Top Secret HEXAGON

Hexagon
Sensor Subsystem

SV-11 (SN-014)
FLIGHT READINESS REPORT

DECEMBER 1975

Handle via
BYEMAN Channels
BYE-3503/75

Reverse side blank

Top Secret

PUBLICATION REVIEW

This report has been reviewed and is approved.

Major, USAF
1211 Ass't Vehicle Manager

FOREWORD

This report has been prepared for and by direction of the Office of Secretary of the Air Force, Director of Special Projects.

We are indebted to the Air Force Special Projects Production Facility, Westover Air Force Base, Massachusetts, for their support in preparing and reducing the data contained within this report prior to deactivation of the AFSPPF Evaluation Directorate in the summer of 1975. We are also grateful for the support of the National Photographic Interpretation Center, particularly the Applied Photo Science Division, for their excellent support in the preparation and publication of this report.

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SECTION I

INTRODUCTION

1.1 SUMMARY

For 1414 film, flight focus should be set at 51 microns and 77 microns for the Forward and Aft Cameras, respectively. In addition to 1414, the Aft Camera contains Conventional Color (SO-255), Infrared False Color (SO-130) and Ultra-Ultra Thin Base Black and White (SO-208) films. The SO-208 has a total thickness of 1.7 mils as compared to the present 1414 total thickness of 2.0 mils. This is the first HEXAGON flight system to utilize this material. The Aft Camera flight focus should be set at 60 microns for SO-208 and at 107 microns for SO-255 and SO-130 Films. The vacuum test data is summarized in Table 1-1.

TABLE 1-1

VACUUM TEST EVENT SUMMARY

	Test Results	
Chamber A	Forward Camera	Aft Camera
1414 Film		
XT Mean Smear (inch/second)	-.004	.009
IT Mean Smear (inch/second)	-.009	.017
PBF (microns)	60	73
Peak Resolution (cycles/mm)	167	163
SO-255 Film		
XT Mean Smear (inch/second)	.017	-.008
PBF (microns)	90	103
Peak Resolution (cycles/mm)	117	117

Inter Test Events
- Forward and Aft Camera MC Servo Replaced
- SSC Box Replaced (13A1)
- OOAA Box Replaced (1A7)
- Forward and Aft Platens Removed for Retrofit

TABLE 1-1 (CONT'D)

	Forward Camera	Aft Camera
Chamber A-2 (1414 Film)		
First A-2 (1A-2) Test		
XT Mean Smear (inch/second)	.001	-.001
IT Mean Smear (inch/second)	-.007	.000
PBF (microns)	45	70
Peak Resolution (cycles/mm)	179	187
Inter Test Events		
Aft Camera Platen Tilt Advanced 16 Microns		
Second A-2(2A-2 Test)		
XT Mean Smear (inch/second)	.004	.002
IT Mean Smear (inch/second)	-.019	.001
PBF (microns)	45	78
Peak Resolution (cycles/mm)	178	177

NOTES:

1. Mean smear values and peak resolution were taken from the 0° collimators at a Vx/h of .052 radian/second at 70°F.
2. All best focus (PBF) data is based on tribar data.
3. The Aft Camera will be launched with a mixed load of 1414, SO-255, SO-130 and SO-208 Films.
4. All Chamber A-2 tests were run on 1414 material.

The OOAA adjustments recommended for flight are summarized in Table 1-2. The SO-208 material was not photographically tested in SV-11; however, the OOAA flight adjustments provided in this table are recommended based upon Chamber A test data from another system. Oribital operations with SO-208 are constrained to 120 degree scan angle lengths only.

TABLE 1-2

RECOMMENDED OOAA ADJUSTMENTS
(counts)

Motion Component	Film Type	Forward Camera	Aft Camera
In-Track	1414	+1	-3
Cross-Track	1414	0	0
Cross-Track	SO-255/SO-130	N/A	Δ -15
Cross-Track	SO-208	N/A	Δ +4

The changeable filters installed in both cameras will be utilized in flight in the following manner: Both cameras will be launched with W-12 equivalent filters. The Forward Camera contains film type 1414 only and will utilize the W-12 for the entire mission. The Aft Camera, however, contains a mixed film load and will utilize the W-12 for the 1414, SO-208, and the SO-130. The SO-255 will be exposed with the W-2E3 equivalent filter.

1.2 SYSTEM IMPROVEMENTS

The following improvements were made on SV-11:

A. The Forward Section has 180° wrap builder rollers (B/R) in all RV positions. RV-1 has a cage-up B/R design while RVs 2, 3, and 4 have a cage-down design. SV-10 had a 0° wrap B/R in position 1 and 180° wrap cage-up in positions 2, 3, and 4.

Position 1 will be caged and uncaged in a manner similar to that of previous RVs, while positions 2, 3, and 4 do not require the time delay associated with uncaging the B/R. However, as a result of the cage-down B/R design, the RV transfer sequence will include raising and then lowering the B/R 1/8 inch prior to initiating the double wrap and again prior to initiating the cut and tail wrap portions of the transfer sequence.

B. The pneumatics module is replaced with a unit having twice the volume of the previous design. The new module also incorporates a built-in series resistor in the pressure transducer circuits to protect against a shorted transducer. The previous design required the addition of a resistor external to the module in order to provide this protection.

1.3 AREAS OF CONCERN

During the assembly and testing of SV-11 (SN-014) at SVIC, several anomalies occurred which should be noted. None of the following concerns are significant enough to preclude launching of SV-11, nor should they impact the system's optical performance.

1.3.1 High Forward Brake-Slip Force

RV-2B (TU-025) and RV-4B (TU-022,) both have out-of-specification forward brake-slip force. RV-4B only slightly exceeds the specification of 15.0 to 17.7 pounds with a measured value of 18.0 lbs. RV-2B brake-slip force was measured at 20.4 pounds. The concern is based on the film tension that would occur if the brake is erroneously applied during film transport. This concern has resulted in constraining RV-2 to a maximum film velocity of 62.2 inches per second when the take-up radius is greater than 13.2 inches. With this constraint, the condition is acceptable and the Government will use as is.

1.3.2 Forward Camera Erratic Tracking

While performing film tracking tests, the Forward camera tracking was found to be erratic and symptomatic of a mechanical tracking problem. Extensive inspection, alignment, and rework of the fine film path tracking subassemblies failed to correct the problem. The anomaly was finally traced to excessive edge damage on the film itself and proper tracking resulted when the film stack was replaced. The film edge damage has been attributed to multiple spooling of film used on the problem film stack. SV-11 has demonstrated excellent tracking using a variety of film stacks and film types since this anomaly. For this reason, the Government will use as is.

1.3.3 Sequence Failure

While running the vertical baseline test, the Sequence Command and Control (SCC) box failed such that the Forward Camera film drive and metering capstans were commanded to a negative 110 inches per second film velocity while the take-up and supply servos were commanded to plus 18 inches per second. The result was a runaway condition which could not be controlled via ESD commanding and power to the system had to be removed to shut down the system. The sequencer was removed and replaced with another unit and the system was thoroughly inspected and tested as well as a detailed analysis performed to insure that no components were overstressed during the failure. All subsequent analysis and tests show that the problem was corrected by replacing the sequencer (and related SESD box) and that other system components were not overstressed. For these reasons, the Government will use as is.

1.3.4 Integrator Reset Anomaly

RV-3 of SV-10 experienced an on-orbit anomaly similar to that which occurred on SV-8. This anomaly results in an erroneous tension indication in the take-up servo loop and may result in the take-up servo reacting and causing a film tension transient. The problem in SV-10 was intermittent and has not reoccurred during extensive testing of the recovered take-up assembly. Although tests are continuing in an attempt to isolate and correct the cause of this problem, the impact should it reoccur on subsequent block II systems is minimal and can be eliminated by imposing operating constraints successfully used on SV-8 and SV-10. For this reason, the Government will use as is.

1.3.5 Power Distribution System Relays

A 50 amp relay in the Power Distribution System (PDS) of SV-10 failed on-orbit in the off position and resulted in the failure of the Aft Camera to turn on. The relay was commanded repeatedly and was successfully freed of a jam apparently caused by contamination. The relay operated properly for the rest of the mission. Subsequent investigation has shown the techniques used to build and test these relays have not been sufficiently adequate to preclude contamination in this relay type. Subsequent 50 amp relays on SV-12 and following systems will have optimum manufacturing and testing controls imposed, however, these relays could not be made available and retrofitted in time for SV-11. The relays used on SV-11 have been X-radiographed and found to contain no loose contamination which could cause a malfunction. Also, no other system has experienced a 50 amp relay contamination failure either in ground testing or in on-orbit operation. For these reasons, the Government will use as is.

1.3.6 Low Take-up Velocity (TU-030A/SV-11-1)

During Chamber A-1 testing, RV-1A ran at one-half the commanded velocity and the Forward Camera coarse tension dropped to 1.2 pounds. Analysis indicated this would have resulted if the ground return signal path was open. Inspection of the wiring harness disclosed a loose connection in the ground return electrical circuit. The 3W160 cable was replaced and the problem has not recurred during subsequent testing. For this reason, the Government will use as is.

1.3.7 Brake Release Verify Signal (TU-030A/SV-11-1)

The RV-1B brake release verify signal operated intermittently during WCFO testing and is suspected to be an intermittent wire connection in the SCC box. The sensor worked properly during A-2 and subsequent testing. The signal is a diagnostic only and is not critical to system operation. For this reason, the Government will use as is.

1.3.8 Platen Torque Disturbance

During vertical preship testing, a disturbance in the Forward Camera photo-mode and return-mode platen torque levels was observed. Careful analysis of all test data showed intermittent torque disturbances after the platen repair that occurred between Chamber A-1 and A-2 testing. Examination of the platen showed a twisted 5° light pipe was moving away from its normal position during platen cycling. The twist was removed from the light pipe and operation was normal during special tests as well as vertical preship testing completed after repair. For this reason, the Government will use as is.

1.3.9 Forward Camera In-track Smear

Instances of out-of-specification 2-sigma in-track smear on the Forward Camera were observed during Chamber A-2 photographic tests. Test data indicated the in-track smear increases with increased scan angle length. The smear values are acceptable and are similar to smear values encountered during factory acceptance testing. Other systems have also experienced similar 2-sigma smear values and the cause is being investigated. Because the SV-11 smear rates and resolution are acceptable, the Government will use as is.

1.4 WCFO FACTORY TEST FLOW

The test flow for SV-11 at the WCFO is shown in Figure 1-1. The Milestone Schedule is shown in Table 1-3. A summary of the major activities is provided in the following paragraphs.

1.4.1 Forward-section Buildup

Forward-section buildup and test was started on 18 April 1974 and completed on 29 July 1974. The Forward Steerer Servo (5A1) was replaced due to an improper output voltage level. The forward force necessary to pull against the brake on RV-2 and RV-4 was 20.4 lbs and 18.0 lbs respectively; these forces were beyond the specification limits of 15.0 to 17.7 lbs. Both units were accepted as satisfactory; however, a constraint was placed in HSSOP on RV-2 which limits the film velocity to a maximum of 62.2 inches per second when the take-up radius is greater than 13.2 inches. The following retrofits were incorporated:

A. Builder Roller Full Switch was disabled in all RVs.

B. Torsion Rod Bracket 621-3216 was replaced with an improved design.

C. Radius Potentiometer was secured to the shaft on RV-2.

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ASSEMBLY AND TEST FLOW AT SVIC

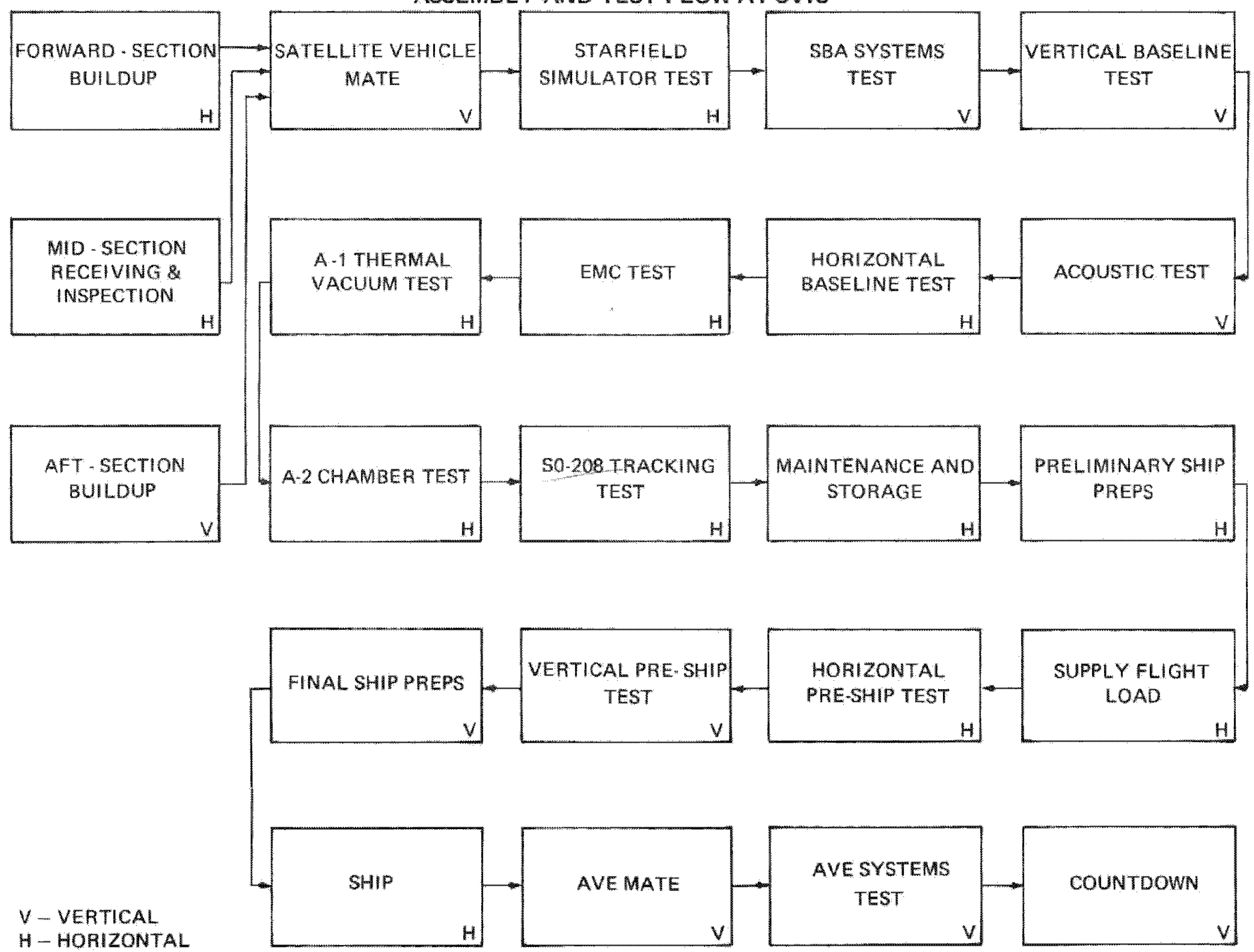

FIGURE 1-1

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TABLE 1-3

SV-11 MILESTONE SCHEDULE

	Activity	Date Completed
1.	Forward-section Buildup	29 July 1974
2.	Mid-section R & I	3 July 1974
3.	SV Mate	12 September 1974
4.	Starfield Simulator Test	20 November 1974
5.	Vertical Baseline Test	6 January 1975
6.	Acoustic Test	9 January 1975
7.	Horizontal Baseline Test	17 January 1975
8.	EMC Test	28 January 1975
9.	Chamber A-1 Test	29 March 1975
10.	Chamber A-2 Test	
	1st Vacuum	21 May 1975
	2nd Vacuum	3 June 1975
11.	Preliminary Shipping Preparation	22 October 1975
12.	Final Shipping Preparation	5 November 1975
13.	Ship	10 November 1975
14.	AVE Mate	10 November 1975
15.	AVE Systems Test	14 November 1975
16.	Countdown	23 November 1975

Note: Items 11 - 16 show projected dates based on present time lines.

1.4.2 Mid-Section Receiving and Inspection (R & I)

The Mid-section was received at the WCFO on 13 May 1974. SBAC performed only those tasks necessary to allow SSC to start testing. In parallel activity, SSC reloaded the supply with stacks containing 5% more film than previous stacks in order to validate system performance with the increased weight prior to committing SV-9's flight load to the larger stacks. R & I testing started on 23 May 1974 and was completed on 3 June 1974 with no significant anomalies. SBAC activity on the mid-section continued from 4 June 1974 to 22 July 1974. On 11 and 12 July, the Forward and Aft Camera platens were removed for slit and shutter spring rework. Upon return and installation of the platens on 7 August 1974, an overstress of the platen encoders necessitated the removal of the platens and output Film Drive Servos (3A1) for repair. In order to gain as much schedule time as possible, it was decided to proceed with vehicle mate without the platens and Film Drive Servo Boxes.

1.4.3 SV Mate

The mechanical mating of the Aft, Mid and Forward-sections was completed on 9 September 1974. Some difficulty was experienced with incorrect shims on the Mid-section interface. Also, a small portion of an articulator blanket was inadvertently caught between the Mid and Forward-sections, necessitating a de-mate and re-mate of these sections. On 16 September the SV was returned to the R & I area for re-installation of the platens. After installation of the platens, the Forward Camera exhibited erratic tracking which was ultimately traced to the Forward Camera supply stack.

The tracking problem investigation covered the period from 16 September to 18 November. During this interval the Forward Camera platen, cross-over, film drive and looper were removed and examined. Hardware that was questionable by various criteria was replaced. None of the rework had any appreciable effect on tracking and eventually the Forward and Aft Camera film supply stacks (rolls 260 and 261) were replaced with rolls 269 and 257, respectively. Tracking was excellent with the new stacks. The two stacks that were removed were sent to the manufacturer for evaluation of physical film characteristics (thickness, wedging, etc).

Other activity during this period included removal of the supply for temporary use on SV-9 (prior to removal of rolls 260 and 261) and removal of the On-Orbit Adjust Assembly Box (1A7) for permanent use on SV-9. A replacement OOAA box was subsequently installed on SV-11.

Two retrofits were incorporated:

A. The PDS was replaced with an improved (013) configuration.

B. The pneumatics module was replaced with one having larger spheres.

1.4.4 Starfield Simulator Test

The Starfield Simulator Test was completed 20 November 1974. The Forward Camera MC Servo went into oscillation during this test and, having been found to be defective, was replaced. The test was completed using the Aft Camera 2A3 box installed on the Forward Camera.

1.4.5 Vertical Baseline Test

The Vertical Baseline test was started on 13 December 1974. During the test, the System Command and Control box (13A1) failed to respond properly to the shutdown commands and vehicle power had to be removed while both cameras were running. Several areas of the system were inspected and mechanically and electrically tested for damage. The system was found to be satisfactory. The supply had a substantial amount of despooled film which had to be removed. Both the sequencer (13A1) and the SESD box (13A2) were replaced.

Vertical Baseline testing was resumed and completed on 6 January 1975 with no further incidents.

1.4.6 Acoustic Test

The system was installed in the acoustic cell on 8 January 1975 and the test completed on 9 January 1975 with no discrepancies.

1.4.7 Horizontal Baseline Test

The Horizontal Baseline Test was run and completed on 17 January 1975. During the test it was noted that the RV-1 Aft Camera Brake Verify diagnostic was missing. Troubleshooting indicated that the problem was in the sequencer; however, the unit has been accepted for use as is. A retrofit on the crossover pneumatics tubing was also performed during this time period.

1.4.8 EMC Test

An EMC Test was performed 22 January to 28 January 1975, and the results were acceptable.

1.4.9 Thermal Vacuum Test

The Satellite Vehicle was installed in Chamber A-1 on 18 March 1975 and testing was completed on 29 March 1975. Two significant anomalies occurred in the test:

A. RV-1 had an improper response at start-up. Troubleshooting found the problem to be a loose wire connection in a Forward-section cable. The cable was replaced.

B. The Fine Tension Sensor diagnostic on the Forward Camera platen was noisy.

The platen was removed on 16 April 1975 and the tension sensor potentiometer replaced. The platen was returned to the WCFO and reinstalled on 9 May 1975. Platen installation and retest were accomplished without incident. Also, the supply was reloaded with stacks containing various batches of 1414 and SO-208 Film. These stacks were made for the A-2 Chamber Test of SV-11 to evaluate problems surfaced during SVIC flow of SV-10 and to study the relationship between film processing, exposure settings, and film characteristics.

1.4.10 Chamber A-2 Photographic Test

The SV was installed in the Chamber A-2 on 12 May 1975 and testing was completed on 3 June 1975. The testing consisted of an expanded in-air test and two vacuum tests. The in-air test provided significant pre-vacuum exposure, sync-flash, and smear slit data. The first vacuum test provided data to evaluate exposure levels versus film processing methods. This test was completed on 21 May 1975. Data analysis indicated that a platen tilt of 16 microns was required on the Aft Camera. This was accomplished on 30 May 1975 prior to the second vacuum test. The second vacuum test was essentially a conventional A-2 test consisting of thru focus, pitch, OOAA, and filter change tests. In addition, there were tests to evaluate the characteristics of a specific 1414 emulsion batch as a function of exposure and processing. The second vacuum test was completed on 3 June 1975. Data analysis confirmed the focal plane tilt position for the Aft Camera platen. A high 2 sigma in-track smear was found on the Forward Camera.

1.4.11 Post Chamber A-2 Test

A special tracking test was run with SO-208 film. The test was limited to 120° scan angle lengths. The results showed that system tracking was not substantially different from tracking with 1414 film material.

An abbreviated Starfield Simulator Test was also performed to further assess SO-208 performance in the sensor subsystem.

1.4.12 Hardware Changes and Retrofits

A summary of all hardware changes and retrofits performed at the SVIC or MWFO facilities is presented in Table 1-4.

TABLE 1 - 4

HARDWARE CHANGES AT SVIC/MWFO FACILITIES

	CHANGE	DATE	REASON	REVERIFICATION
1.	STR'R SER (5A1) MR 64609 OLD 5055 NEW 5024	5/10/74	EDGE SENSOR VOLTAGE OUT OF SPEC	FEWO FAK 11-01
2.	PDS (14A1) MR 5116 (OTD) OLD 5017 NEW 5010	5/16/74	OPEN TECH CERT ITEM (TEMPORARY INSTALLATION)	R & I TEST
3.	SV-11 (RV-1) BRACKETS ON ARTS 5103, 5104, AND 5110	5/17/74	ECO 11676 IMPROVED DESIGN (RETROFIT)	FEWO FAK 11-01
4.	TUA-20 (RV-4)	6/5/74	ECO 8712 DISABLE FULL REEL SWITCHES (RETROFIT)	FEWO FAK 11-01
5.	HTR BLANKET (ART 5110) MR 64625 OLD 6019 NEW 6044	6/12/74	DAMAGED CABLE	R & I TEST
6.	TUA-20 (RV-3)	6/19/74	ECO 8449 DISABLE FULL REEL SWITCHES (RETROFIT)	FEWO FAK 11-01

TABLE 1 - 4 (CONT'D.)

	CHANGE	DATE	REASON	REVERIFICATION
7.	OOAA 91A7) MR 64627 (AGAINST SV-9) OLD 5010 NEW 5004	6/20/74	FOR USE ON SV-9	HORIZONTAL BASELINE
8.	TUA-20 (RV-2)	7/8/74	ECOs 8449, 8484, DISABLE FULL REEL SWITCHES (RETROFIT)	FEWO FAK 11-01
9.	TUA-47 (RV-2)	7/8/74	FEWO T25A-010 SECURE SHAFT ON "R" POT (MRB 0864) (RETROFIT)	POST FWD SECT FUNCTIONAL
10.	TUA-20 (RV-1)	7/12/74	ECOs 8449,8484 DISABLE FULL REEL SWITCHES (RETROFIT)	FEWO FAK 11-01
11.	SV-11-2 OLD 5010 NEW 5016	8/7/74	ECO 11355 INCREASED CAPACITY PN MODULE (RETROFIT)	MS R & I
12.	SV-11-3	8/8/74	ECO 10178 CONTAMINATION CONTROL (SU) (RETROFIT)	NOT REQ'D POST FLIGHT
13.	PDS (14A1) MR 5116 (OTD) OLD 5010 NEW 5016	9/23/74	PM 671 CHANGE TO LATEST CON- FIGURATION	POST R & I TEST

TABLE 1 - 4 (CONT'D.)

	CHANGE	DATE	REASON	REVERIFICATION
14.	D-BAR (FD-A) MR 64652 OLD N/A NEW 5315	10/17/74	REWORK DUE TO TRACKING PROBLEM	FEWO 11-35
15.	LO-A ROLLERS MR 64652 TOTAL OF 21 ROLLERS	11/2/74	PM 677 LO SUSPECTED CAUSE OF TRK PROBLEM	FEWO 11-32
16.	MC SER (2A3) MR 64663 OLD 1010 NEW 1021	11/20/74	IN/OUT D AND MC SER, LO WENT INTO OSC AT END OF RUN	STARFIELD TEST FEWO 11-39
17.	MC SER (2A3) MR 64668 OLD 1025 NEW 1038	12/10/74	CHASIS TO 28V RETURN SHORT	VERT BASELINE & SBAC RETEST
18.	SESD (13A2) MR 64665 OLD 5105 NEW 5107	12/19/74	SYSTEM DID NOT RESPOND TO FT+ COM- MAND.	NOT VALIDATED DUE TO PROBLEM WITH S/N 5107
19.	SESD (13A2) MR 64670 OLD 5107 NEW 5106	12/19/74	MISSING SEAL DOOR OPEN VERIFY ON S/N 5107	FEWO 11-44
20.	SCC (13A1) MR 64669 OLD 1009 NEW 1011	12/19/74	ABNORMAL SHUT DOWN	VERTICAL BASELINE
21.	MC SER (2A3) MR 64673 OLD 1038 NEW 1026	1/12/75	NOISE SPIKES ON FILM TO BAR DIAGNOSTIC SIGNAL	HORIZONTAL BASELINE
22.	CABLE ASSY 3W160 MR 64678	4/22/75	RV-1 IMPROPER START-UP	PRE A-2 CHAMBER TEST

SECTION II

CHAMBER A-2 TEST PLAN

2.1 INTRODUCTION

The purpose of Chamber A-2 testing is to evaluate the resolution performance, plane of best focus, platen tilt, and the adequacy of the image motion compensation (IMC) settings of the camera system prior to flight.

During the test flow, SV-11 was subjected to two Chamber A-2 tests. The first (1A-2) test was a series of special tests conducted with the following objectives:

1. To determine the optimum exposure of 1414 Film for peak resolution of the 2:1 tri-bar target as a function of processing.

