	5	51
61	2	25	6	42
44	3	26	5	51
62	4	26	6	42
42	5	27	4	63
155	5	27	5	51
63	9	28	7	34
155	5	29	4	63
47	5	30	5	51
63	7	31	5	51
186	4	32	5	51

Average of 55 readings 54 c/mm

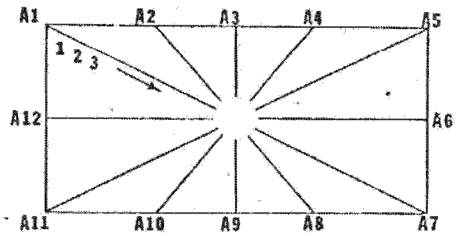
FORMAT AREA BREAKDOWN SHEET

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 4-26

TABLE 4-18

*TERRAIN CAMERA RESOLUTION STATISTICS



Terrain Format

Lens AWAR 51.3 L/mm
System AWAR 51.3 L/mm

Format Position	Resolution in lines/mm (Tan/rad) A1	A2	A3	A4	A5	A6	A7
1	40				41		39
2	42				40	48	44
3	40				41	42	47
4	44				43	50	47
5	48				46	46	47
6	46				47	50	50
7	53	58		55	54	57	56
8	55	54	54	54	54	57	58
9	48	49	48	48	48	49	51
10	56	55	55	54	55	57	56
11	56	56	60	54	59	55	56

Format Position	A8	A9	A10	A11	A12		Zonal Average
1				38			40
2				41	43		43
3				43	47		43
4				45	45		47
5				49	47		47
6				52	53		50
7	58		57	57	60		56
8	55	57	54	58	59		56
9	51	51	46	50	44		49
10	59	59	55	58	60		57
11	56	58	57	55	57		57

