~~TOP SECRET-HEXAGON~~

HEXAGON SENSOR SUBSYSTEM

SV-8 (SN-011)

FLIGHT READINESS REPORT

FEBRUARY 1974

This report consists of 103 pages.

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FLIGHT READINESS REPORT
SV-8 (SN-011)

PUBLICATION REVIEW

This report has been reviewed and is approved.

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FOREWORD

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

The preparation, collection, and reduction of the data contained within were accomplished by the Air Force Special Projects Production Facility, Westover Air Force Base, Massachusetts. We are indebted for the continued excellent support provided by Colonel Clark E. Davison, Commander, and his staff.

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SECTION I

INTRODUCTION

1.1 SUMMARY

Flight focus should be set at 68 microns and 25 microns for the Forward and Aft Cameras respectively for 1414 Film. In addition to 1414, the Aft Camera contains both conventional Color (SO-255) and Infrared (FE-3916) Films. When using SO-255 and FE-3916 Films, the Aft Camera should be set at 55 microns. 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
	Cross-Track (inch/second)	-.002	.015
	In-Track (inch/second)	.013	.024
1414 Film			
	PBF (microns)	72	34
	Peak Resolution (cycles/mm)	192	200
	Cross-Track (inch/second)	-.014	-.006
	In-Track (inch/second)	.007	.022
SO-255 Film			
	PBF (microns)	114	69
	Peak Resolution (cycles/mm)	121	104
Inter Test Events			
	Servo Inhibit Assembly (SIA) Retrofit		
	SCC Box Replaced (13A1)		
	OOAA Box Replaced (1A7)		
	Aft Camera 3A1-2 Output Drive Servo Replaced		
	PDS 14A1 Refurbished		
	Four inch roller preload retrofit		
A-2 Test			
1414 Film	Cross-Track (inch/second)	-.019	.039
1414 Film	In-Track (inch/second)	.034	.033
1414 Film	PBF (microns)	68	25
1414 Film	Peak Resolution (cycles/mm)	194	185

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. Mean smear cross-track data for SO-255 Color Film from Chamber A is the residual after a .200 inch/second decrease in film speed correction was made for both the Forward and Aft Cameras.

3. All best focus (PBF) data is based on tribar data.

4. The Aft Camera will be launched with a mixed load of 1414, SO-255, and IR Films.

5. Chamber A focus data is normalized for infinity focus.

OOAA adjustments recommended for flight are summarized in Table 1-2.

TABLE 1-2

RECOMMENDED OOAA ADJUSTMENTS

(counts)

Motion Component	Film Type	Forward Camera	Aft Camera
In-Track	1414	-4	-2
Cross-Track	1414	1	-3
Cross-Track	SO-255/FE-3916	N/A	-17

1.2 SYSTEM IMPROVEMENTS

The following lists the improvements and changes on SV-8:

A. The Servo Inhibit Assembly (SIA) has been incorporated on all systems effective with SV-8. The SIA inhibits the drive servos from dithering when the RPG is at pause. The SIA function is commandable as follows:

(1) Reset, inhibit the servos at pause.

(2) Override, does not inhibit the servos at pause.

B. The metering capstan settling time improvement was incorporated for the first time on SV-8. This change decreases the FBS error which existed in the first few degrees of photo mode on previous systems. The improvement was achieved by modifying the optical bar, drive capstan, and metering capstan servos. In addition, the MCSE signal resonance, characteristic of previous systems, was shifted and attenuated.

C. The Supply Unit Fences improvement prevents the Supply stack from telescoping during rewind operations.

D. The Supply Unit Accelerometers modification. This change consisted of removing the two vibration sensors from the Supply reel of SV-8. These were the same type of vibration sensors which were mounted on the Supply reel of SV-7.

1.3 AREAS OF CONCERN

The assembly and testing cycle of SV-8 (SN-011) at SVIC was accomplished without any major incidents. There were some anomalies which should be noted. None of the following concerns are significant enough to preclude the launching of SV-8, nor should they impact the system's optical performance.

1.3.1 Ground Test Skin Current

The design improvement that provided Backup Film Transport-Off with Camera Power-Off inadvertently interconnects vehicle ground point to SSTC ground when the SSTC ESD is activated. The interconnection of these ground sources resulted in a 100 milli-amp skin current on the vehicle. The skin current is the result of a design error which does not affect the electrical ground isolation of the flight configuration. For this reason, the Government will use as is.

1.3.2 Improper Command Sequence ESDs

During Chamber A-1 testing at SVIC, the SS had two emergency shutdowns (ESDs) that were caused by improper command sequences. The ESDs resulted in non-uniform stacking of the film on the Take-up. When the film was retrieved, the off-stacking caused ripping, tearing, and finally, complete separation of the film. Inspections and tests subsequent to the ESDs indicated no damage to the Sensor System; therefore, the Government will use as is.

1.3.3 Chamber A-1 Contamination

During Chamber A-1 testing, outgassing of some substance occurred. The specific contaminant (Dimethyl Terephthalate) has been identified and is not injurious to the optical coatings. The quantity of contaminant was about one fourth that found on SV-7. Based on the successful performance of 1207, the Government will use as is.

1.3.4 Film Drive Dither

During a constant velocity run after Chamber A-2 testing, the input and output film drive summed error dithered for about .5 second at 23 cycles. The dither occurred just before ramp-down. Because this dither occurred only once and then just before ramp-down, the Government will use as is.

1.3.5 Platen Tilt

The initial evaluation of the Chamber A-2 Forward Camera data indicated a need for 13 to 20 microns of tilt across the slit. Chamber A data from SSC indicated no need for tilt. The concern is that in the past four SVs, Chamber A-2 testing has indicated a need for additional tilt on the Forward side. The orbital data for these four SVs has not supported the tilt indication based on Chamber A-2 data. The Government is therefore concerned about any tilt indications, especially on the Forward side, arising from Chamber A-2 testing. The Government and SSC are currently studying the collimator configuration to determine if there is any problem inherent in the collimator design or implementation.

1.3.6 Fluted Film

The 47' closest to the TU core showed fluted edges on both sides after Chamber A-1 testing. The edges of the film were not nicked, broken, or torn. The fluting appeared to be caused by the pulling of film at high tension over a sharp edge. The damage occurred simultaneously on both sides of the film. The pattern of damage is not typical of Sensor Subsystem film damage, but appears to be a manufacturing defect. For this reason, the Government will use as is.

1.3.7 Motor Encoder Phasing Test

A special Motor/Encloder Phasing Test was run on TUA-021A at SSC/WCFO to determine if a potential stator winding separation from the core existed. This potential problem was identified on TUA-026A.

The Motor/Encoder Phasing Test in the field was devised for recycled/refurbished TUAs to stress the epoxy bond between the stator winding and core in both rotational directions to determine the presence of a shift in the motor/encoder phase relationship.

The test indicated no evidence of a shift in the motor/encoder phase relationship to TUA-021A. Based on the test results and a worst case analysis, it was concluded by the Government that TUA-021A is satisfactory for flight.

1.3.8 Contamination

Contamination continues to be a concern even though this system has not experienced any anomalies directly resulting from contamination.

All cleaning techniques and preventative measures previously used were incorporated in this system. The final RV and TUA inspection process has been modified because a connector dust cap was recovered in the 1207-3 RV. These modified procedures resulted in finding a small piece of lens tissue, a 1/4" long piece of safety wire, and a connector dust cap in RV-4.

1.4 WCFO FACTORY TEST FLOW

The overall test flow for SV-8 at WCFO is shown in Figure 1-1. The following paragraphs provide brief descriptions of the activities during each of the major tests. Table 1-3 provides the schedule information for the factory flow.

ASSEMBLY AND TEST FLOW AT SVIC

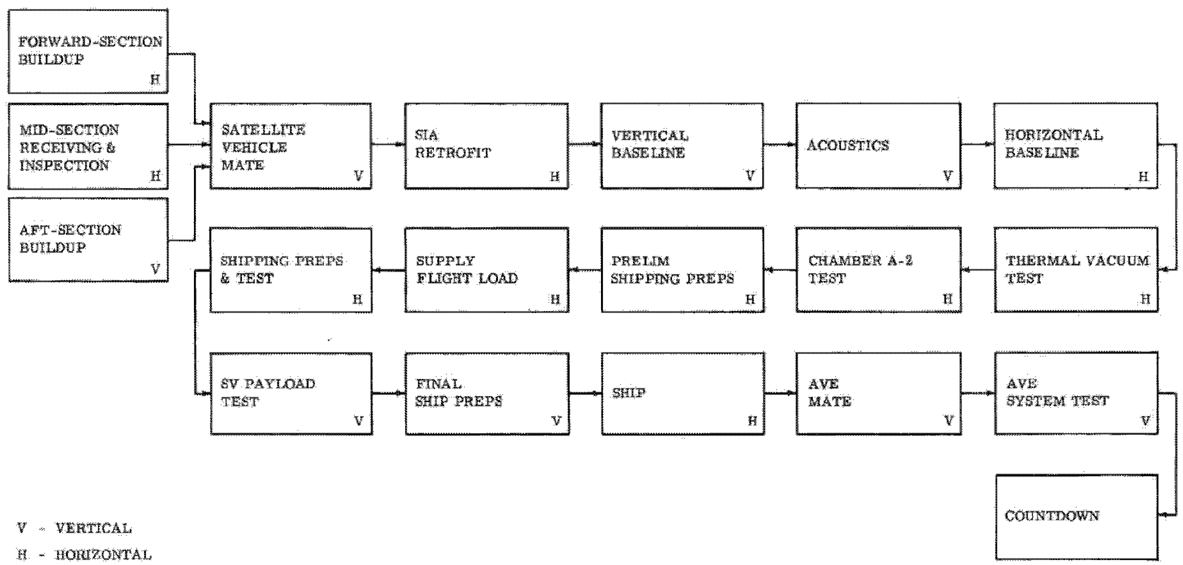


FIGURE 1-1

TABLE 1-3

SV-8 MILESTONE SCHEDULE

	Activity	Date Completed
1.	Mid-section R&I	25 April 1973
2.	Forward-section Buildup	27 June 1973
3.	SV Mate	9 July 1973
4.	Vertical Baseline	10 September 1973
5.	Acoustic Test	21 September 1973
6.	Horizontal Baseline	26 September 1973
7.	Chamber A Test	24 October 1973
8.	Chamber A-2 Test	3 November 1973
9.	Preliminary Shipping Preparation	7 January 1974
10.	Final Shipping Preparation	28 January 1974
11.	Ship	27 February 1974
12.	AVE Mate	27 February 1974
13.	AVE Systems Test	3 March 1974
14.	Countdown	13 March 1974

NOTE: Items 9-14 show projected dates for completion of those activities.

1.4.1 Forward-section Buildup

Buildup and testing were completed on 27 June 1973. During functional testing of the Forward-section film path the carriage position TM of the Aft Steerer was observed to be noisy. Replacement of the Carriage Pot Assembly resolved this problem. Take-up No. 29 (Position No. 2) was replaced with Take-up No. 21A. This replacement was due to a failure of the Aft Camera brake during the wrap-cut-wrap sequence into Position 3. Retest of Take-up 21A was performed satisfactorily.

1.4.2 Mid-section Receiving and Inspection

The Mid-section was received at the West Coast Facility on 16 January 1973. The period from 16 January thru 12 March was devoted to SBAC R&I assembly work. The SSC R&I testing commenced on 16 March 1973 and was concluded on 30 March. Data analysis revealed a DC offset on the Aft Camera FBS signal (P-452). The problem was traced to a broken wire in cable 2W173, P13. The cable was repaired and verification of this fix was completed on 12 April 1973.

The Mid-section was placed in vertical storage on 1 May 1973 awaiting the availability of its Aft-section.

1.4.3 Satellite Vehicle Mate

The mechanical mating of the Mid-section and Forward-section was completed on 9 July 1973. No problems were encountered.

1.4.4 Servo Inhibit Assembly (SIA) Retrofit & Retest

Due to an ECS failure during the SBA test, it was decided to move the vehicle to the R&I area for performance of the SIA retrofit. During the post retrofit confidence test, it was discovered that the SU brake verify signals were shorted together in the SCC Box.

The vehicle was returned to the VIS on 31 August 1973.

1.4.5 Vertical Baseline Test

The SCC Box (SN-1011) was replaced with SN-1017 from SV-9 prior to performance of the Vertical Baseline Test, which was completed 10 September 1973. Data analysis revealed an offset in the Forward Camera Airborne FBS signal which subsequently resulted in the replacement of the OOAA Box.

1.4.6 Acoustic Environment

The vehicle was erected in the Acoustics Chamber on 20 September 1973 and subjected to the acoustic environment on 21 September 1973. No problems were encountered.

1.4.7 Horizontal Baseline Test

The Horizontal Baseline Test was completed on 26 September 1973. A twisted quad ring in the Looper A cover caused a failure of the film path pneumatic leak test. The ring was replaced and retest of the film path was successful.

1.4.8 Thermal Vacuum Chamber Test

The vehicle was installed in Chamber A-1 for the first time on 8 October 1973. Leaks in the chamber required removal of the vehicle for welding of the chamber wall. The chamber testing was completed on 24 October 1973. Two command timing errors in nested pair sequences resulted in ESDs to the Sensor System. Subsequent testing and investigations revealed no degradation to the hardware resulting from either of these occurrences.

1.4.9 Chamber A-2 Photographic Tests

The Chamber A-2 in-air tests were completed on 29 October 1973. Pumpdown began 31 October 1973. Vacuum and post vacuum runs were completed 3 November 1973. No significant data anomalies were encountered during this test.

Table 1-4 lists the hardware changes at the SVIC Facility.

TABLE 1-4

HARDWARE CHANGES AT SVIC FACILITY

CHANGE	DATE	REASON	REVERIFICATION
1. TUA-029, AFT (MR 64420).	6/15/73	AFT BRAKE SEIZED.	FEWO T21A-002 TUA-021A WAS REPLACEMENT FOR TUA-029.
2. CARRIAGE POT (AFT OR ACTIVE MECHANICAL ART STEERER 5102) (MR 64377).	4/18/73	AFT CARRIAGE POT SIGNAL EXTREMELY NOISY.	FEWO FAK 8-012.
3. FS CABLE 3W160 CONNECTOR P3 (MR 64322).	2/23/73	PIN NO. 73 RECESSED.	RETEST PER FTI-WVT-10016.
4. ART SN 5101 AFT ENC (MR 64326).	2/23/73	"R" ALIGNMENT W/ CHUTE IS OUT-OF-SPECIFICATION.	FTI-WVT-10015 REALIGNMENT CHECK.
5. TUA-045, AFT "R" E/O (MR 64347).	3/29/73	SPIN DOWN TESTS OUT-OF-SPECIFICATION.	FEWO T45-004.
6. TUA-045, FWD & AFT, A-15 ELECTRONICS.	5/23/73	REPLACE PER RETROFIT TUA-026, REV A.	FEWO T45-009.
7. TUA-045 AFT DRIVE ASSEMBLY.	6/1/73	CONFIGURATION CHANGE PER RETROFIT SV8-1.	FEWO T45-008.
8. TUA-045A, FWD, CH A-2 ELECTRONICS (MR 64408).	5/30/73	RESISTANCE READINGS OUT-OF-SPECIFICATION.	FEWO T45-010.
9. TUA-044 D/O SOLENOID ASSY-RETROFIT TUA-022A, FWD & AFT.	2/19/73	ECO 9542.	FORWARD-SECTION BUILDUP.
10. TUA-044, FWD C/A "R" MR.	3/15/73	EXCESSIVE SPIN-DOWN.	FEWO T44-008.
11. TUA-044, AFT "R" O/E MR.	3/15/73	BAD NICK IN ONE END.	FEWO T44-010.
12. TUA-044, FWD & AFT A-15 ELECTRONICS RETROFIT TUA-026A.	5/14/73	ECO 8402 & 9846.	FEWO T44-013.

TABLE 1-4 (CONT'D)

CHANGE	DATE	REASON	REVERIFICATION
13. TUA-044, FWD & AFT DRIVE ASSEMBLY RETROFIT SV8-1.	6/1/73	ECO 10150.	FORWARD-SECTION BUILDUP.
14. TUA-042, FWD & AFT D/O PIN ASSEMBLY RETROFIT TUA-022A.	1/24/73	ECO 9542.	FORWARD-SECTION BUILDUP.
15. TUA-042, FWD & AFT A-15 ELECTRONICS RETROFIT TUA-026A.	5/21/73	ECO 10427, 10145 & 10515.	FEWO T42-014.
16. TUA-042 DRIVE ASSEMBLIES.	6/1/73	ECO 10150.	FORWARD-SECTION BUILDUP.
17. 14A1 PDS.	5/19/73	REFURBISH PLAN (PILOT MSG 0640).	FEWO SV8-009.
18. 13A1 SCC (MR 64471).	9/5/73	SU BRAKE REL VERIFY ON FWD & AFT REGARDLESS OF MODE.	FEWO-SV8-017.
19. 14A1 PDS.	9/28/73	REFURBISH PLAN PM-613.	FEWO SV8-020.
20. 1A7 OOAA (MR 64501).	10/2/73	FBS-A PROBLEM.	FEWO SV8-022.
21. 3A1-2 D AFT SER OUT (MR 64529).	11/7/73	OPERATION ANOMALOUS DURING CREEP SEQ.	HORIZONTAL PRE-SHIP.
22. 3A1 D AFT SER OUT (MR 64529).	11/29/73	WRONG CONFIGURATION. ITEM 21 WAS AN INTERIM FIX ONLY.	HORIZONTAL PRE-SHIP.
23. 4" ROLLER PRELOAD.	11/19/73	RETROFIT SV8-5.	SU UPLOAD.
24. SUPPLY CAGE MECHANISM.	11/19/73	RETROFIT SV8-6.	SU UPLOAD.