2. To correlate FIDAP sync-flash mean smear with smear slit derived values to determine if the historical 3 count IT OOAA error in setting the Aft Camera for flight was related to sync-flash AGE.

3. To determine if changes to the skew setting, plane of best focus, or platen tilt had occurred because of the removal of the platens for retrofit prior to the A-2 testing.

The second (2A-2) test was a standard test sequence that included several additional sequences whose purpose was to evaluate the effects of film batch 38 (1414 Film) on system performance. The details of these tests are discussed in Sections IV and V of this report.

2.2 TEST IMPLEMENTATION

The Chamber A-2 tests are conducted in three parts. The first part consists of an in-air test that serves basically to verify the functionality of the test setup, to assure the alignment of the system to the collimators, and to establish the illumination levels required for proper film exposure.

The second portion of the test is conducted in soft vacuum. Resolution, platen tilt, plane of best focus, and film synchronization characteristics are determined during this test phase.

For the vacuum test, the flight image motion compensation (IMC) must be disabled. This necessitates a configuration change; therefore, it is necessary to verify system operation in the final configuration when vacuum testing is completed. For this reason, the third portion of the test is a second in-air test conducted after having reconfigured the sensor to the flight configuration.

This system is equipped with in-flight changeable filters on both cameras. A test was run to determine the repeatability of the filters to respond to commanded positions.

2.3 COLLIMATOR TARGETS

All collimator target reticles are the same, and collimators in Chamber A-2 are currently set to infinity focus. Figure 2-1 shows a photographic reproduction of the current Chamber A-2 target reticle configuration.

2.4 TEST SEQUENCE

Tables 2-1 and 2-2 present a listing of the first and second A-2 test sequences.

CHAMBER A-2 TARGET RETICLE

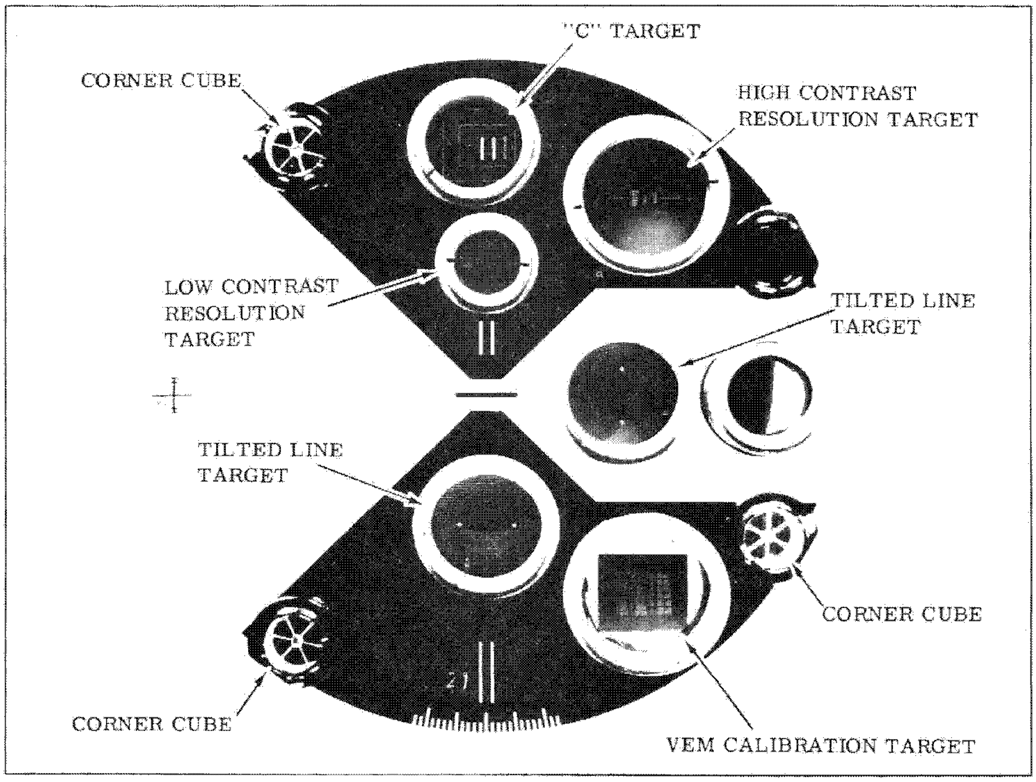

FIGURE 2-1

TABLE 2-1

1A-2 TEST SEQUENCES

Run	Seq	Vx/h (rad/sec)	Slit Width (inches)	Pitch Angle (degrees)	Scan Angle (degrees)	Scan Center (degrees)	Frames	IMC	Illumination
822	C	.036	.910	0	90	0	10	Dis	Flash
823	V	.052	.910	0	30	0	144	Ena	Flash
824	N	.044	.910	0	30	0	33	Ena	Flash
832	XB	.044	.259	-2.5	30	0	80	Dis	Continuous
835	C	.036	.910	0	90	0	10	Dis	Flash
842	Z	.052	.303	0	90	0	70	Dis	Continuous
843	Z	.052	.303	0	90	0	70	Dis	Continuous
845	Z	.052	.303	0	90	0	70	Dis	Continuous
846	Y	.052	.303	0	30	0	70	Dis	Continuous
847	Y	.052	.303	0	30	0	70	Dis	Continuous
848	Y	.052	.303	0	30	0	70	Dis	Continuous
849	Y	.052	.303	0	30	0	70	Dis	Continuous
853	K	.052	.303	2.0	30	0	144	Dis	Continuous
856	K	.052	.303	2.5	30	0	144	Dis	Continuous
859	K	.052	.303	-2.0	30	0	144	Dis	Continuous

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TABLE 2-1 (Continued)

Run	Seq	Vx/h (rad/sec)	Slit Width (inches)	Pitch Angle (degrees)	Scan Angle (degrees)	Scan Center (degrees)	Frames	TMC	Illumination
862	K	.052	.303	-2.5	30	0	144	Dis	Continuous
866	Y	.052	.303	0	30	0	70	Dis	Continuous
867	Y	.052	.303	0	30	0	70	Dis	Continuous
868	Y	.052	.303	0	30	0	70	Dis	Continuous
869	Y	.052	.303	0	30	0	70	Dis	Continuous
870	Z	.052	.303	0	90	0	70	Dis	Continuous
871	Z	.052	.303	0	90	0	70	Dis	Continuous
872	Z	.052	.303	0	90	0	70	Dis	Continuous
874	Y	.052	.303	0	30	0	70	Dis	Continuous
875	Y	.052	.303	0	30	0	70	Dis	Continuous
876	Y	.052	.303	0	30	0	70	Dis	Continuous
877	Y	.052	.303	0	30	0	70	Dis	Continuous
878	Z	.052	.303	0	90	0	70	Dis	Continuous
879	Z	.052	.303	0	90	0	70	Dis	Continuous
880	Z	.052	.303	0	90	0	70	Dis	Continuous
882	K	.052	.303	0	30	0	144	Dis	Continuous

TABLE 2-2

2A-2 TEST SEQUENCES

Run	Seq	Vx/h (rad/sec)	Slit Width (inches)	Pitch Angle (degrees)	Scan Angle (degrees)	Scan Center (degrees)	Frames	IMC	Illumination
891	K	.052	.303	0	0	0	144	Dis	Continuous
894	K	.052	.303	-1.0	30	0	144	Dis	Continuous
897	K	.052	.303	-2.0	30	0	144	Dis	Continuous
899	K	.052	.303	-2.5	30	0	144	Dis	Continuous
902	K	.052	.303	1.0	30	0	144	Dis	Continuous
904	K	.052	.303	2.0	30	0	144	Dis	Continuous
905	K	.052	.303	2.5	30	0	144	Dis	Continuous
908	K	.052	.303	0	30	0	144	Dis	Continuous
910	L	.044	.259	0	30	0	53	Dis	Continuous
911	R	.052	.910	0	90	0	33	Dis	Continuous
912	R	.052	.910	0	90	0	33	Ena	Flash
913	U	.044	.910	0	30	0	144	Ena	Flash
914	M	.044	.910	0	90	0	33	Ena	Flash
915	J	.052	.615	0	30	0	144	Dis	Continuous
916	V	.052	.910	0	30	0	144	Ena	Flash
919	H	.052	.303	0	90	0	144	Dis	Continuous

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TABLE 2-2 (Continued)

Run	Seq	Vx/h (rad/sec)	Slit Width (inches)	Pitch Angle (degrees)	Scan Angle (degrees)	Scan Center (degrees)	Frames	IMC	Illumination
922	YY	.052	.303	0	30	0	111	Dis	Continuous
924	YY	.052	.303	0	30	0	111	Dis	Continuous
925	ZZ	.052	.303	0	120	0	111	Dis	Continuous
927	YY	.052	.303	0	30	0	111	Dis	Continuous
929	YY	.052	.303	0	30	0	111	Dis	Continuous
930	YY	.052	.303	0	30	0	111	Dis	Continuous
931	YY	.052	.303	0	30	0	111	Dis	Continuous
932	YY	.052	.303	0	30	0	111	Dis	Continuous
936	N	.044	.910	0	30	0	33	Ena	Flash
937	P	.052	.910	0	30	0	33	Dis	Continuous
938	N	.044	.910	0	30	0	33	Ena	Flash
939	P	.052	.910	0	30	0	33	Ena	Flash

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SECTION III

SYSTEM RESOLUTION PERFORMANCE

3.1 INTRODUCTION

The Chamber A-2 Readiness test data evaluation has determined that the SV-11 Camera System's resolution performance is satisfactory for this mission. The two cameras have essentially equivalent performance of 175 cycles/mm in-track and 160 cycles/mm cross-track for 2:1 contrast tribar resolution. The resolution data presented in this section is from the second Chamber A-2 test. The resolutions tests reviewed in this section are as follows:

A. Resolution as a function of field angle.

B. Resolution comparison between Chambers A and A-2.

C. Resolution variability.

3.2 TEST PARAMETERS

The optical bar sets in SV-11 are 041 and 032 on the Forward and Aft Cameras, respectively. Each camera incorporates an In-flight Changeable Filter Assembly (ICF) having equivalent W-12 and W-2E3 Filters. All the test sequences run in Chamber A-2 with the exception of Seq L used the W-12 Filter. Seq L test data is used to determine if a focus shift results with the use of the W-2E3; the results of this test is discussed in Section V. Resolution tests and sign conventions used for the pitch sequences are given in Table 3-1, page 3-6.

3.3 TEST RESULTS

3.3.1 Resolution as a Function of Field Angle

In-track and cross-track thru-focus resolution data at seven field positions are given in Figures 3-1 and 3-2, for the Forward and Aft Cameras respectively. The test conditions used during the thru-focus/thru pitch sequences, which comprise this data base, were at a Vx/h of .052 and a slit width of .303 inch with IMC disabled. Based on the 2:1 contrast tribar resolution at each field position, a platen position resulting in peak resolution is chosen. In addition, the line arrays from the same frame are scanned microdensitometrically and the data reduced via the FOCMO program resulting in an independent determination of optimum platen position. This data is summarized in Table 5-1 and is adjusted for collimator defocus. The platen position of peak focus determined from lines are indicated by arrows in Figures 3-1 and 3-2 and are also adjusted for collimator defocus.

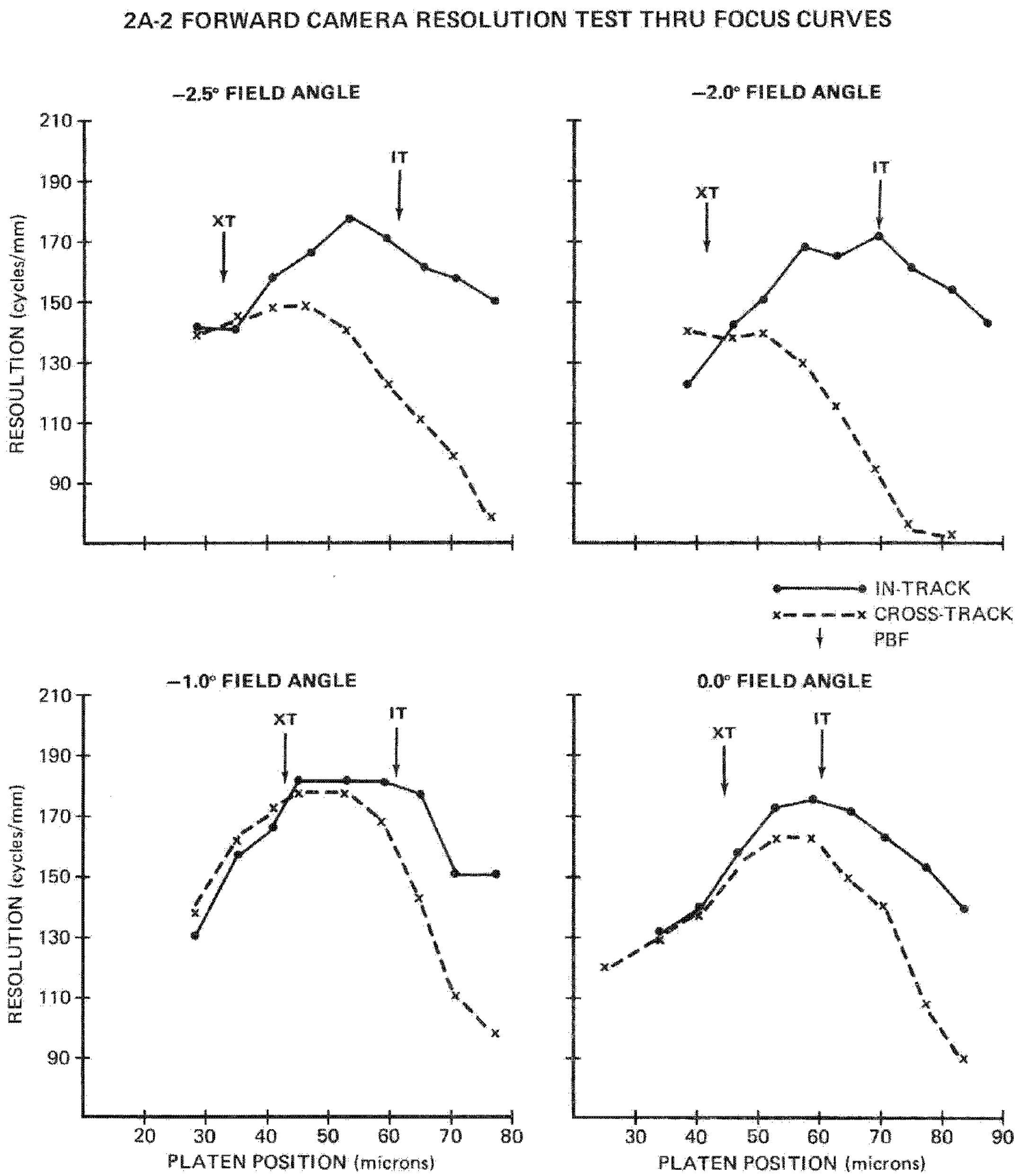

2A-2 FORWARD CAMERA RESOLUTION TEST THRU FOCUS CURVES
–2.5° FIELD ANGLE
–2.0° FIELD ANGLE
–1.0° FIELD ANGLE
0.0° FIELD ANGLE
RESOLUTION (cycles/mm)
PLATEN POSITION (microns)
XT
IT
IN-TRACK
CROSS-TRACK
PBF
210
190
170
150
130
110
90
20
30
40
50
60
70
80
90

FIGURE 3-1

2A-2 FORWARD CAMERA RESOLUTION TEST THRU FOCUS CURVES

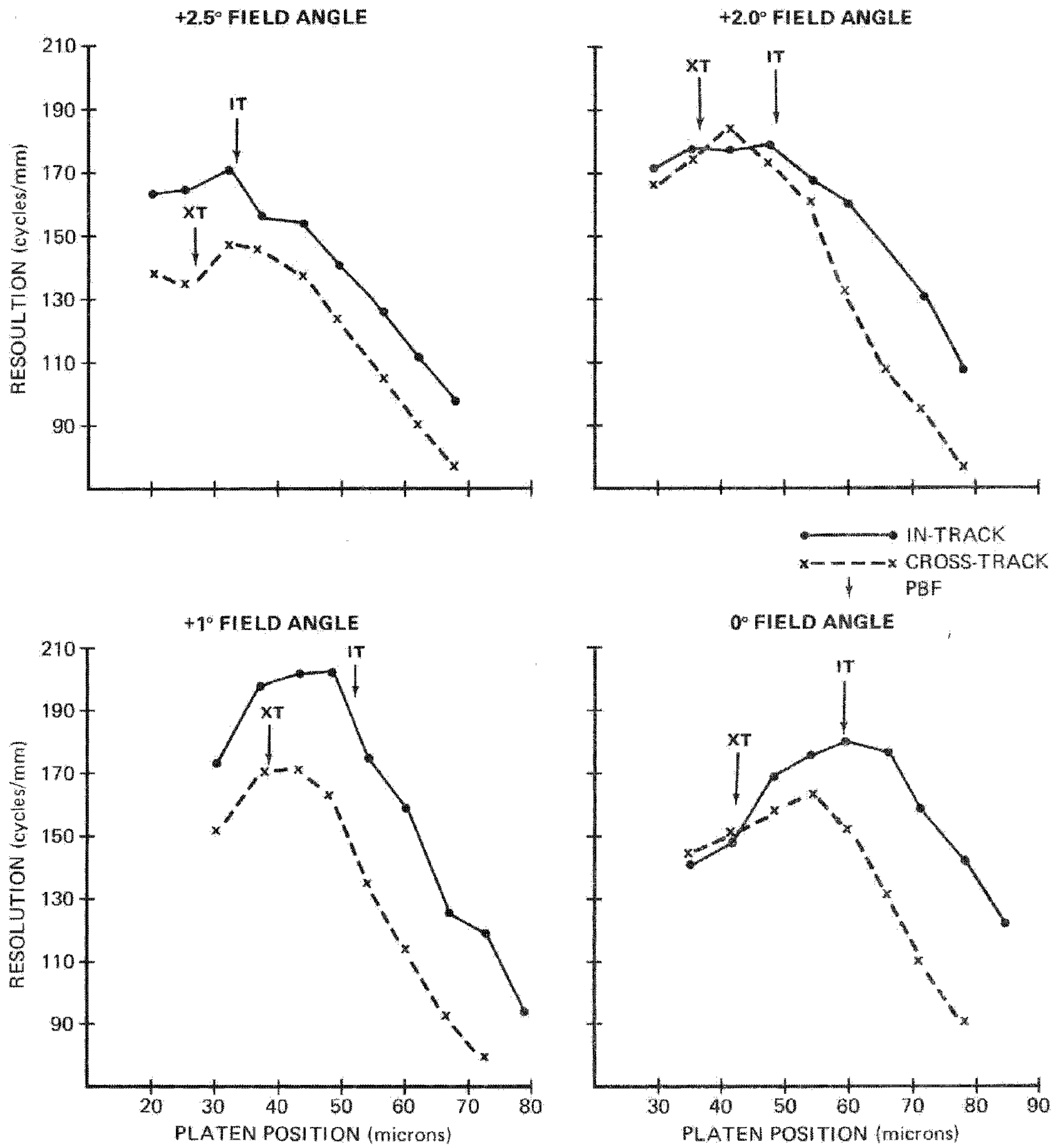


FIGURE 3-1 (cont'd)

2A-2 AFT CAMERA RESOLUTION TEST THRU FOCUS CURVES

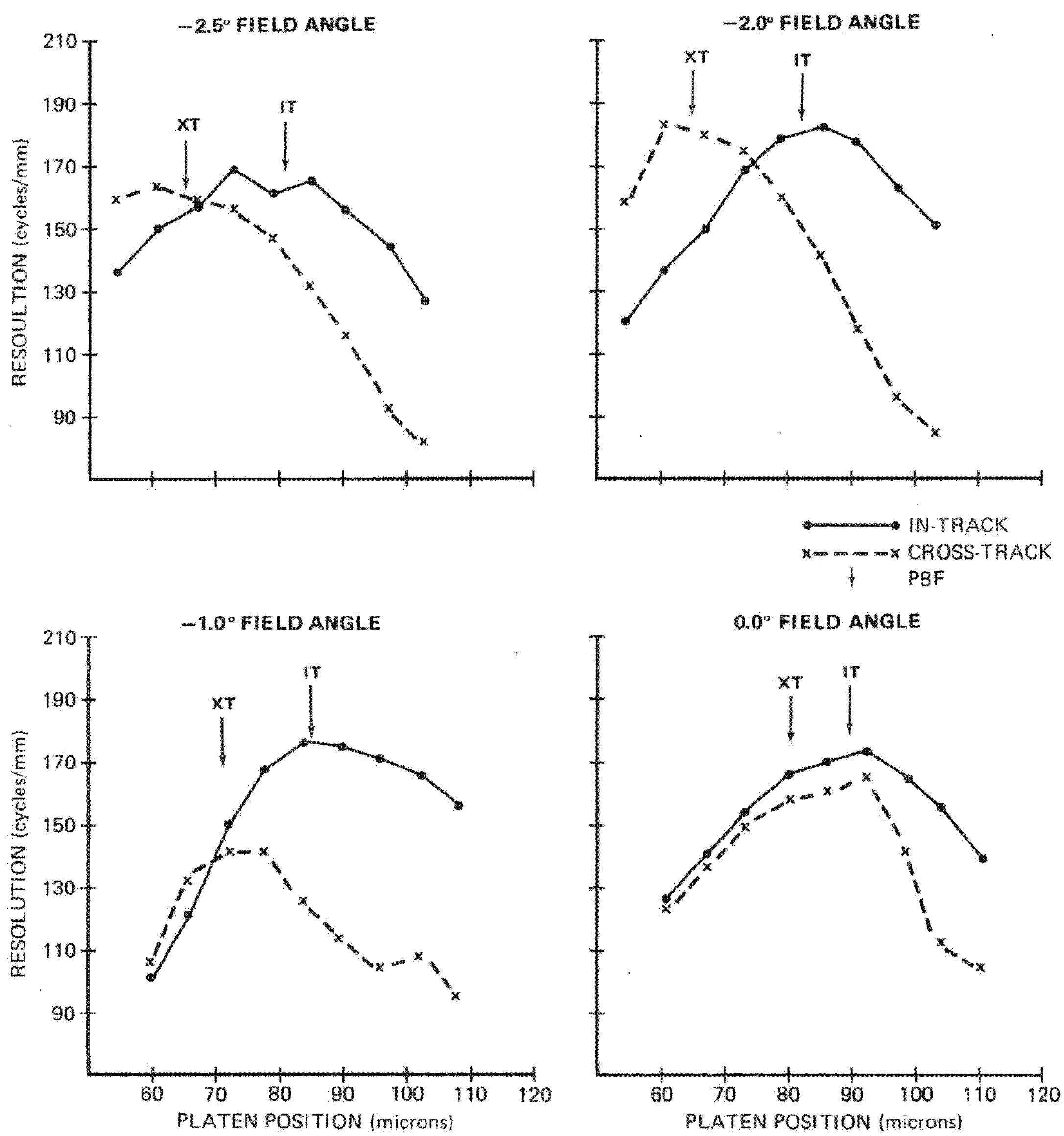


FIGURE 3-2

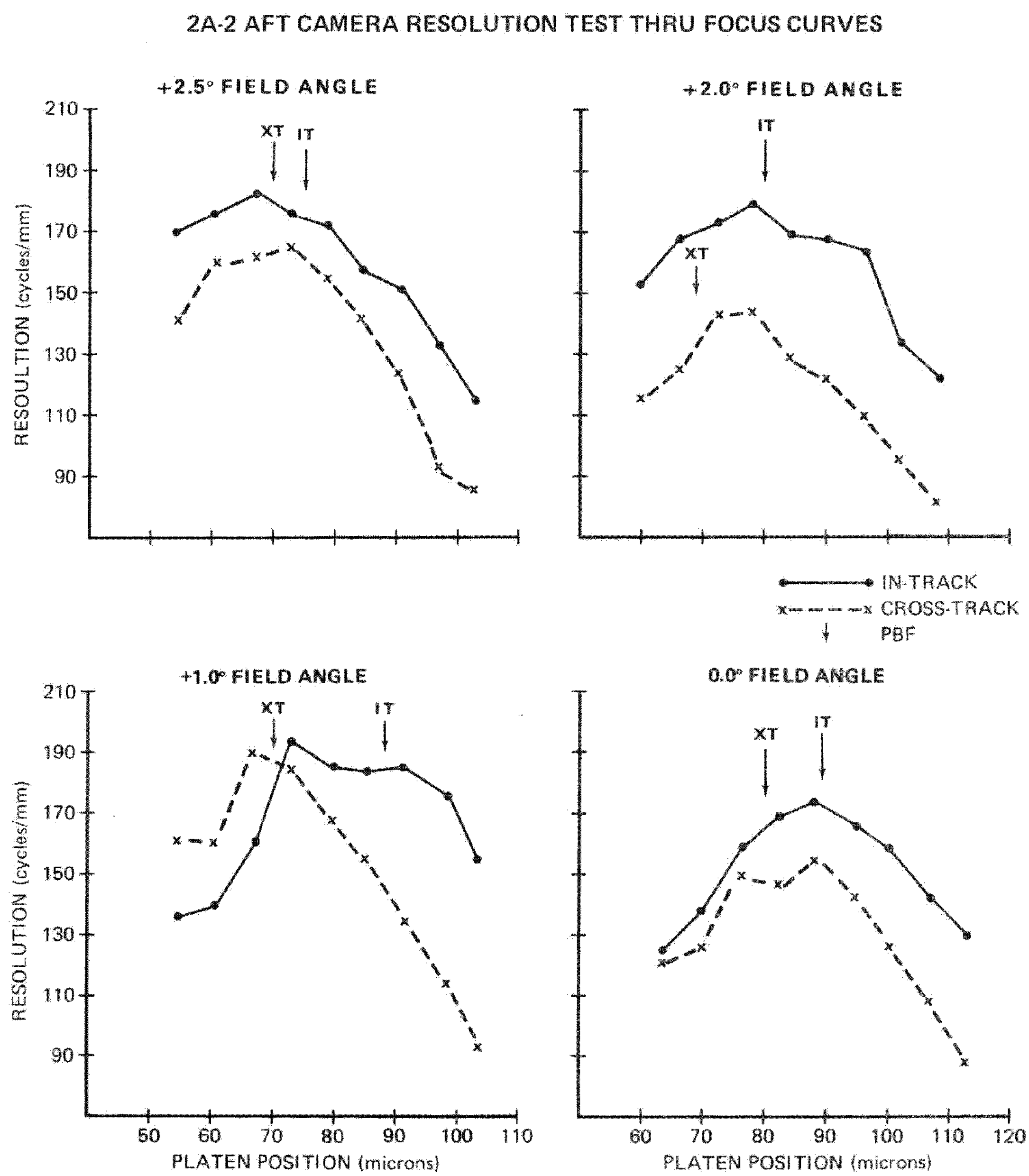


FIGURE 3-2 (cont'd)

TABLE 3-1

2A-2 RESOLUTION TEST SUMMARY AND SIGN CONVENTION

Run	Seq	Scan Length (degrees)	Vehicle Pitch (degrees)	Sign Convention (0° Scan) Forward Camera	Aft Camera
891	K	30	0.0	0.0	0.0
894	K	30	-1.0	1.0	-1.0
897	K	30	-2.0	2.0	-2.0
899	K	30	-2.5	2.5	-2.5
902	K	30	1.0	-1.0	1.0
904	K	30	2.0	-2.0	2.0
905	K	30	2.5	-2.5	2.5
908	K	30	0.0	0.0	0.0

NOTES:
1. All of these test runs had 144 frames (nine thru focus platen positions at six micron intervals) at a Vx/h value of .052 radians/second and a slit width of .303 inch.
2. Plus pitch means nose up.
3. Plus field refers to the non-titled edge of the format.