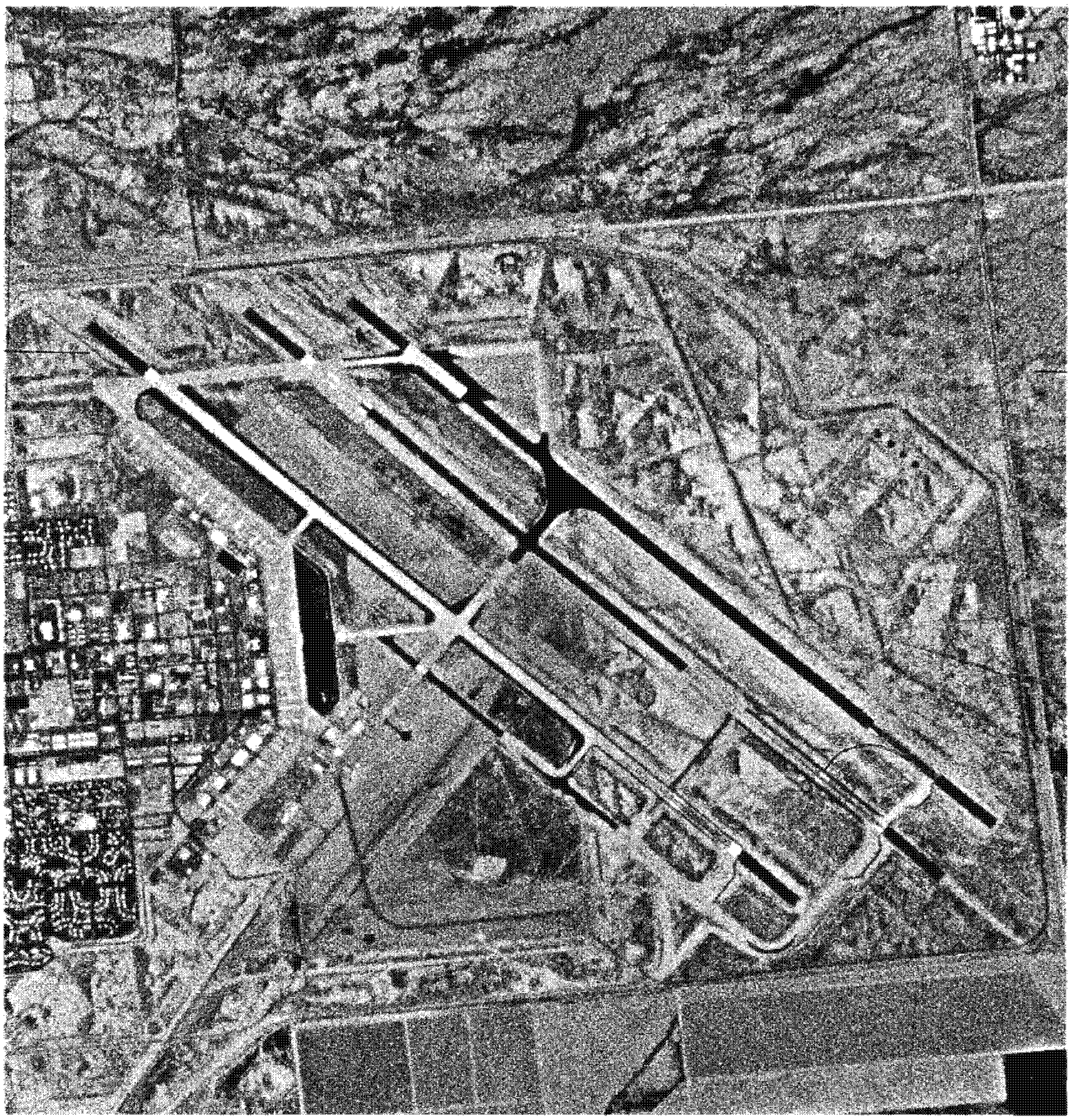
*Manufacturer's Data

TYPICAL TERRAIN IMAGERY—MISSION 1208

Terrain camera: Op 068; frame 004; Williams AFB, Phoenix, Arizona; 10× enlargement

FIGURE 4-27

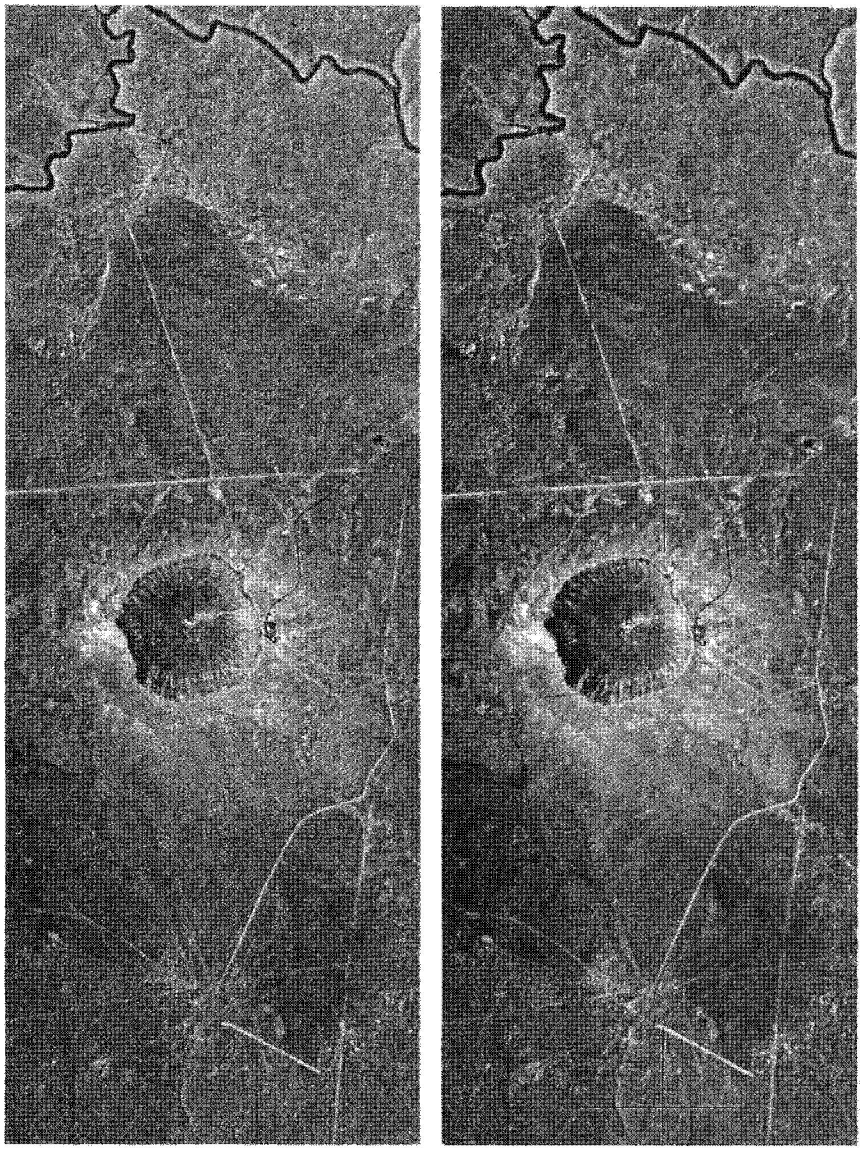
TYPICAL TERRAIN IMAGERY—MISSION 1208



Terrain camera: Op 068; frame 004; Williams AFB, Phoenix, Arizona; 20× enlargement