NOTE: TUA-021A is a refurbished unit and replaced TUA-029. There have been no changes to TUA-021A since it was technically certified by the customer.

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-8 was subjected to one Chamber A-2 test. The details of this test are discussed in Sections IV and V of this report.

A description of the standard sequences run in Chamber A-2 is presented in Table 2-1.

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 image motion compensation (IMC) must be disabled from the flight configuration. This necessitates a configuration change; therefore, it is necessary to reverify system operation in the final flight 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 condition.

This system is equipped with in-flight changeable filters on both cameras. A special test was run to determine the repeatability of the filter response to position commands.

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.

TABLE 2-1

CHAMBER A-2 TEST SEQUENCES

Run	Seq	Vx/h (rad/sec)	Slit Width (inches)	Pitch Angle (degrees)	Scan Angle (degrees)	Scan Center (degrees)	Frames	IMC	Illumination
26	K	.052	.303	-1.0	30	0	144	Dis	Continuous
29	K	.052	.303	-2.0	30	0	144	Dis	Continuous
30	K	.052	.303	-2.5	30	0	144	Dis	Continuous
37	H	.052	.303	2.0	90	0	144	Dis	Continuous
38	K	.052	.303	2.5	30	0	144	Dis	Continuous
34	H	.052	.303	1.0	90	0	144	Dis	Continuous
42	H	.052	.303	0	90	0	144	Dis	Continuous
43	G	.044	.525	0	90	0	144	Dis	Continuous
46	L	.044	.259	0	90	0	53	Dis	Continuous
45	C	.036	.910	0	90	0	10	Dis	Continuous
47	W	.044	.910	0	90	0	104	Ena	Flash
48	Q	.036	.910	0	90	0	33	Ena	Flash
49	V	.052	.910	0	90	0	104	Ena	Flash
51	JA	.052	.615	0	60	15	144	Dis	Continuous
52	JB	.052	.615	0	60	-15	143	Dis	Continuous
53	F	.036	.205	0	90	0	184	Dis	Continuous
59	M	.044	.910	0	90	0	23	Ena	Flash
60	R	.052	.910	0	90	0	33	Ena	Flash
61	R	.052	.910	0	90	0	33	Ena	Flash
62	Q	.036	.910	0	90	0	33	Ena	Flash
63	M	.052	.910	0	90	0	23	Ena	Flash

CHAMBER A-2 TARGET RETICLE

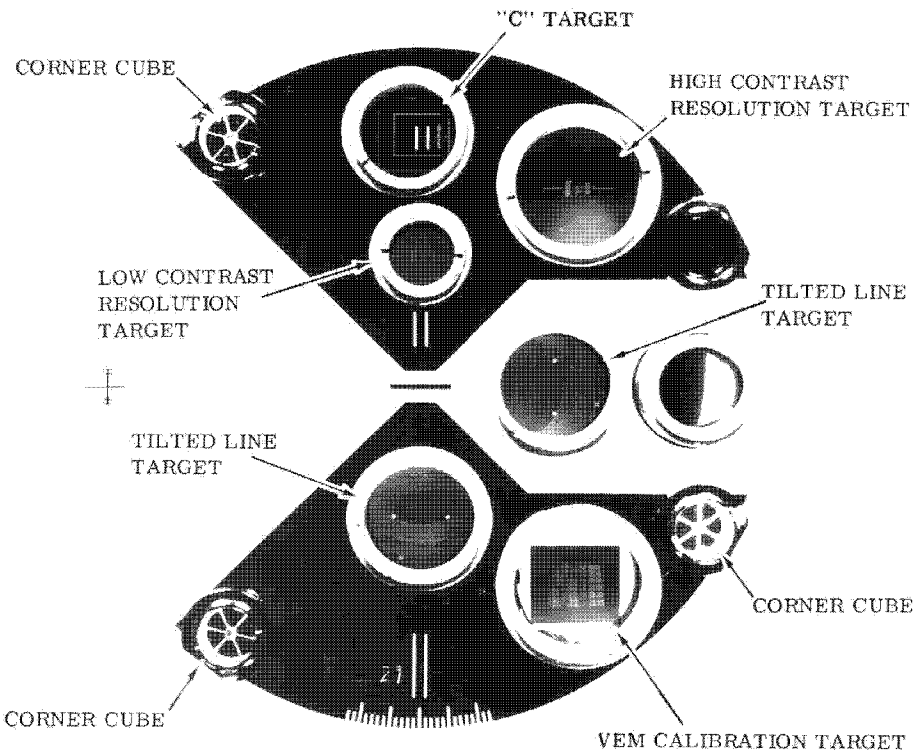


FIGURE 2-1

SECTION III

SYSTEM RESOLUTION PERFORMANCE

3.1 INTRODUCTION

During the Chamber A-2 test, resolution performance was determined for the 1414 Film. Based on the results of these tests, no further readiness testing was recommended. This section discusses the results of the following tests:

A. Resolution as a function of field angle.

B. Resolution as a function of slit width.

C. Comparison between Chambers A and A-2 resolution performance.

D. Resolution variability.

Resolution reported here is from AFSPPF readings of 2:1 contrast tribar targets located in the West Coast collimator reticles. The resolution data is processed by a computer program called RESOLUTE which, along with other output, provides a listing of the mean and standard deviation of the data as a function of platen position.

3.2 TEST PARAMETERS

The optical bar sets in SV-8 are: Set 035 on the Forward Camera and 037 on the Aft. Each camera has an in-flight changeable filter assembly (ICF) which incorporates the 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 was a test to determine if a focus shift results with the use of the W-2E3 Filter. The analysis of this test is recorded in Section V. Resolution tests analyzed in this section are summarized in Table 3-1. Sign conventions used for the pitch sequences are given in Table 3-2.

3.3 TEST RESULTS

3.3.1 Resolution as a Function of Field Angle

In-track and cross-track thru focus resolution data at the five field positions are given for both cameras in Figures 3-1 and 3-2. The test conditions used during the thru focus/thru pitch sequences, which made up this data base, were a Vx/h of .052 and a slit width of .303 inches. A single platen position representing peak resolution from each test was selected based on the 2:1 contrast tribar readings at each of the tested field locations. These frames were then microdensitometrically analyzed using the FOCMO Program to determine the position of best focus from the line arrays. These line determined PBFs are also

TABLE 3-1

CHAMBER A-2 RESOLUTION TEST SUMMARY

— Forward Camera —

Run	Sequence	Scan Length (degrees)	Vx/h (radians/sec)	Slit Width (inches)	Pitch (degrees)	Platen Positions (number/increment)	No. of Frames
26	K	30	.052	.303	-1.0	9/6	144
29	K	30	.052	.303	-2.0	9/6	144
30	K	30	.052	.303	-2.5	9/6	144
34	H	90	.052	.303	1.0	9/6	144
37	H	90	.052	.303	2.0	9/6	144
38	K	30	.052	.303	2.5	9/6	144
42	H	90	.052	.303	0	9/6	144
53	F	90	.036	.205	0	13/6	183
51	JA	60	.052	.615	0	8/6	144

— Aft Camera —

Run	Sequence	Scan Length (degrees)	Vx/h (radians/sec)	Slit Width (inches)	Pitch (degrees)	Platen Positions (number/increment)	No. of Frames
26	K	30	.052	.303	-1.0	9/6	141
29	K	30	.052	.303	-2.0	9/6	141
30	K	30	.052	.303	-2.5	9/6	141
34	H	90	.052	.303	1.0	9/6	141
37	H	90	.052	.303	2.0	9/6	141
38	K	30	.052	.303	2.5	9/6	141
42	H	90	.052	.303	0	9/6	141
53	F	90	.036	.205	0	13/6	180
52	JB	60	.052	.615	0	9/6	140

TABLE 3-2

PITCH/FIELD SIGN CONVENTIONS

(degrees)

Vehicle Pitch	Forward Camera 0° Scan	Forward Camera 37° Scan	Aft Camera 0° Scan	Aft Camera 37° Scan
-2.5	2.5	NA	-2.5	NA
-2.0	2.0	NA	-2.0	NA
-1.5	1.5	NA	-1.5	NA
-1.0	1.0	NA	-1.0	NA
-0.5	0.5	2.4	-0.5	-2.4
0	0	2.5	0	-2.0
0.5	-0.5	1.6	0.5	-1.6
1.0	-1.0	1.2	1.0	-1.2
1.5	-1.5	0.8	1.5	-0.8
2.0	-2.0	0.4	2.0	0.4
2.5	-2.5	0.0	2.5	0.0

NOTES:
1. Plus pitch means nose up.
2. Plus field refers to the non-titled, time track edge of the format.
3. NA means not acquired.

FORWARD CAMERA RESOLUTION AS A FUNCTION OF PLATEN POSITION
FOR VARIOUS FIELD ANGLES

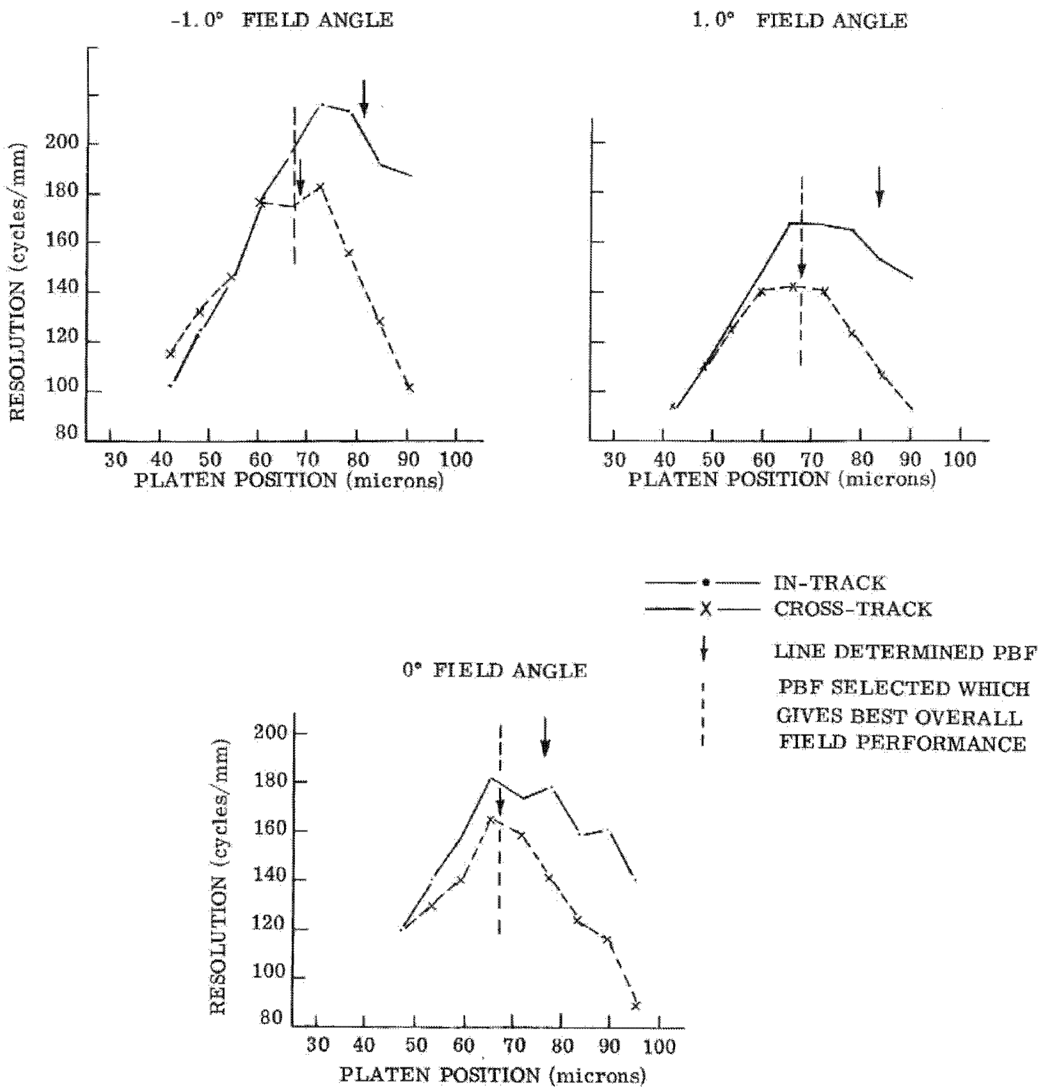
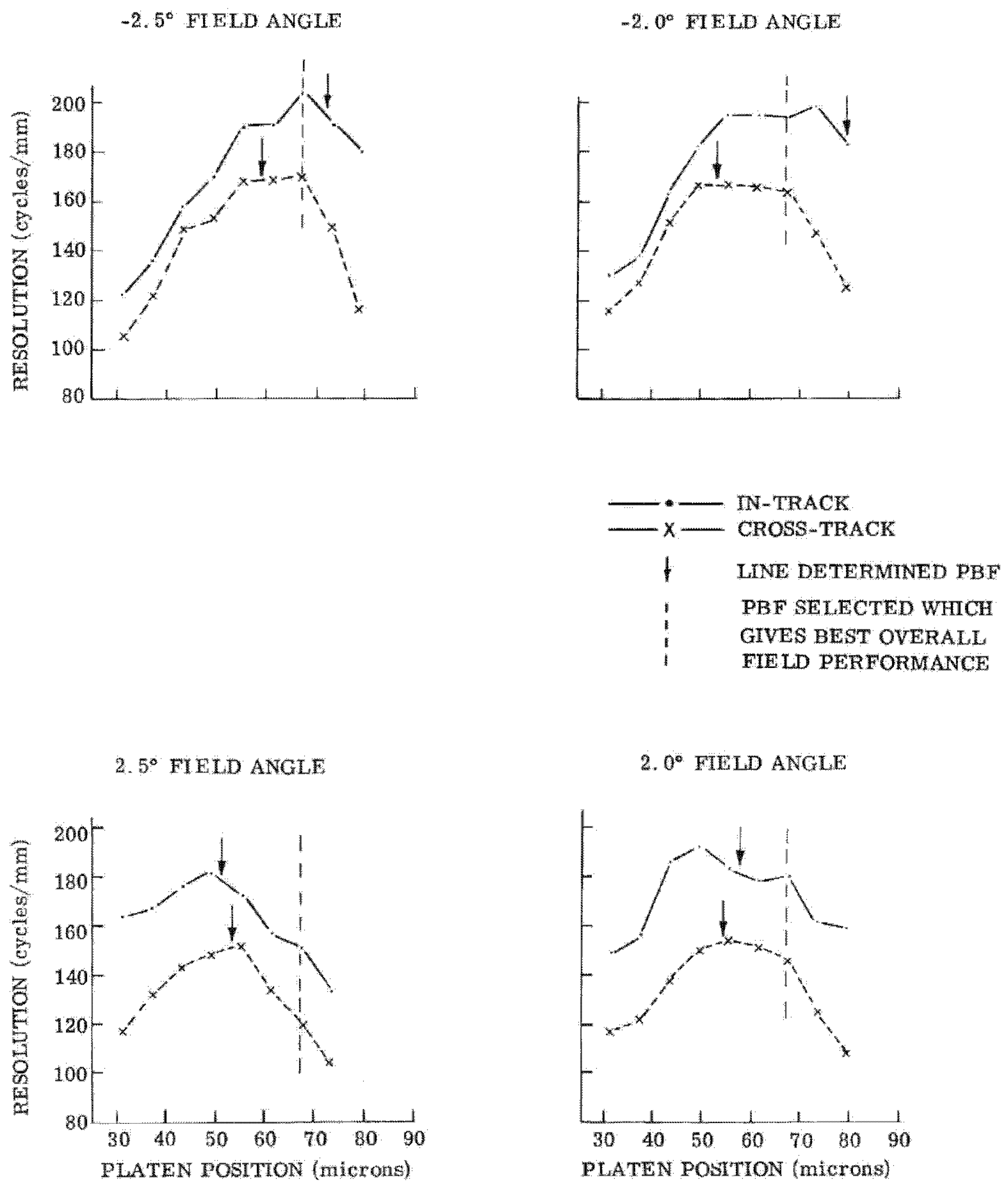