3.3.2 Resolution Comparison Between Chambers A and A-2

Comparisons of resolution performance were made using those thru focus tests that occurred at the 0° field position in the two chambers, see Figure 3-3. Both sets of data represent 2:1 contrast average tribar readings by individual AFSPPF personnel. Chamber A material is Versamat B-modified processed, while Chamber A-2 is dual gamma processed. The Chamber A data is normalized to the 2A-2 data with respect to platen position. The resolution levels are not comparable; i.e., the Chamber A data is unusually high. The Chamber A data was reread by AFSPPF personnel, since a change in tribar reading criterion occurred between the Chamber A and A-2 tests. The reread data yielded essentially the same values. Two SSC IRARS qualified readers read the on-axis peak resolution platen positions for Chamber A

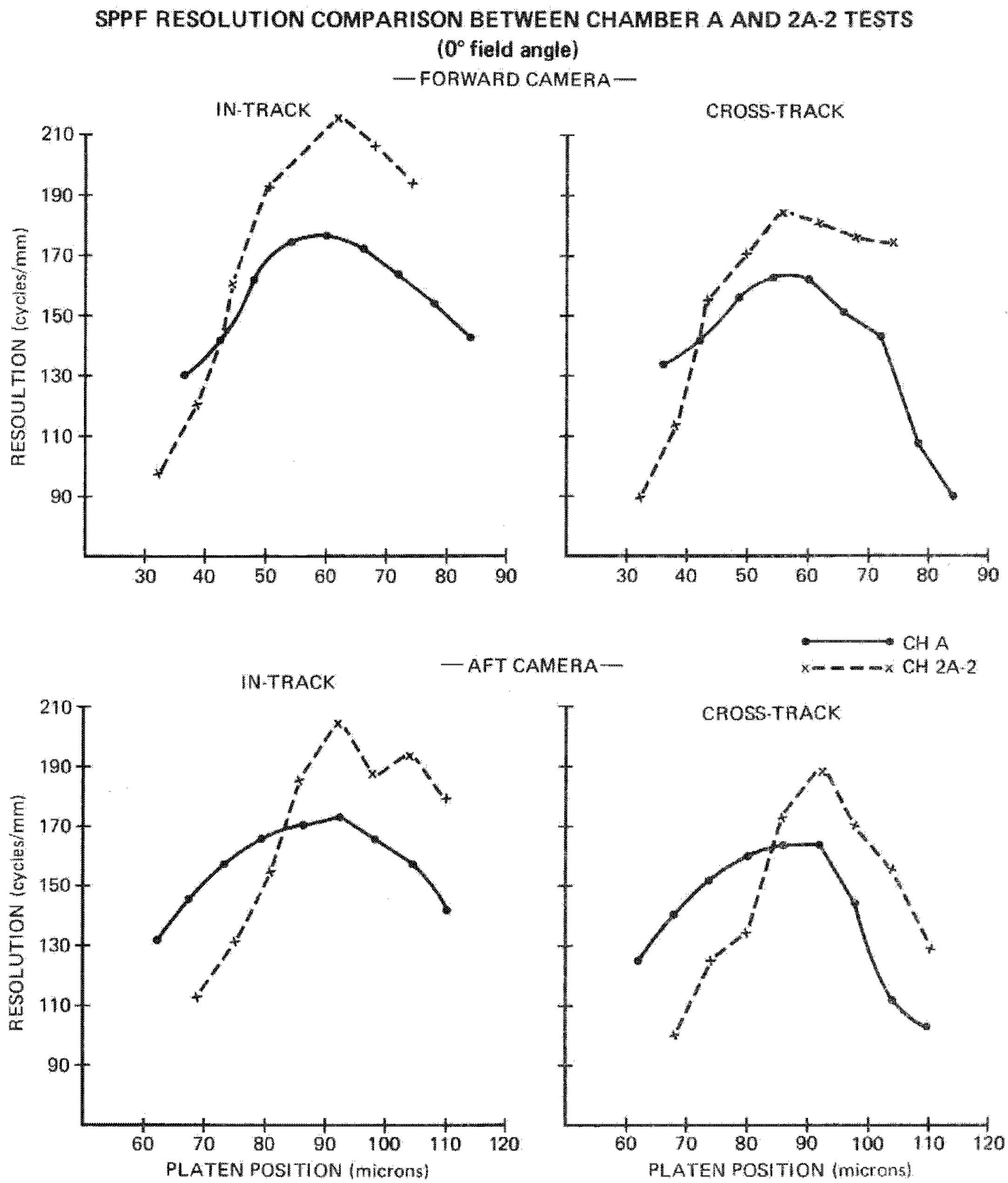

SPPF RESOLUTION COMPARISON BETWEEN CHAMBER A AND 2A-2 TESTS
(0° field angle)
— FORWARD CAMERA —
IN-TRACK
CROSS-TRACK
RESOLUTION (cycles/mm)
210
190
170
150
130
110
90
30
40
50
60
70
80
90
CH A
CH 2A-2
— AFT CAMERA —
IN-TRACK
CROSS-TRACK
60
70
80
90
100
110
120
PLATEN POSITION (microns)

FIGURE 3-3

and A-2 (Table 3-2). This data indicates good agreement between the two organizations for the Chamber A-2 data; and the SSC data indicates comparable resolution levels between Chamber A and A-2.

TABLE 3-2

ON AXIS PEAK RESOLUTION (cycles/mm)

0° Field Angle

		A		1A-2		2A-2	
Camera	Reader	IT	XT	IT	XT	IT	XT
Forward	SPPF	210	181	200	180	178	164
	SSC	174	159	190	168	190	166
Aft	SPPF	212	180	193	176	174	160
	SSC	174	152	195	178	188	165

Table 3-3 gives the PBFs determined for the 0° field position for both cameras in Chambers A and A-2. Tribar and line diagnostics are compared separately. The Forward and Aft Camera platens were replaced between Chambers A and A-2 testing.

TABLE 3-3

PBF SHIFTS BETWEEN CHAMBERS A AND A-2
(microns)

		Predicted A-2		Actual A-2	
Camera	Field Angle (degrees)	Tribars	Lines	Tribars	Lines
Forward	0	62	63	61	60
Aft	0	84*	86*	92	86

*Based upon platen tilt between 1A-2 and 2A-2.

3.4 SELECTION OF PLATEN POSITION FOR FIELD OPTIMIZED PERFORMANCE

Field profiles at a particular platen position, in terms of 2:1 contrast tribar data from the 2A-2 test, are given in Figures 3-4 and 3-5. The positions were chosen to encompass that platen setting that yields the best overall performance. This data is summarized in Tables 3-4 and 3-5. For each platen position, the resolution performance was derived directly from Figures 3-4 and 3-5 using interpolation between data points where necessary. Based on this analysis, the Forward Camera platen setting for optimum performance is 45 microns and the Aft Camera setting is 78 microns.

The average resolution across the field is 168 cycles/mm in-track, 151 cycles/mm cross-track for the Forward Camera, and 171 cycles/mm in-track, 154 cycles/mm cross-track for the Aft Camera; see Tables 3-4 and 3-5.

3.5 RESOLUTION VARIABILITY

A measure of image quality variability in terms of 2:1 contrast tribar readings is the ratio of the standard deviation (sigma)-to-mean resolution for forty replicate tribar images. The mean resolution and sigma are determined for three platen positions (including the PBF), for the in-track and cross-track data, at each of the field positions obtained in the pitch sequence. These results are averaged and the previously mentioned ratio ascertained. This data is used to characterize a given test case (see Table 3-6). Both cameras have an average 8% variability for the in-track and cross-track direction.

3.6 EXPECTED ON-ORBIT RESOLUTION

The expected on-orbit resolution performance for SV-11 (Table 3-7) is based on the 2A-2 test results combined with the Chamber D field curvature. The primary assumption in this prediction is that the Chamber A-2 indicated field curvature is nonexistent on-orbit. This assumption is deemed valid, since historically the on-orbit performance (SV-6 thru 10) is more closely represented by the Chamber D measure of field curvature and astigmatism than Chamber A-2.

Based on this data, on-orbit performance will be equivalent on both cameras with average resolution values of 175 cycles/mm and 160 cycles/mm for the in-track and cross-track directions, respectively.

TABLE 3-4

SN-014 (SV-11) FIELD RESOLUTION PERFORMANCE
(cycles/mm)

Forward Camera

— In-Track —

Platen Position (microns)	FIELD ANGLE (degrees) -2.5	-2.0	-1.0	0.0	+1.0	+2.0	+2.5	Mean ± 1σ
30	141	125	136	(124)	169	177	167	148 ± 22
35	141	140	157	131	189	178	162	157 ± 21
40	155	149	164	138	199	174	154	162 ± 20
45	164	162	180	152	202	167	150	168 ± 18
50	172	166	183	166	197	161	139	169 ± 18
55	176	167	182	174	174	148	129	164 ± 19
60	169	169	181	175	158	135	116	158 ± 24
65	162	161	178	173	135	119	103	147 ± 29

— Cross-Track —

Platen Position (microns)	-2.5	-2.0	-1.0	0.0	+1.0	+2.0	+2.5	Mean ± 1σ
30	140	140	144	(124)	150	182	142	146 ± 18
35	143	138	163	132	164	178	145	152 ± 17
40	147	139	170	138	170	168	141	153 ± 15
45	148	133	178	148	166	154	133	151 ± 16
50	144	122	178	159	156	130	122	144 ± 21
55	134	108	174	163	133	110	108	133 ± 27
60	121	91	163	160	114	97	93	120 ± 31

NOTE: Extrapolated Values are in parenthesis.

TABLE 3-5

SN-014 (SV-11) FIELD RESOLUTION PERFORMANCE
(cycles/mm)

Aft Camera

—In-Track—

Platen Position (microns)	Field Angle (degrees) -2.5	-2.0	-1.0	0.0	+1.0	+2.0	+2.5	Mean ± 1σ
60	147	134	102	124	139	152	175	130 ± 23
65	154	145	118	137	154	165	180	150 ± 23
70	162	158	143	149	177	170	179	163 ± 14
75	165	170	160	159	190	175	174	170 ± 11
80	161	178	170	167	186	175	169	172 ± 8
85	164	182	176	170	184	169	157	172 ± 10
90	156	178	175	173	185	167	151	169 ± 12
95	145	167	171	170	179	163	138	162 ± 15
100	134	156	166	162	168	140	123	150 ± 18

—Cross-Track—

Platen Position (microns)	-2.5	-2.0	-1.0	0.0	+1.0	+2.0	+2.5	Mean ± 1σ
60	163	178	107	121	161	115	157	143 ± 28
65	160	180	130	132	181	122	160	152 ± 24
70	157	176	140	142	187	136	163	157 ± 19
75	152	169	141	152	179	143	160	157 ± 14
80	144	156	134	159	166	139	152	150 ± 18
85	131	140	122	160	156	126	140	139 ± 14
90	117	120	113	164	138	122	124	128 ± 18
95	100	102	105	154	122	112	101	114 ± 19
100	86	90	107	130	105	98	89	101 ± 15

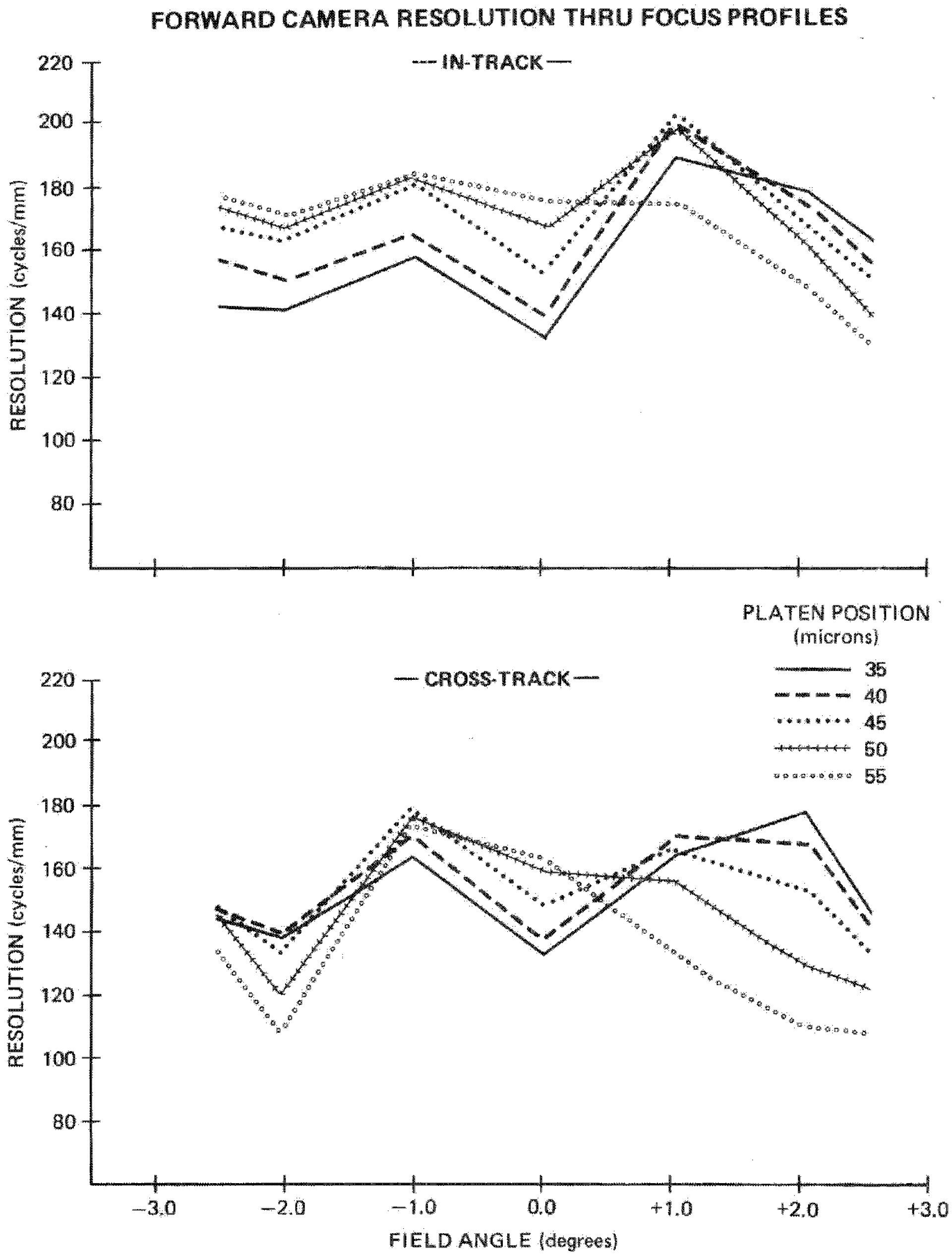

FORWARD CAMERA RESOLUTION THRU FOCUS PROFILES
— IN-TRACK —
— CROSS-TRACK —
RESOLUTION (cycles/mm)
220
200
180
160
140
120
100
80
PLATEN POSITION (microns)
35
40
45
50
55
−3.0
−2.0
−1.0
0.0
+1.0
+2.0
+3.0
FIELD ANGLE (degrees)

FIGURE 3-4

AFT CAMERA RESOLUTION THRU FOCUS PROFILES

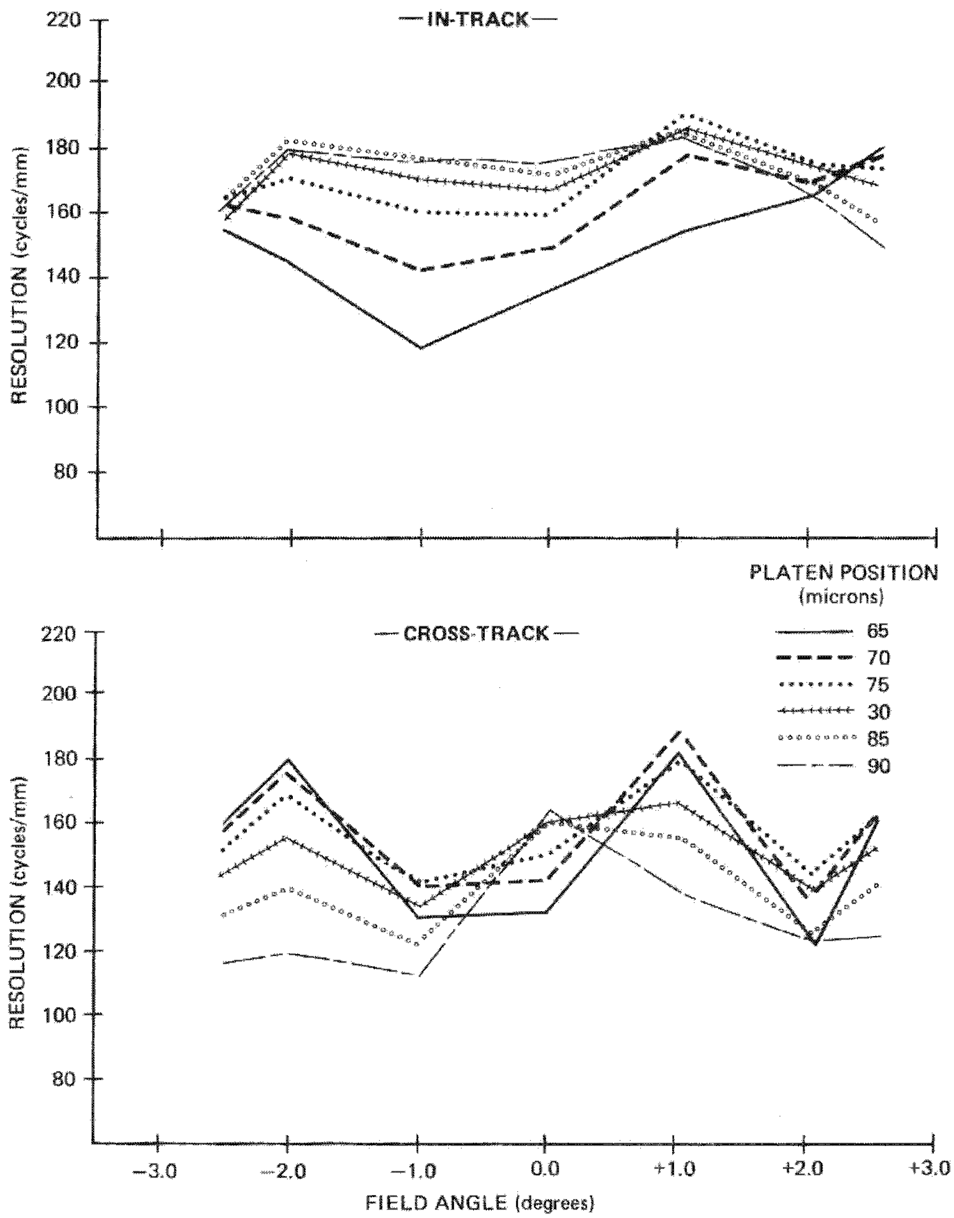


FIGURE 3-5

TABLE 3-6

RESOLUTION VARIABILITY
Vx/h of 0.052, Slit Width of .303 Inch

— Forward Camera —

Field Angle (degrees)	In-Track Mean (cy/mm)	In-Track Standard Deviation	In-Track Ratio	Cross-Track Mean (cy/mm)	Cross-Track Standard Deviation	Cross-Track Ratio
2.5	163	14	.09	141	13	.09
2.0	178	17	.10	177	15	.08
1.0	204	17	.08	168	11	.06
0.0	174	15	.08	158	14	.09
-1.0	183	17	.09	175	12	.07
-2.0	166	11	.07	136	12	.09
-2.5	172	13	.08	145	11	.08

— Aft Camera —

Field Angle (degrees)	In-Track Mean (cy/mm)	In-Track Standard Deviation	In-Track Ratio	Cross-Track Mean (cy/mm)	Cross-Track Standard Deviation	Cross-Track Ratio
2.5	178	10	.06	160	12	.07
2.0	173	15	.09	138	10	.07
1.0	187	18	.10	182	15	.08
0.0	171	12	.07	159	13	.08
-1.0	173	15	.09	138	13	.09
-2.0	179	15	.09	178	13	.07
-2.5	164	12	.07	160	13	.08

TABLE 3-7

SV-11 EXPECTED ON-ORBIT PERFORMANCE

—Forward Camera—

Field Angle (degrees)	In-Track (cycles/mm)	Cross-Track (cycles/mm)	Geometric Mean (cycles/mm)
-2.5	174	148	160
-2.0	160	138	149
-1.0	182	175	178
0	175	163	169
1.0	199	169	183
2.0	167	167	167
2.5	169	137	152
Average	175	157	166

—Aft Camera—

Field Angle (degrees)	In-Track (cycles/mm)	Cross-Track (cycles/mm)	Geometric Mean (cycles/mm)
-2.5	166	158	162
-2.0	168	179	173
-1.0	168	142	154
0	174	162	168
1.0	193	188	190
2.0	177	139	157
2.5	180	162	171
Average	175	162	168

SECTION IV

FILM SYNCHRONIZATION TESTS

4.1 INTRODUCTION

Film synchronization tests are conducted on the HEXAGON Program to directly measure the smear introduced into the imagery. This information is then used to adjust the film velocity and the platen skew angle to minimize smear characteristics. Smear values measured in the tests are also used analytically to predict the camera system performance by combining them with independent measures of the optical system modulation transfer function (MTF) and the measure of camera dynamic focus as determined from Chamber A thermal vacuum tests. This section contains the results of the 1414 Film synchronization tests, including the photographic and electromechanical evaluation of the On-Orbit Adjust Assembly (OOAA) tests. Color film testing was not accomplished during any of the Chamber A-2 tests.

4.2 GRAVITY EFFECTS ON IMAGE MOTION

The gravity induced image motion corrections for this flight model were determined by dynamic image motion tests. Gravity corrections for a Vx/h of .052 are displayed in Table 4-1; the FIDAP Program scales these values to the appropriate test Vx/h.

TABLE 4-1

GRAVITY CORRECTION DATA FOR A Vx/h OF .052
(inch/second)

	Collimator Position (degrees)			
Direction	-45	0	37	55
—Forward Camera—				
In-Track	.033	-.004	-.033	-.046
Cross-Track	-.013	-.026	-.029	-.023
—Aft Camera—				
In-Track	.035	-.002	-.037	-.046
Cross-Track	-.018	-.026	-.029	-.018

4.3 "C" TARGET ROTATION

Measurements on SN-001 thru SN-006 have shown that the "C" targets of Chamber A are not perfectly aligned with respect to the scan planes of the cameras. The effect of the "C" target rotation is to change the predicted in-track flash target displacements when IMC is enabled, and hence to alter the sync data. The rotation for each Chamber A-2 collimator has been measured on the test film. All sync-flash data in this report has been corrected for these measured rotations.

4.4 OOAA CALIBRATION EVALUATION

The results of the OOAA calibaration sequences performed during the Chamber A-2 in-air and vacuum tests are presented in Tables 4-2 and 4-3. Table 4-2 shows the results of the OOAA calibration at Vx/h of .052 and 0° scan position for the 1A-2 in-air test, and at Vx/h values of .052 and .044 for the 2A-2 vacuum test.

Figures 4-1 and 4-2 are plots of the data from the 1A-2 test and Figures 4-3 and 4-4 are plots from the 2A-2 test. Straight lines have been fitted to the points using the least squares technique. The equations of these best fit straight lines are listed in Table 4-3, together with the correlation that indicates the accurary of fit. A comparison of the OOAA calibration curves at Vx/h of .052 shows good correlation between the 1A-2 and 2A-2 test results and the theoretical curves.

4.5 SYNC ERROR MEASUREMENT SUMMARY

Tables 4-4 and 4-5 present the summary of the SV-11 film synchronization performance from the Chamber A and the two Chamber A-2 tests. The following are significant observations and analyses relating to film synchronization.

4.5.1 Chamber A Versus Chamber A-2 Comparison

No significant difference was noted between the Chamber A and Chamber A-2 mean image motion on both the Forward and Aft Cameras.

4.5.2 Forward Camera Two Sigma Values

The Forward Camera in-track smear two sigma values were above specification on the 90 degree scan 2-A2 test sequences. Test Sequence 914 M at Vx/h of .044 had a measured two sigma of .056 and Sequence 911 R at Vx/h of .052 had a measured two sigma of .074 at the 0° scan position. A similar condition was experienced during the acceptance testing of SN-014. The two sigma in-track values decrease with decreasing scan angles; i.e., 30° and 60° scan angles have lower two sigmas than 90° and 120° scan angles.

TABLE 4-2

PHOTOGRAPHIC MEAN ERROR VERSUS COMMAND FROM

OOAA CALIBRATION SEQUENCE, 0° COLLIMATOR

	OOAA Command		Forward Camera				Aft Camera			
			1A-2		2A-2		1A-2		2A-2	
Nominal Vx/h	Skew	Velocity	IT	XT	IT	XT	IT	XT	IT	XT
.052	15	-20			.109	-.271			-.144	-311
	10	10	.088	135	.080	.135	-.112	.137	-.108	.119
	5	5	.038	.069	.035	.057	-.058	.083	-.056	.077
	0	0	-.007	.001	-.019	.004	.000	-.001	.001	-.018
	-5	- 5	-.053	-.066	-.068	-.086	-.043	-.070	-.057	-.080
	-10	-10	-.100	-.151	-.107	-.124	- 105	-.153	.113	-.167
	-15	-15			-.161	-.222			.156	-.203
.044	15	-20			.100	-.257			-.147	-.223
	10	10			.076	.125			-.096	.092
	5	5			.031	.076			-.062	.068
	0	0			-.005	-.003			-.017	.016
	- 5	- 5			-.048	-.053			-.028	-.064
	-10	-10			-.083	-.143			-.067	-.118
	-15	-15			-.116	-.173			.119	-.172

NOTE: 1. All mean errors are stated using the FIDAP sign convention and in inch/second units.