FIGURE 4-28

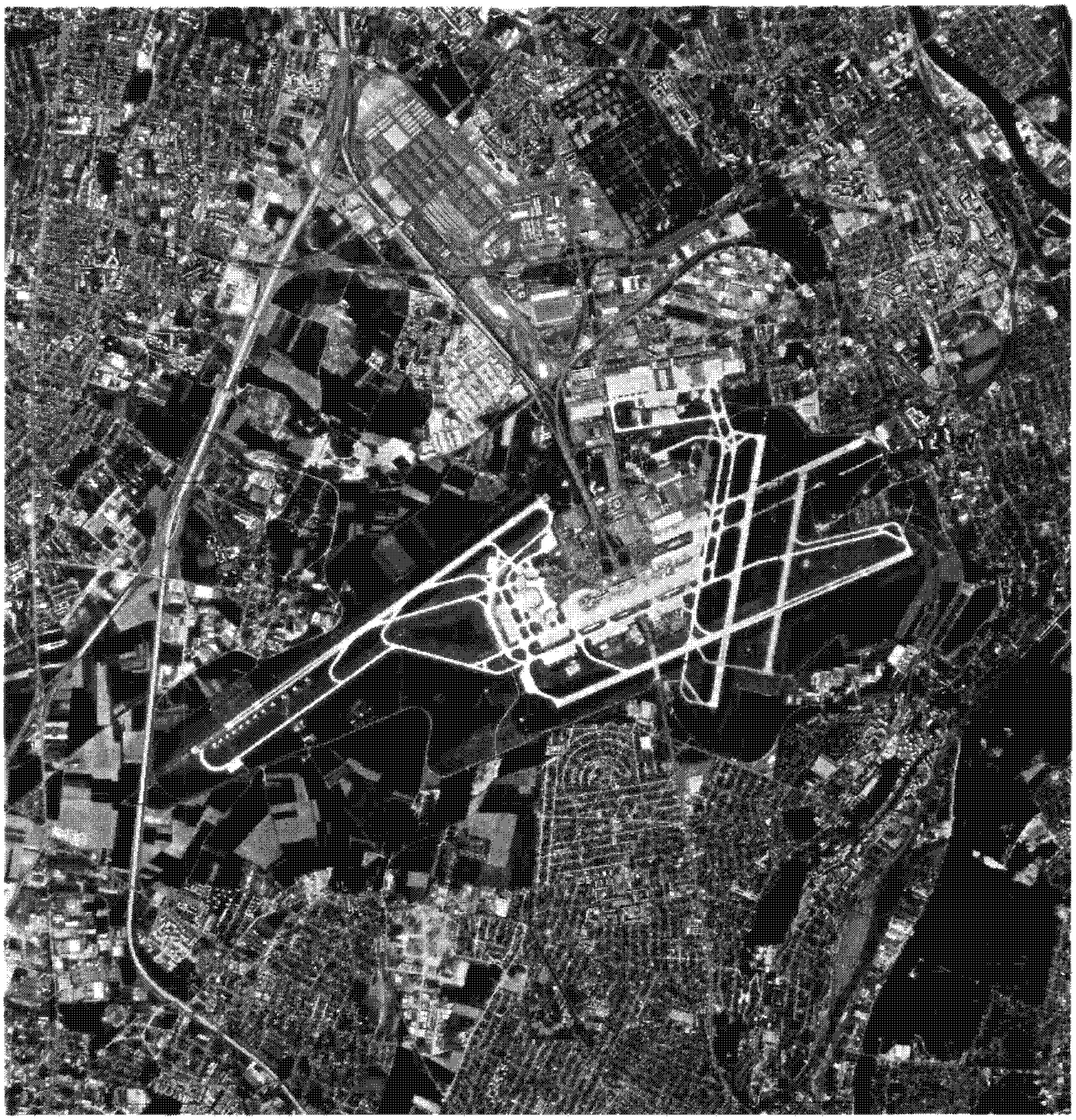
EXAMPLE OF STEREO PAIR TERRAIN IMAGERY



Terrain camera: Op 068; frames 001 and 002; meteor crater; Winslow, Arizona; 10× enlargement

FIGURE 4-29

TYPICAL TERRAIN IMAGERY—MISSION 1208



Terrain camera: Op 104; frame 001; Charles DeGaulle Airport, Paris, France; 10× enlargement