FIGURE 3-1

FORWARD CAMERA RESOLUTION AS A FUNCTION OF PLATEN POSITION FOR VARIOUS FIELD ANGLES (CONT'D)



AFT CAMERA RESOLUTION AS A FUNCTION OF PLATEN POSITION FOR VARIOUS FIELD ANGLES

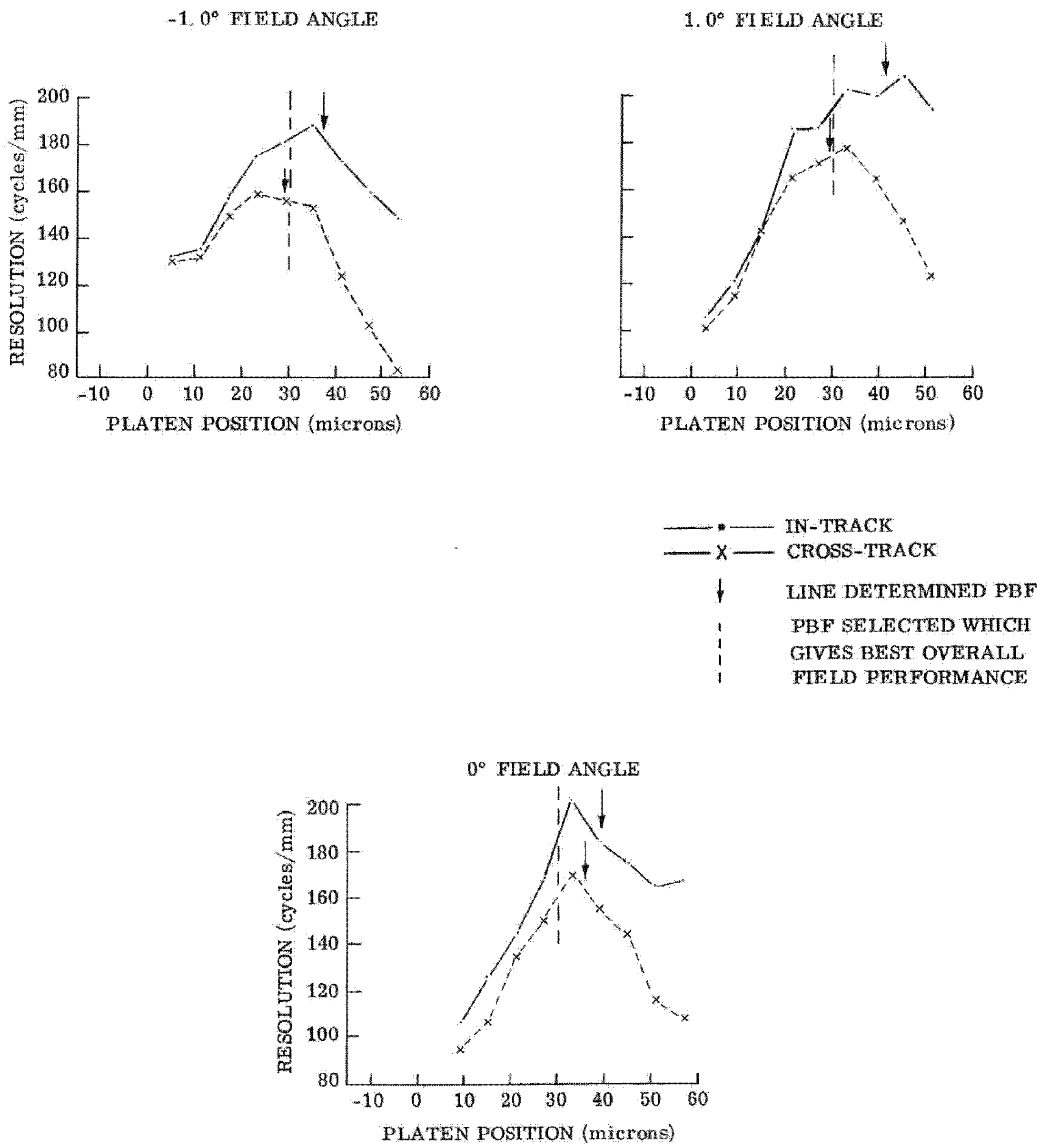
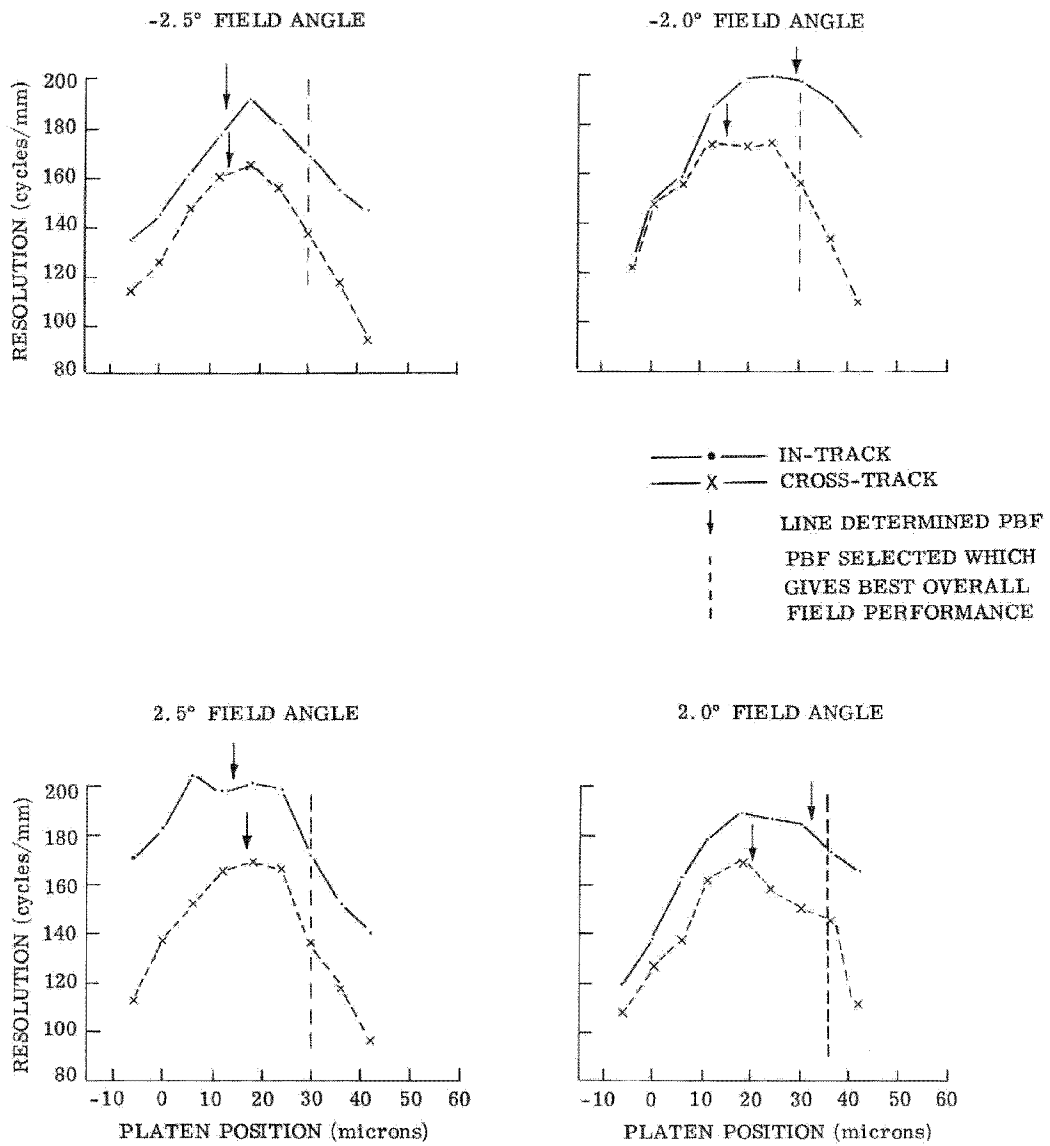


FIGURE 3-2

AFT CAMERA RESOLUTION AS A FUNCTION OF PLATEN POSITION
FOR VARIOUS FIELD ANGLES (CONT'D)



presented in Figures 3-1 and 3-2. Collimator defocus has been accounted for in these determinations. As in past Chamber A-2 tests, only the 0° collimators were used to generate the above data, since the field collimators do not encompass the entire sweep across the web.

Field profiles at a particular platen position, in terms of the 2:1 contrast tribar data from the Chamber A-2 test, are given in Figures 3-3 and 3-4. The positions were chosen so as to encompass that platen setting which gives the best overall performance. The data given in Figures 3-3 and 3-4 is summarized in Tables 3-3 and 3-4. The resolution performance was derived directly from Figures 3-1 and 3-2, using interpolation between data points where necessary. Based on this analysis, the Forward Camera platen setting for optimum performance falls between 65 and 70 microns; a 67 micron setting was selected. The most favorable position on the Aft Camera is at 30 microns. These two best focus platen positions are shown as vertical dashed lines in Figures 3-1 and 3-2 to show the difference from the peak performance made across the field. There was a significant difference from the peak noted at the 2° and 2.5° field positions of the Forward Camera; while the only significant departure noted from the Aft Camera was at the ±2.5° field positions. Average resolution thus balanced across the field (Tables 3-3 and 3-4) is 180 cycles/mm in-track and 155 cycles/mm cross-track for both cameras.

Figures 3-1 and 3-2 reveal several aspects of resolution performance based on the measured maximum resolution at each of the seven field positions tested, see Table 3-5. The in-track performance is consistently superior to cross-track. The superiority ranges from 9% to 20% on the Forward and 11% to 17% on the Aft, but average is approximately 15% for each camera. This 15% difference is attributed to differences in the MTFs introduced by the asymmetrical shape of the central obscuration. The range of maximum in-track and cross-track resolution is greater for the Forward than the Aft, although the average levels are essentially the same: approximately 195 cycles/mm in-track and 165 cycles/mm cross-track. The 2.5° field position resolution is not suppressed, as it has been with previous camera systems tested via the vehicle pitch configuration in Chamber A-2.

CHAMBER A-2 RESOLUTION ACROSS THE FIELD AS A FUNCTION OF PLATEN POSITION FOR FORWARD CAMERA

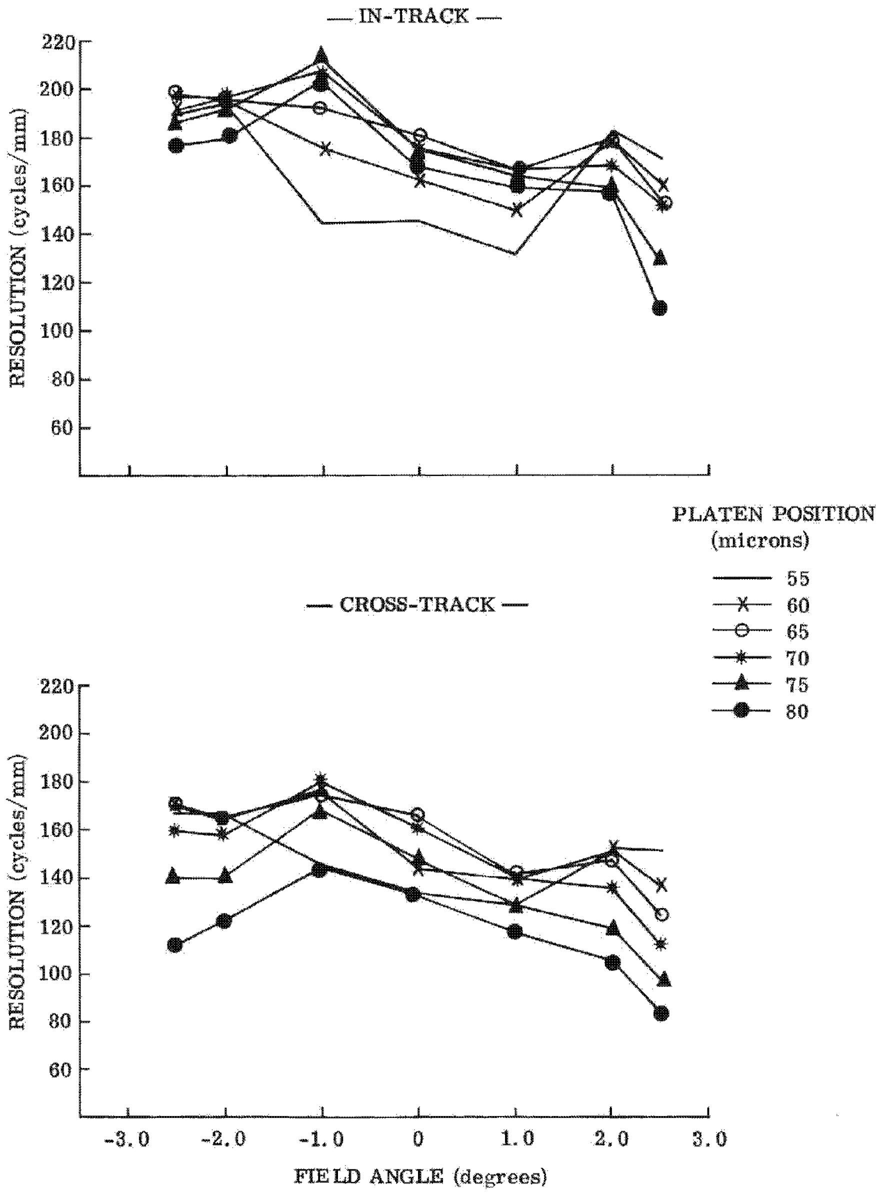


FIGURE 3-3

CHAMBER A-2 RESOLUTION ACROSS THE FIELD AS A FUNCTION OF PLATEN POSITION FOR AFT CAMERA

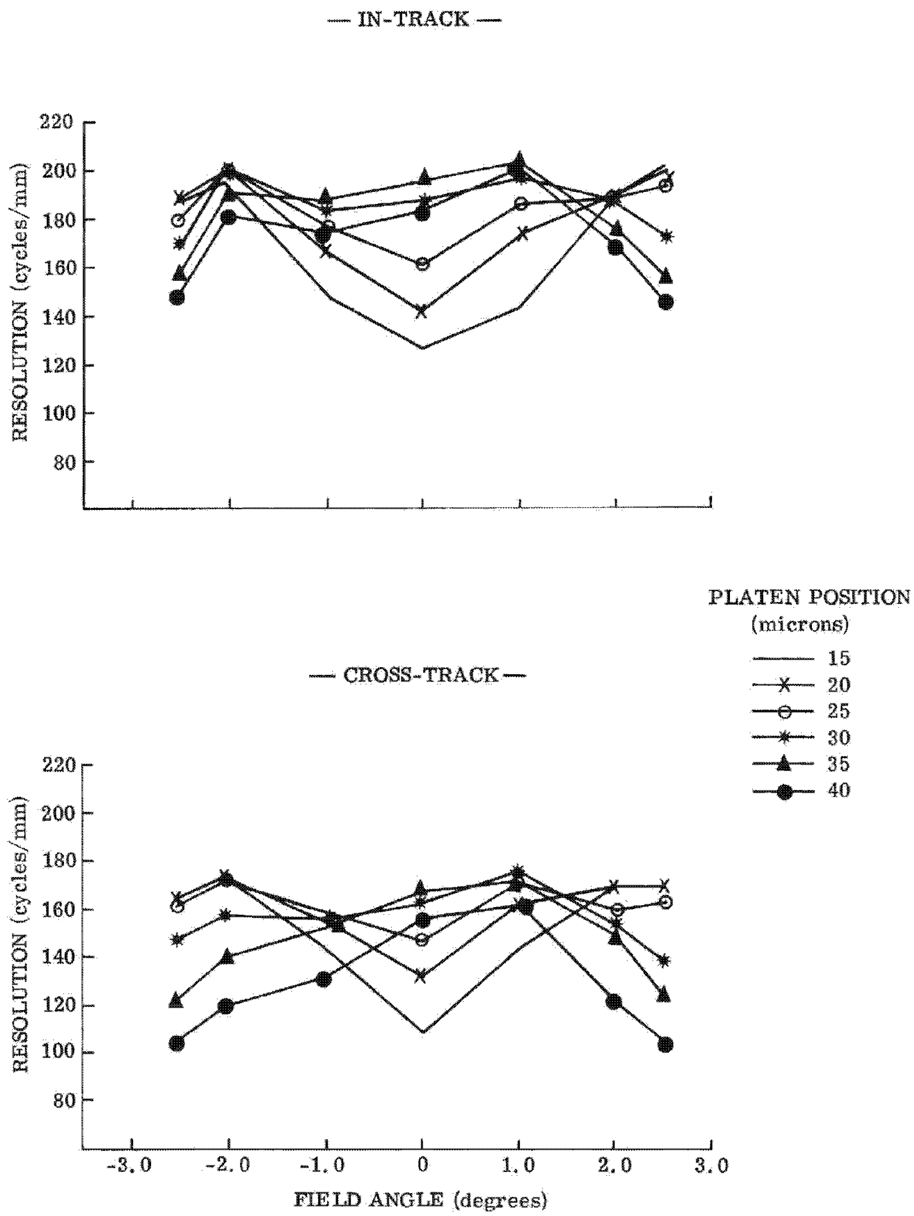


FIGURE 3-4

TABLE 3-3

CHAMBER A-2 FORWARD CAMERA FIELD RESOLUTION PERFORMANCE

(cycles/mm)

— In-Track —

Platen Position (microns)	Field Angle (degrees) -2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average
55	190	195	146	146	132	183	172	166
60	192	195	176	163	150	179	161	173
65	198	195	192	181	166	180	153	181
70	197	197	208	176	167	170	142	180
75	187	192	213	176	165	160	130*	175
80	177*	180*	204	169	160	158	110*	165

— Cross-Track —

Platen Position (microns)	-2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average
55	167	167	146	134	128	154	152	150
60	170	166	176	144	140	152	137	155
65	170	165	174	165	142	148	125	156
70	160	158	180	161	141	137	113	150
75	140	140	168	148	130	120	98*	135
80	112*	122*	144	133	118	106	84*	117

NOTE: The asterisk (*) denotes extrapolated values.