2. Blanks indicate that no tests were performed at those OOAA commands.

TABLE 4-3

OOAA CALIBRATION SEQUENCE BEST-FIT LINEAR EQUATIONS

(0° Collimator)

Camera	Nominal Vx/h	Direction	1A-2 Best-Fit Equation	1A-2 Correlation Coefficient	2A-2 Best-Fit Equation	2A-2 Correlation Coefficient
Forward	.052	In-Track	Y=.0093X-.007	.9997	Y=.0092X-.019	.9978
		Cross-Track	Y=.0141X-.002	.9974	Y=.0135X-.006	.9973
	.044	In-Track			Y=.0075X-.005	.9965
		Cross-Track			Y=.0127X+.003	.9965
Aft	.052	In-Track	Y=-.0107X-.004	.9976	Y=-.0104X+.003	.9985
		Cross-Track	Y= .0146X-.003	.9937	Y=.0143X-.012	.9953
	.044	In-Track			Y=-.0087X-.0154	.9992
		Cross-Track			Y=.0111X-.002	.9948

NOTES:

1. See Figures 4-1 to 4-4
2. In the best fit equations X represents the command in counts and Y represents the response in inches/second.
3. The Y responses are stated using the FIDAP sign convention.
4. There was no testing at a Vx/h of .044 during 1A-2.

1A-2 TEST
FORWARD CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND
AT 0° SCAN POSITION

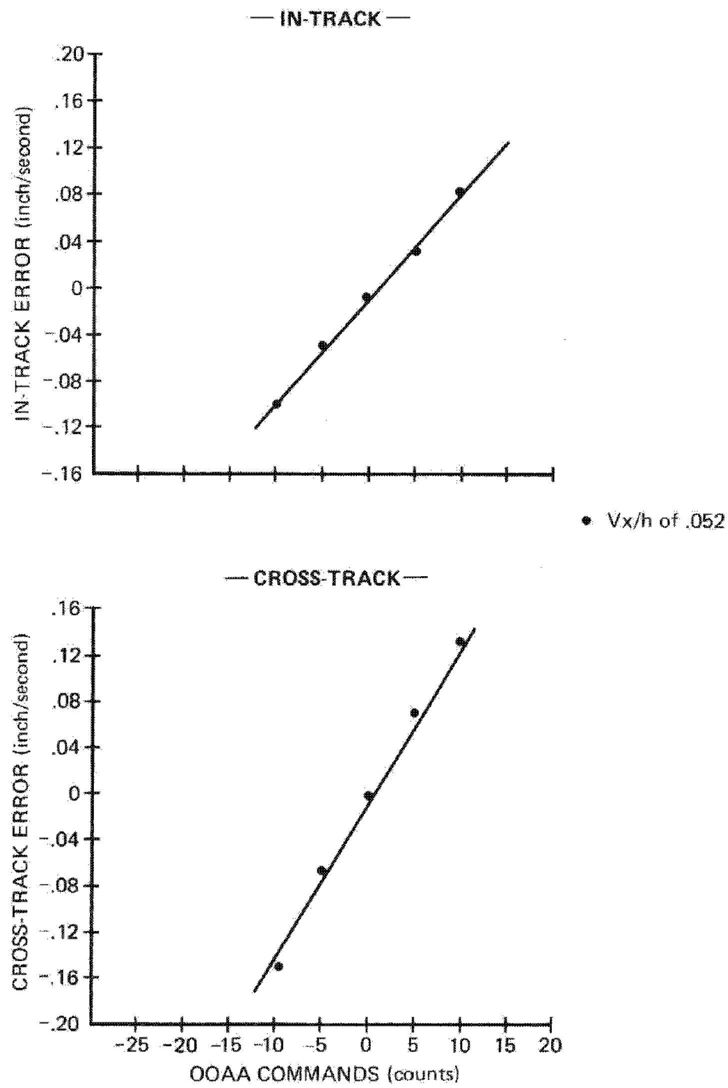


FIGURE 4-1

1A-2 TEST
AFT CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND AT 0° SCAN POSITION

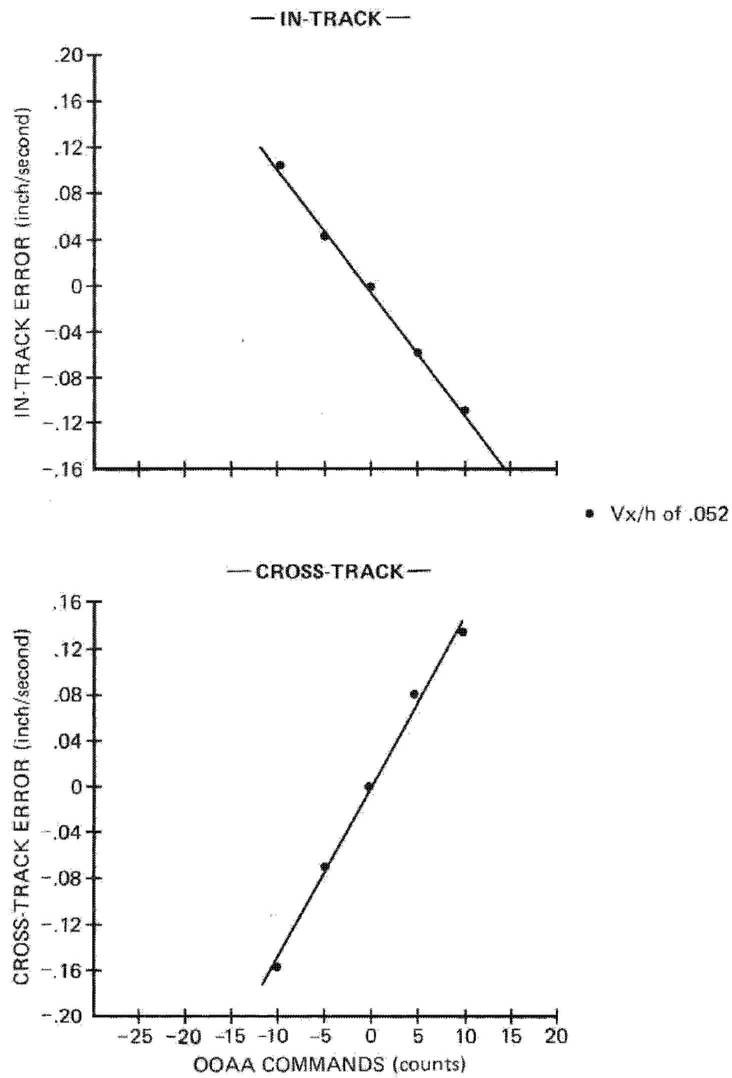


FIGURE 4-2

2A-2 TEST
FORWARD CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND
AT 0° SCAN POSITION

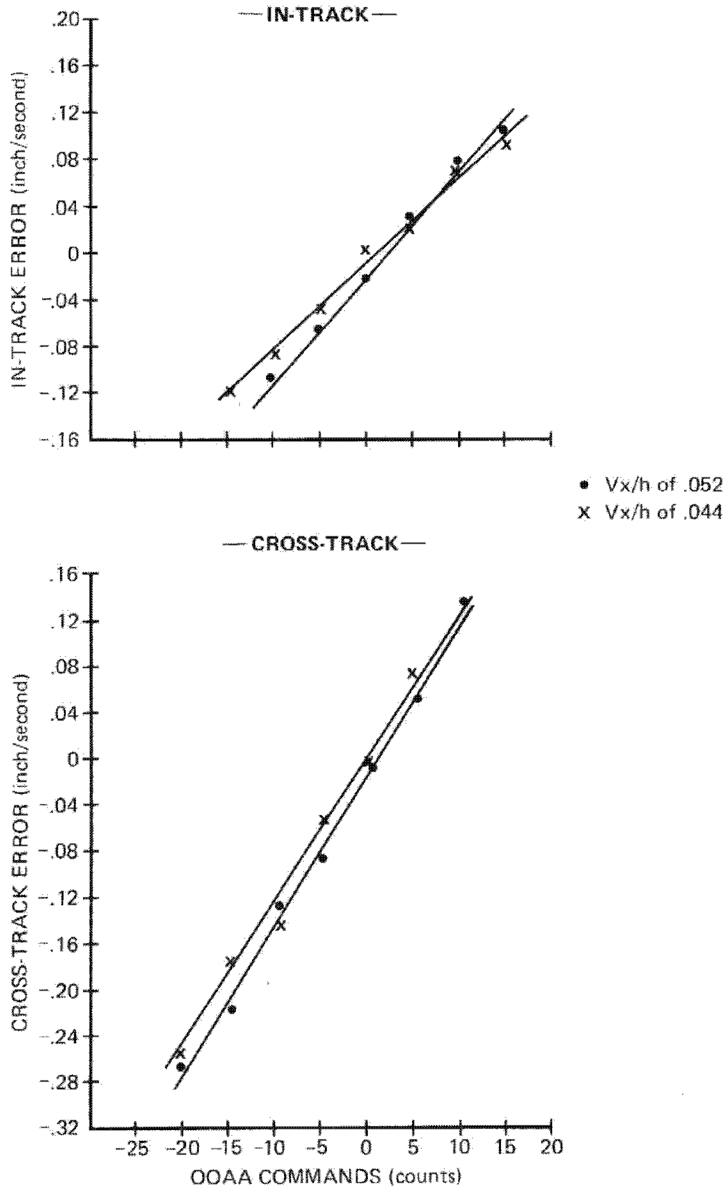


FIGURE 4-3

2A-2 TEST
AFT CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND AT 0° SCAN POSITION

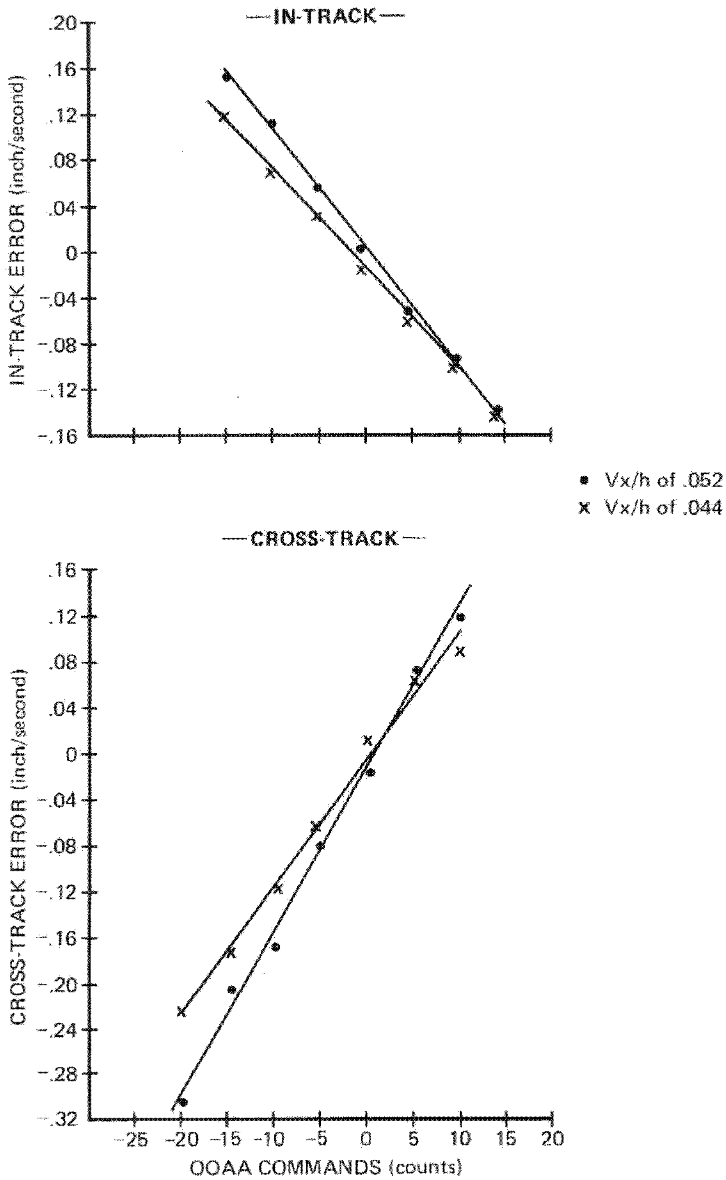


FIGURE 4-4

TABLE 4-4

FILM SYNCHRONIZATION ERROR SUMMARY

FORWARD CAMERA, 0° COLLIMATOR
(inch/second)

Nominal Vx/h	Direction	Spec	Chamber A	Chamber A-2			
			Vac Accept SSC	1A-2 Vac Box In	2A-2 Vac Box In	Post 2A-2 Box In	Post 2A-2 Box Out
.052	IN-TRACK MEAN	±.050	−.009	−.007	−.032		−.003
	IN-TRACK TWO SIGMA	.050	.040	.021	.074*		.027
	CROSS-TRACK MEAN	±.050	−.004	.001	−.007		.005
	CROSS-TRACK TWO SIGMA	.100	.062	.050	.070		.047
.044	IN-TRACK MEAN	±.050	−.026	.006	−.024	.000	.002
	IN-TRACK TWO SIGMA	.050	.044	.028	.056*	.025	.020
	CROSS-TRACK MEAN	±.050	−.006	−.019	−.012	.005	−.001
	CROSS-TRACK TWO SIGMA	.100	.053	.046	.057	.036	.045
.036	IN-TRACK MEAN	±.035	−.013				
	IN-TRACK TWO SIGMA	.037	.036				
	CROSS-TRACK MEAN	±.045	.006				
	CROSS-TRACK TWO SIGMA	.098	.038				

NOTES:
1. Table Information:
   (a) All data is (+) unless otherwise noted.
   (b) Plus (+) cross-track error indicates the platen leads optical bar.
   (c) Plus (+) cross-track error means film speed is too fast.
   (d) The FIDAP sign convention is used.
2. There was no testing at the Vx/h value of .036 during Chamber A-2 testing.
3. The asterisk (*) indicates out-of-specification data.
4. The data was collected at 70°F with IMC enabled.

TABLE 4-5

FILM SYNCHRONIZATION ERROR SUMMARY

AFT CAMERA, 0° COLLIMATOR
(inch/second)

Nominal Vx/h	Direction	Spec	Chamber A	Chamber A-2			
			Vac Accept SSC	1A-2 Vac Box In	2A-2 Vac Box In	Post 2A-2 Box In	Post 2A-2 Box Out
.052	IN-TRACK MEAN	±.050	.017	.000	−.001		−.001
	IN-TRACK TWO SIGMA	.050	.026	.029	.040		.027
	CROSS-TRACK MEAN	±.050	.009	−.001	.022		.001
	CROSS-TRACK TWO SIGMA	.100	.038	.036	.060		.037
.044	IN-TRACK MEAN	±.050	.004	−.004	−.011	−.005	−.004
	IN-TRACK TWO SIGMA	.050	.029	.020	.041	.021	.016
	CROSS-TRACK MEAN	±.050	−.002	.005	−.020	.007	.000
	CROSS-TRACK TWO SIGMA	.100	.048	.036	.037	.032	.034
.036	IN-TRACK MEAN	±.035	.003				
	IN-TRACK TWO SIGMA	.037	.029				
	CROSS-TRACK MEAN	±.045	−.003				
	CROSS-TRACK TWO SIGMA	.098	.034				

NOTE: 1. Table Information:
(a) All data is (+) unless otherwise noted.
(b) Plus (+) in-track error indicates the platen leads optical bar.
(c) Plus (+) cross-track error means film speed is too fast.
(d) The FIDAP sign convention is used.
2. There was no testing at the Vx/h value of .036 during Chamber A-2 testing.
3. The data was collected at 70°F with IMC enabled.

The specific cause of this intermittent high two sigma values is not known at this time and is under investigation.

4.6 ON-ORBIT IMAGE MOTION ERROR PREDICTIONS

The predictions of SV-11 on-orbit image motions errors at a Vx/h of .052 are depicted on an original negative frame format for the Forward and Aft Cameras in Figures 4-5 and 4-6. These predicted errors were developed by the algebraic combination of the most recent sync-flash data with the orbital image motion errors. This data is corrected for both gravity and "C" target rotation. These errors are listed in Table 4-6.

4.6.1 Correlation Between Sync-Flash and Smear Slit Derived Velocity Error

A special test was performed on SV-11 to determine if the historical 3 counts IT OOAA correction required on-orbit is related to the sync-flash AGE. The Aft Camera was pitched approximately 2.8 degrees to acquire the zero degree collimator IT line target in the smear slit and the sync target in the main part of the format. The XT OOAA bias was commanded to plus 9 counts and the IT was varied by plus and minus 20 counts about zero in 5 count increments. Ten frames were acquired at each setting. The smear slit double images of the line target were scanned on a microdensitometer and the data was processed through the FIDAP program The data is summarized in Table 4-7 for each OOAA setting and the linear regression is plotted in Figure 4-7. Both the individual means for each setting and the intercept of the best fit line yield excellent correlation between the sync-flash and smear slit derived values of mean velocity error. Although the source of the three count discrepancy is not revealed by the test results, the sync-flash AGE can be eliminated as a cause.

4.7 CONCLUSIONS AND RECOMMENDATIONS

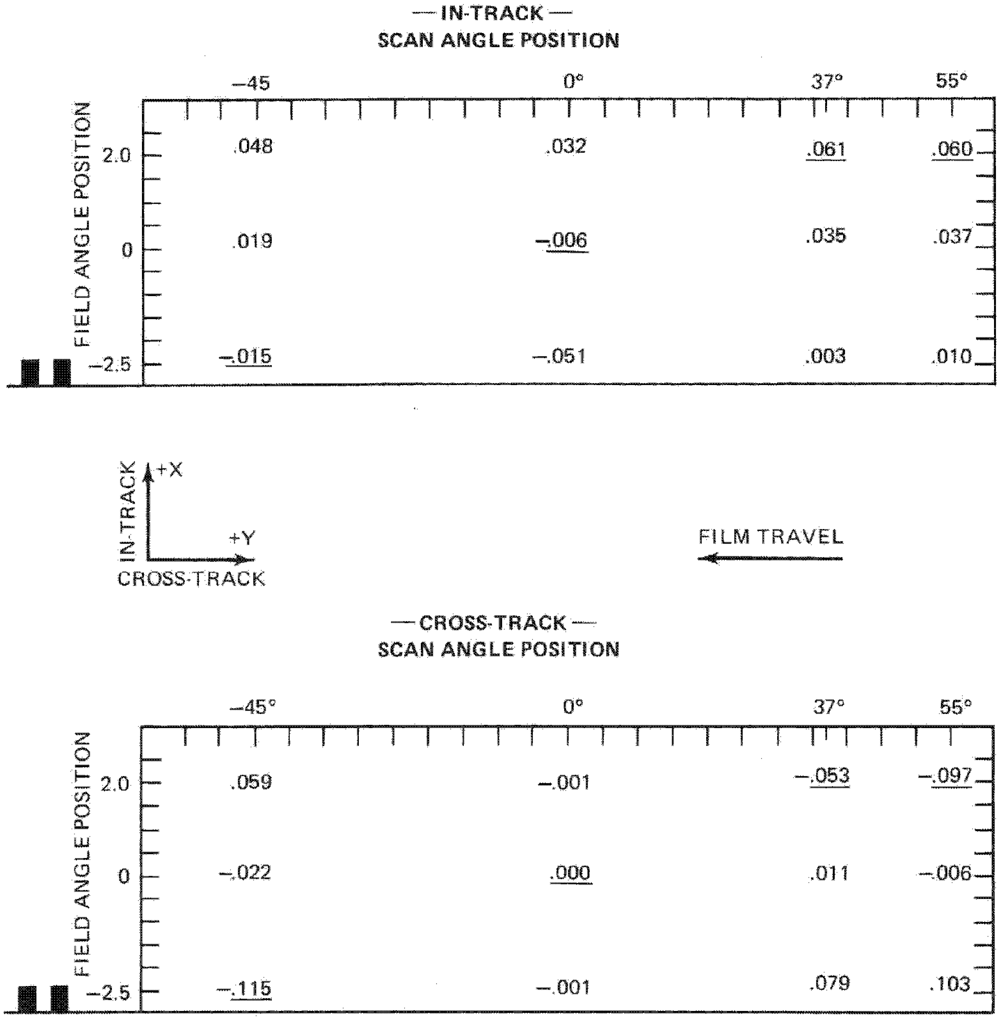
A. With nominal OOAA setting, the Forward and Aft Camera mean errors are all within specification.

B. Even though the mean smear values for both cameras are within specification, the following OOAA changes are recommended to further reduce the mean smear errors:

(1) An OOAA skew adjustment of plus 1 command count from nominal is recommended for in-track compensation of the Forward Camera.

(2) An OOAA skew adjustment of minus 3 command counts from nominal is recommended for in-track compensation of the Aft Camera. The mean smear data for the Aft Camera indicated that no adjustment to the nominal OOAA setting be made; however, based on the historical flight adjustments made on SV-6 thru SV-8 and the flight nominal on SV-10, a minus 3 count setting is being recommended.

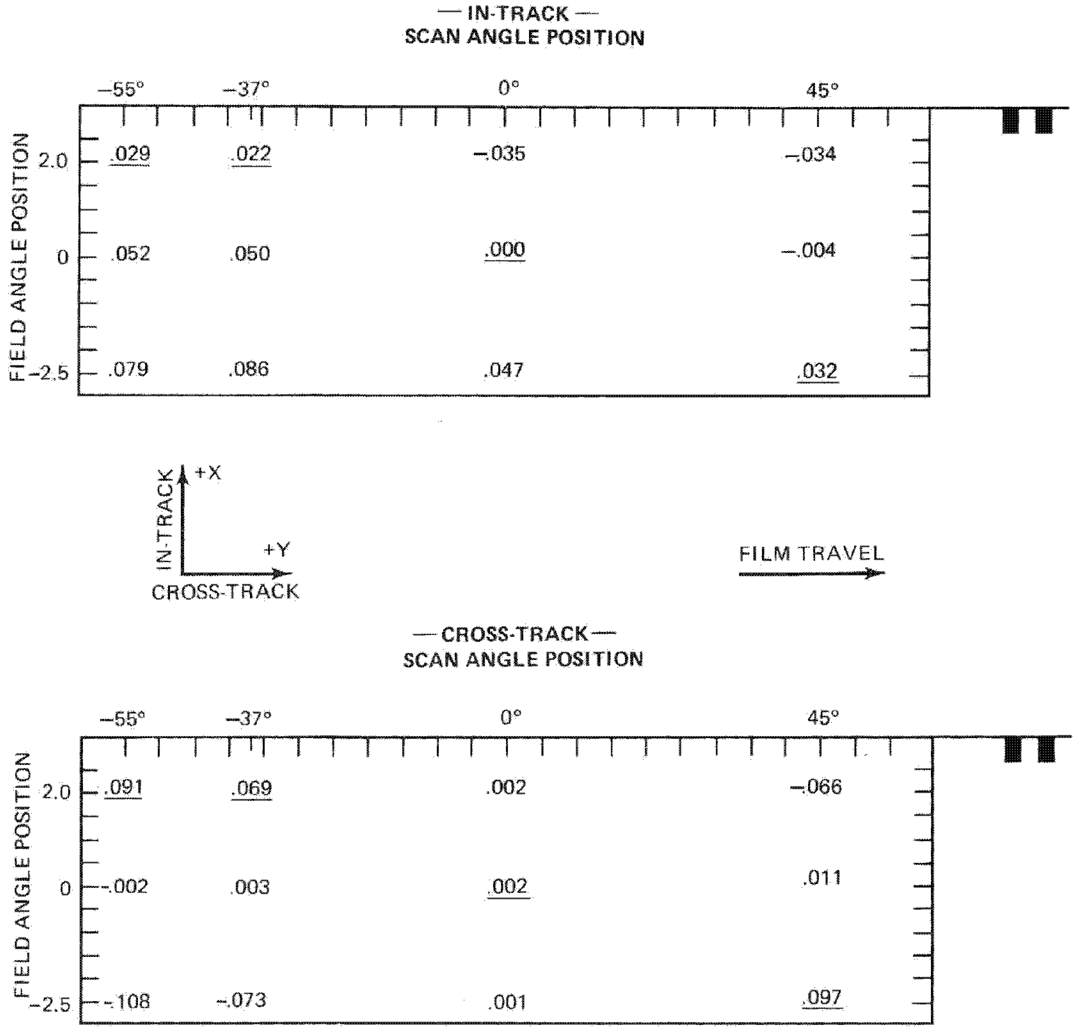
FORWARD CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION
(Vx/h of .052)



NOTES: 1. Original negative emulsion side up.
2. Underlined numbers are at collimator locations.
3. Signs are expressed in orbital image plane coordinates.
4. Values are in inch/second.
5. Values include the effect of the recommended OOAA adjustment.

FIGURE 4-5

AFT CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION
(Vx/h=.052)



NOTES:
1. Original negative emulsion side up.
2. Underlined numbers are at collimator locations.
3. Signs are expressed in orbital image plane coordinates.
4. Values are in inches/second.
5. Values include the effect of the recommended OOAA adjustment.