FIGURE 4-30

TYPICAL TERRAIN IMAGERY—MISSION 1208

Terrain camera: Op 020; frame 002; Zealand, Denmark;
10× enlargement

FIGURE 4-31

Approved for Release: 2025/06/18 C05137303

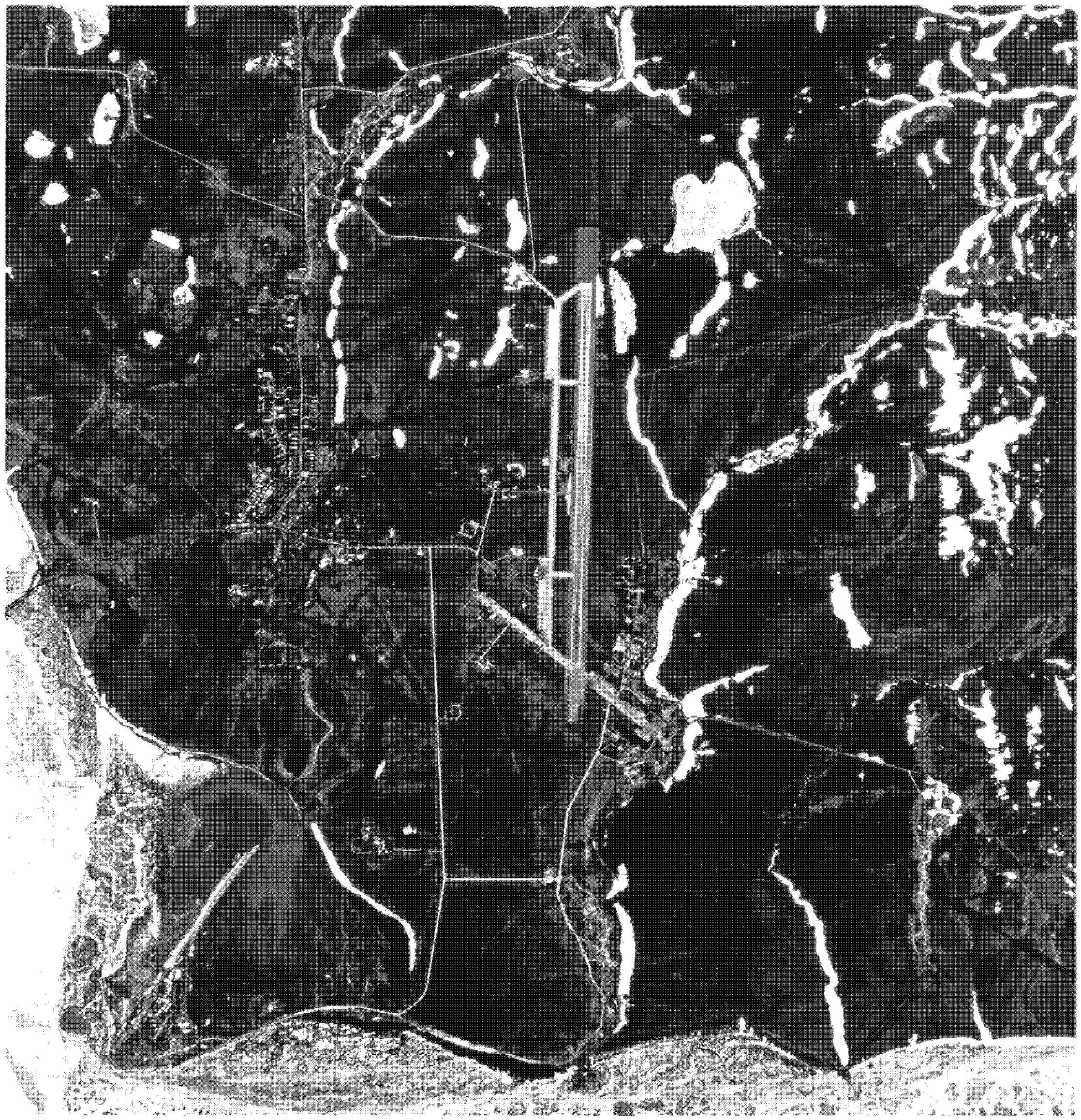
TYPICAL TERRAIN IMAGERY—MISSION 1208

Terrain camera: Op 108; frame 008; Novoalekseyevka (Dam), Russia; 10× enlargement