TABLE 3-4

CHAMBER A-2 AFT CAMERA FIELD RESOLUTION PERFORMANCE

(cycles/mm)

— In-Track —

Platen Position (microns)	Field Angle (degrees) -2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average
15	185	192	148	126	142	186	200	168
20	187	199	166	141	173	189	199	179
25	178	199	176	160	185	187	192	182
30	168	197	182	186	195	185	171	183
35	156	190	186	195	201	175	154	180
40	148	180	174	182	200	168	144	171

— Cross-Track —

Platen Position (microns)	-2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average
15	163	172	143	107	142	167	167	152
20	162	171	154	130	160	167	167	159
25	160	170	157	145	169	157	160	160
30	136	156	155	160	174	151	136	153
35	121	139	152	165	172	147	121	145
40	104	119	130	154	160	120	103	127

TABLE 3-5

MEASURED MAXIMUM RESOLUTION DATA

(cycles/mm)

Field Position (degrees)	Forward Camera		Aft Camera	
	In-Track	Cross-Track	In-Track	Cross-Track
-2.5	203	169	191	164
-2.0	198	167	199	173
-1.0	214	181	186	158
0	181	165	202	170
1.0	167	142	206	176
2.0	192	154	189	169
2.5	181	151	204	169
Averages	191	161	197	168

3.3.2 Resolution as a Function of Slit Width

During the A-2 tests, resolution performance was obtained at a Vx/h of .052 with slit widths of .615" and .303 inch. Exposure differences were accounted for by adjustment of collimator illumination levels. The thru focus data from these tests are shown in Figures 3-5 and 3-6. The Forward Camera performance drops by 15% at best focus, for both the in-track and cross-track cases, at the wide slit position. This is consistent with the losses measured in the acceptance testing of this camera in 5 out of 6 test cases, see Figure 4-4, SN-011 Acceptance Team Report (BYE 15312-72). The Aft Camera performance shows no difference in peak resolution with the two slit widths tested. The Acceptance Team did not report data for this camera. As SV-8 is expected to be launched in March, however, the anticipated slit widths will be narrow (.2" to .3") and will decrease as the mission progresses. Thus, no loss in performance on either camera is expected due to the slit widths on Mission 1208.

3.3.3 Comparison of Chambers A and A-2 Resolution Performance

Comparisions of resolution performance were made using those thru focus tests which occurred at similar field positions in the two chambers, see Figures 3-7 and 3-8. Both sets of data represent 2:1 tribar readings read by AFSPPF personnel. Due to the difference in focus settings of the collimators used in these chambers, the two sets of data are offset with respect to their absolute platen positions, but are made comparable to one another. Table 3-6 gives the PBFs expected in Chamber A-2 based on: (1) Chamber A tests, (2) the tribar and line PBFs actually measured in Chamber A-2, and (3) the differences in microns between the two test beds. The differences are seen to be negligible.

CHAMBER A-2 RESOLUTION AS A FUNCTION OF SLIT WIDTH FOR FORWARD CAMERA AT 0° PITCH AND 0° FIELD ANGLES

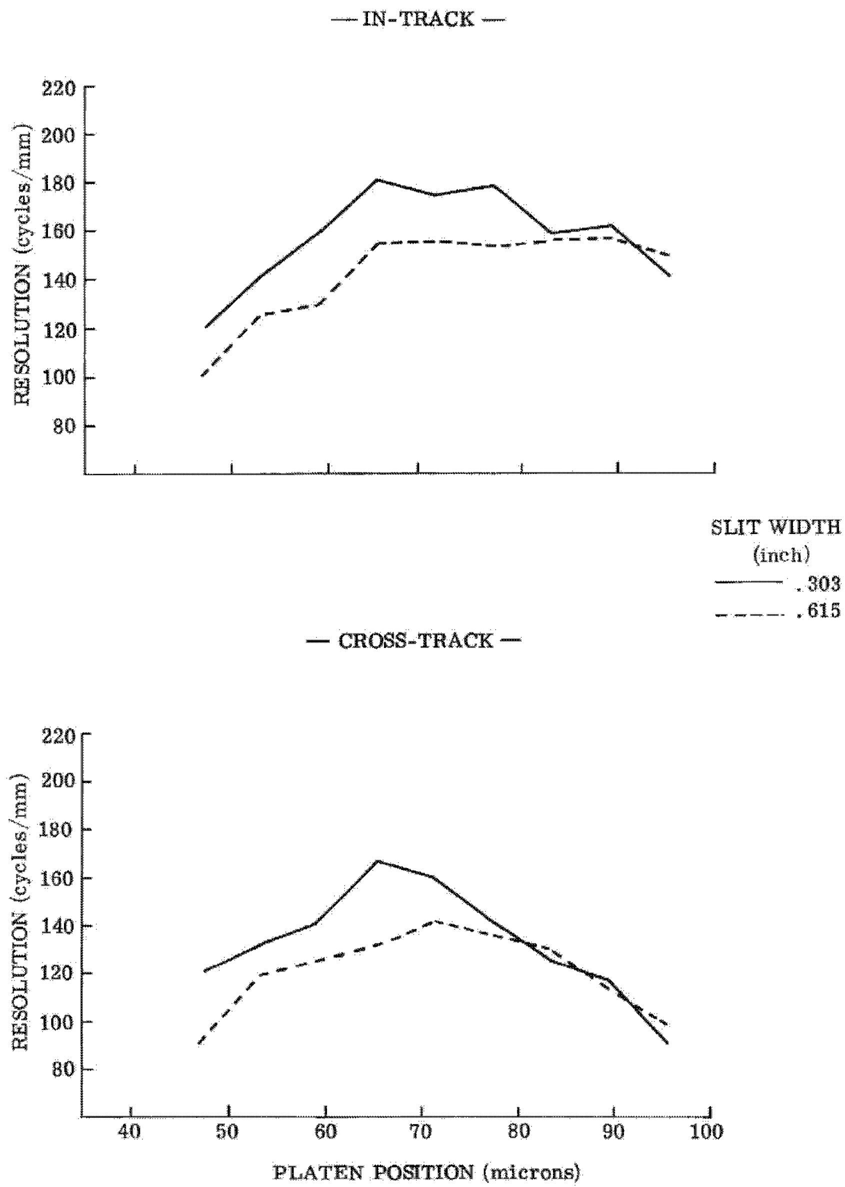


FIGURE 3-5

CHAMBER A-2 RESOLUTION AS A FUNCTION OF SLIT WIDTH FOR AFT CAMERA AT 0° PITCH AND 0° FIELD ANGLES

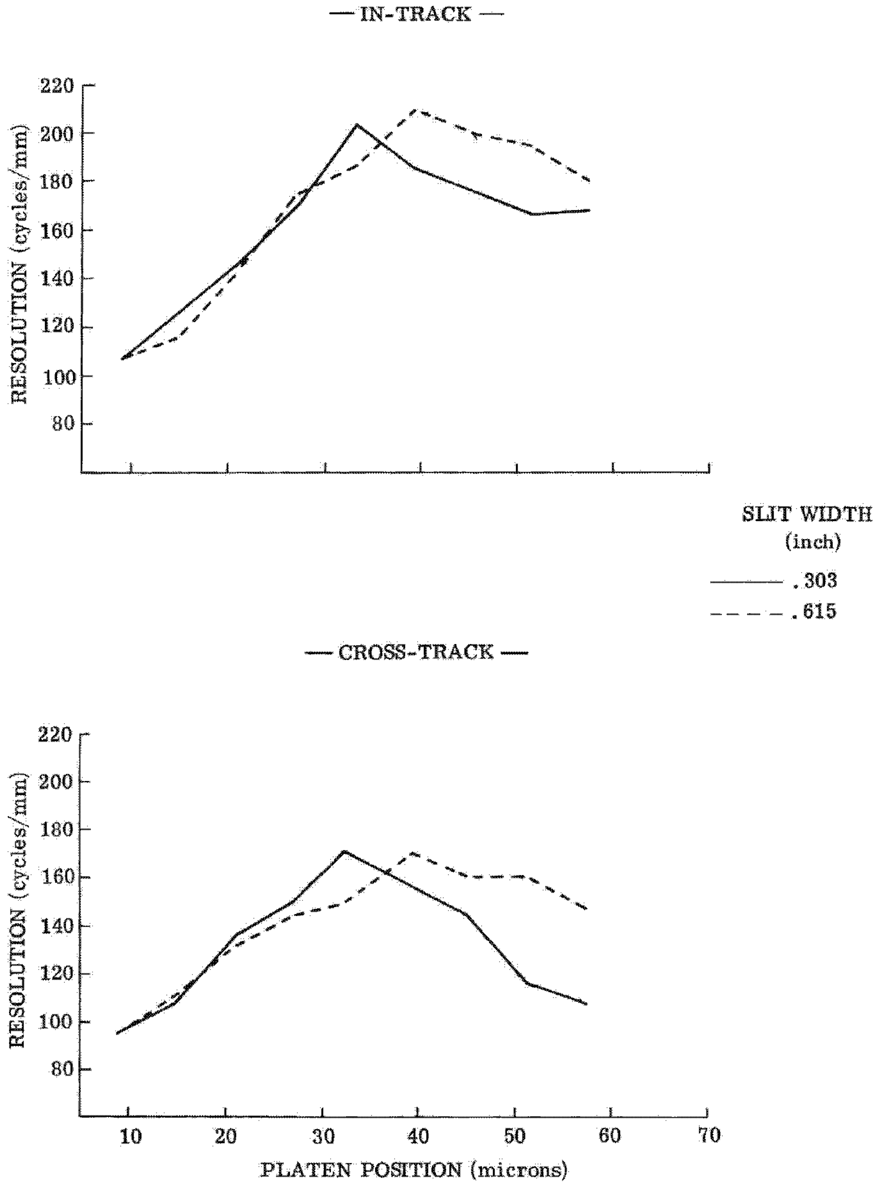


FIGURE 3-6

CHAMBER A VERSUS CHAMBER A-2 RESOLUTION COMPARISON
FOR FORWARD CAMERA

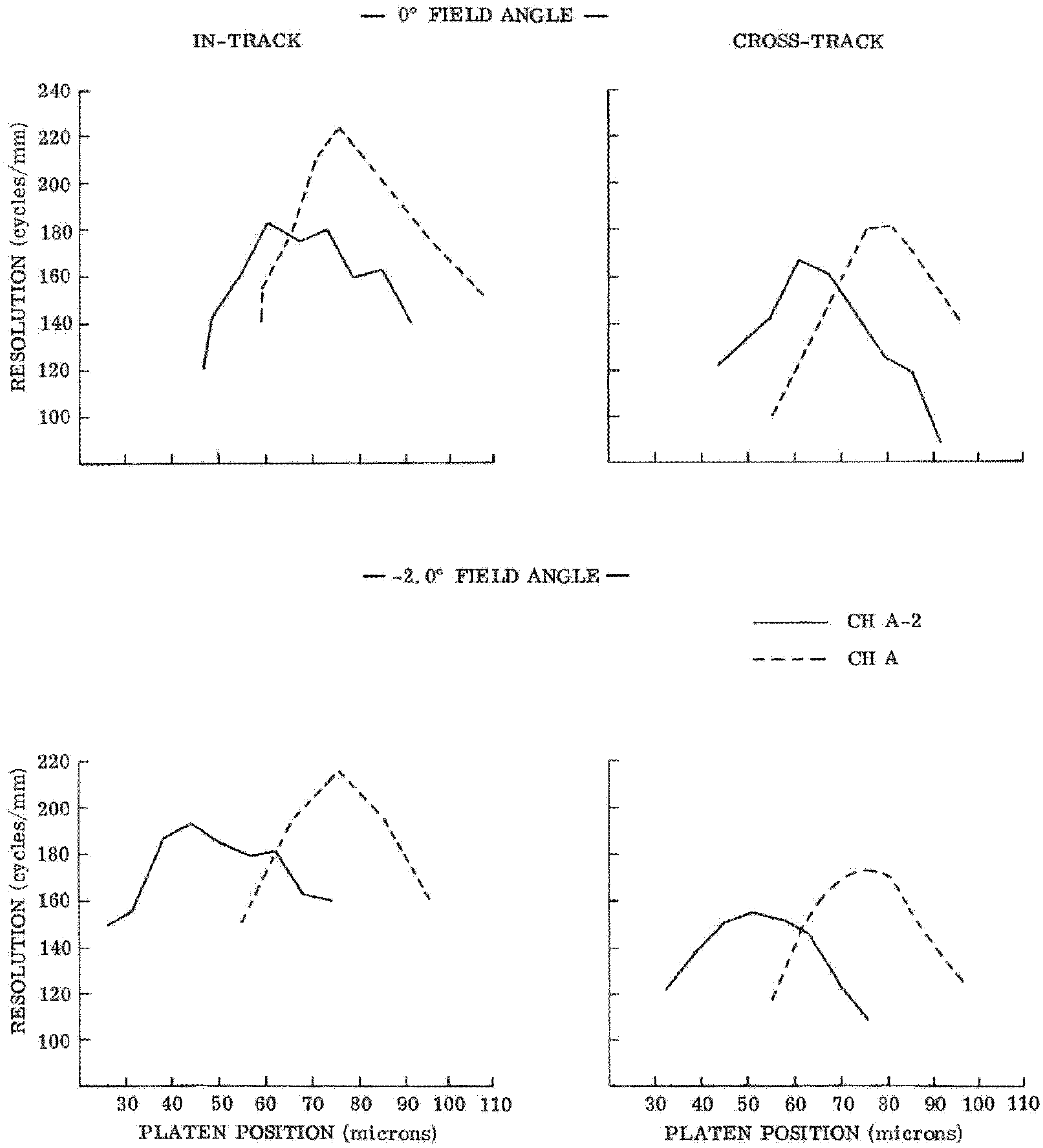


FIGURE 3-7

CHAMBER A VERSUS CHAMBER A-2 RESOLUTION COMPARISON

FOR AFT CAMERA

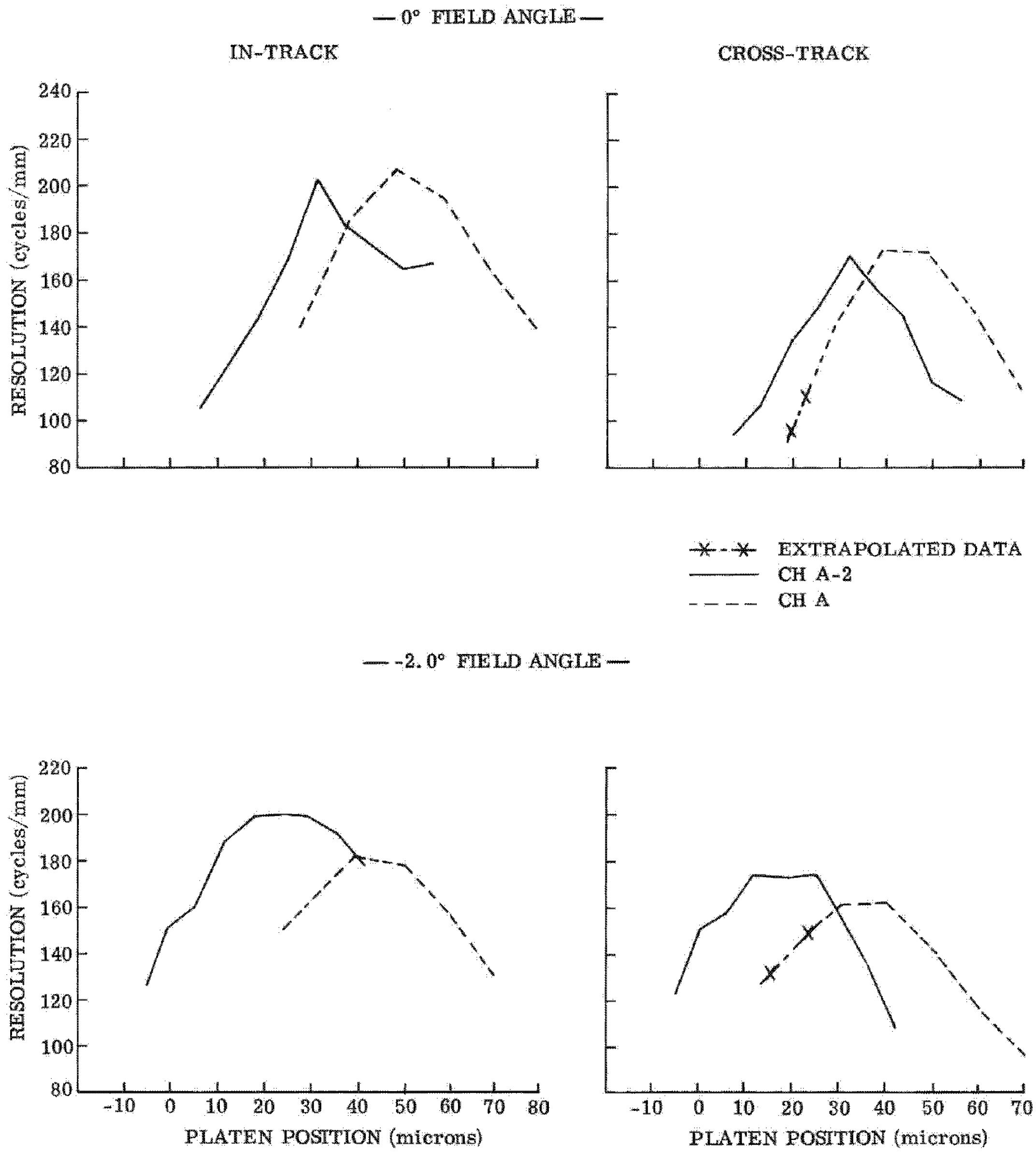


FIGURE 3-8

TABLE 3-6

FOCUS SHIFTS BETWEEN CHAMBERS A AND A-2

(microns)