FIGURE 4-6

TABLE 4-6

ORBITAL IMAGE MOTION ERRORS AT Vx/h OF .052, 70°F
(inch/second)

Forward Camera

	IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	-45	0	37	55	-45	0	37	55	-45	0	37	55	-45	0	37	55	-45	0	37	55	-45	0	37	55
FRAME POSITION (DEGREES)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0	0	0	0	0	0	0	0	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
SHEAR ERROR	.007	-.014	.027	.029	-.023	0	.011	0	.007	-.014	.027	.029	-.023	0	.011	0	.007	-.014	.027	.029	-.023	0	.011	0
ORBITAL FIXED KNOWN	.033	.038	.026	.023	.082	-.001	-.064	-.097	.004	0	0	0	.001	0	0	.006	-.030	-.045	-.032	-.027	-.092	.001	.068	.103
ORBITAL RESULTANT	.040	.024	.053	.052	-.059	-.001	-.053	-.097	.011	-.014	.027	.029	-.022	0	.011	-.006	-.023	-.059	-.005	.002	-.115	.001	.079	.103
RECOMMENDED OOAA BIAS	.008	.008	.008	.008	0	0	0	0	.008	.008	.008	.008	0	0	0	0	.008	.008	.008	.008	0	0	0	0
RESULTANT	.048	.032	.061	.060	-.059	-.001	-.053	.097	.019	-.006	.035	.037	-.022	0	.011	.006	-.015	-.051	.003	.010	-.115	.001	.079	.103

Aft Camera

	IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	45	0	-37	-55	45	0	-37	-55	45	0	-37	-55	45	0	-37	-55	45	0	-37	-55	45	0	-37	-55
FRAME POSITION (DEGREES)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0	0	0	0	0	0	0	0	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
SHEAR ERROR	-.004	0	.050	.046	.010	.002	.003	.004	-.004	0	.050	.046	.010	.002	.003	.004	-.004	0	.050	.046	.010	.002	.003	.004
ORBITAL FIXED KNOWN	-.030	-.035	-.028	-.017	-.076	0	.066	.087	0	0	0	.006	.001	0	0	-.006	.036	.047	.036	.033	.087	-.001	-.076	-.112
ORBITAL RESULTANT	-.034	-.035	.022	.029	-.066	.002	.069	.091	-.004	0	.050	.052	.011	.002	.003	-.002	.032	.047	.086	.079	.097	.001	-.073	-.108
RECOMMENDED OOAA BIAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESULTANT	-.034	-.035	.022	.029	.066	.002	.069	.091	-.004	0	.050	.052	.011	.002	.003	-.002	.032	.047	.086	.079	.097	.001	-.073	-.108

NOTES: 1. ALL SIGNS EXPRESSED IN ORBITAL IMAGE PLANE COORDINATES ARE DIRECTLY APPLICABLE FOR INPUT TO THE CRYSPER PROGRAM.
2. THE RESULTANT ERRORS FOR THE IN-TRACK AND CROSS-TRACK DATA FROM BOTH CAMERAS FOR 45 AND 55 DEG POSITIONS ARE CHAMBER A DATA ADJUSTED FOR THE DIFFERENCE BETWEEN CHAMBER A AND A2.

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C. A delta velocity adjustment derived from the acceptance test of minus 15 command counts from flight nominal is recommended for both the SO-255 and the SO-130 materials.

D. A delta velocity adjustment of plus four command counts from flight nominal is recommended for the SO-208 material.

TABLE 4-7

SYNC-FLASH AND SMEAR SLIT DERIVED VELOCITY ERROR AS A FUNCTION OF OOAA BIAS

		VELOCITY ERROR (in/sec)			
		SYNC-FLASH		SMEAR SLIT	
FRAME	OOAA BIAS	MEAN	2σ	MEAN	2σ
1-10	-20	.193	.083	.189	.030
18-27	-15	.149	.061	.140	.014
28-36	-10	.104	.063	.096	.026
38-47	0	.025	.037	Not Measurable	
48-56	+10	-.063	.059	-.072	.019
58-66	+15	-.113	.044	-.122	.026
68-77	+20	-.143	.068	-.158	.019

1A-2 AFT CAMERA SYNC FLASH/SMEAR SLIT COMPARISON

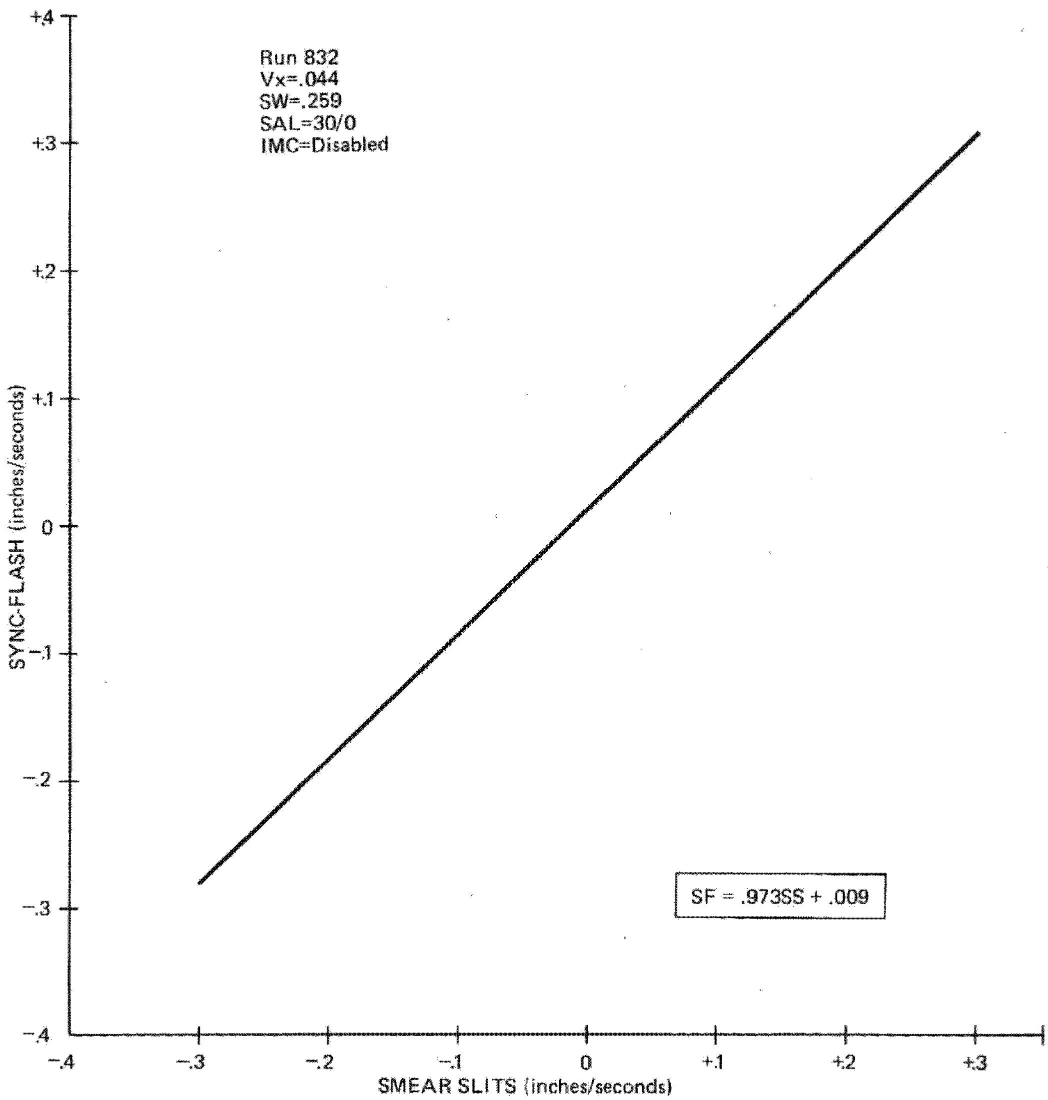

FIGURE 4-7

SECTION V

FLIGHT FOCUS

5.1 INTRODUCTION

The Forward Camera supply of SV-11 will be comprised of 1414 Film while the Aft Camera supply will be comprised of 1414, SO-208, SO-255 and SO-130. The recommended flight focus settings for the 1414 portion of SV-11 are 51 microns for the Forward Camera and 77 microns for the Aft Camera. Natural Color Film (SO-255) and Infrared False Color Film (SO-130) on the Aft Camera will require a platen offset of +30 microns resulting in a focus setting of 107 microns for these portions.

Additionally, SO-208, a black and white equivalent to 1414 on Ultra Ultra Thin Base (UUTB), will be used on the Aft Camera. Based on limited testing, indications are that a -17 micron offset will result in optimum focus. Therefore, with SO-208 film, the Aft Camera platen should be set at 60 microns.

This section presents the rationale for these decisions as well as the analysis of platen tilt adequacy and the effect of filter change on focus.

5.2 PLATEN TILT ASPECTS

As described in Section III, thru focus tribar and line data acquired at seven field positions across the format are provided by a series of vehicle pitch tests using the 0° collimator; the data is shown in Figures 3-1 and 3-2. For assessing the adequacy of platen tilt, the PBFs from both diagnostics are summarized in Table 5-1; PBFs for the thru focus resolution data were chosen from smoothed curves.

In all but two cases (Forward Camera cross-track direction at -2.5° and 0.0°) the two diagnostics yield fairly good agreement. The results for each diagnostic, with the exception of these two cases, where the PBF determined by tribars is used, are averaged to determine the PBF for any condition. With regard to the two discrepant cases, the one at -2.5° is possibly the result of a flat thru focus response; the other is unexplainable at this time and will be examined with A-2 test data for SV-12. The best estimate in-track and cross-track PBFs are averaged for a final assessment of PBF. Figure 5-1 is a plot of these results in comparison with Chamber D interferometric measurements made on the individual optical bars. As in the past, the field curvature as measured in Chamber A-2 is greater than that measured in Chamber D. This is especially true in the case of the Forward Camera. In addition to the increased field curvature,

TABLE 5-1

TRIBAR AND LINE DETERMINATIONS OF PBF
(microns)

Raw Data

	Forward Camera				Aft Camera				Best Estimates				Final Assessment	
	Tribars		Lines		Tribars		Lines		Forward Camera		Aft Camera			
Position (degrees)	IT	XT	IT	XT	IT	XT	IT	XT	IT	XT	IT	XT	Forward Camera	Aft Camera
-2.5	56	47	61	32	78	61	81	66	59	47*	80	64	53	72
-2.0	56	41	60	32	85	65	82	65	58	37	84	65	48	75
-1.0	56	53	61	43	85	75	85	71	59	48	85	73	54	79
0.0	63	62	61	45	91	87	89	80	62	62*	90	84	62	89
+1.0	47	43	50	39	83	68	89	70	49	41	86	69	45	78
+2.0	38	35	39	27	80	74	80	69	39	31	80	72	35	76
+2.5	33	35	34	27	70	70	75	70	34	31	73	70	33	72

NOTES: 1. The data was collected with the 0° collimator adjusted for infinity focus.

2. The asterisk (*) indicates PBF positions determined from tribar thru focus curves only.

COMPARISON OF FIELD CURVATURE BETWEEN CHAMBER A-2 AND CHAMBER D

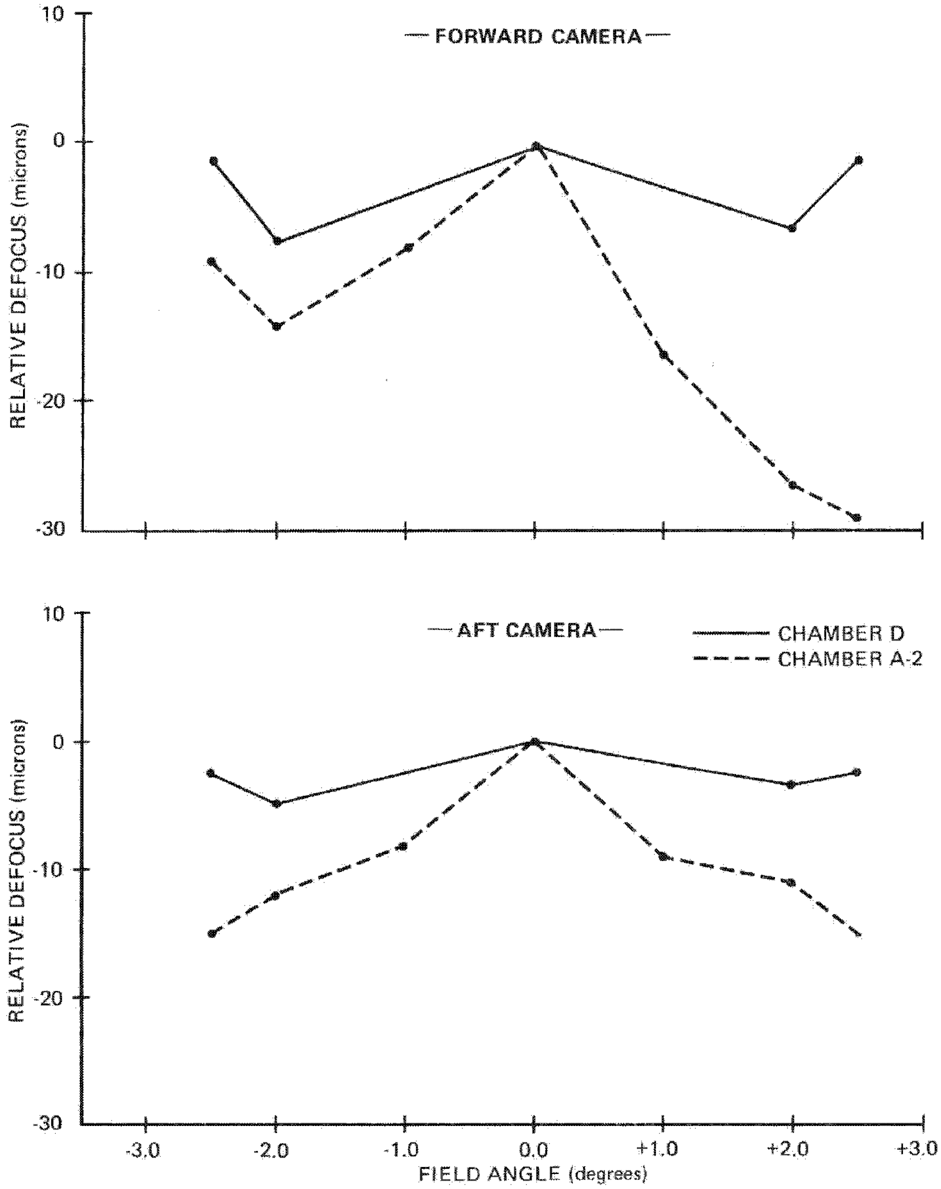

FIGURE 5-1

the platen appears tilted. The historic relationship between these two chambers is characteristic, as seen in Figure 5-2. This figure presents a comparison of the SV-11 field curvature with those of the previous five systems similarly tested via the vehicle pitch configuration. As can be seen, there is a striking similarity in the data, including the asymmetry between the plus and minus field of the Forward Camera.

Based on this historical comparison, the apparent tilt of the Forward Camera platen is judged to be non-existent. This conclusion is supported by VEM analysis of image quality across the minor axis from Mission 1206 thru 1210, which reveals no evidence of a mistilted platen on either the Forward or Aft Cameras. In summary, the Readiness Team feels that the SV-11 platens are adequately aligned for launch.

5.3 EFFECT OF FILTER CHANGE ON FOCUS

Both cameras of SV-11 are equipped with In-flight Changeable Filters (ICF) allowing a choice between a W-12 and a W-2E3 filter. During Readiness Testing (2A-2), Sequence L was run to determine if changes in either resolution performance or focus occur when a change in filter is made. The test parameters for this sequence were a Vx/h of .044 and a slit width of .259 inch, with IMC disabled. The results of this analysis indicate no detectable difference in PBF or resolution level on either camera as a result of changing filters.

Replicate frames were acquired with each filter in place at platen positions of 59 and 86 microns for the Forward and Aft Cameras, respectively. These platen settings are adequately close to the verified 2A-2 nadir peaks of 59 microns on the Forward and 88 microns on the Aft Camera to allow a meaningful comparison. No significant change in the 2:1 contrast mean resolution performance was found for either filter on either camera, see Table 5-2.

Microdensitometry of the line targets from the same frames was performed and the data reduced via the FOCMO program to determine PBFs for each filter. Again, no significant difference was found between filters for either camera, see Table 5-3.

5.4 SELECTION OF LAUNCH PLATEN POSITIONS

Based on the resolution performance analysis in Section III, the platen positions resulting in balanced field performance are 45 microns for the Forward Camera and 78 microns for the Aft Camera. These platen positions must be corrected for vehicle altitude, gravity effects, and collimator focus errors as follows:

HISTORICAL COMPARISON OF CHAMBER A-2
MEASURED FIELD CURVATURE

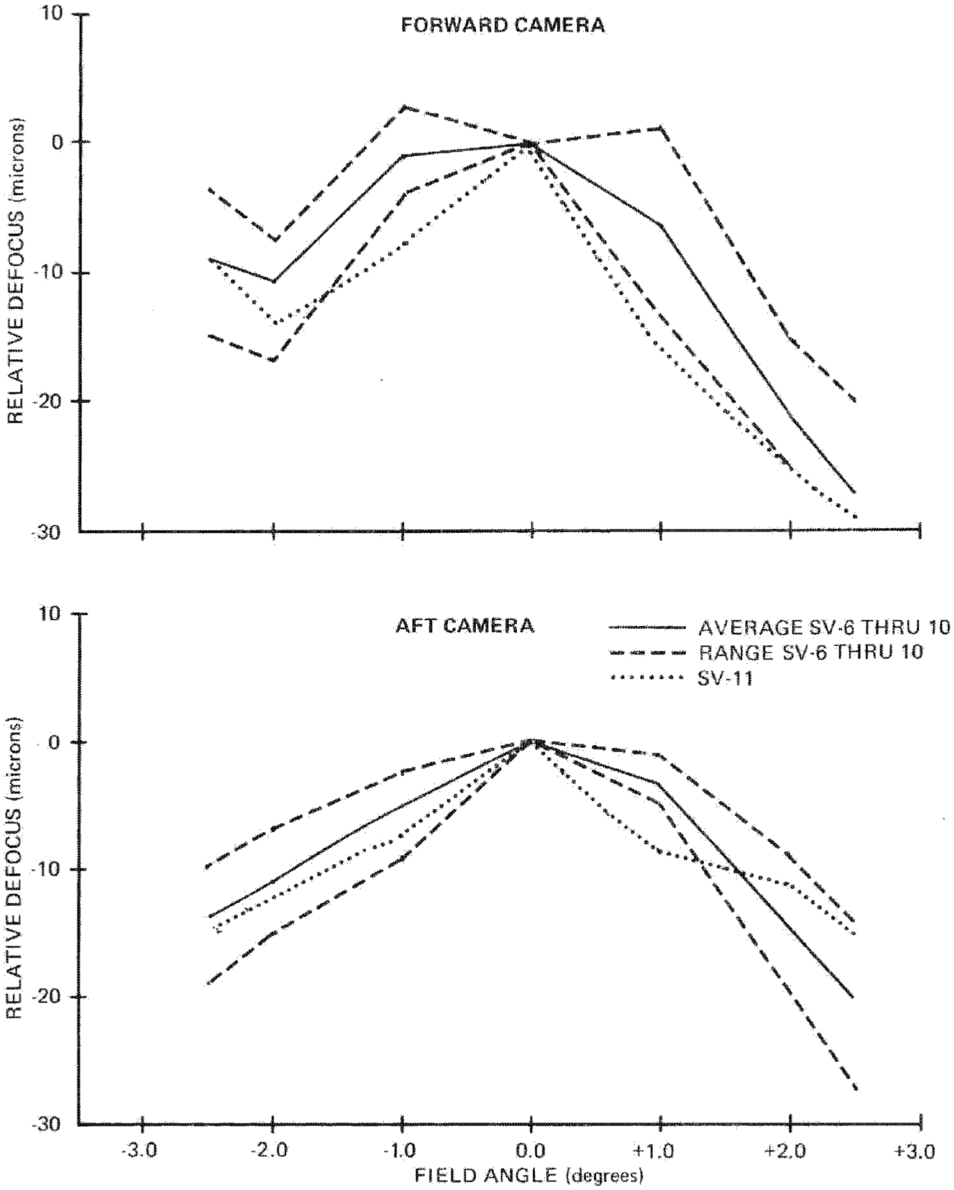

FIGURE 5-2

TABLE 5-2

COMPARISON OF RESOLUTION LEVELS BETWEEN THE TWO FILTERS
(cycles/mm)

		Forward Camera		Aft Camera	
	Filter	IT	XT	IT	XT
	W-12	190	167	192	169
	W-2E3	186	154	177	160
	W-12	186	158	191	169
	W-2E3	186	167	187	169
	W-12	182	161	184	169
Average	W-12	186	162	189	169
Average	W-2E3	186	161	182	165

TABLE 5-3

COMPARISON OF LINE DETERMINED FOCUS BETWEEN THE TWO FILTERS
(microns)

		Forward Camera		Aft Camera	
	Filter	IT	XT	IT	XT
	W-12	56.2	46.3	90.9	76.4
	W-2E3	57.9	47.5	91.6	80.5
	W-12	57.0	46.9	90.8	78.2
	W-2E3	57.9	48.1	92.6	80.3
	W-12	57.7	47.3	88.7	78.4
Average	W-12	57.0	46.8	90.1	77.7
Average	W-2E3	57.9	47.8	92.1	80.4

A. The collimators in Chamber A-2 are set for infinity focus. Since the reference orbit for Mission 1211 is approximately 90 NM, a correction of 14 microns is required to focus the camera for a finite object distance. This adjustment is made so that 0° scan will be in focus, see Figure 5-3.

B. The following consideration is given for the on-orbit effect on focus due to gravity release as compared to the chamber test. The Chamber C measured residual 0° astigmatism on-axis is $-.08\lambda$ for OB Set 041 (Forward Camera) and $-.11\lambda$ for OB Set 032 (Aft Camera). As with previous Readiness Tests, the deformation of the folding flat is assumed to be fully spherical. With this assumption, focus shift (in microns) obeys a linear relationship with residual 0° astigmatism ($\delta\lambda$); i.e., $f = \delta\lambda$ (137). The resultant corrections in focus are therefore -11 microns for the Forward Camera and -15 microns for the Aft Camera.

C. Chamber A-2 collimator focus is monitored interferometrically and changes measured. During Readiness Test operations, the Forward Camera 0° collimator focus deviation was measured to be plus 3 microns while the Aft Camera 0° collimator deviation was measured as 0 microns.

These three correction factors are applied to the optimum platen positions as determined in Section III to establish the recommended launch settings. Table 5-4 presents these factors for SV-11.

TABLE 5-4

LAUNCH FOCUS SETTINGS
(microns)

Factor	Forward Camera	Aft Camera
Platen Position for Best Resolution Across the Field	45	78
Adjustment for 90 NM Altitude	14	14
Adjustment for Gravity Release on Fold Flat Assuming Spherical Deformation	-11	-15
Collimator Defocus Adjustment	3	0
Launch Platen Position	51	77

FOCUS CORRECTIONS AS A FUNCTION OF ALTITUDE AND SCAN ANGLE

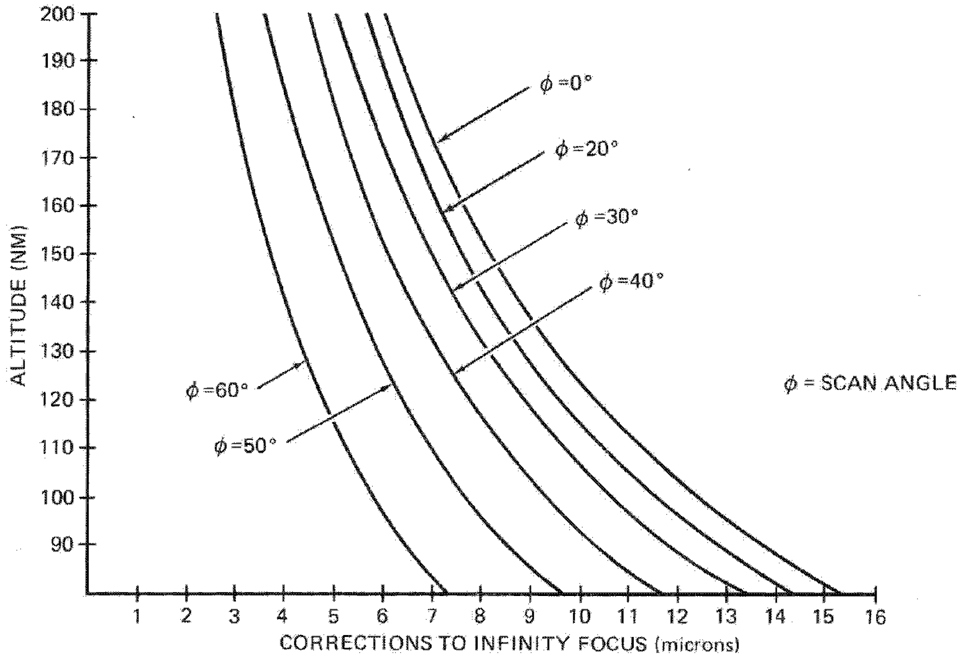

FIGURE 5-3

SECTION VI

ON-ORBIT PERFORMANCE ESTIMATES

6.1 INTRODUCTION

Preflight performance predictions are made for each HEXAGON mission using the CRYSPER Program. CRYSPER predicts the on-orbit performance of the camera system in its expected operating environment. The predictions are two sigma low estimates of resolution in both cycles/mm at the camera as well as ground resolved distance (GRD) of the image. The program has three basic sections that are linked together, each describing a major aspect of the final system resolution. The three sections are:

A. An orbital model which uses as input data the orbital elements for the mission and specific characteristics of the targets. The output of this section of the program is ordered by target access and consists of the solar ephemeris as well as the geometry of each access.

B. An atmospheric model which uses the data generated in the previous section and computes the apparent contrast of each target accessed. It uses an extensive data bank of atmospheric measurements which has been collected over the five best years. This data bank enables this section of the program to estimate the haze levels on a geographic and seasonal probability basis.

C. A camera performance model which is a mathematical description of the performance characteristics of the camera system and flight vehicle. This section uses the output from both of the previous sections as well as the film characteristics and the camera smear/optical performance data under the various operating conditions. The calculation of resolution is obtained by intersecting the system modulation transfer function (MTF) with a threshold modulation (TM) curve that describes the film characteristics under the exposure/contrast conditions prevalent during exposure. CRYSPER has been configured to compute a table of resolution values in either cycles/mm at the film plane or ground resolved distance (GRD) in feet for a range of solar altitudes and latitudes over the entire 120° format. The solar altitude is computed for given latitudes based on the orbital and solar ephemeral data. The computation for the solar altitude is based on the latitude at 0° scan angle. Because of the geometry of the orbital elements and camera configuration, a small difference of approximately 2° maximum is expected in the solar altitude at high scan angles relative to the published angle for 0° scan. This will not affect the prediction significantly. The benefit derived from this change enables one to determine the appropriate predictions based on the expected solar elevation for a given target or area knowing only the geographic latitude of the target. These tables have been used in all previous readiness reports. The table, however, has three limitations:

(1) It is for an average of the in-track and cross-track resolution.

(2) The MTF at the 0° and ±2.0° field positions is averaged and used throughout the length of a frame.

(3) It is for only one focus position.

6.2 CRYSPER CONCEPTS

During the design and test stages of building a camera system, a set of standard conditions is used that is generally based on best exposure and 2:1 apparent target contrast. This provides a stable base from which design predictions can be compared against actual test chamber results. During flight, though, these stable conditions do not exist.

Each operational target is acquired under its own unique set of conditions. Even the same targets acquired on a later revolution will exhibit new characteristics that will influence the ultimate performance. Two factors that are not within engineering control are the target reflectances and the prevailing haze conditions at the time of exposure. These two factors have a direct and significant influence on performance.