FIGURE 4-32

~~TOP SECRET-RUFF NOFORN~~

EXAMPLE OF 3414 TERRAIN PHOTOGRAPHY



Terrain camera: Op 201; frame 002; Airfield in Eastern USSR; 10× enlargement

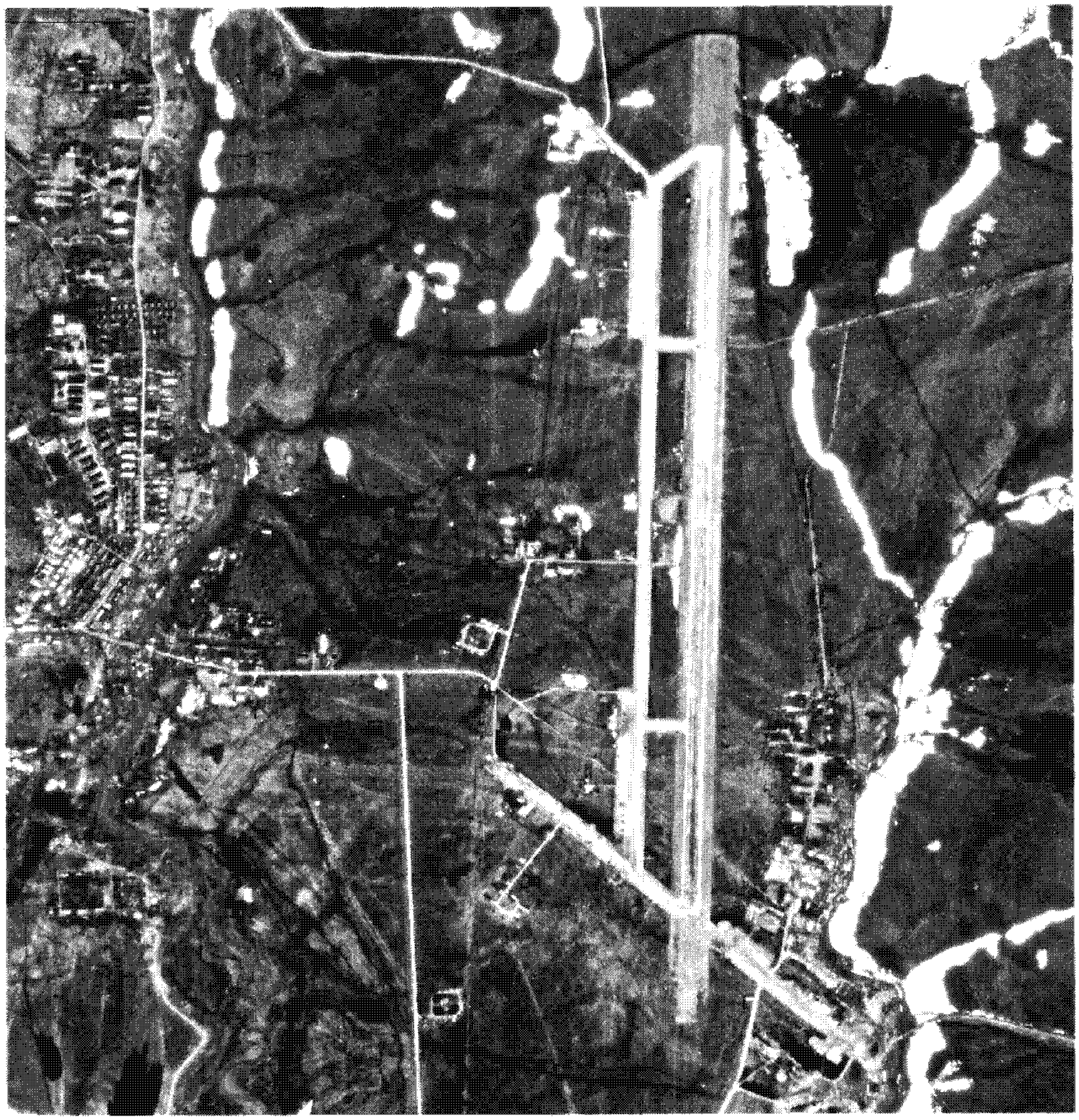
FIGURE 4-33

~~TOP SECRET-RUFF NOFORN~~

ICL-TCS-2013-74

HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

EXAMPLE OF 3414 TERRAIN PHOTOGRAPHY



Terrain camera: Op 201; frame 002; Airfield in Eastern USSR; 20× enlargement

FIGURE 4-34

4.3.8 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 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.

Procedures

All data blocks for the PFA evaluation were read manually using the 10× reading device provided by the Camera Contractor.

Evaluation Results

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

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. Occasionally the V/h value for the first frame following an update during an operate does not agree with the remaining frames; in this case the specification is not satisfied. However, this frame would still have a common ground point with associated trilap frames. Table 4-19 illustrates the described condition.