Factor	Forward Camera	Aft Camera
Chamber A	86	47
120 NM to ∞ correction	-10	-10
Expected Chamber A-2 PBF	76	37
Chamber A-2 Tribars	69 (-7)	30 (-7)
Chamber A-2 Lines	74 (-2)	33 (-4)

The Forward Camera peak performance as measured in Chamber A was 8% to 18% higher than that measured in Chamber A-2 for both the in-track and cross-track data, the average difference being 12 percent. The Chamber A field performance of the Forward Camera was flat with no requirement for tilt. This does not agree with the Chamber A-2 data, which has about 20 microns of field curvature along with an apparent platen tilt requirement. Detailed examination of the platen tilt question is given in Section V.

A similar comparison between the chambers for the Aft Camera shows equivalent performance at 0° of field for both the in-track and cross-track data. The -2.0° field data was 8% higher in Chamber A-2 than in Chamber A test. This difference is not considered significant. Field curvature as measured during acceptance testing was about 5 to 7 microns with some apparent tilt required. The readiness testing indicates a field curvature of 20 microns with no tilt required. At present, these differences between chambers are not clearly understood. However, the performance measured in both chambers meets requirements and is not a cause for concern.

In summary, there is no significant difference in PBF determination and resolution performance between acceptance and readiness testing. What is consistently different between the two test beds, however, is the field curvature and platen tilt indications. The Chamber A-2 configuration is more susceptible to error in this regard than Chamber A.

3.3.4 Variability of Resolution

A measure of image quality variability in terms of the 2:1 tribar readings is the ratio of the standard deviation-to-mean resolution for a series of replicated tribar images. For a given field position, this ratio was generated for four platen positions about the PBF. These were then averaged and used to characterize a given test case.

This analysis was done at each of the field positions obtained in the pitch and wide slit test sequences for both the in-track and cross-track resolution data, see Table 3-7. Both cameras have about the same amount of variability (7% on the average) at each of the tested field positions. For the wide .615" slit case, the Forward Camera data has a greater variability (10%) than that found with the .303" slit. This increase in resolution variability due to wide slit usage with the Forward Camera is commensurate with selective loss of resolution performance level under the same conditions. No change in variability was detected in the Aft Camera data with the wide slit.

TABLE 3-7

RESOLUTION VARIABILITY

Field Angle (degrees)	Forward Camera In-Track	Forward Camera Cross-Track	Aft Camera In-Track	Aft Camera Cross-Track
— Vx/h of .052, Slit Width of .303" —				
2.5	.06	.07	.07	.06
2.0	.05	.08	.06	.07
1.0	.06	.08	.06	.05
0.0	.06	.08	.06	.08
-1.0	.07	.08	.07	.08
-2.0	.07	.05	.06	.07
-2.5	.07	.06	.06	.07
— Vx/h of .052, Slit Width of .615" —				
0.0	.11	.10	.07	.07

NOTE: These values are a computation of $\frac{\text{standard deviation (cycles/mm)}}{\text{mean (cycles/mm)}}$.

3.4 CONCLUSIONS AND RECOMMENDATIONS

A. Both cameras have adequate average resolution performance across the field of 167 cycles/mm at 2:1 contrast. The average resolution ranged between 155 and 179 cycles/mm.

B. The best resolution performance balance across the field is obtained with a platen position of 67 microns on the Forward and 30 microns on the Aft Camera under readiness test conditions.

C. Wide slits introduce measurable resolution loss and increased resolution variability on the Forward Camera only. However, this is not considered to be significant factor due to the anticipated March launch.

D. The 2.5° field position resolution performance is not suppressed as it has been for previous camera systems.

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 system 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 either 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

(inches/second)

	Collimator Position (degrees)			
Direction	-45	0	37	55
Forward Camera				
In-Track	.027	-.004	-.025	-.030
Cross-Track	-.011	-.021	-.025	-.011
Aft Camera				
In-Track	.030	-.002	-.030	-.035
Cross-Track	-.018	-.023	-.016	-.010

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 SV-8 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 calibration sequences performed during the Chamber A-2 vacuum test are presented in Tables 4-2 and 4-3 and Figures 4-1 thru 4-4. Table 4-2 shows the results of the OOAA tests run at Vx/h values of .052 and .044 at the 0° and 37° scan positions. Figures 4-1 and 4-4 are plots of the 0° and 37° scan position data. Straight lines have been fitted to the points using the least squares technique. The equations of these best fit straight lines for the 0° collimator are listed in Table 4-3, together with the correlation that indicated the accuracy of fit. A comparison of the OOAA calibration curves shows that uniformity exists between the 0° and 37° results.

The mean smear as calculated from the FIDAP Program shows good correlation between the OOAA calibration test curves and the theoretical curves, with the exception of the Forward Camera in the cross-track direction. The calibration curves at a Vx/h of .052 and .044 did not intersect as seen in Figure 4-1. This condition did not exist in the acceptance test data prior to the metering capstan servo modification.

The scale factors for both the in-track and cross-track were slightly smaller than those expected from the nominal design. The Forward Camera scale factors are 5.2% to 11.2% lower than nominal, while the Aft are 1.6% to 7.3% lower. These deviations from nominal are not critical over the operating range of the OOAA settings.

4.5 SYNC ERROR MEASUREMENT SUMMARY

Tables 4-4 thru 4-7 present the summary of the SV-8 film synchronization performance from the Chamber A and Chamber A-2 tests. The following are significant observations and analysis relating to the film synchronization.

4.5.1 Chamber A Versus Chamber A-2 Comparison

The comparison between the mean smear data from Chamber A and Chamber A-2 tests was fair. The differences in the mean errors, which are not significant for the 0° scan position, can be explained by the fact that the OOAA box was changed between the two tests. As with previous systems, the 37° position did not compare well with the 55° position. The Forward Camera has a positive change of .07 inch/second in-track from the Chamber A test indicating an in-track velocity ramp.

4.5.2 Flight Configuration Test

Data from post Chamber A-2 vacuum tests with the IMC disable box removed (box-out) indicated no change in the mean image motion errors of either camera.

4.6 ON-ORBIT IMAGE MOTION ERROR PREDICTIONS

The predictions of SV-8 on-orbit image motion errors at a Vx/h of .052 are depicted on an original negative frame format for the Forward and Aft Cameras, see Figures 4-5 and 4-6. These figures were

TABLE 4-2

PHOTOGRAPHIC MEAN ERROR VERSUS COMMAND FROM OOAA CALIBRATION SEQUENCE

			Error (inches/second)							
			Forward Camera				Aft Camera			
Nominal	OOAA Command		0° Collimator		37° Collimator		0° Collimator		37° Collimator	
Vx/h	Skew	Velocity	IT	XT	IT	XT	IT	XT	IT	XT
.052	15	-5	.181	-.083	.219	-.089	-.150	-.037	-.182	-.060
	5	-21	.076	-.323	.123	-.340	-.063	-.257	-.182	-.289
	0	0	.033	-.019	.088	-.045	.009	.039	-.041	-.023
	-5	10	-.010	.095	.035	.110	.036	.164	.005	.178
	-15	5	-.094	.047	-.060	.057	.116	.125	.090	.092
.044	15	-5	.150	-.068	.202	-.094	-.137	-.017	-.166	-.049
	5	-21	.064	-.270	.117	-.270	-.057	-.214	-.073	-.221
	0	0	.037	-.004	.088	-.022	-.018	.031	-.048	.044
	-5	10	.002	.158	.052	.100	.021	.166	-.014	.122
	-15	5	-.072	.054	-.027	.061	.103	.083	.078	.069

NOTE: All mean errors are stated using the FIDAP sign convention.

TABLE 4-3

OOAA CALIBRATION SEQUENCE BEST-FIT LINEAR EQUATIONS
FOR THE 0° COLLIMATOR

Camera	Nominal Vx/h	Direction	Best-Fit Equation	Correlation Coefficient
Forward	.052	In-Track	Y = .037 + .009X	.9979
		Cross-Track	Y = -.029 + .0136X	.9977
	.044	In-Track	Y = .036 + .0073X	.9981
		Cross-Track	Y = -.006 + .0125X	.9999
Aft	.052	In-Track	Y = -.014 - .009X	-.9988
		Cross-Track	Y = .037 + .014X	.9977
	.044	In-Track	Y = -.018 - .008X	-.9999
		Cross-Track	Y = .036 + .012X	.9979

NOTES: 1. See Figures 4-1 and 4-2.

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.