An effort has been undertaken to quantify these two characteristics so that the CRYSPER Program could be used to predict the ground resolved distance for accessed intelligence targets with some relation to reality. The haze has been estimated as a probability distribution on a geographic and seasonal basis. It is a useful estimate on a statistical basis, which is the best one could hope for in making preflight predictions. The target reflectance aspect has been handled by assigning a high and low reflectance to each COMIREX target category. These values were based on density measurements made from past reconnaissance photography. The contrast of these targets is low, the maximum being slightly above 2:1 on the ground. Intelligence target contrasts are further reduced (to perhaps 1.5:1) by the atmospheric haze.

Mobile Controlled Range Network (CORN) tribar targets will be photographed during domestic passes for engineering purposes. These targets have a ground contrast of approximately 5:1. They are useful in assessing on-orbit performance in relation to system design and testing because these targets have, on clear days, an apparent contrast somewhat higher than 2:1 at the camera aperture.

In order to accommodate both the engineering and intelligence needs for resolution predictions, two separate CRYSPER runs are made. The engineering run uses an average haze condition and the nominal CORN tribar target reflectances of 7-33 percent. This equates to placing a CORN tribar target at all format locations and photographing it on "average" days, see Table 6-1. CRYSPER approximates the engineering ground based tests by controlling the major non-camera related variables and produces GRD values between 2 feet and 9 feet as the design indicates. The run for intelligence application equates to replacing the intelligence target with a CORN tribar target that nearly matches it in contrast, and photographing it under atmospheric conditions typical of those at this time of year. Hence it is not uncommon to have CRYSPER predictions for high obliquity/low solar elevation photography of 10 to 15 feet GRD. This is true even though the camera system is operating according to its design, see Table 6-2.

A third type of performance prediction entitled CRYSPER VEM resolution has been included in this section of the readiness report, see Table 6-3. These predictions are designed to relate to the VEM resolution data acquired during the PFA time period and the subsequent in-depth analyses of the mission. VEM provides an estimate of the 2:1 contrast resolution in cycles/mm, the basic performance measure of the camera system. The VEM matrix is calibrated to 2:1 contrast resolution irrespective of the contrast of the edge itself, so the atmospheric subroutines of CRYSPER, which ultimately adjust the AIM curve for exposure and contrast, are bypassed. At the present time SSC/WCFO is in the process of correlating VEM measurements with CRYSPER VEM predictions in hopes of determining the best method of predicting performance. This will be a continuing mission-to-mission effort with reports issued following each mission.

A fourth type of CRYSPER prediction is included in this section of the readiness report as Table 6-4. This is a set of CRYSPER Intelligence Target predictions for the first five days of the mission. In these predictions CRYSPER utilizes the typical reflectance for the target type and the obliquity/solar elevation/nominal atmospheric conditions at the time of acquisition. This should provide a representative sample of GRD to be experienced for all intelligence targets acquired during this portion of the mission.

6.3 PREDICTIONS FOR MISSION 1211

A series of CRYSPER runs have been made to estimate the performance from Mission 1211. The predicted orbit elements for launch at 2000Z on 29 November 1975 were used along with the performance estimates from the Chamber A acceptance test and the latest Chamber A-2 test. Chamber A-2 provides data at only two collimator locations, whereas Chamber A has three. In order to have as much data as possible for determining the synchronization errors as a function of scan angle, both sets of data are used. There are, however, some inconsistencies in the data between these two tests. This causes slight inconsistencies in the resolution predictions as a function of scan angle. All runs are for descending passes.

The output used for the first three tables has been expanded to include GRD in feet. The computation used to convert from film plane resolution in cycles/mm to GRD takes into account the slant range and perspective factors of the acquisition. It is therefore a number that relates to flat objects on the ground; i.e., CORN tribar targets.

6.4 UNCERTAINTIES IN PERFORMANCE ESTIMATES

The predictions in this section have been based upon laboratory data combined with nominal orbit parameters and nominal atmospheric conditions. These predictions assume two-sigma low performance of the camera system.

Past readiness reports have also included worse case CRYSPER predictions based upon an additional .05 IPS film velocity error combined with an eight micron defocus error. Based upon current VEM/CRYSPER correlation studies these additional errors have been determined to be excessively pessimistic. For this reason the Mission 1211 readiness report, as well as all future readiness reports, will not contain the worse case predictions.

It should be noted that the predictions presented herein are valid only for the early portion of the mission. As the mission progresses and atmospheric as well as orbit conditions change these estimates are updated via the Rebound-231 data messages sent to various interested agencies.

TABLE 6-1

MISSION 1211 CRYSPER PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR 7-33% REFLECTANCE TARGETS (CORN TRIBAR SIMULATIONS)

(lines/mm and feet)

TYPICAL RESOLUTION OBTAINABLE FROM EACH CAMERA SYSTEM (IN LINES/MM) FOR VARIOUS SUN AND SCAN ANGLES

(0 CENTER 120 SCAN)

	SCAN		-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	LAT	SUN													
	70	-2	62	68	71	76	85	90	94	95	94	94	91	86	79
	65	2	69	74	76	81	91	98	103	104	103	102	98	92	82
	60	7	75	81	83	87	99	107	114	115	114	113	109	104	94
	55	12	93	101	102	108	121	130	136	138	137	134	129	122	111
AFT CAMERA	50	17	114	123	125	132	145	154	159	160	159	156	150	143	139
	45	22	128	136	142	149	162	171	176	177	176	172	165	154	142
SSN 014 OSN 32B	40	27	139	148	154	162	174	183	187	188	187	183	176	164	151
	35	32	147	157	164	172	184	191	196	196	196	192	184	172	158
	30	37	154	164	172	180	191	198	202	203	202	198	191	178	164
	20	47	164	175	184	192	202	208	211	212	213	209	201	188	173

(0 CENTER 120 SCAN)

	SCAN		-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	LAT	SUN													
	70	-2	62	68	74	79	83	87	88	89	82	79	74	71	65
	65	2	67	72	79	84	89	93	95	95	87	83	77	74	68
	60	7	72	80	86	91	96	101	102	104	94	90	83	80	76
	55	12	86	92	99	104	109	113	114	116	105	100	94	90	85
FORWARD CAMERA	50	17	106	115	123	129	135	140	140	142	131	126	117	112	104
	45	22	120	132	141	148	154	159	158	160	151	145	136	129	116
SSN 014 OSN 41A	40	27	131	144	154	161	168	172	171	173	165	159	150	142	129
	35	32	139	153	164	172	178	182	181	183	176	170	161	152	138
	30	37	145	160	172	179	186	190	189	190	184	179	169	159	144
	20	47	154	170	182	191	197	202	201	201	196	192	183	170	159

TYPICAL RESOLUTION OBTAINABLE FROM EACH CAMERA SYSTEM (IN FEET) FOR VARIOUS SUN AND SCAN ANGLES

(0 CENTER 120 SCAN)

	SCAN		-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	LAT	SUN													
	70	-2	19.34	11.18	8.01	6.15	4.86	4.25	3.96	4.02	4.37	5.00	6.32	8.93	15.22
	65	2	16.98	10.25	7.41	5.71	4.48	3.87	3.60	3.65	3.97	4.56	5.77	8.24	14.35
	60	7	15.48	9.19	6.75	5.25	4.08	3.49	3.22	3.25	3.53	4.06	5.12	7.24	12.42
	55	12	12.32	7.33	5.43	4.20	3.29	2.85	2.66	2.70	2.93	3.40	4.30	6.10	10.40
AFT CAMERA	50	17	10.05	5.98	4.42	3.44	2.74	2.39	2.26	2.30	2.50	2.91	3.69	5.17	8.85
	45	22	8.85	5.37	3.87	3.02	2.44	2.14	2.04	2.07	2.25	2.62	3.32	4.75	8.04
SSN 014 OSN 32B	40	27	8.12	4.91	3.54	2.77	2.26	1.99	1.91	1.94	2.10	2.45	3.11	4.44	7.49
	35	32	7.65	4.64	3.32	2.60	2.14	1.91	1.82	1.86	2.01	2.33	2.96	4.24	7.15
	30	37	7.32	4.44	3.17	2.49	2.06	1.84	1.77	1.80	1.94	2.26	2.86	4.11	6.91
	20	47	6.95	4.21	3.00	2.36	1.97	1.78	1.71	1.74	1.87	2.16	2.74	3.92	6.62

(0 CENTER 120 SCAN)

	SCAN		-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	LAT	SUN													
	70	-2	19.32	11.23	7.67	5.90	4.96	4.40	4.22	4.31	5.00	5.93	7.73	10.86	18.09
	65	2	17.58	10.43	7.13	5.49	4.59	4.06	3.90	3.96	4.66	5.56	7.30	10.27	17.35
	60	7	16.09	9.36	6.48	5.03	4.20	3.70	3.58	3.61	4.28	5.11	6.72	9.31	15.37
	55	12	13.43	8.03	5.62	4.36	3.66	3.28	3.18	3.21	3.80	4.53	5.91	8.26	13.59
FORWARD CAMERA	50	17	10.79	6.41	4.48	3.49	2.95	2.63	2.57	2.60	3.03	3.60	4.69	6.57	10.99
	45	22	9.44	5.56	3.90	3.04	2.57	2.31	2.27	2.29	2.62	3.10	4.02	5.66	9.62
SSN 014 OSN 41A	40	27	8.60	5.07	3.54	2.78	2.35	2.12	2.09	2.11	2.38	2.81	3.63	5.14	8.75
	35	32	8.13	4.76	3.33	2.61	2.21	2.00	1.97	2.00	2.23	2.63	3.39	4.80	8.21
	30	37	7.77	4.55	3.18	2.50	2.12	1.92	1.89	1.92	2.13	2.50	3.22	4.58	7.85
	20	47	7.40	4.33	3.03	2.37	2.02	1.83	1.80	1.83	2.02	2.36	3.01	4.32	7.46

PARAMETERS ASSOCIATED WITH THE LAST ENTRY IN THE FAR RIGHT COLUMN OF THE TABLE

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE D A	DATE M O	DATE Y R	RDOH	INERTIAL VELOCITY (FT/SEC)
19 40 2	20	10	1	4	185.04	3	12	75	0.00020	25670.94

SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)		OBLATE EARTH RADIUS		SATELLITE TO EARTH CENTER(NM)	VXOH	VYOH
19.9776	33.927	88.6	+	3442.6	=	3531.1	0.0462	0.00265

TABLE 6-2

MISSION 1211 CRYSPER PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR 10-20% REFLECTANCE TARGETS (NOMINAL INTELLIGENCE TARGETS)

(lines/mm and feet)

TYPICAL RESOLUTION OBTAINABLE FROM EACH CAMERA SYSTEM (IN LINES/MM) FOR VARIOUS SUN AND SCAN ANGLES

(0 CENTER 120 SCAN)

	LAT	SUN (SCAN →)	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	44	52	56	61	67	71	74	74	73	72	69	64	56
	65	2	46	55	61	65	71	74	77	77	76	75	72	66	57
	60	7	57	65	68	73	82	88	92	93	92	91	87	80	68
	55	12	74	82	85	91	100	106	110	111	110	108	103	96	84
AFT CAMERA	50	17	88	98	103	109	119	125	128	129	128	125	119	111	98
	45	22	98	109	115	122	131	137	140	141	140	136	130	121	107
SSN 014 OSN 32B	40	27	106	117	124	131	140	146	148	149	148	144	137	128	113
	35	32	111	123	131	138	147	152	154	155	154	150	143	132	118
	30	37	116	128	136	143	151	157	159	159	158	154	147	136	122
	20	47	122	135	143	150	158	163	165	165	163	160	153	142	127

(0 CENTER 120 SCAN)

	LAT	SUN (SCAN →)	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	45	53	59	63	66	69	71	71	66	64	59	55	49
	65	2	46	55	63	67	70	73	74	74	70	67	62	58	51
	60	7	56	65	71	77	81	85	85	86	79	75	69	65	57
	55	12	68	76	83	88	93	97	97	99	90	86	79	74	67
FORWARD CAMERA	50	17	83	93	101	107	113	117	117	119	111	104	97	91	82
	45	22	94	106	114	121	126	129	130	132	124	119	111	103	93
SSN 014 OSN 41A	40	27	102	114	124	130	135	139	138	139	133	128	121	112	101
	35	32	108	121	131	137	142	146	145	146	141	136	128	121	108
	30	37	115	128	135	142	147	151	150	151	146	141	133	126	113
	20	47	121	135	142	150	154	158	157	157	153	149	141	133	120

TYPICAL RESOLUTION OBTAINABLE FROM EACH CAMERA SYSTEM (IN FEET) FOR VARIOUS SUN AND SCAN ANGLES

(0 CENTER 120 SCAN)

	LAT	SUN (SCAN →)	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	26.94	14.69	10.15	7.72	6.14	5.39	5.07	5.16	5.61	6.48	8.24	11.95	21.23
	65	2	25.28	13.76	9.21	7.15	5.75	5.07	4.80	4.90	5.34	6.18	7.81	11.40	20.59
	60	7	20.47	11.49	8.19	6.27	4.94	4.26	3.96	4.02	4.38	5.06	6.44	9.36	17.05
	55	12	15.62	9.07	6.50	4.98	3.99	3.49	3.28	3.34	3.63	4.20	5.36	7.76	13.76
AFT CAMERA	50	17	12.98	7.53	5.36	4.14	3.33	2.96	2.81	2.86	3.09	3.61	4.61	6.66	11.74
	45	22	11.54	6.71	4.77	3.70	3.01	2.68	2.56	2.60	2.82	3.30	4.20	6.07	10.64
SSN 014 OSN 32B	40	27	10.68	6.22	4.41	3.42	2.80	2.51	2.41	2.45	2.65	3.11	3.97	5.72	10.00
	35	32	10.12	5.91	4.17	3.25	2.64	2.40	2.31	2.36	2.55	2.99	3.81	5.49	9.58
	30	37	9.74	5.70	4.02	3.13	2.60	2.33	2.25	2.29	2.49	2.91	3.71	5.35	9.28
	20	47	9.33	5.46	3.85	3.01	2.52	2.27	2.18	2.24	2.43	2.83	3.60	5.18	8.96

(0 CENTER 120 SCAN)

	LAT	SUN (SCAN →)	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	26.23	14.37	9.67	7.38	6.18	5.49	5.28	5.40	6.20	7.32	9.68	13.96	24.33
	65	2	25.56	13.69	8.90	6.90	5.78	5.16	4.98	5.08	5.83	6.90	9.09	13.09	22.97
	60	7	20.84	11.56	7.85	5.97	4.98	4.42	4.28	4.33	5.09	6.12	8.05	11.58	20.27
	55	12	16.98	9.72	6.68	5.15	4.30	3.83	3.72	3.76	4.42	5.29	7.05	10.02	17.24
FORWARD CAMERA	50	17	13.72	7.89	5.43	4.21	3.51	3.15	3.08	3.10	3.59	4.33	5.67	8.09	13.98
	45	22	12.03	6.91	4.78	3.73	3.14	2.83	2.74	2.77	3.19	3.79	4.94	7.09	12.25
SSN 014 OSN 41A	40	27	11.02	6.36	4.40	3.44	2.91	2.64	2.58	2.62	2.95	3.49	4.52	6.49	11.24
	35	32	10.41	6.02	4.17	3.27	2.77	2.51	2.46	2.50	2.79	3.30	4.27	6.03	10.44
	30	37	9.85	5.69	4.03	3.15	2.67	2.42	2.38	2.42	2.69	3.17	4.09	5.79	10.00
	20	47	9.41	5.47	3.87	3.03	2.57	2.34	2.29	2.34	2.59	3.04	3.90	5.54	9.51

PARAMETERS ASSOCIATED WITH THE LAST ENTRY IN THE FAR RIGHT COLUMN OF THE TABLE

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE DA MO YR	RDUH	INERTIAL VELOCITY (FT/SEC)
19 40 2	33	7	1	4	185.04	3 12 75	0.00020	25670.94

SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)		OBLATE EARTH RADIUS		SATELLITE TO EARTH CENTER (NM)	VXOH	VYOH
19.9776	33.927	88.6	+	3442.6	=	3531.1	0.0462	0.00265

TABLE 6-3

MISSION 1211 CRYSPER VEM PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR 2:1 APPARENT CONTRAST OBJECTS

(lines/mm and feet)

TYPICAL RESOLUTION OBTAINABLE FROM EACH CAMERA SYSTEM (IN LINES/MM) FOR VARIOUS SUN AND SCAN ANGLES
(0 CENTER 120 SCAN)

	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	77	79	79	82	90	95	99	100	100	101	100	99	97
	65	2	83	84	83	86	97	101	105	107	107	107	110	108	107
	60	7	82	84	84	87	98	106	112	114	113	113	111	109	105
	55	12	97	101	101	104	117	124	129	131	131	127	125	121	115
AFT CAMERA	50	17	116	120	120	127	138	145	150	151	151	149	143	138	133
	45	22	128	132	136	141	151	158	162	163	163	161	157	149	142
SSN 014 OSN 32B	40	27	136	140	146	151	160	167	170	171	171	168	164	155	148
	35	32	141	150	152	157	166	172	175	175	175	173	169	163	151
	30	37	145	154	157	162	170	175	178	179	178	176	172	166	154
	20	47	154	160	163	169	176	180	182	183	182	180	176	170	161

(0 CENTER 120 SCAN)

	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	75	78	81	85	87	91	93	94	87	84	80	79	80
	65	2	79	82	86	90	94	95	97	98	90	87	84	83	84
	60	7	79	82	87	91	95	100	101	102	93	90	84	83	83
	55	12	88	93	97	101	105	109	109	111	102	98	92	90	88
FORWARD CAMERA	50	17	107	113	118	123	127	131	130	133	124	120	113	111	106
	45	22	122	128	133	138	142	145	144	147	139	135	129	125	120
SSN 014 OSN 41A	40	27	131	137	143	148	152	155	154	156	149	145	139	135	129
	35	32	137	143	150	155	158	162	160	162	157	153	146	142	135
	30	37	141	148	155	159	163	170	169	170	162	158	152	146	140
	20	47	146	154	160	170	174	176	175	176	173	169	159	152	145

TYPICAL RESOLUTION OBTAINABLE FROM EACH CAMERA SYSTEM (IN FEET) FOR VARIOUS SUN AND SCAN ANGLES
(0 CENTER 120 SCAN)

	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	15.44	9.67	7.26	5.71	4.55	4.01	3.75	3.81	4.12	4.65	5.74	7.78	12.40
	65	2	14.22	8.99	6.82	5.37	4.21	3.76	3.50	3.54	3.82	4.33	5.14	6.99	11.03
	60	7	14.15	8.88	6.69	5.27	4.11	3.53	3.26	3.29	3.55	4.05	5.05	6.89	11.18
	55	12	11.81	7.35	5.52	4.37	3.43	2.99	2.80	2.84	3.06	3.57	4.45	6.13	10.08
AFT CAMERA	50	17	9.85	6.15	4.59	3.57	2.88	2.54	2.40	2.44	2.63	3.03	3.87	5.34	8.65
	45	22	8.86	5.55	4.04	3.20	2.61	2.32	2.21	2.24	2.42	2.79	3.49	4.93	8.05
SSN 014 OSN 32B	40	27	8.31	5.20	3.75	2.97	2.45	2.19	2.10	2.14	2.31	2.66	3.32	4.71	7.68
	35	32	7.98	4.86	3.58	2.84	2.37	2.12	2.04	2.08	2.24	2.58	3.22	4.46	7.47
	30	37	7.79	4.73	3.47	2.76	2.31	2.08	2.00	2.04	2.20	2.54	3.17	4.38	7.36
	20	47	7.42	4.61	3.37	2.69	2.26	2.05	1.98	2.02	2.18	2.51	3.13	4.33	7.09

(0 CENTER 120 SCAN)

	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	70	-2	15.92	9.75	7.03	5.53	4.70	4.18	4.01	4.08	4.72	5.55	7.15	9.67	15.09
	65	2	14.84	9.19	6.57	5.15	4.35	3.96	3.82	3.86	4.51	5.34	6.74	9.10	14.10
	60	7	14.74	9.08	6.39	5.05	4.24	3.75	3.63	3.66	4.31	5.11	6.66	8.99	14.10
	55	12	13.02	7.99	5.72	4.50	3.81	3.42	3.34	3.35	3.92	4.62	6.00	8.21	13.15
FORWARD CAMERA	50	17	10.64	6.49	4.66	3.68	3.13	2.82	2.76	2.77	3.21	3.78	4.86	6.66	10.81
	45	22	9.30	5.73	4.12	3.27	2.79	2.52	2.48	2.50	2.83	3.33	4.26	5.86	9.50
SSN 014 OSN 41A	40	27	8.62	5.33	3.82	3.03	2.59	2.36	2.32	2.35	2.63	3.08	3.92	5.41	8.78
	35	32	8.26	5.07	3.64	2.90	2.48	2.26	2.22	2.25	2.51	2.93	3.72	5.14	8.37
	30	37	8.02	4.91	3.53	2.81	2.41	2.15	2.11	2.14	2.43	2.83	3.59	4.98	8.11
	20	47	7.81	4.78	3.44	2.67	2.29	2.09	2.06	2.10	2.30	2.67	3.46	4.83	7.87

PARAMETERS ASSOCIATED WITH THE LAST ENTRY IN THE FAR RIGHT COLUMN OF THE TABLE

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE DA MO YR	RDOH	INERTIAL VELOCITY (FT/SEC)
19 40 2	20	10	1	4	185.04	3 12 75	0.00020	25670.94

SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)		OBLATE EARTH RADIUS		SATELLITE TO EARTH CENTER(NM)	VXOH	VYOH
19.9776	33.927	88.6	+	3442.6	=	3531.1	0.0462	0.00265

TABLE 6-4

MISSION 1211 CRYSPER INTELLIGENCE TARGET PREDICTIONS

FOR FIRST FIVE DAYS OF MISSION

TARGET IDENT		REV	DATE DA/MO/YR	TIME (GMT) HR MN SC	OBLIQ (DEG)	ALT (NM)	SLANT RANGE (NM)	SOLAR ELEV (DEG)	FWD GRD (FT)	AFT GRD (FT)	REFL %
CH	3B0087D	6	30/11/75	4 55 38	-24	88.1	98.2	36	4.6	4.7	10/13
CH	3E0106A	6	30/11/75	4 55 35	-34	88.1	109.1	36	4.2	4.1	20/30
CH	3B0086A	6	30/11/75	4 55 29	-17	88.1	93.5	35	4.1	4.2	10/13
CH	2C0147A	6	30/11/75	4 54 59	44	87.9	125.4	33	5.8	5.3	20/29
UR	1A0019RA	8	30/11/75	7 49 6	-40	87.9	117.3	22	4.7	4.8	12/23
UR	1A0019RB	8	30/11/75	7 49 6	-40	87.9	117.7	22	4.8	4.9	12/23
UR	1A0019RC	8	30/11/75	7 49 5	-40	87.9	117.6	22	4.8	4.9	12/23
UR	1A0019H	8	30/11/75	7 49 4	-36	87.9	110.7	22	4.3	4.3	12/23
UR	1A0019RD	8	30/11/75	7 49 5	-40	87.9	118.2	22	4.8	4.8	12/23
UR	1A0019RE	8	30/11/75	7 49 5	-41	87.9	119.3	22	4.9	4.9	12/23
UR	1A0019RF	8	30/11/75	7 49 4	-39	87.9	115.1	22	4.6	4.7	12/23
SU	4C0219	9	30/11/75	9 23 55	-1	90.0	91.4	48	2.4	2.4	4/ 9
UR	7A1403A	9	30/11/75	9 15 21	43	88.4	124.9	13	9.1	7.5	10/15
UR	6B1148	10	30/11/75	10 43 40	-42	88.4	122.5	13	6.9	6.7	10/20
UR	2A0004	10	30/11/75	10 43 30	-21	88.5	96.6	12	4.3	4.0	23/44
UR	1G0004B	10	30/11/75	10 40 6	7	90.2	92.3	-1	6.3	6.0	4/ 9
UR	4B0012	21	1/12/75	2 57 39	-43	88.2	123.4	17	6.5	6.6	4/ 9
IN	2C1425	23	1/12/75	6 1 23	-32	90.2	108.1	46	4.0	4.0	20/29
IN	2C1368	23	1/12/75	6 0 20	-24	89.4	99.5	41	3.5	3.5	20/29
UR	3B0039	23	1/12/75	5 53 10	-44	88.5	126.2	12	13.4	12.8	10/13
PK	4A0177	24	1/12/75	7 29 11	13	89.7	93.5	43	2.6	2.5	4/ 9
PK	2C1179	24	1/12/75	7 29 10	11	89.7	93.0	43	3.1	3.0	20/29
UR	2A0023	26	1/12/75	10 19 2	10	88.4	91.2	14	3.4	3.1	23/44
FR	1B0181	27	1/12/75	11 49 47	23	88.2	97.2	23	3.2	2.9	12/23
FR	3A0005A	33	1/12/75	20 56 28	42	108.2	148.7	88	5.9	5.7	20/30
CH	4C0057	38	2/12/75	4 3 25	13	88.6	92.3	27	2.9	2.8	4/ 9
IN	2C1598	39	2/12/75	5 35 19	-34	90.2	111.3	41	4.3	4.3	20/29
UR	3B0015	39	2/12/75	5 28 56	38	88.5	114.4	15	9.0	7.9	10/13
PK	2C0962	40	2/12/75	7 2 28	-43	89.5	124.9	36	5.5	5.5	20/29
PK	7A1943	40	2/12/75	7 2 15	-18	89.3	95.7	35	3.4	3.3	10/15
PK	2C1445	40	2/12/75	7 2 5	-41	89.3	120.6	34	5.2	5.2	20/29
UR	3B0037	41	2/12/75	8 24 39	9	88.7	91.3	10	6.5	6.3	10/13
UR	6A0175	41	2/12/75	8 22 8	-23	89.5	98.7	0	5.4	5.4	13/30
EG	2A0058	42	2/12/75	9 59 44	35	89.8	112.1	37	3.7	3.4	23/44
UR	9P0005	42	2/12/75	9 56 20	31	88.6	105.8	23	3.8	3.3	10/20
UR	1J0013	42	2/12/75	9 56 14	11	88.6	91.8	23	3.7	3.6	12/17
UR	9P0003	42	2/12/75	9 56 2	23	88.6	98.3	22	3.4	3.0	10/20
UR	6B0180C	42	2/12/75	9 55 43	-35	88.5	111.1	21	4.3	4.4	10/20
UR	6B0180B	42	2/12/75	9 55 40	-37	88.5	113.0	21	4.5	4.5	10/20
UR	6A0124A	42	2/12/75	9 53 35	13	88.7	92.6	12	3.7	3.1	13/30
UR	1G0001A	42	2/12/75	9 51 19	-25	89.2	100.6	3	7.1	7.3	4/ 9
GE	9P0001	43	2/12/75	11 22 53	-29	88.6	103.1	16	4.3	4.3	10/20

SECTION VII

ELECTROMECHANICAL SYSTEM EVALUATION

7.1 INTRODUCTION

The electromechanical evaluation reported in this section was derived from telemetry data from the tests run at the West Coast facility using MACFACT, Strip Charts, CALCOMP Plots, and other evaluation techniques.