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

Calibration Mode Time Words

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

It should be noted from the table that the fiducials are exposed prior to the opening of the stellar shutters. The exposure time for both cameras is approximately 2 seconds. No data block readout is available for the total exposure time of this camera.

4.4 MISSION FRAME COVERAGE AND STATISTICS

In order to provide a more comprehensive data package for each mission of the mapping camera system (MCS), illustrations of the mapping, charting, and geodetic (MC&G) requirements, the 90 to 100 percent clear trilap frame coverage (Figure 4-35), and a table of mission statistics (4-22) have been assembled for this summary.
Additional related mission statistics are provided in Tables 4-23 and 4-24.

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TABLE 4-19

FIDUCIAL EXPOSURE ELAPSE TIME STATISTICS
Operate 105 Frame 1-12

FRAME	ELAPSE TIME INTERVAL*	V/h
1		.0491
	8.97131	
2		.0491
	8.96797	
3		.0491
	8.96800	
4		.0491
	8.96797	
5		.0491
	8.96803	
6		.0494
	8.91387	
7		.0494
	8.90944	
8		.0494
	8.90931	
9		.0494
	8.90937	
10		.0494
	8.90937	
11		.0494
	8.90944	
12		.0494

*Data block column #4 - internal clock time

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TALENT-KEYHOLE
CONTROL SYSTEM ONLY

TABLE 4-20

MID-EXPOSURE TIME COMPARISON
(All Times in Secs)

OP	FRAME	MID-EXPOSURE DIFFERENCES (+y)S/FIDUCIAL	MID-EXPOSURE DIFFERENCES (-y)P/FIDUCIAL	TOTAL EXPOSURE TIME (+y)S	TOTAL EXPOSURE TIME (-y)P
70	1	.00270	.00311	.20178	.20222
	2	.00266	.00309	.20175	.20225
	3	.00266	.00309	.20175	.20225
	4	.00267	.00312	.20178	.20225
	5	.00267	.00312	.20178	.20231
	6	.00266	.00309	.20181	.20225
	7	.00264	.00308	.20178	.20228
	8	.00261	.00302	.20178	.20222
	9	.00261	.00306	.20178	.20225
104	1	-.00055	-.00014	.20191	.20216
	2	-.00062	-.00022	.20187	.20219
	3	-.00062	-.00023	.20187	.20222
	4	-.00061	-.00019	.20191	.20219
	5	-.00066	-.00019	.20187	.20225
	6	-.00059	-.00016	.20187	.20225
	7	-.00061	-.00019	.20191	.20225
121	1	-.00187	-.00145	.20194	.20216
	2	-.00184	-.00144	.20194	.20219
	3	-.00184	-.00145	.20194	.20216
	4	-.00188	-.00145	.20194	.20222
	5	-.00191	-.00145	.20194	.20222
	6	-.00188	-.00145	.20194	.20222
	7	-.00191	-.00147	.20194	.20219

TABLE 4-21

C-MODE TIME WORD STATISTICS
(All 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
202	4	88.01719	88.04922	90.30859	2.25937	88.04922	90.30834	2.25912
	5	108.06334	108.09537	110.35475	2.25937	108.09537	110.35447	2.25909
	6	128.10947	128.14150	130.40091	2.25941	128.14150	130.40059	2.25909
	7	148.15556	148.18759	150.44700	2.25941	148.18762	150.44672	2.25909
203	1	26.33681	26.36884	28.62819	2.25934	26.36884	28.62794	2.25909
	2	46.38291	46.41494	48.67434	2.25941	46.41494	48.67403	2.25909
	3	66.42903	66.46106	68.72044	2.25937	66.46106	68.72019	2.25912
	4	86.47516	86.50719	88.76653	2.25934	86.50722	88.76628	2.25906