FORWARD CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 0° SCAN POSITION

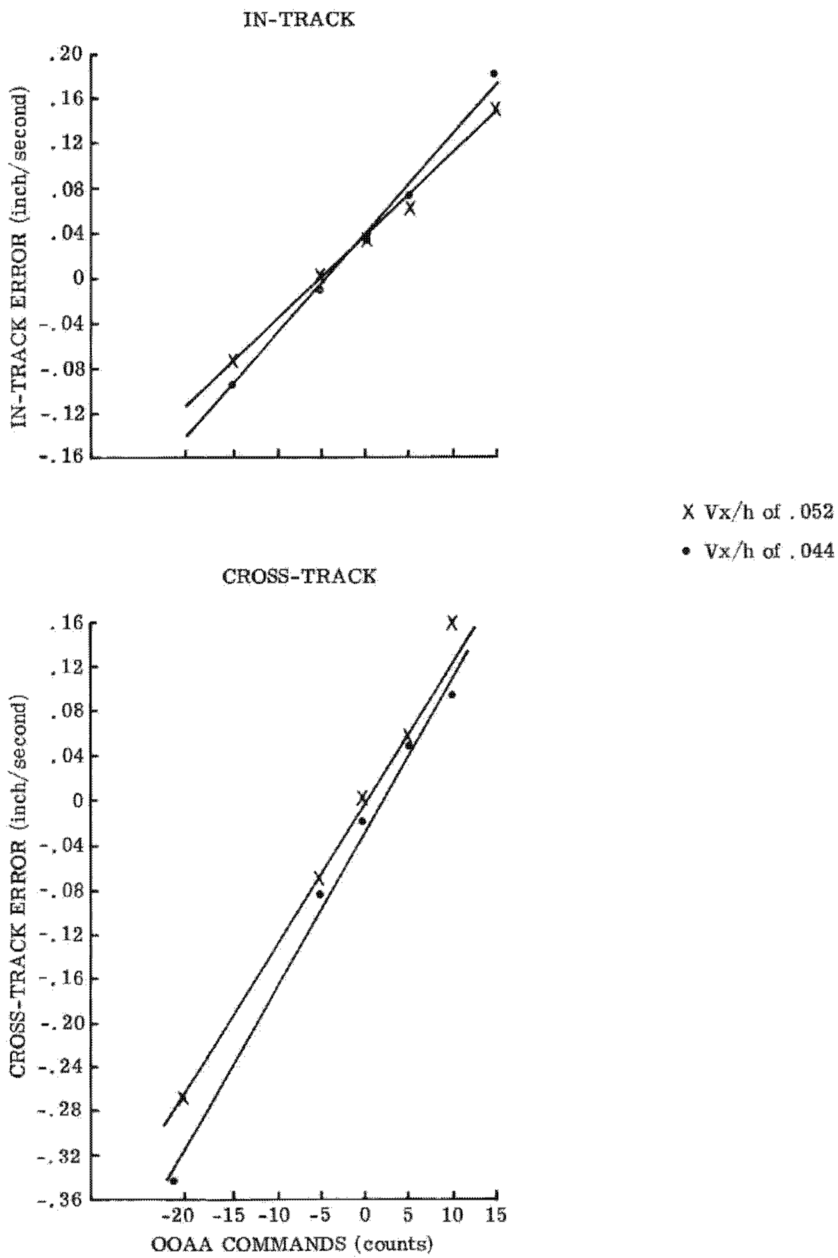


FIGURE 4-1

FORWARD CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 37° SCAN POSITION

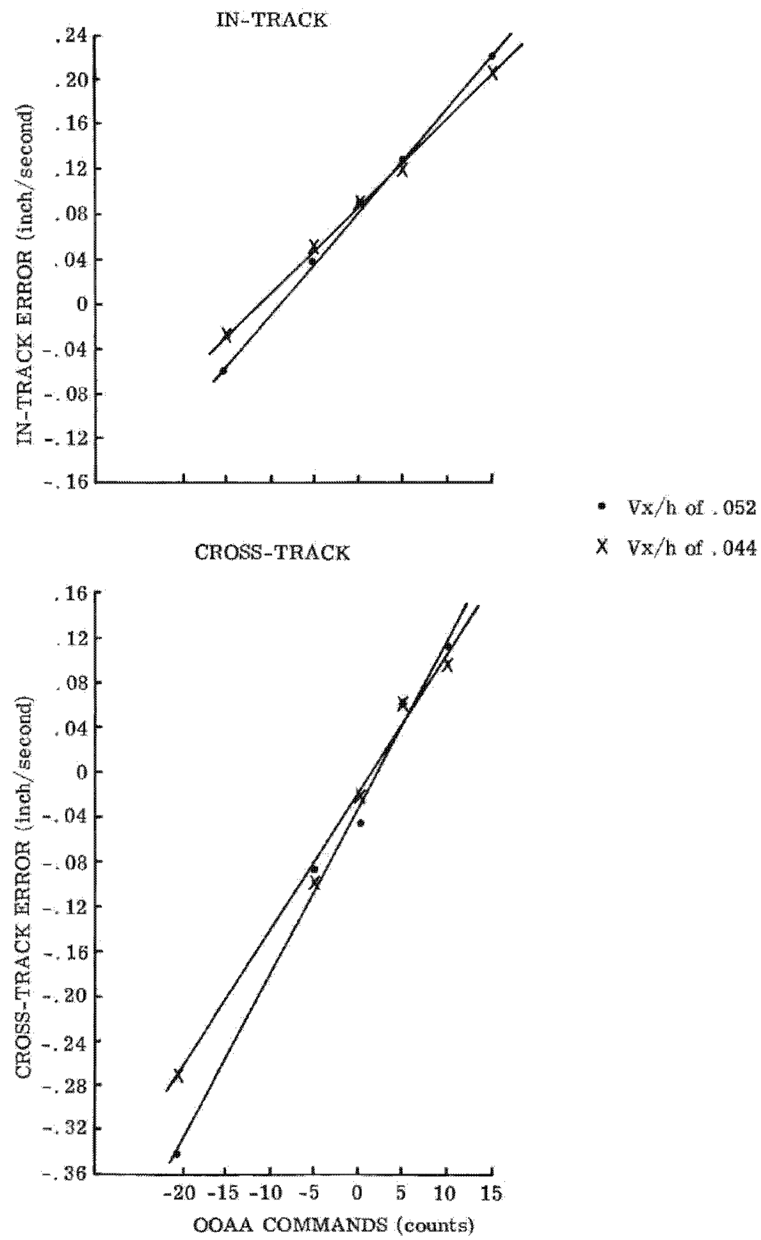


FIGURE 4-2

AFT CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 0° SCAN POSITION

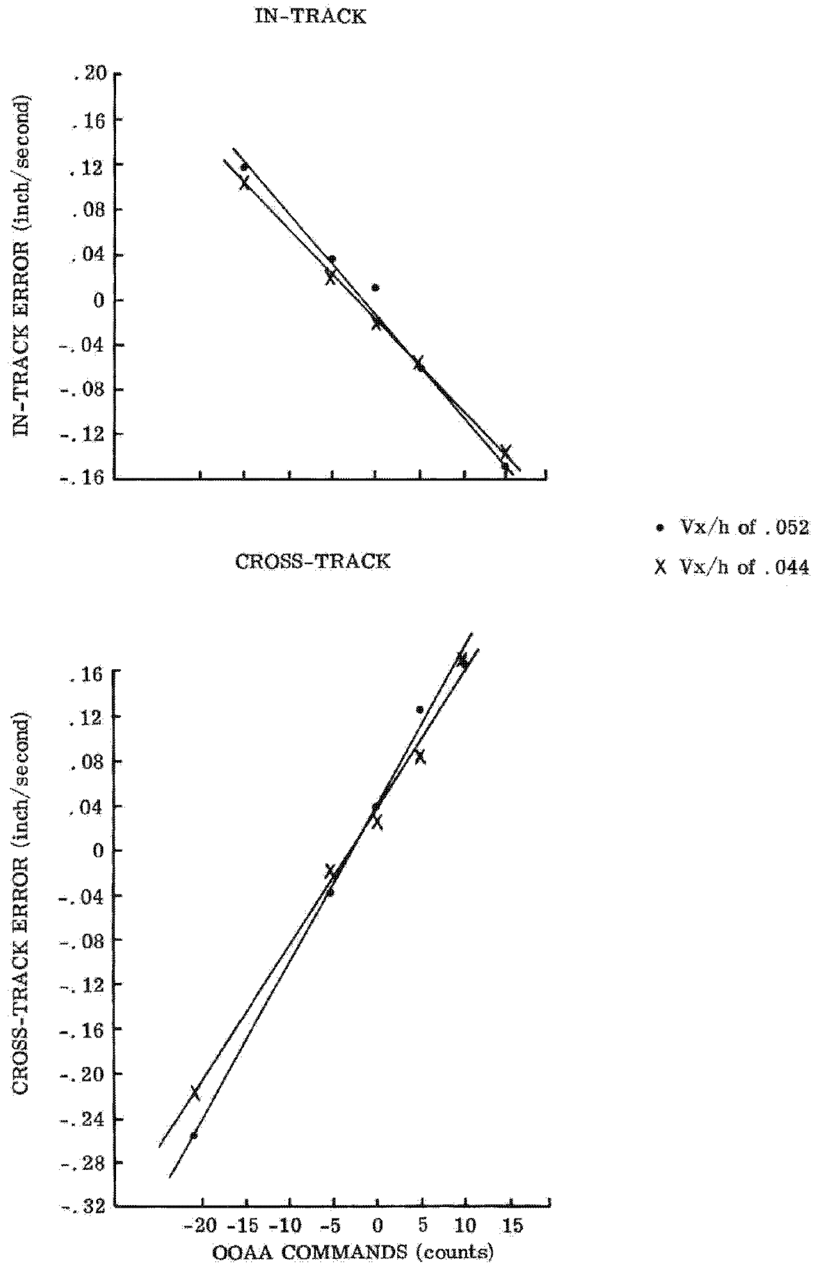


FIGURE 4-3

AFT CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND AT 37° SCAN POSITION

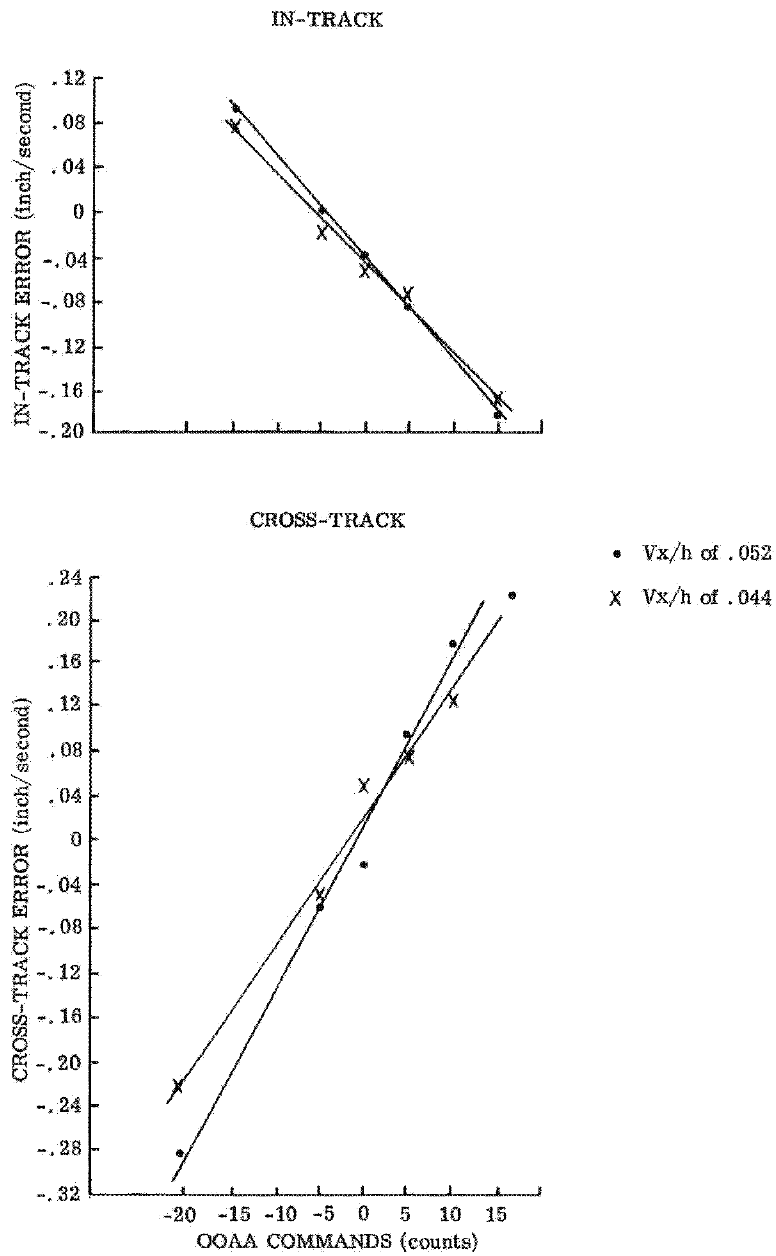


FIGURE 4-4

TABLE 4-4

FILM SYNCHRONIZATION ERROR SUMMARY

Forward Camera IMC Enabled Temperature 70°

Nominal Vx/h	Direction	Spec	0° COLLIMATOR				
			Chamber A		Chamber A-2		
			Vac Accept		Vacuum	Post Vac	Post Vac
			SSC	SPPF	Box-In	Box-In	Box-Out
.052	IN-TRACK MEAN	±.050		.014	.033	.029	.034
	IN-TRACK TWO SIGMA	.050		.031	.034	.021	.032
	CROSS-TRACK MEAN	±.050		-.002	-.019	-.039	-.017
	CROSS-TRACK TWO SIGMA	.100		.029	.055	.044	.045
.044	IN-TRACK MEAN	±.050		.015	.037	.030	.027
	IN-TRACK TWO SIGMA	.050		.034	.041	.016	.027
	CROSS-TRACK MEAN	±.050		.002	-.005	-.023	-.029
	CROSS-TRACK TWO SIGMA	.098		.039	.051	.057	.057
.036	IN-TRACK MEAN	±.035		.008	.017	-	.027
	IN-TRACK TWO SIGMA	.037		.030	.027	-	.021
	CROSS-TRACK MEAN	±.045		.003	-.023	-	.009
	CROSS-TRACK TWO SIGMA	.098		.038	.043	-	.038

NOTE: Table Information

(a) All data (+) unless noted.

(b) Plus (+) in-track error indicates the platen leads optical bar.

(c) Plus (+) cross-track error means film speed is too fast.

(d) This is the FIDAP sign convention.

TABLE 4-5

FILM SYNCHRONIZATION ERROR SUMMARY

Forward Camera IMC Enabled Temperature 70°

Nominal Vx/h	Direction	55° COLLIMATOR			37° COLLIMATOR		
		Spec	Chamber A Vac Accept		Chamber A-2		
			SSC	SPPF	Vacuum Box-In	Post Vac Box-In	Post Vac Box-Out
.052	IN-TRACK MEAN	±.050		.013	.082*	.075*	.074*
	IN-TRACK TWO SIGMA	.050		.030	.042	.031	.030
	CROSS-TRACK MEAN	±.050		-.036	-.045	-.028	-.027
	CROSS-TRACK TWO SIGMA	.100		.038	.079	.049	.042
.044	IN-TRACK MEAN	±.050		.019	.088*	.058*	.067*
	IN-TRACK TWO SIGMA	.050		.023	.042	.026	.025
	CROSS-TRACK MEAN	±.050		-.028	-.021	-.035	-.066
	CROSS-TRACK TWO SIGMA	.098		.032	.041	.041	.037
.036	IN-TRACK MEAN	±.045		.016	.050*	-	.052*
	IN-TRACK TWO SIGMA	.037		.016	.048	-	.016
	CROSS-TRACK MEAN	±.045		-.027	-.020	-	-.015
	CROSS-TRACK TWO SIGMA	.098		.049	.052	-	.033

* Out-of-specification.

NOTE: Table Information

(a) All data (+) unless noted.

(b) Plus (+) in-track error indicates the platen leads optical bar.

(c) Plus (+) cross-track error means film speed is too fast.

(d) This is the FIDAP sign convention.

TABLE 4-6

FILM SYNCHRONIZATION ERROR SUMMARY

Aft Camera — IMC Enabled — Temperature 70°

Nominal Vx/h	Direction	0° COLLIMATOR						
		Spec	Chamber A Vac Accept SSC	Chamber A Vac Accept SPPF	Chamber A-2 Vacuum Box-In	Chamber A-2 Post Vac Box-In	Chamber A-2 Post Vac Box-Out
.052	IN-TRACK MEAN	±.050		.002	-.008	-.015	-.022
	IN-TRACK TWO SIGMA	.050		.024	.033	.025	.025
	CROSS-TRACK MEAN	±.050		.015	.039	.049	.044
	CROSS-TRACK TWO SIGMA	.100		.048	.064	.054	.051
.044	IN-TRACK MEAN	±.050		-.003	-.017	-.018	-.024
	IN-TRACK TWO SIGMA	.050		.022	.027	.034	.019
	CROSS-TRACK MEAN	±.050		.018	.031	.028	.022
	CROSS-TRACK TWO SIGMA	.098		.040	.055	.040	.074
.036	IN-TRACK MEAN	±.035		0.0	-.015	-	-.007
	IN-TRACK TWO SIGMA	.037		.019	.039	-	.017
	CROSS-TRACK MEAN	±.045		.001	.008	-	.024
	CROSS-TRACK TWO SIGMA	.098		.028	.084	-	.048

NOTE: Table Information

(a) All data (+) unless noted.

(b) Plus (+) in-track error indicates the platen leads optical bar.

(c) Plus (+) cross-track error means film speed is too fast.

(d) This is the FIDAP sign convention.

TABLE 4-7

FILM SYNCHRONIZATION ERROR SUMMARY

Aft Camera | IMC Enabled | Temperature 70°

Nominal Vx/h	Direction	55° COLLIMATOR			37° COLLIMATOR		
		Spec	Chamber A		Chamber A-2		
			Vac Accept		Vacuum	Post Vac	Post Vac
			SSC	SPPF	Box-In	Box-In	Box-Out
.052	IN-TRACK MEAN	±.050		-.048	-.045	-.035	-.034
	IN-TRACK TWO SIGMA	.050		.025	.038	.040	038
	CROSS-TRACK MEAN	±.050		.014	-.021	-.028	-.015*
	CROSS-TRACK TWO SIGMA	.100		.031	.062	.042	.046
.044	IN-TRACK MEAN	±.050		-.048	-.045	-.033	-.028
	IN-TRACK TWO SIGMA	.050		.017	.029	.024	.022
	CROSS-TRACK MEAN	±.050		.026	.033	.070	.027
	CROSS-TRACK TWO SIGMA	.098		.032	.056	.067	.066
.036	IN-TRACK MEAN	±.045		-.030	-.026	-	-.025
	IN-TRACK TWO SIGMA	.037		.015	.036	-	.023
	CROSS-TRACK MEAN	±.045		.022	.002	-	-.005*
	CROSS-TRACK TWO SIGMA	.098		.036	.085	-	.041

* Out-of-specification.

NOTE: Table Information

(a) All data (+) unless noted.

(b) Plus (+) in-track error indicates the platen leads optical bar.

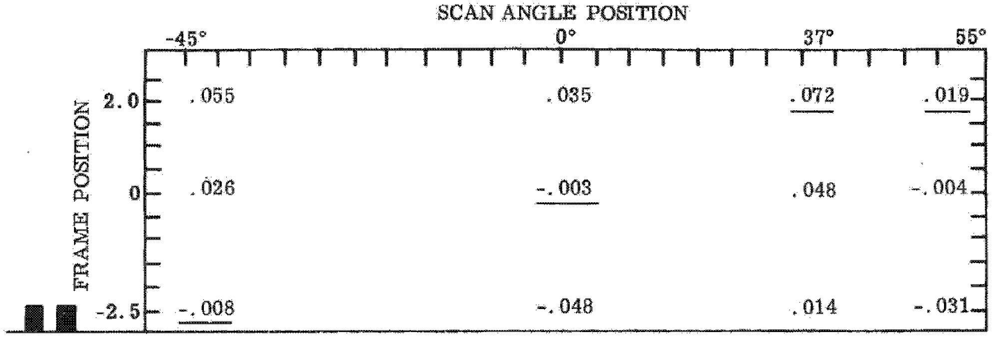
(c) Plus (+) cross-track error means film speed is too fast.

(d) This is the FIDAP sign convention.

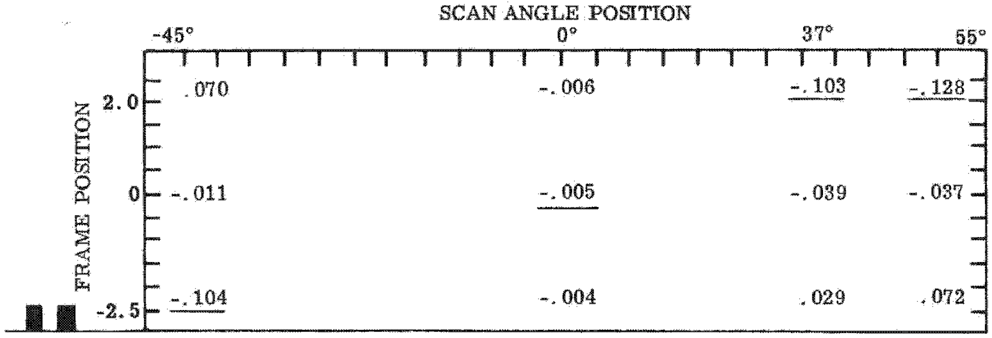
FORWARD CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION

(Vx/h of .052)

IN-TRACK



CROSS-TRACK



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 4-5

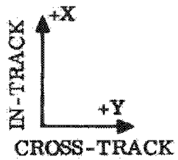
AFT CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION

(Vx/h of .052)

IN-TRACK

SCAN ANGLE POSITION

FRAME POSITION	-55°	-37°	0°	45°
2.0	.010	.014	-.043	-.058
0	.033	.040	-.010	-.028
-2.5	-.068	.076	.037	.008



FILM TRAVEL →

CROSS-TRACK

SCAN ANGLE POSITION

FRAME POSITION	-55°	-37°	0°	45°
2.0	.150	.084	.003	-.071
0	.057	.018	.003	.006
-2.5	-.047	-.058	.002	.092

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

developed by the algebraic combination of the most recent synchronous 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 4-8. Note that the predictions include the effect of the below recommended OOAA adjustments in Figures 4-5 and 4-6 and Table 4-8.

4.7 CONCLUSIONS AND RECOMMENDATIONS

A. With a nominal OOAA setting, the Forward Camera meets specification with the exception of the in-track means at the 37° position. However, with the recommended OOAA skew adjustment, the out-of-specification mean smear at 37° is not expected to seriously degrade performance. With a nominal OOAA setting, the Aft Camera mean errors are all within specification.

B. Even though both cameras are within specification, the following OOAA changes to both cameras are recommended to further reduce the mean smear errors. These recommendations are based on the zero smear intercept of the .044 and .052 lines, see Figures 4-1 and 4-3.

(1) An OOAA velocity adjustment of +1 command count from nominal is recommended for cross-track compensation of the Forward Camera.

(2) An OOAA skew adjustment of -4 command counts from nominal is recommended for in-track compensation of the Forward Camera.