7.2 SCAN MODE, SCAN SECTOR PLACEMENT, AND SHUTTER OPERATION

The capability to operate at various scan angle lengths and scan centers is demonstrated by the testing at WCFO. The contractor's evaluation indicates that the system meets the specified requirements with the following exceptions:

A. The commanded platen position modulation is incorrect for the first frame with certain scan angle/scan center combinations and causes significant in-track smear. This is due to a late PSW-Not signal from the SCC box. The PSW-Not signal will normally occur at 69.5° (Optical Bar A) once the Forward/Aft Camera enable signal has been generated by the SCC. However, for the first frame the signal occurs in conjunction with the first Forward Camera transition point. Depending on the selected scan angle and scan center, the transition points may occur after 69.5°, delaying generation of the PSW-Not signal. Table 7-1 lists the scan modes affected for each camera.

TABLE 7-1

SCAN MODES AFFECTED BY LATE PSW-NOT SIGNAL

Scan Center (degrees)	Scan Length (degrees) 30	60	90	120
-45	Aft	N/A	N/A	N/A
-30	Aft	Aft	N/A	N/A
-15	Aft	Aft	-	N/A
0	-	-	-	-
15	Forward	Forward	-	N/A
30	Forward	Forward	N/A	N/A
45	Forward	N/A	N/A	N/A

NOTE: Dashes denote scan modes not affected; Scan Center/Scan Length combinations not obtainable are denoted by N/A.

B. The first frame of operation on both cameras has an early opening and closing (6 to 10 degrees) of the shutter. This operation is a characteristic of the design.

7.3 'TUNITY/OPERATIONAL SOFTWARE DATA BASE INPUTS

Table 7-2 summarizes SV-10 inputs to the 'TUNITY data base.

TABLE 7-2

'TUNITY/OPERATIONAL SOFTWARE DATA BASE INPUTS

	Input	Forward	Aft
1.	OB Stow Angle (degrees)	178	179
2.	OB Start Uncertainty (seconds)	.15	.10
3.	FT Start Uncertainty (seconds)		
	VI Enable	1.33	1.45
	VI Disable	.25	.25
4.	OB Acceleration (radians/sec^2)	.284	.287
5.	FT Acceleration (inches/sec^2)	4.61	4.67
6.	Focal Length (inches)	59.984	59.975
7.	Optical Lens Number	041	032
8.	Plane of Best Focus (microns)	51	77
9.	PBF Altitude (NM)	85	85
10.	Lift-off Filter Configuration	W-12	W-12
11.	OOAA Orbital Nominals		
	Cross-Track (Command Counts)	0	0
	In-Track (Command Counts)	+1	-3

TABLE 7-2 (Con't)

	Input	Forward		Aft
12.	On-axis On-orbit Image Motion Error Predictions			
	Cross-Track (inch/second)	-.011	37°	.003
		.000	0°	.002
		-.022	45°	.011
	In-Track (inch/second)	.035	37°	.050
		-.006	0°	.000
		.019	45°	-.004
13.	Frame Lengths } See Table 7-7			
14.	Interframe Spacing } See Table 7-7			
15.	PN Use Rate (pound/minute) A-2 = .0234			
16.	First Frame Early Shutter Open From 5° Mark to Start of Image (inches)	6.1		6.0
17.	SLW SLEW Rate (inch/second)	.0898		.0898

NOTE: Values in Item 12 include the effect of the recommended OOAA adjustments.

7.4 SLIT WIDTH

Table 7-3 summarizes the values extracted from slit width calibration. All measured values are within specification limits.

7.5 LATERAL SEPARATION FOCUS SENSOR (LSFS)

The LSFS ground test calibration curves for Mission 1211 are shown in Figure 7-1. These data were obtained from Seq K of the A-2 Chamber Test (Vx/h of .052, IMC disabled, 72°F).

The slopes of the calibration curves at the plane of best focus are approximately 1.6 microns/count for the Forward Camera and 2.0 microns/count for the Aft Camera.

TABLE 7-3

SLIT WIDTH DATA
(inches)

	Forward Camera		Aft Camera	
Command	Telemetry Reading	Film Measurement	Telemetry Reading	Film Measurement
.080	.079	.080	.079	.075
.150	.150	.155	.150	.150
.281	.280	.280	.277	.280
.525	.517	.525	.522	.517
.910	.892	.900	.901	.900
.525	.533	.530	.527	.530
.281	.283	.285	.280	.280
.150	.147	.150	.147	.150
.080	.079	.080	.079	.075

7.6 OPTICAL BAR ANGULAR VELOCITY SCALING TO Vx/h

The optical bar velocity has been within the required ±1% of the commanded velocity in tests run at the WCFO Facility.

Table 7-4 is a tabulation of optical bar velocity scaling data obtained from tests conducted in Chamber A-1. The data shows maximum/minimum percentage velocity errors (measured versus commanded) calculated from the 0°-180° pulses.

FOCAL PLANE POSITION VERSUS LSFS COUNTS AT 72° F

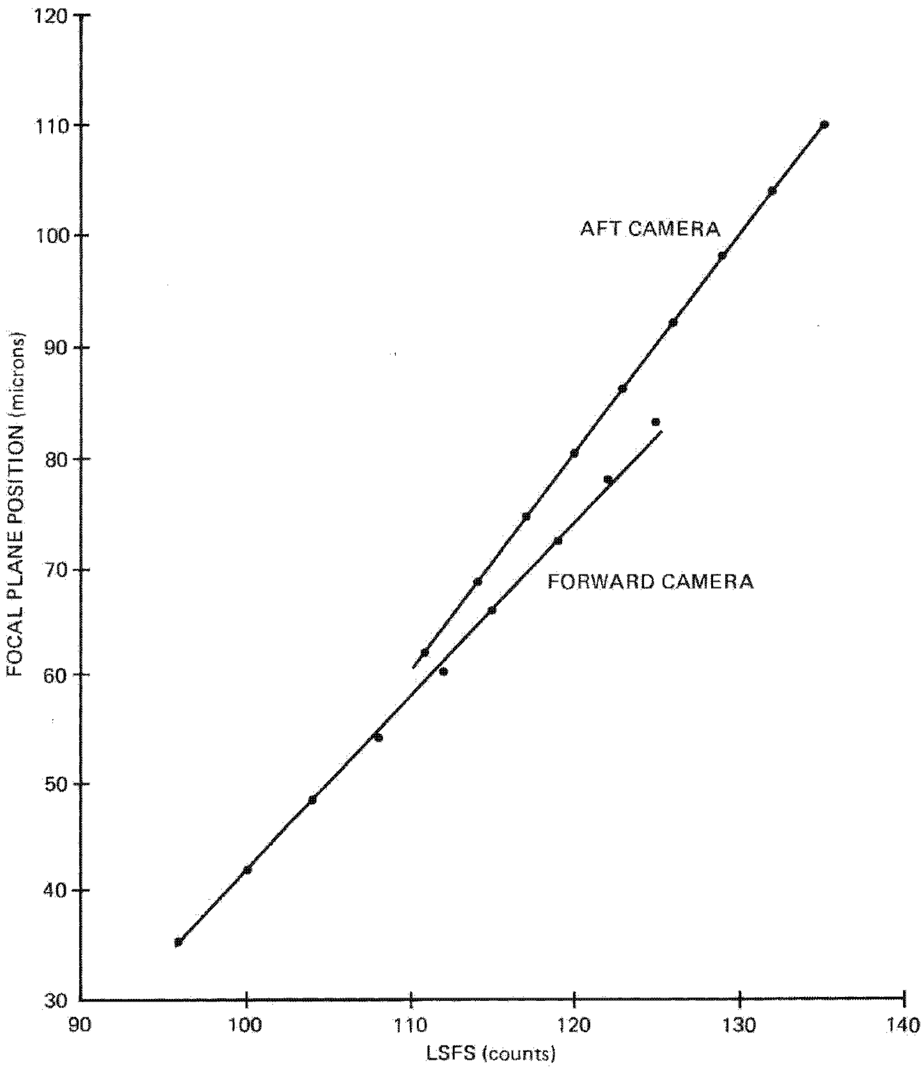

FIGURE 7-1

TABLE 7-4

CHAMBER A-1 OPTICAL BAR VELOCITY SCALING

DATA CALCULATED FROM 0° - 180° PULSES

(percent)

Sequence	Vx/h (rad/sec)	Forward Optical Bar Max %	Forward Optical Bar Min %	Aft Optical Bar Max %	Aft Optical Bar Min %
682-2	.044	.369	.297	.369	.297
682-3	.048	.413	.328	.413	.328
682-4	.052	.444	.344	.444	.344

7.7 METERING CAPSTAN (MC) TO OPTICAL BAR (OB) SYNCHRONIZATION

The Metering Capstan Summer Error (MCSE) signals and Film-to-Bar Synchronization (FBS) signals were used during WCFO testing to assess the expected photographic performance. Table 7-5 is a tabulation of the mean value and standard deviation of both signals obtained from the Chamber A-2 tests. The FBS signals (P451 and P452) follow the nominal expected profiles.

TABLE 7-5

CHAMBER A-2 FILM-TO-BAR SYNCHRONIZATION

(inch/second)

Seq	Scan Angle Length/Scan Center (degrees)	Vx/h (radians/second)	Parameter	Forward Camera MCSE	Forward Camera FBS	Aft Camera MCSE	Aft Camera FBS
M	90/0	.044	Mean	.009	.010	.009	-.001
			Std Dev	.023	.022	.020	.019
R	90/0	.052	Mean	-.003	.005	-.007	.005
			Std Dev	.022	.024	.018	.022

7.8 PLATEN PERFORMANCE

Table 7-6 presents the maximum, minimum, mean, and standard deviation for the platen photo mode summed error signal. All values are in arc-seconds using a scale factor of 98.7 arc-seconds per volt.

The data is based on three sequences from Chamber A-1 tests and is representative of the platen servo performance during WCFO testing. All of the recorded values are within the limits of ±26.9 arc-seconds.

TABLE 7-6

PLATEN PHOTO SUMMED ERRORS

(arc-seconds)

	Forward Camera		
Factor	Run 682-2	Run 682-3	Run 682-4
Maximum	11.7	13.7	13.7
Minimum	-11.8	-11.8	-11.8
Mean	-0.8	-1.3	-1.1
Std Dev	5.2	5.3	5.4
	Aft Camera		
Maximum	11.7	9.8	11.7
Minimum	11.8	-11.8	-11.8
Mean	0.9	0.9	0.7
Std Dev	6.1	6.3	6.3

7.9 FINE TENSION SENSOR PERFORMANCE

The differential fine tension sensors have been limit checked by MACFACT at ±0.1 pounds for all WCFO testing done on SV-11. The Forward and Aft Camera differential tension was always within tolerance.

7.10 FRAME LENGTH AND INTERFRAME SPACING

The EM data indicates that the frame lengths and interframe spaces meet the specified requirements. Measurements made on the retrieved film from tests indicated that the frame length and interframe spaces are within specified limits. Table 7-7 reflects frame length and interframe spacing data obtained from the horizontal baseline test.

7.11 STEERER PERFORMANCE

SV-11 Steerer performance has been satisfactory as indicated by telemetry during the WCFO test cycle. Rewinds of up to 76 inches/second were demonstrated during A-1 chamber testing and proper steering was observed.

7.12 METERING CAPSTAN SETTLING TIME

The settling times for both cameras were determined by examining the FBS signal for 10 frames during Chamber A-1 test runs 682-2, 682-3, and 682-4 from Sequence RX-1A. The results are summarized as follows:

A. Run 682-2 (Vx/h = .044)

(1) Forward Camera

The film-to-bar sync error was less than .05 ips by shutter open on all frames.

(2) Aft Camera

The film-to-bar sync error exceeded .05 ips by shutter open only on Frame 8 at the rate of .059 ips.

B. Run 682-3 (Vx/h = .048)

For both the Forward and Aft Cameras, the film-to-bar sync error was less than .05 ips by shutter open on all frames.

C. Run 682-4 (Vx/h = .052)

(1) Forward Camera

The film-to-bar sync error exceeded .05 ips by shutter open only on Frame 9 at the rate of .054 ips at .6° after shutter open.

TABLE 7-7

SUMMARY OF FRAME LENGTH AND INTERFRAME SPACING

(inches)

— Forward Camera —

Subsystem Command and Control	Seq	Scan Angle (degrees)	Frame Length	Interframe
No. 1	12-1	30	31.38	2.80
	11-1	60	62.76	2.98
	15	90	94.20	2.66
	11-2	120	125.65	2.91
No. 2	22-1	30	31.36	2.98
	21-1	60	62.76	3.03
	25	90	94.13	2.82
	21-2	120	125.63	2.96

— Aft Camera —

Subsystem Command and Control	Seq	Scan Angle (degrees)	Frame Length	Interframe
No. 1	12-1	30	31.33	2.71
	11-1	60	62.72	2.75
	15	90	94.27	2.70
	11-2	120	125.57	2.79
No. 2	22-1	30	31.32	2.69
	21-1	60	62.73	2.80
	25	90	94.74	2.71
	21-2	120	125.53	2.79

(2) Aft Camera

The film-to-bar sync error was less than .05 ips by shutter open on all frames.

7.13 METERING CAPSTAN FOURIER ANALYSIS

MACFACT results and SSTC strip charts show that the metering capstan summed error signal for both cameras contains relatively insignificant resonances throughout the Vx/h range from .044 to .054 radian/second. A special resonance test was performed during the horizontal pre-ship test. Both cameras contained relatively insignificant resonances throughout the Vx/h range from .0429 to .0375 radian/second. There are no Vx/h restrictions imposed on this flight. Fourier analyses were performed on three frames for each camera at a Vx/h of .0479 radian/second. Frames 13 thru 15 were taken with a scan length of 120° from A-1 chamber test run 682-3, Sequence RX-1A. Figures 7-2 and 7-3 show the MCSE signal and corresponding line spectrums for Frame 14 of both cameras.

MCRECON was run for each camera over the same frames used for Fourier Analysis. Figure 7-4 shows a typical FBS error plot for the Forward and Aft Cameras. These plots are comparable to those on SV-10.

7.14 AUGIE PERFORMANCE EVALUATION CRITERIA

The metering capstan summed errors, input and output fine tensions, optical bar summed errors, and platen photo summed errors are measurements that are limit checked in AUGIE. The limit check occurs only during the period when the shutter signal indicates open. The algorithm provides the limit check and out-puts all telemetry values that have a PCM count magnitude that falls outside the defined limits. The limits are established for each measurement and input to the AUGIE software during the pre-flight mode generation cycle. The following criteria was used to establish the limits for those performance evaluation parameters listed.

A. <u>Forward Camera Metering Capstan Summed Error (P403)</u>

The mean for P403 was derived from several 2A-2 test sequences. One hundred and sixteen PCM counts (2.30 volts) was selected as the most representative mean value. The mean shift as the result of changing variables in the test sequence (scan length, Vx, Vy, OOAA bias, etc.) was determined to be 2 PCM counts. The mean standard deviation for the representative test sequences was .021 inch/second. This results in a 3 sigma equivalent to .063 inch/second (5 PCM counts). Therefore, to set the limits for P403 in the AUGIE, the mean shift was added to the 3 sigma to obtain a 7 PCM count tolerance (.140 volts). See Table 7-8.

METERING CAPSTAN AND LINE SPECTRUM FROM FOURIER ANALYSIS
(Run 682, Forward Camera, Frame 014)

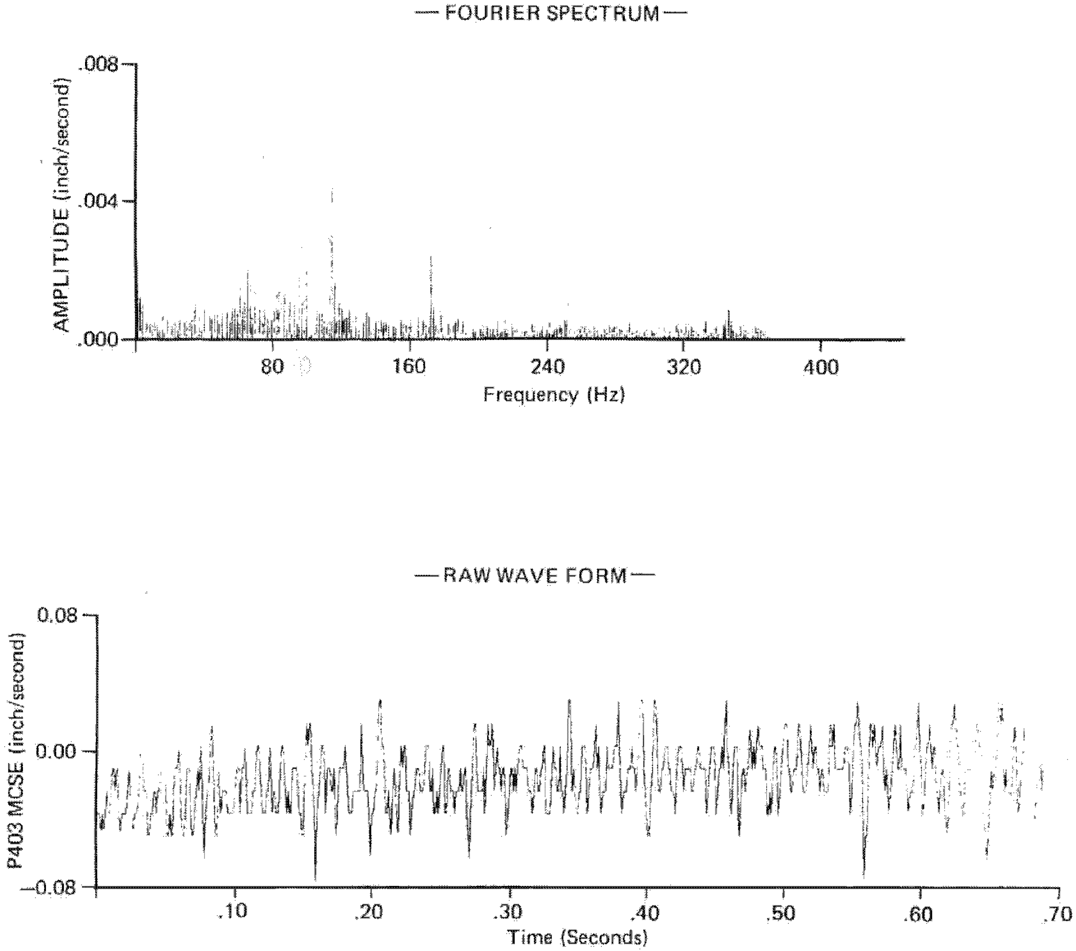

FIGURE 7-2

METERING CAPSTAN AND LINE SPECTRUM FROM FOURIER ANALYSIS
(Run 682, Aft Camera, Frame 014)

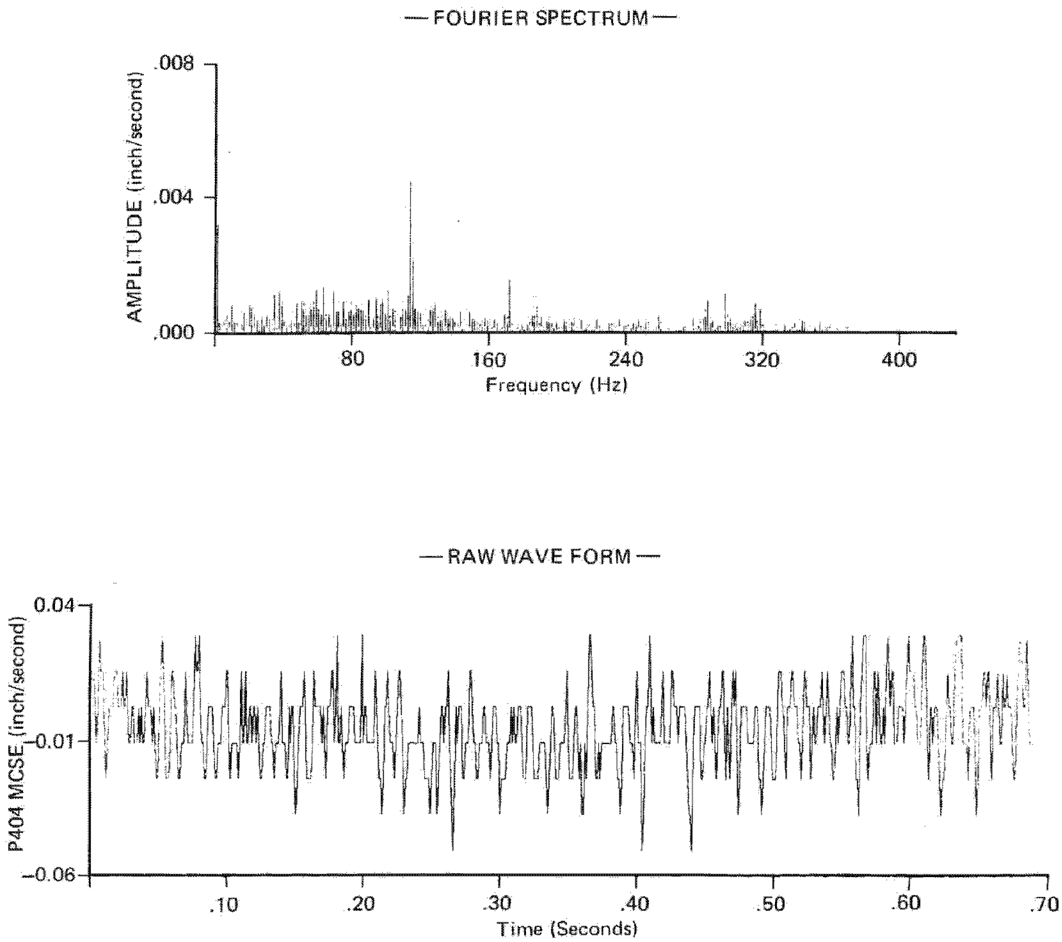

FIGURE 7-3

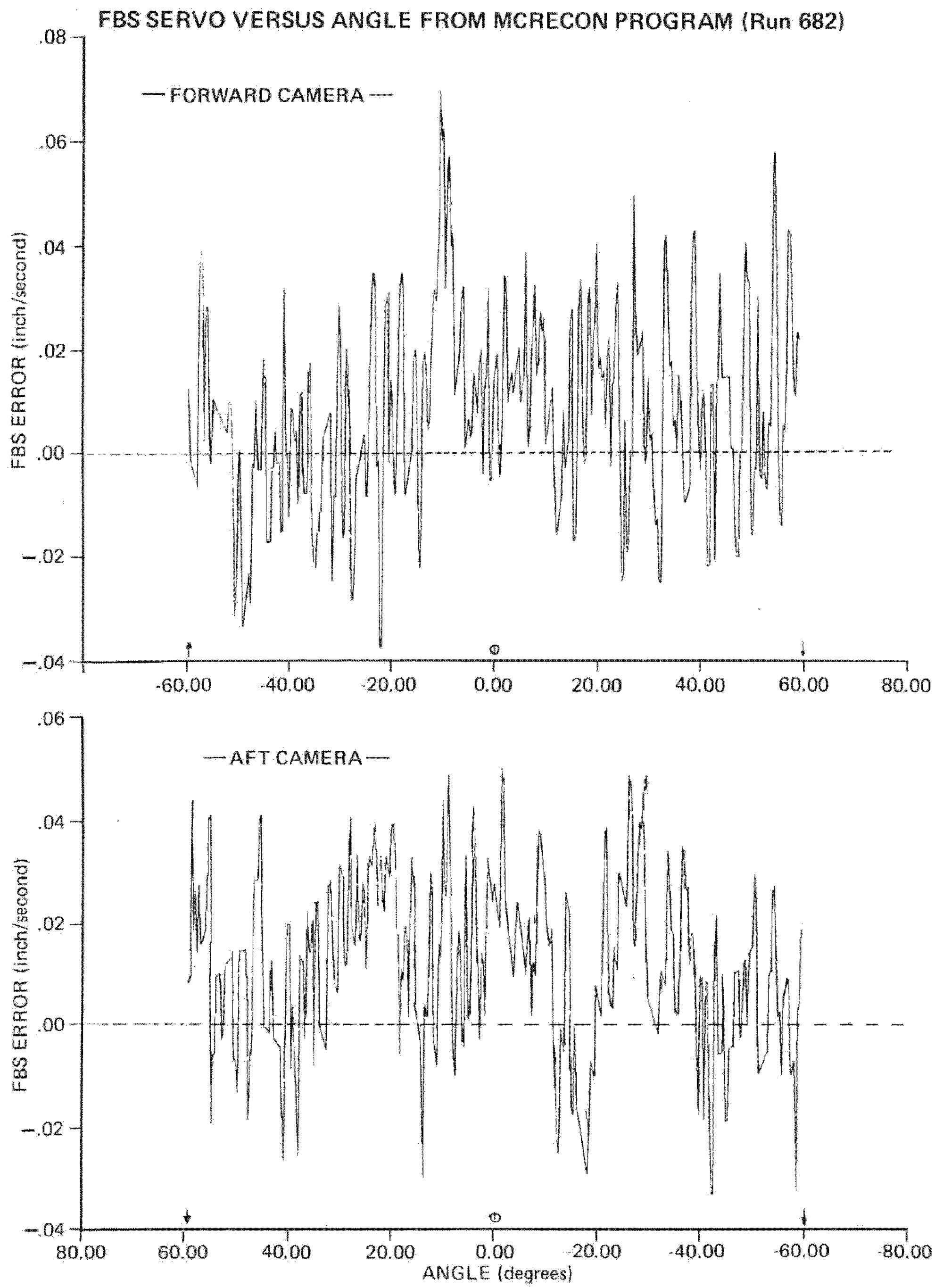
FBS SERVO VERSUS ANGLE FROM MCRECON PROGRAM (Run 682)
FORWARD CAMERA
FBS ERROR (inch/second)
.08
.06
.04
.02
.00
−.02
−.04
-60.00
-40.00
-20.00
0.00
20.00
40.00
60.00
80.00
AFT CAMERA
FBS ERROR (inch/second)
.06
.04
.02
.00
−.02
−.04
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
ANGLE (degrees)

FIGURE 7-4

TABLE 7-8

AUGIE ON-ORBIT SYSTEM CALIBRATION LOG

Parameter	Camera	Data Nominal		Tolerance		Nomenclature
		Volts	Eng Units	Volts	Eng Units	
Metering Capstan Summed Error	Fwd	2.30	0.0 in/sec	.140	.0933 in/sec	P403
	Aft	2.24	0.0 in/sec	.120	.0800 in/sec	P404
Input Fine Tension	Fwd	2.50	0.0 pounds	.280	.104 pounds	P703
	Aft	2.50	0.0 pounds	.280	.104 pounds	P708
Platen Photo Summed Error	Fwd	2.50	0.0 arc-sec	.260	25.7 arc-sec	P411
	Aft	2.50	0.0 arc-sec	.260	25.7 arc-sec	P412
Optical Bar Summed Error	Fwd	N/A	N/A	.240	1.0 lb-ft	P501
	Aft	N/A	N/A	.240	1.0 lb-ft	P502

Approved for Release: 2025/06/18 C05137289

B. Aft Camera Metering Capstan Summed Error (P404)

The mean for P404 was determined from the same test sequences used to compute the mean for P403. One hundred and thirteen PCM counts (2.24 volts) was selected as the most representative mean value. The mean shift for P404 as a result of changing test variables was determined to be 2 PCM counts. The mean standard deviation for the test sequences was .015 inch/second. This results in a 3 sigma equivalent to .045 inch/second (4 PCM counts). Therefore, to set the limits for P404 in the AUGIE, the mean shift was added to the 3 sigma to obtain a 6 PCM count tolerance (.120 volts). See Table 7-8.