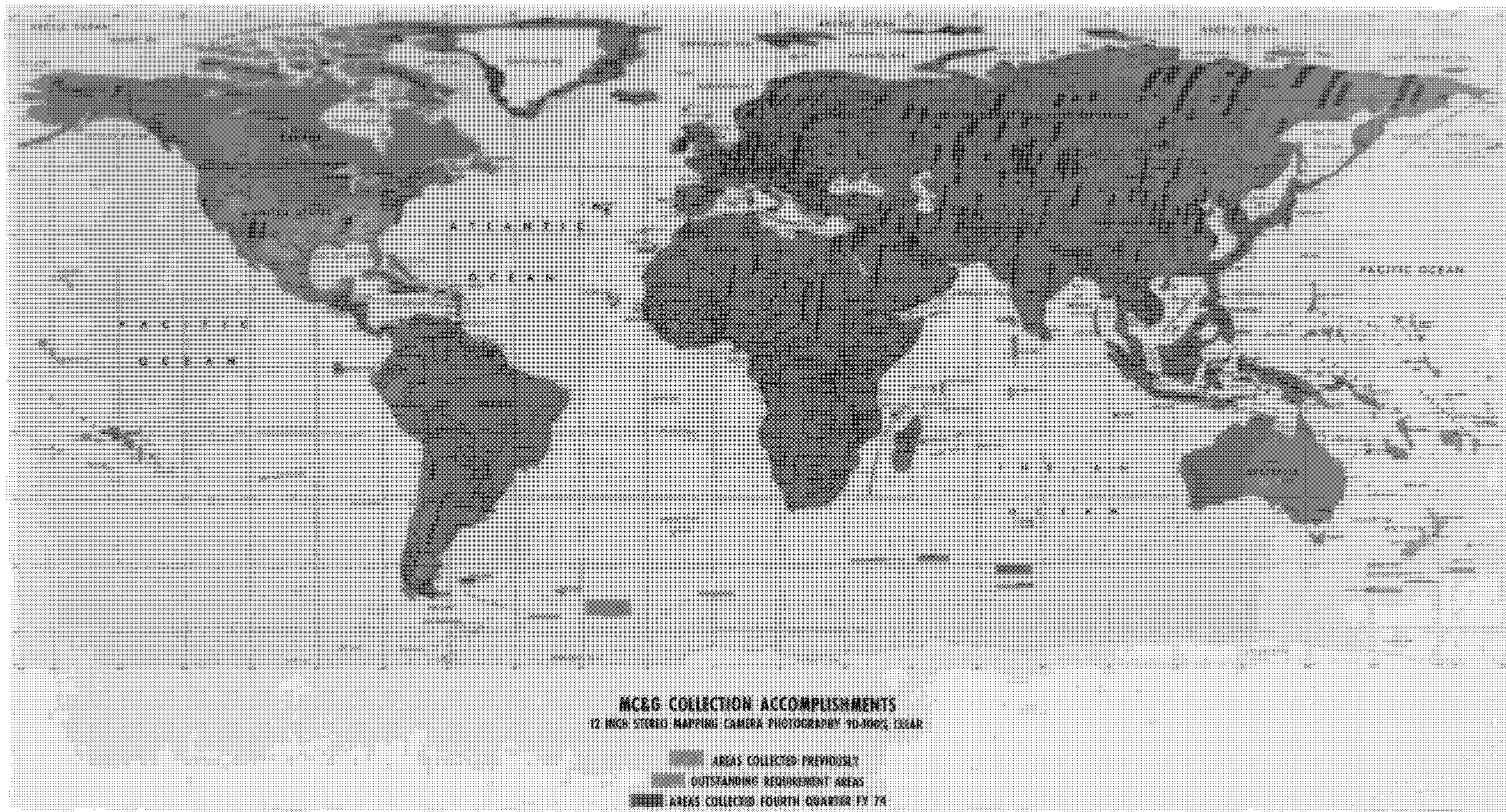
TABLE 4-22

MISSION FRAME COVERAGE STATISTICS

Mission Number	1205-5	1206-5	1207-5	1208-5
+Total Accessed	*5,894	6,282	6,671	6,487
Unique Trilap MC&G Coverage (Acceptable)	2,700	2,400	2,600	1,300
+Total Accessed Trilap	4,457	4,936	5,021	4,418
+Total Accessed Bilap	719	672	825	1,035
+Total Accessed Mono	718	673	825	1,034
Redundant Coverage Within a Mission	70	150	150	470
Redundant Mission to Mission Coverage		160	410	977

*Thousands of Square Nautical Miles

+MPR derived values



MAPPING, CHARTING, AND GEODETIC REQUIREMENTS FOR MISSION 1208

FIGURE 4-35

TABLE 4-23

MISSION STATISTICS

Mission Number	1205	1206	1207	1208
Launch date	9 Mar 73	13 Jul 73	10 Nov 73	10 Apr 74
Launch time	1300 PST	2022 GMT	1210 PT	2020 GMT
Satellite vehicle	SV-5	SV-6	SV-7	SV-8
ST system	S/N 003	S/N 005	S/N 004	S/N 006
Orbit inclination (degrees)	95.696	96.207	96.93	94.52
Initial perigee (NM)	85.252	87.681	88.673	85.55
Initial apogee (NM)	158.008	155.342	154.400	164.73
Argument of perigee (degrees)	133.584	139.626	142.801	141.36
Initial period (minutes)	88.83098	88.8643	88.883	89.01
Range of photo altitudes (approx. - NM)	85-156	86-116	87-119	86-117
Range of sun angles (degrees)	9-90	12-90	1-85	16-86
Recovery date	20 Apr 73	24 Aug 73	7 Jan 74	9 Jun 74
Recovery time	2336Z/1536 PST	2331 GMT/Z	2245 GMT	2231 GMT
Recovery rev	683	683	942	973
Comment	Routine air catch (12,400 feet)	Routine air catch (12,800 feet)	Routine air catch	Routine air catch