(3) An OOAA velocity adjustment of -3 command counts from nominal is recommended for cross-track compensation of the Aft Camera.

(4) An OOAA skew adjustment of -2 command counts from nominal is recommended for in-track compensation of the Aft Camera.

C. A velocity adjustment derived from the acceptance test of -14 command counts from the flight nominal is recommended for Aft Camera cross-track compensation for both SO-255 and FE-3916 materials. This velocity adjustment assumes the mechanical characteristics of the FE-3916 material are similar to SO-255.

TABLE 4-8

ORBITAL IMAGE MOTION ERRORS AT Vx/h OF .052, 70° F

(inches/second)

Forward Camera

	IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	-45	0	55	37	-45	0	55	37	-45	0	55	37	-45	0	55	37	-45	0	55	37	-45	0	55	37
FRAME POSITION (DEGREES)	-2.5	0	2.0	2.0	-2.5	0	2.0	2.0	2	-2.5	0	0	2	-2.5	0	0	0	2	-2.5	-2.5	0	2	-2.5	-2.5
SMEAR ERROR	.058	.033	.032	.082	-.026	-.019	-.045	-.053	.058	.033	.032	.082	-.026	-.019	-.045	-.053	.058	.033	.032	.082	-.026	-.019	-.045	-.053
ORBITAL FIXED KNOWN	-.030	0	.023	.026	-.092	0	-.097	-.064	.033	-.045	0	0	.082	.001	-.006	0	.004	.038	-.027	-.032	.001	-.001	.103	.068
ORBITAL RESULTANT	.028	.033	.055	.108	-.118	-.019	-.142	-.117	.091	-.012	.032	.082	.056	-.018	-.051	-.053	.062	.071	.005	.050	-.025	-.020	.058	.015
RECOMMENDED OOAA BIAS	-.036	-.036	-.036	-.036	.014	.014	.014	.014	-.036	-.036	-.036	-.036	.014	.014	.014	.014	-.036	-.036	-.036	-.036	.014	.014	.014	.014
RESULTANT	-.008	-.003	.019	.072	-.104	-.005	-.128	-.103	.055	-.048	-.004	.048	.070	-.004	-.037	-.039	.026	.035	-.031	.014	-.011	-.006	.072	.029

Aft Camera

	IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK				IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	45	0	-55	-37	45	0	-55	-37	45	0	-55	-37	45	0	-55	-37	45	0	-55	-37	45	0	-55	-37
FRAME POSITION (DEGREES)	-2.5	0	2.0	2.0	-2.5	0	2.0	2.0	2	-2.5	0	0	2	-2.5	0	0	0	2	-2.5	-2.5	0	2	-2.5	-2.5
SMEAR ERROR	-.010	.008	.045	.058	-.037	-.039	.021	-.024	-.010	.008	.045	.058	-.037	-.039	.021	-.024	-.010	.003	.045	.058	-.037	-.039	.021	-.024
ORBITAL FIXED KNOWN	.036	0	-.017	-.028	.087	0	.087	.006	-.030	.047	.066	0	-.076	-.001	-.006	0	0	-.035	.033	.036	.001	0	-.112	-.076
ORBITAL RESULTANT	.026	.008	.028	.032	.050	-.039	.108	.042	-.040	.055	.051	.058	-.113	-.040	.015	-.024	-.010	-.025	.078	.094	-.036	-.039	-.091	-.100
RECOMMENDED OOAA BIAS	-.018	-.018	-.018	-.018	.042	.042	.042	.042	-.018	-.018	-.018	-.018	.042	.042	.042	.042	-.018	-.018	-.018	-.018	.042	.042	.042	.042
RESULTANT	.008	-.010	.010	.014	.092	.003	.150	.084	-.058	.037	.033	.040	-.071	.002	.057	.018	-.028	-.043	.060	.076	.006	.003	-.049	-.058

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.

SECTION V

FLIGHT FOCUS

5.1 INTRODUCTION

The recommended focus settings for the black and white (1414) portion of SV-8 are 68 microns for the Forward and 25 microns for the Aft Camera. Conventional color film (SO-255) and an experimental infrared film (FE-3916) will be included as part of the Aft payload. For the SO-255 and FE-3916 portions of this mission, the platen position should be set at 55 microns, an adjustment of +30 microns. This section gives the rationale for these decisions and includes an analysis of platen tilt adequacy and the filter change effect on focus.

5.2 PLATEN TILT ASPECTS

As described in Section III, thru focus tribars and lines at seven field positions across the full format are provided via a series of vehicle pitch tests using the 0° collimator. This data is presented 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. Tribar resolution data was hand-smoothed to locate central tendency. For cross-track, the two diagnostics consistently substantiate one another, i.e., the difference in PBF is 3 microns or less; and the "best estimates" are simply the averages of two independent determinations. The in-track situation is not as straightforward in that there is a tendency for the line PBFs to focus approximately 8 microns longer than the tribar PBFs. Since more credence is attributed to the thru focus resolution methodology, the line data was not included in the "best estimates". One exception to this is the Aft Camera +1° field case in which the tribar diagnostic does not go thru focus in the usual way; and the "best estimate" is the line determined PBF -8 microns. The "final assessment" PBFs are then the average of the in-track and cross-track "best estimate" PBFs. Figure 5-1 is a plot of these results in comparison with Chamber D interferometric measurements made on the individual optical bars.

The readiness test data analysis indicates 20 microns of field curvature on both cameras which is significantly different from the original optical bar data of 5 microns or less. The fact that this discrepant relationship between Chambers A-2 and D is characteristic is illustrated in Figure 5-2. Figure 5-2 presents a comparison of the SV-8 readiness data to the three preceding systems similarly tested via the vehicle pitch configuration. There is a marked similarity of the four sets of final data, including the asymmetry between the plus and minus field of the Forward Camera. All of the data, normalized to a common central null point, falls within ±6 microns of a central tendency. This can be attributed to measurement noise.

Based on this historical comparison, the apparent mistilt of the Forward Camera platen is judged to be non-existent. Further support of this judgment comes from the fact that VEM analysis of image quality

TABLE 5-1

TRIBAR AND LINE DETERMINATIONS OF PBF

Position (degrees)	Raw Data								Best Estimates				Final Assessment	
	Forward Camera				Aft Camera				Fwd Camera		Aft Camera			
	Tribars		Lines		Tribars		Lines							
	IT	XT	IT	XT	IT	XT	IT	XT	IT	XT	IT	XT	Forward	Aft
-2.5	64	61	72	59	19	16	13	14	64	60	19	15	62	17
-2.0	64	58	79	53	23	18	29	15	64	56	23	17	60	20
-1.0	74	67	81	68	31	28	37	29	74	67	31	28	71	30
0	68	67	76	67	35	33	39	36	68	67	35	34	68	35
1.0	70	66	83	68	41	29	41	29	70	67	33	29	69	31
2.0	51	56	57	54	22	19	32	20	51	55	22	19	53	21
2.5	49	53	51	53	15	17	14	17	50	53	15	17	51	16

CHAMBER A-2 VERSUS CHAMBER D FIELD CURVATURE COMPARISON

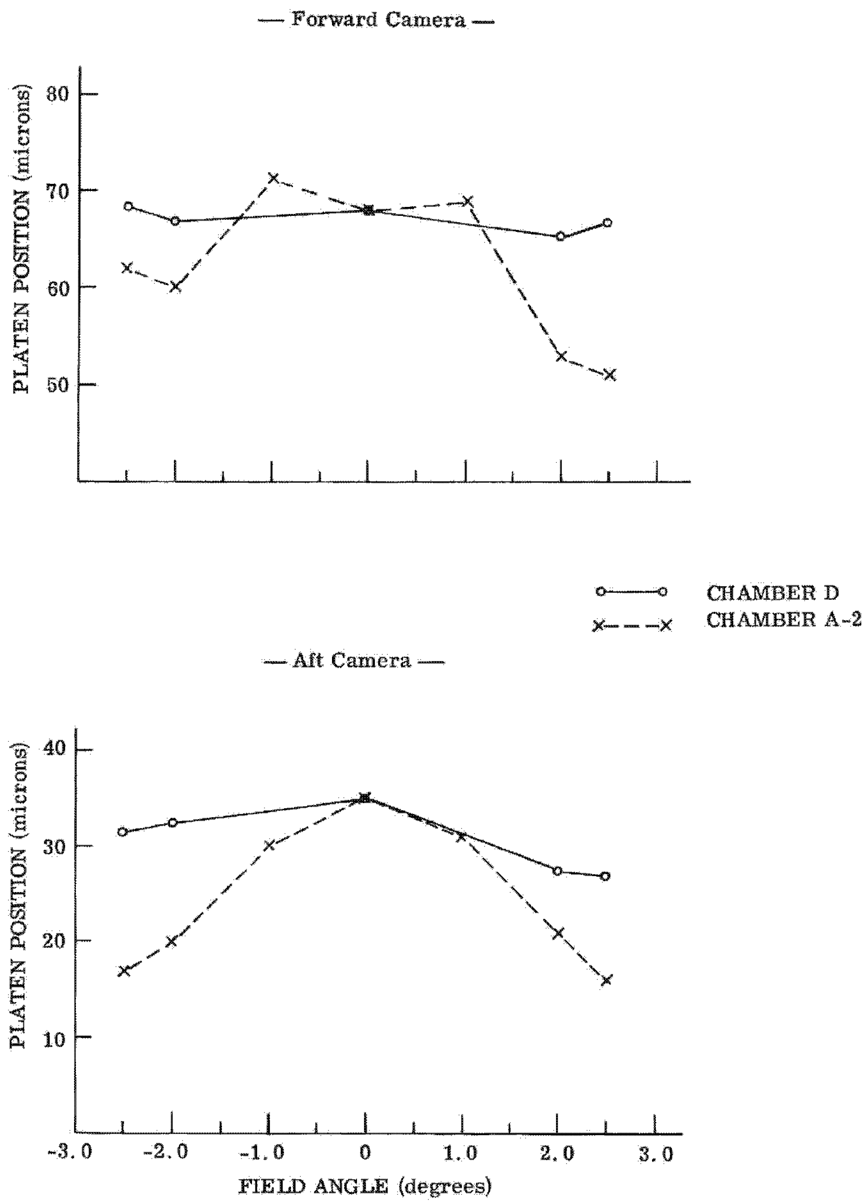


FIGURE 5-1

HISTORICAL COMPARISON OF CHAMBER A-2 MEASURED FIELD CURVATURES

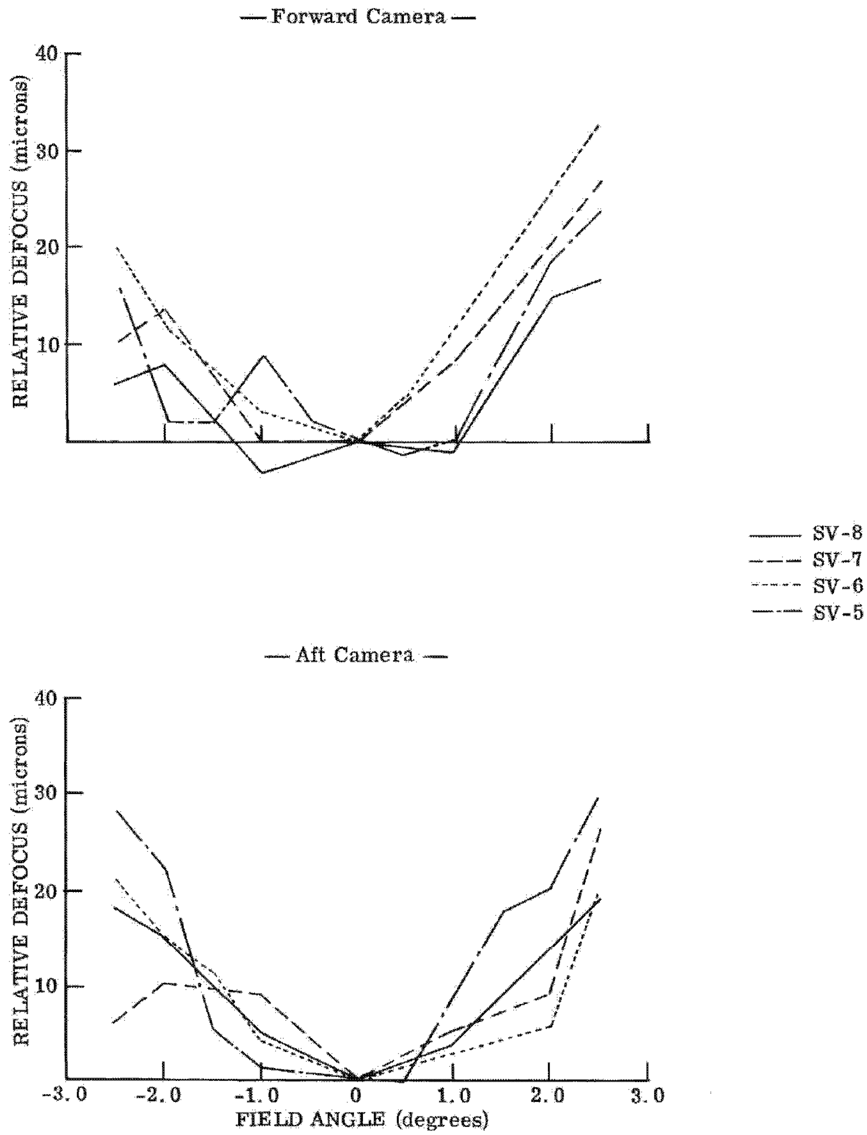


FIGURE 5-2

across the web near nadir from Missions 1205, 1206, and 1207 reveals no evidence of platen mistilt on the Forward or Aft Cameras. This PFA analysis of mission photography also indicates a degree of effective field curvature less severe than the camera/film Chamber A-2 configuration but more severe than the optical bar Chamber D configuration. In summary, the Readiness Team feels that the SV-8 platen tilt is adequate for launch.

5.3 IN-FLIGHT CHANGEABLE FILTER (ICF) PERFORMANCE

Both cameras are equipped with ICFs which allow a choice between two filters, a Wratten 12 or a Wratten 2E3. Seq L was run to determine if changes in either performance level or PBF occur when a change is made from one filter to the other. Test parameters were a Vx/h of .018, a slit width of .259", and the IMC disabled. The results of this analysis are that no detectable difference was noted in resolution or focus on the 1414 Film when switching from one filter to the other.

Replicate frames were acquired with each filter in place at platen positions of 71 and 33 microns for the Forward and Aft Cameras respectively. No change in the 2:1 contrast geometric mean resolution performance was found for either camera with the use of the different filters, see Table 5-2. Microdensitometric analysis of the line targets from the same frames was done using the FOCMO Program to determine PBFs for each filter. Again, no difference was found between the filters for either camera, see Table 5-3.

TABLE 5-2

COMPARISON OF AVERAGE RESOLUTION WITH TWO FILTERS

(cycles/mm)

	Forward Camera		Aft Camera	
Filter	Average Resolution	Sample Size	Average Resolution	Sample Size
W-12	193	26	185	20
W-2E3	181	18	175	18
W-12	173	18	182	18
W-2E3	177	18	183	18
W-12	179	18	184	24
Average:				
W-12	182	62	184	62
W-2E3	179	36	179	36

TABLE 5-3

COMPARISON OF LINE DETERMINED FOCUS WITH TWO FILTERS

(microns)

		In-Track		Cross-Track	
Camera	Filter	PBF	Sample Size	PBF	Sample Size
Forward	W-12	78	31	64	31
	W-2E3	78	18	65	18
Aft	W-12	45	31	37	31
	W-2E3	45	18	38	18

5.4 SELECTION OF LAUNCH PLATEN POSITION

Based upon the resolution performance analysis in Section III, optimally balanced field performance is at platen settings of 67 microns for the Forward and 30 microns for the Aft Camera. Corrections are made for vehicle altitude, gravity effects, and collimator focus as follows:

A. Collimators in Chamber A-2 are set for infinity focus. The reference orbit for Mission 1208 will provide a photographic acquisition average altitude of approximately 85 NM. This difference requires a correction of 14 microns, see Figure 5-3.

B. The on-orbit gravity release effect on focus is measured interferometrically on the individual optical bars by taking measurements with the gravity vector stressing the folding flat via appropriate positioning of the bar. The Chamber C measured residual 0° astigmatism on-axis is $-.11\lambda$ for OB Set 035 (Forward Camera) and $-.14\lambda$ for OB Set 037 (Aft Camera). Consistent with previous readiness procedures, the deformation of the folding flat is assumed to be fully spherical. With this assumption, focus shift (Δ F in microns) is a linear relationship to residual 0° astigmatism ($\delta\lambda$), i.e., $\Delta F = \delta\lambda$ (137). The resultant corrections in focus are, therefore, -15 microns for the Forward and -19 microns for the Aft Camera.

C. Chamber A-2 collimator focus settings are monitored interferometrically and can depart from specification. During readiness test operations, the Forward 0° collimator was monitored at 2.4 microns deviation and the Aft 0° collimator was monitored to be .5 micron.