C. Input and Output Fine Tension (P703, P704, P707, P708)

The reporting limits for the fine tensions were set so that any deviation of more than .104 pound from the 2.5 pound nominal would be reported. See Table 7-8.

D. Platen Photo Summed Error (P411, P412)

The mean for both the Forward and Aft Camera was determined to be 126 PCM counts (2.50 volts). The limits in AUGIE were set to the budgeted platen photo summed error tolerance. Test sequences from the Chamber A-2 showed that the performance was within the budgeted tolerance. See Table 7-8.

E. Optical Bar Summed Error (P501, P502)

The OB summed error signals were processed from camera power-on to camera power-off using a 12 PCM count rate algorithm. The tolerance of 12 PCM counts is approximately 1 pound-foot. See Table 7-8.

7.15 ON ORBIT ADJUSTMENT ASSEMBLY (OOAA)

The OOAA calibration tests consisted of 2A-2 Sequences U and V, in which skew commands of 0, ±5, ±10, and ±15 steps and Vf commands of 0, ±5, ±10, -15, and -20 steps were executed. The results of these modulation commands are summarized in Figures 7-5 thru 7-8 showing both nominal smear calculated from photographic measurements (FIDAP) and the FBS telemetry indications. This data has been used to adjust the FBS nominals in the computer programs which are used to evaluate flight FBS performance to bring them into agreement with FIDAP.

CHAMBER A-2, FORWARD CAMERA OOAA-ψ CALIBRATION

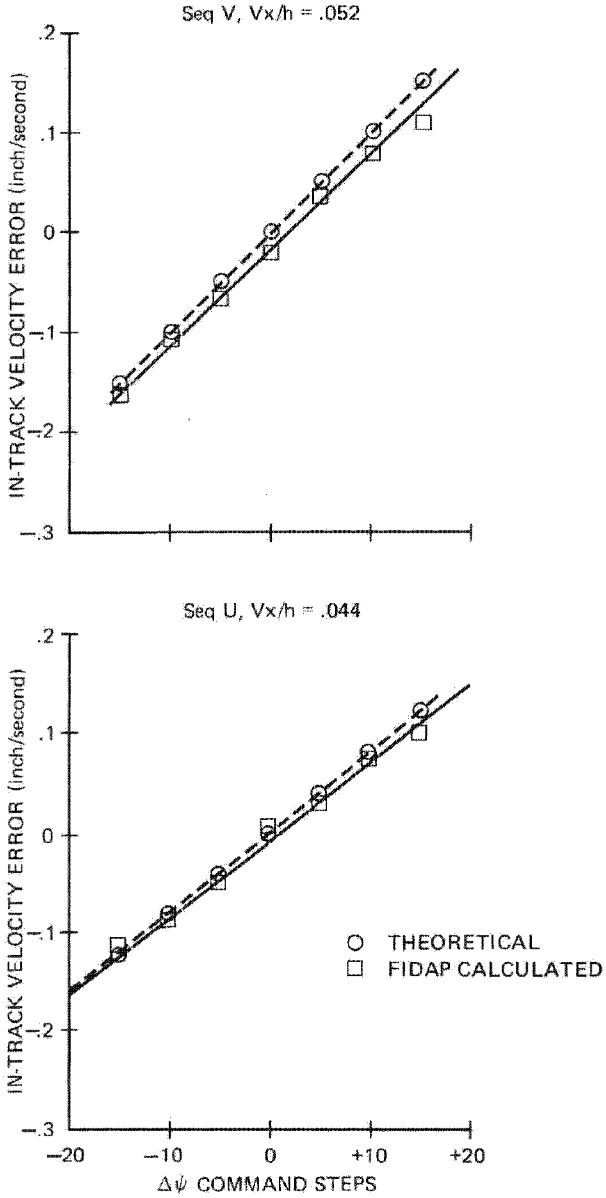

FIGURE 7-5

CHAMBER A-2, FORWARD CAMERA OOAA-FBS CALIBRATION

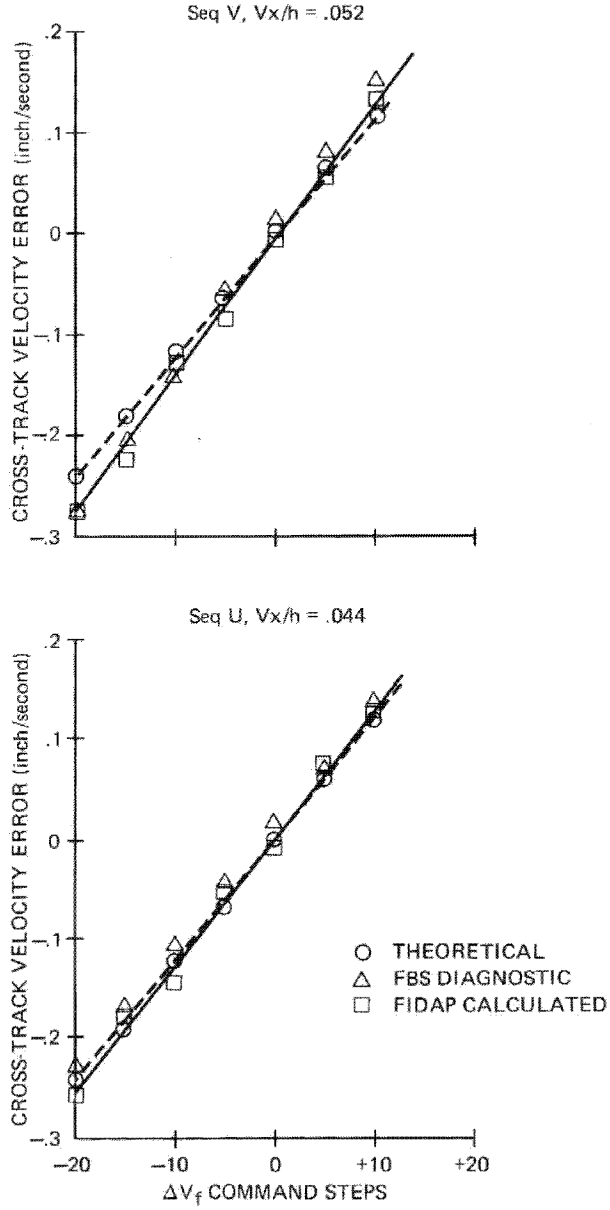

FIGURE 7-6

CHAMBER A-2, AFT CAMERA OOAA-ψ CALIBRATION

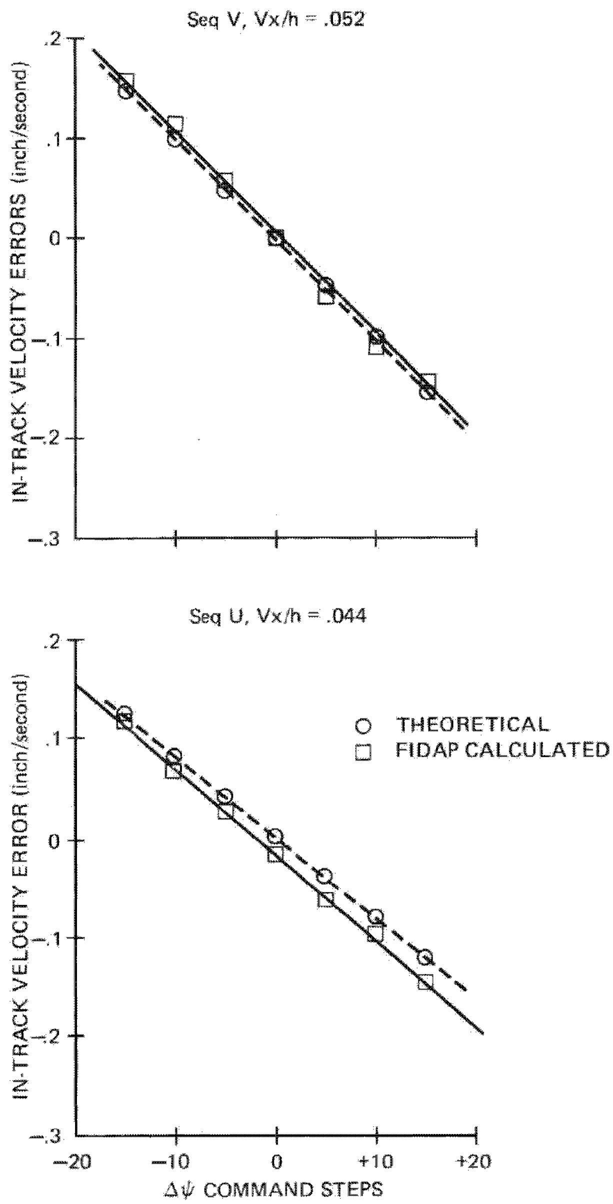

FIGURE 7-7

CHAMBER A-2, AFT CAMERA OOAA-FBS CALIBRATION

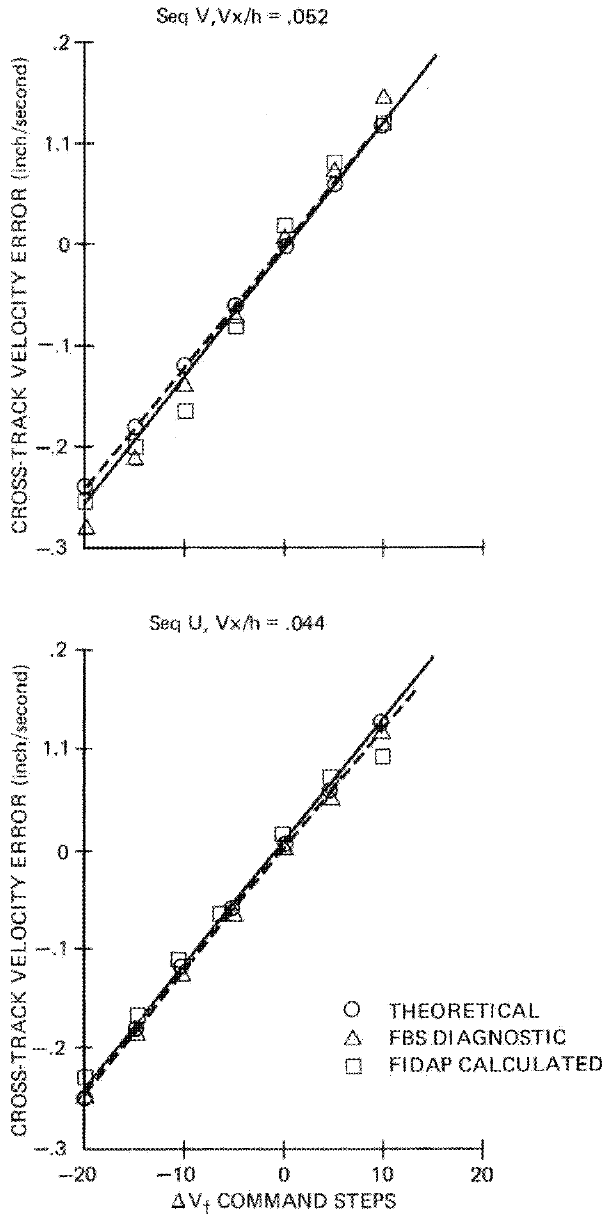

FIGURE 7-8

Reverse side blank

SECTION VIII

PHYSICAL CHARACTERISTICS

8-1 EVALUATION RESULTS

8.1.1 Film Markings

Material from both cameras was generally free of scratches and abrasions. There were characteristic static discharge marks and signatures of film path components. These were most notable in the last frames of each sequence and since their locations were predictable, they are believed to be caused by the rewind.

8.1.2 Ancillary Data

The format markings, including the scan angle, time track, SVT work, and start-of-frame/start-of-operation marks are bright and well within specified size. Only one extra SOF mark was noted and it was found in an interop space. All other marks were properly located. The time track marks are of good quality and suitable for film velocity mensurations.

8.1.3 Fine Film Path Tracking

Index dot-to-film edge tracking measurements from the Chamber A-1 material were made on nearly all scan mode/scan center combinations using various Vx/h values and rewind constants.

The test runs showed tracking variations on the Forward Camera from 0.9 mm to 2.3 mm from the film edge and had an average value of 1.6 mm. The Aft Camera dots showed a tracking variation from 1.7 mm to 2.6 mm with an average value of 2.2 mm.

Measurements were made on several test runs from the Chamber A-2 test material on Frames 001-010 and 101-110. The purpose of these measurements is to verify whether there were any beginning-of-operation tracking disturbances caused by film start-up. While there is some evidence of this on the Forward Camera in the 30° mode, it is not unusual following a rewind constant (RWC) of -25 inches/second, see Table 8-1. The results did not show a significant difference from the Chamber A-1 tracking data. Unfortunately, the Chamber A-2 test does not give the opportunity to measure many scan mode/scan center/Vx/h combinations and all RWCs are the same. The Horizontal Preship Test has a more complete set of these combinations and the tracking data from this test are presented in Table 8-2. A comparison of the Horizontal Preship tracking data with that of past systems is shown in Table 8-3. A Forward and Aft Camera milestone tracking summary is shown in Figures 8-1 and 8-2. This computer generated summary is at the same scale as the summary plots performed at the PFA following RV recovery, so direct comparisons between test and flight data are possible.

8-2 CONCLUSIONS

A. Both cameras exhibited minor electrostatic discharge and roller marks.

B. All format ancillary data are of proper size, density, and location.

C. The tracking is stable throughout all runs tested. Neither camera shows any tracking problems associated with start-of-operations.

TABLE 8-1

FILM TRACKING MEASUREMENTS

(millimeters)

	Scan Angle/Scan Center (degrees)					
	Forward Camera			Aft Camera		
	30/0	30/0	90/0	30/0	30/0	90/0
Vx/h:	.052	.044	.052	.044	.044	.042
FRAME						
1	1.6	1.9	1.9	2.0	2.6	2.2
2	1.0	0.9	1.6	2.2	2.4	2.1
3	0.9	1.1	1.9	2.2	2.4	2.1
4	1.2	1.8	1.7	2.0	2.4	2.2
5	1.4	1.8	1.6	2.0	2.4	2.4
6	1.5	1.6	1.7	2.1	2.4	2.1
7	1.4	1.7	1.6	2.2	2.4	2.3
8	1.5	1.6	1.8	2.1	2.6	2.1
9	1.5	1.8	1.6	2.2	2.4	2.3
10	1.5	2.0	1.6	2.3	2.5	2.1
101	1.6	1.6	1.6	2.3	2.4	2.1
102	1.6	1.8	1.6	2.3	2.6	2.0
103	1.7	1.7	1.5	2.3	2.6	2.2
104	1.8	1.8	1.6	2.3	2.7	2.2
105	1.8	1.9	1.7	2.2	2.7	2.2
106	1.7	1.8	1.6	2.2	2.6	2.2
107	1.6	1.9	1.6	2.2	2.5	2.2
108	1.6	1.8	1.6	2.4	2.4	2.2
109	1.6	2.0	1.6	2.5	2.6	2.1
110	1.6	1.9	1.5	2.3	2.6	2.2
Average	1.5	1.7	1.6	2.2	2.5	2.2

TABLE 8-2

TRACKING DATA FROM HORIZONTAL PRESHIP TEST

—Forward Camera—

SSC	Seq.	SA/SC (degrees)	Vx/h	No. of Frames	RWC (ips)	Tracking (mm) Max	Min	Avg
1	12-1	20/20	.044	6	-22	1.8	1.5	1.6
1	12-2	60/15	.028	7	- 5	1.8	1.2	1.6
1	13	120/0	.052	8	None	2.0	1.7	1.9
1	15	90/-15	.052	5	None	1.9	1.7	1.8
2	25	90/-15	.052	5	None	2.0	1.6	1.8
2	23	120/0	.052	8	None	2.1	1.8	1.9
2	22-1	30/30	.044	6	-22	2.0	1.4	1.6
2	22-2	60/15	.028	7	- 5	1.9	1.4	1.7
2	24	60/0	.044	6	- 5	2.0	1.6	1.7

—Aft Camera—

SSC	Seq.	SA/SC (degrees)	Vx/h	No. of Frames	RWC (ips)	Tracking (mm) Max	Min	Avg
1	12-1	30/30	.044	6	-22	2.2	1.8	2.0
1	12-2	60/15	.028	4	- 5	2.3	2.0	2.2
1	13	120/0	.052	8	None	1.6	1.3	1.5
1	15	90/-15	.052	5	None	1.9	1.6	1.7
2	25	90/-15	.052	5	None	1.7	1.6	1.6
2	23	120/0	.052	8	None	1.7	1.3	1.5
2	22-1	30/30	.044	6	-22	2.1	1.6	1.9
2	22-2	60/15	.028	4	- 5	2.3	2.1	2.2
2	24	60/0	.044	6	- 5	2.3	1.7	2.0

TABLE 8-3

TRACKING COMPARISON OF RECENT SYSTEMS

AS MEASURED IN THE HORIZONTAL PRESHIP TEST

(millimeters)

—Forward Camera—

	Scan Angle/Scan Center (degrees)								
SYSTEM	30/30	60/15	90/-15	30/30	60/15	90/-15	120/0	120/0	Average
SV-3	2.2	1.9	2.0	2.6	2.0	1.9	1.8	1.9	2.0
SV-4	3.0	3.1	2.0	2.6	2.8	2.0	2.8	2.0	2.5
SV-5	2.3	2.3	2.5	2.4	2.4	2.4	2.6	2.5	2.4
SV-6	1.9	1.7	2.6	2.1	1.7	2.5	2.8	2.8	2.2
SV-7	2.4	2.4	N/A	1.9	2.3	N/A	1.8	1.8	2.1
SV-8	N/A	2.3	2.1	2.0	2.1	2.0	2.1	2.1	2.1
SV-9	1.8	2.0	2.0	2.4	2.1	2.2	1.9	1.8	2.0
SV-10	1.9	1.8	1.9	1.6	1.9	2.0	1.9	1.9	1.9
SV-11	1.6	1.6	1.8	1.6	1.7	1.8	1.9	1.9	1.7
				—Aft Camera—					
SV-3	3.4	2.0	2.8	3.0	2.8	2.4	2.2	2.4	2.6
SV-4	3.3	3.1	2.6	3.0	3.1	2.6	2.8	2.8	2.9
SV-5	1.7	3.0	1.2	1.7	2.7	0.9	1.6	2.0	1.9
SV-6	2.2	2.1	2.1	1.9	2.0	1.9	1.5	1.5	1.9
SV-7	2.4	2.4	N/A	2.5	2.3	N/A	2.3	2.3	2.4
SV-8	N/A	2.5	2.0	2.0	2.6	2.0	2.1	2.0	2.1
SV-9	3.3	3.4	3.4	3.2	3.5	3.5	3.3	3.4	3.4
SV-10	2.8	2.5	2.3	3.0	2.3	2.2	2.3	2.3	2.5
SV-11	2.0	2.2	1.7	1.9	2.2	1.6	1.5	1.5	1.8

NOTE: These measurements are averages of all frames in the sequence as measured from the film edge to the center of the SVT index dots.

SUMMARY OF FORWARD CAMERA MILESTONE TRACKING

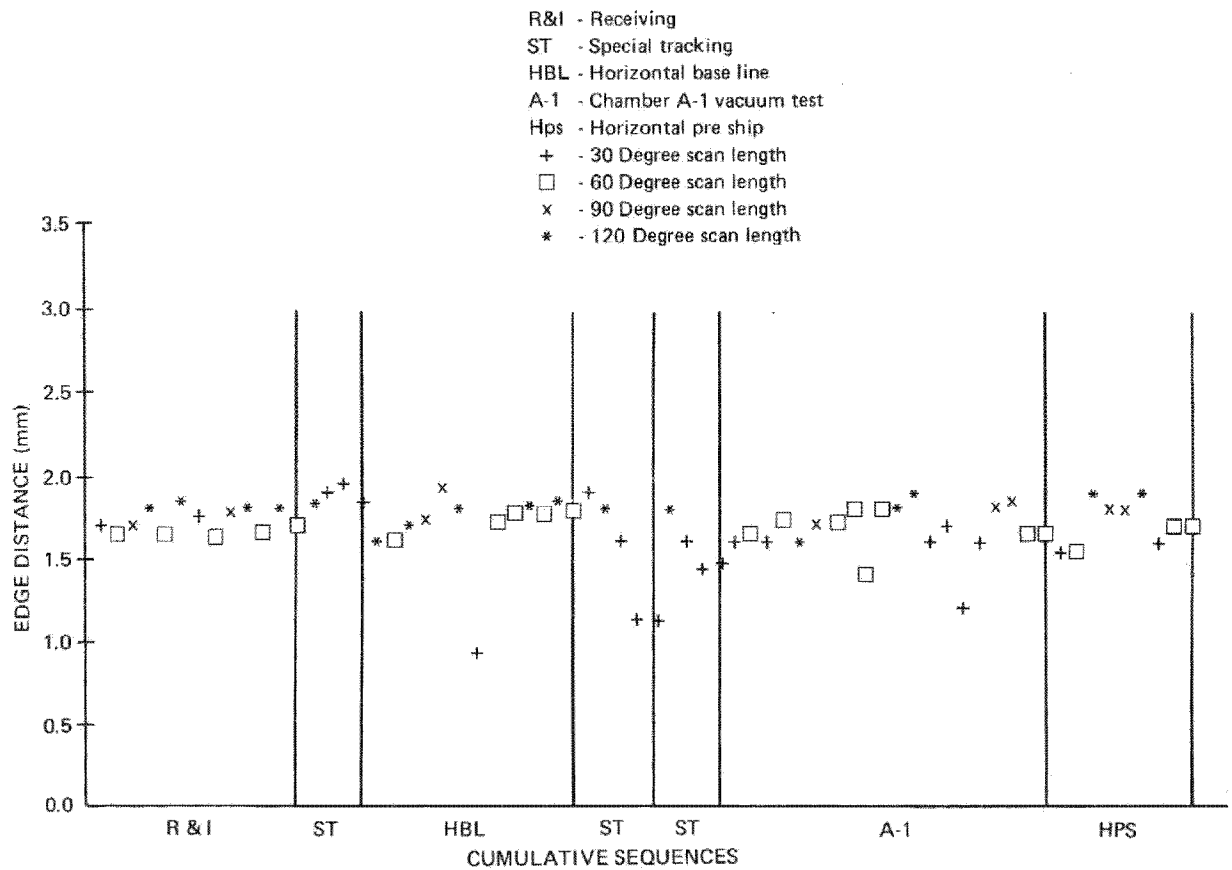

FIGURE 8-1

SUMMARY OF AFT CAMERA MILESTONE TRACKING

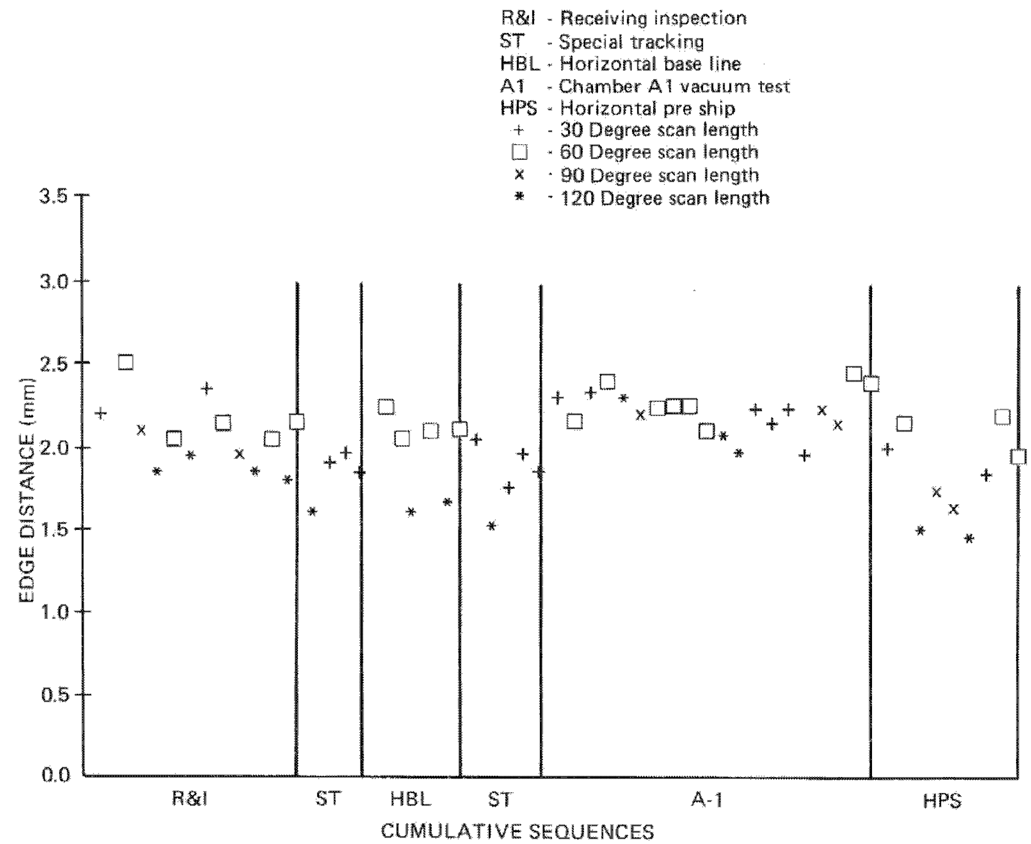

FIGURE 8-2

Reverse side blank