TABLE 4-24

CAMERA STATISTICS

Mission Number	Camera Designation	Focal Length (mm)	Standard Deviation (mm)	Filter Type	Reseau S/N	Lens S/N
1205	T	306.3281	0.0010	WR-21	014	003
	(-y)P	253.2472	0.0063	None	023	007
	(+y)P	253.5919	0.0071	None	017	006
1206	T	304.8521	0.0009	WR-21	016	005
	(-y)P	253.2181	0.0053	None	027	011
	(+y)S	253.1646	0.0054	None	026	009
1207	T	305.1991	0.0008	WR-21	015	004
	(-y)P	253.2043	0.0043	None	022	010
	(+y)S	253.1630	0.0046	None	025	008
1208	T	306.7604	0.0011	WR-21	012	006
	(-y)P	253.4402	0.0056	None	024	005
	(+y)S	253.4504	0.0056	None	029	012

SECTION V

CONCLUSIONS, RECOMMENDATIONS, AND ACTION ITEMS

5.1 CONCLUSIONS

5.1.1 Operations

The operation and performance of camera system SN 006 was judged outstanding by the PFA team. All aspects of operation, including telemetry acquisition, were anomaly free for the entire mission. Photographically, the terrain camera performance was equal to the best acquired on past missions and the stellar camera formats contained an adequate number of sixth magnitude star images. The second engineering test using 3414 film was conducted on this flight. The resolution and exposure data from 1207 and 1208 were consistent and provided the final support for using 3414 film as the terrain camera primary load.

Subjective and objective analyses of exposure levels acquired on 3400 and 3414 films (terrain camera) have shown that exposure times were within the camera/algorithm accuracies.

5.2 RECOMMENDATIONS

5.2.1 Mission 1209 Exposure

System 007 (1209) will have a WR-12 (equivalent) filter and the capability to expose frames at 6, 12, and 24 milliseconds adapted to the terrain camera. Exposure analyses of engineering tests using 3414 film on missions 1207 and 1208 provided empirical data for the following exposure recommendations:

Sun Angle, degrees	Exposure Time, milliseconds
0-10	24*
11-46	12
47-90	6

*Under low solar altitudes, exposures will be manually controlled.

5.2.2 "Forced" Process of 3401 Film

Previous results (1207 and 1208) and the added potential of additional exposure latitude available on mission 1209 [using a WR-12 (equivalent) filter and approximately a 3.7-second exposure time] justify continuing the investigation to obtain the optimum sensitivity from 3401 film used for terrain starfield calibration.

5.2.3 Special Process of 3400 Film

Efforts will continue to develop an optimum process for 3400 film that will produce acceptable results when used in the stellar cameras.

5.3 ACTION ITEMS

5.3.1 Missions 1207 and 1208 In-Flight Calibration (DMATC)

Complete the mensuration process and report on the calibration potential of the in-flight starfield calibration conducted on missions 1207 and 1208.

5.3.2 Stellar Camera Operate/Frame Mark Density (Contractor/Processing Facility)

Review the possibilities for increasing the density of the stellar frame marker to aid in detection during optical titling.

5.3.3 Stellar 3400 Special Process Evaluation (DMATC/Processing Facility)

Evaluate and report results of the three special process techniques used on the stellar tag-end (3400) for mission 1208.

5.4 USE OF OTHER FILMS

5.4.1 3414 Film for Terrain Camera

Laboratory tests and two flight tests have produced results that fully support using 3414 film on mission 1209.

5.4.2 3400 Film for Primary Load on Stellar Camera

Approximately 100 feet of 3400 film will be tagged-on the supply for use during the run-out phase. This film will undergo process investigation similar to that conducted on mission 1208.

5.4.3 QX801 Film Tag-On in Terrain Camera

Approximately 30 feet of QX801 film will be added as a tag-on in the terrain load of mission 1209.

APPENDIX

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.

~~TOP SECRET-RUFF NOFORN~~
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