These three correction factors are applied to the optimum platen positions to balance the field as derived in Section III to determine the recommended launch settings. Table 5-4 presents these factors for SV-8:

FOCUS AS A FUNCTION OF ALTITUDE AND SCAN ANGLE

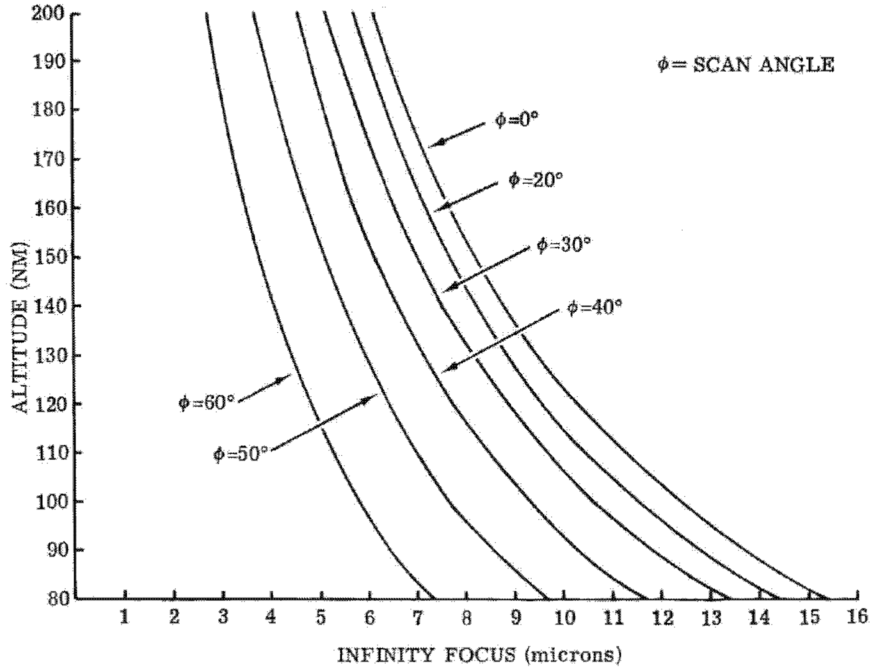


FIGURE 5-3

TABLE 5-4

LAUNCH FOCUS SETTING FACTORS

(microns)

Factor	Forward Camera	Aft Camera
Platen Position for Best Resolution Across Field From Readiness Test Data	67	30
Adjustment for 85 NM Mission Altitude	14	14
Collimator Defocus Adjustment	2	0
Adjustment for Gravity Release on Folding Flat Assuming Spherical Deformation	-15	-19
Launch Platen Position	68	25

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 during the past five 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 $\pm 2.0°$ 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%. 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' and 9' 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 that time of the year. Hence, it is not uncommon to have photography of 10 to 15 feet GRD under these conditions even when the camera 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.

6.3 PREDICTIONS FOR MISSION 1208

A series of CRYSPER runs have been made to estimate the performance from Mission 1208. The CRYSPER output discussed in this section consists of the format/solar altitude table and one page of the target access data for the conditions used. The orbital elements for a March 1974 launch 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 five 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 made in this test have been based primarily on laboratory data. Since there are uncertainties in some of the data, a CRYSPER run was made using a worse case estimate for some of these parameters.

Tables 6-4 and 6-5 are estimates of the performance to be expected with worse case errors of defocus and smear. These tables are comparable to Tables 6-1 and 6-3 respectively. Based on past experience, the magnitude of the focus error can be as much as eight microns, while discrepancies in the synchronization data could produce errors in the mean smear rates of .05 inch/second. The predicted resolution for CORN targets with these errors (Tables 6-4 and 6-5) shows a significant loss in resolution.

TABLE 6-1

MISSION 1208 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)

	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	8	65	76	85	88	95	101	103	99	94	88	83	76	69
	75	13	92	104	118	123	132	138	140	137	132	126	118	109	99
	70	18	105	120	134	141	150	156	160	156	151	145	137	127	114
	65	23	116	132	147	154	163	169	174	171	166	159	150	139	125
AFT CAMERA	60	27	124	142	156	164	173	179	184	181	176	169	160	148	132
	50	35	135	154	165	173	181	187	192	190	185	179	174	161	143
SSN 011 OSN 378	40	43	144	165	175	184	192	197	200	199	195	189	179	171	152
	30	50	150	172	183	192	200	204	206	205	201	195	185	178	157
	20	56	153	177	187	197	204	208	210	209	205	199	189	182	160
	80	8	56	69	75	80	87	93	101	94	89	82	76	74	69
	75	13	89	99	106	114	121	128	136	130	124	117	109	108	99
	70	18	104	116	125	132	140	147	154	148	143	135	127	125	115
	65	23	117	129	139	147	154	161	166	162	156	149	141	137	126
FORWARD CAMERA	60	27	125	140	149	157	164	170	175	171	166	159	150	146	134
	50	35	137	152	160	168	174	179	183	179	175	168	163	158	144
SSN 011 OSN 35A	40	43	145	162	169	178	184	190	193	190	185	178	169	166	152
	30	50	152	169	177	186	192	197	200	196	191	184	175	172	157
	20	56	155	173	181	190	196	201	203	200	195	188	178	175	160

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
	80	8	20.97	11.47	7.58	5.99	4.88	4.28	4.10	4.34	4.92	6.01	7.83	11.44	19.80
	75	13	14.36	8.12	5.37	4.20	3.45	3.07	2.93	3.09	3.45	4.13	5.35	7.78	13.41
	70	18	12.31	6.90	4.63	3.61	2.97	2.65	2.52	2.65	2.94	3.51	4.54	6.57	11.43
	65	23	10.91	6.14	4.14	3.23	2.68	2.40	2.28	2.38	2.64	3.13	4.05	5.86	10.22
AFT CAMERA	60	27	10.01	5.62	3.83	2.99	2.48	2.23	2.12	2.21	2.44	2.89	3.72	5.39	9.47
	50	35	8.91	4.99	3.50	2.74	2.29	2.06	1.97	2.04	2.24	2.65	3.32	4.79	8.41
SSN 011 OSN 378	40	43	8.13	4.56	3.22	2.51	2.11	1.92	1.84	1.90	2.08	2.45	3.14	4.41	7.72
	30	50	7.68	4.30	3.03	2.37	2.00	1.83	1.76	1.81	1.99	2.34	2.99	4.17	7.34
	20	56	7.49	4.17	2.95	2.31	1.96	1.79	1.73	1.78	1.95	2.29	2.93	4.07	7.17
	80	8	24.33	12.51	8.58	6.63	5.32	4.62	4.18	4.56	5.23	6.44	8.53	11.68	19.89
	75	13	14.99	8.59	5.95	4.55	3.75	3.28	3.03	3.24	3.66	4.43	5.79	7.88	13.41
	70	18	12.48	7.15	4.97	3.83	3.18	2.82	2.63	2.79	3.12	3.75	4.88	6.65	11.29
	65	23	10.89	6.29	4.36	3.40	2.84	2.52	2.38	2.51	2.80	3.35	4.33	5.96	10.12
FORWARD CAMERA	60	27	9.95	5.72	4.00	3.10	2.61	2.34	2.22	2.33	2.58	3.08	3.98	5.47	9.29
	50	35	8.73	5.06	3.60	2.82	2.38	2.15	2.06	2.15	2.38	2.82	3.54	4.90	8.33
SSN 011 OSN 35A	40	43	8.04	4.64	3.32	2.59	2.20	1.98	1.90	1.99	2.19	2.60	3.33	4.52	7.69
	30	50	7.58	4.38	3.13	2.45	2.08	1.88	1.82	1.89	2.09	2.47	3.18	4.32	7.34
	20	56	7.39	4.27	3.06	2.40	2.04	1.85	1.79	1.86	2.05	2.42	3.11	4.23	7.19

PARAMETERS ASSOCIATED WITH THE LAST ENTRY INTHE RIGHT HAND 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)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)		OBLATE EARTH RADIUS		SATELLITE TO EARTH CENTER(NM)	VXOH	VYOH
19 39 33	33	7	1	4	129.77	17	3	74	0.00015	25700.78	20.1422	29.060	89.1	+	3442.6	=	3531.6	0.0460	0.00263

TABLE 6-2

MISSION 1208 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)

	SCAN LAT	SUN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	8	45	59	68	72	78	82	84	81	77	72	66	59	49
	75	13	68	81	93	99	106	110	112	110	106	101	94	85	73
	70	18	78	93	105	111	119	123	126	123	120	114	107	98	85
	65	23	87	102	114	121	128	132	135	133	129	124	117	107	93
AFT CAMERA	60	27	93	109	120	127	134	139	142	140	136	130	123	113	99
	50	35	102	118	129	136	143	148	151	149	145	140	132	121	107
SSN 011 OSN 378	40	43	108	124	136	144	150	154	157	155	152	146	138	128	113
	30	50	112	129	140	148	155	158	161	160	156	151	142	132	117
	20	56	115	131	143	151	157	161	163	162	158	153	145	134	119
	80	8	38	54	61	66	72	77	83	78	74	68	62	58	48
	75	13	66	78	86	93	99	105	110	106	102	96	89	85	74
	70	18	78	91	99	107	113	118	123	119	115	109	102	98	86
	65	23	88	101	110	117	123	128	131	128	124	119	111	107	94
FORWARD CAMERA	60	27	94	109	118	125	130	135	138	135	131	125	118	113	101
	50	35	104	118	128	135	140	144	147	144	140	134	127	122	110
SSN 011 DSN 35A	40	43	111	125	135	142	148	152	154	151	147	142	134	128	115
	30	50	115	130	140	147	153	157	158	156	152	146	138	132	119
	20	56	117	132	142	150	155	159	160	158	154	149	141	134	121

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

	SCAN LAT	SUN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	8	30.16	14.73	9.49	7.34	5.94	5.22	5.01	5.28	5.99	7.33	9.75	14.65	27.65
	75	13	19.46	10.40	6.77	5.22	4.29	3.82	3.66	3.83	4.28	5.12	6.70	9.93	18.13
	70	18	16.55	8.90	5.89	4.55	3.75	3.36	3.20	3.35	3.72	4.44	5.78	8.46	15.36
	65	23	14.65	7.93	5.33	4.12	3.41	3.06	2.93	3.05	3.38	4.02	5.21	7.63	13.67
AFT CAMERA	60	27	13.36	7.32	4.94	3.83	3.19	2.87	2.74	2.85	3.16	3.75	4.84	7.07	12.57
	50	35	11.80	6.54	4.48	3.47	2.90	2.61	2.49	2.59	2.86	3.39	4.38	6.35	11.23
SSN 011 OSN 378	40	43	10.81	6.04	4.15	3.21	2.70	2.44	2.34	2.42	2.67	3.15	4.07	5.90	10.34
	30	50	10.26	5.76	3.94	3.07	2.58	2.34	2.26	2.33	2.56	3.02	3.89	5.63	9.84
	20	56	10.00	5.64	3.87	3.01	2.54	2.31	2.22	2.29	2.52	2.98	3.82	5.53	9.63
	80	8	35.81	16.00	10.59	7.96	6.43	5.56	5.05	5.48	6.23	7.77	10.48	14.92	28.47
	75	13	20.14	10.87	7.33	5.58	4.60	4.02	3.73	3.97	4.46	5.41	7.13	10.01	18.07
	70	18	16.62	9.12	6.22	4.75	3.94	3.50	3.29	3.47	3.87	4.66	6.08	8.50	15.17
	65	23	14.49	8.05	5.50	4.25	3.55	3.17	3.01	3.16	3.51	4.20	5.45	7.62	13.49
FORWARD CAMERA	60	27	13.17	7.34	5.05	3.91	3.29	2.95	2.82	2.95	3.27	3.90	5.04	7.05	12.35
	50	35	11.53	6.52	4.50	3.51	2.97	2.68	2.57	2.68	2.97	3.52	4.54	6.33	10.97
SSN 011 OSN 35A	40	43	10.54	6.01	4.17	3.25	2.75	2.48	2.39	2.49	2.75	3.26	4.21	5.88	10.13
	30	50	9.99	5.71	3.97	3.09	2.62	2.37	2.29	2.38	2.63	3.11	4.01	5.62	9.68
	20	56	9.77	5.59	3.89	3.03	2.57	2.34	2.26	2.34	2.59	3.06	3.93	5.53	9.48

PARAMETERS ASSOCIATED WITH THE LAST ENTRY INTHE RIGHT HAND COLUMN OF THE TABLE

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE DA	DATE MO	DATE YR	ROOH	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)		OBLATE EARTH RADIUS		SATELLITE TO EARTH CENTER(NM)	VXOH	VYOH
19 39 33	20	10	1	4	129.77	17	3	74	0.00015	25700.78	20.1422	29.060	89.1	+	3442.6	=	3531.6	0.0460	0.00263

TABLE 6-3

MISSION 1208 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
	80	8	75	81	88	91	97	102	104	100	96	90	85	81	79
	75	13	101	108	119	122	129	134	136	133	129	124	119	112	108
	70	18	115	122	133	137	144	148	152	149	145	140	135	129	122
	65	23	124	134	143	147	154	158	161	159	155	151	145	139	130
AFT CAMERA	60	27	129	141	150	154	160	167	171	169	165	158	152	145	139
	50	35	137	150	157	162	171	175	179	177	174	166	161	153	145
SSN 011 OSN 378	40	43	145	156	164	172	178	181	183	182	179	175	169	159	150
	30	50	149	160	168	177	182	185	187	185	183	178	172	162	153
	20	56	150	162	174	180	184	187	188	187	184	180	174	166	154
	80	8	65	74	77	82	88	94	101	95	90	84	79	80	77
	75	13	97	102	107	113	119	125	132	126	121	115	110	111	109
	70	18	113	118	124	129	135	140	146	141	136	131	125	127	123
	65	23	123	131	136	141	145	151	157	153	147	141	136	137	132
FORWARD CAMERA	60	27	131	139	144	148	153	160	164	160	156	148	143	143	140
	50	35	141	147	153	158	165	169	172	168	164	159	151	151	146
SSN 011 OSN 35A	40	43	146	154	160	168	172	176	178	175	171	166	160	156	150
	30	50	150	158	167	173	177	180	182	179	175	170	164	159	153
	20	56	152	160	170	175	179	182	183	181	177	172	166	163	154

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
	80	8	18.25	10.66	7.31	5.83	4.79	4.22	4.06	4.29	4.84	5.85	7.57	10.66	17.36
	75	13	13.16	7.87	5.30	4.23	3.52	3.15	3.02	3.17	3.53	4.17	5.32	7.57	12.30
	70	18	11.29	6.80	4.65	3.71	3.09	2.78	2.66	2.78	3.08	3.63	4.61	6.46	10.65
	65	23	10.25	6.08	4.25	3.38	2.84	2.57	2.45	2.55	2.81	3.31	4.19	5.87	9.80
AFT CAMERA	60	27	9.61	5.65	3.98	3.18	2.68	2.38	2.27	2.36	2.60	3.10	3.92	5.49	9.01
	50	35	8.79	5.15	3.66	2.92	2.43	2.20	2.11	2.18	2.39	2.85	3.60	5.05	8.29
SSN 011 OSN 378	40	43	8.04	4.83	3.43	2.68	2.28	2.08	2.00	2.07	2.26	2.64	3.33	4.74	7.80
	30	50	7.73	4.63	3.29	2.57	2.20	2.01	1.94	2.00	2.19	2.56	3.22	4.58	7.55
	20	56	7.62	4.57	3.19	2.53	2.17	1.99	1.93	1.98	2.17	2.53	3.19	4.45	7.47
	80	8	20.89	11.66	8.38	6.45	5.25	4.56	4.16	4.53	5.16	6.28	8.21	10.86	17.61
	75	13	13.61	8.34	5.88	4.58	3.82	3.38	3.13	3.34	3.75	4.49	5.75	7.68	12.18
	70	18	11.50	7.05	5.00	3.93	3.30	2.95	2.77	2.93	3.26	3.88	4.96	6.53	10.56
	65	23	10.30	6.23	4.46	3.54	3.00	2.69	2.52	2.65	2.97	3.52	4.47	5.96	9.64
FORWARD CAMERA	60	27	9.53	5.75	4.15	3.29	2.80	2.49	2.38	2.49	2.76	3.29	4.17	5.58	8.90
	50	35	8.48	5.23	3.76	2.99	2.52	2.29	2.19	2.29	2.53	2.97	3.82	5.12	8.24
SSN 011 OSN 35A	40	43	7.98	4.88	3.52	2.75	2.36	2.14	2.06	2.15	2.37	2.78	3.52	4.83	7.79
	30	50	7.65	4.68	3.31	2.63	2.26	2.06	2.00	2.08	2.28	2.67	3.38	4.68	7.55
	20	56	7.54	4.62	3.26	2.60	2.23	2.04	1.98	2.05	2.26	2.64	3.33	4.55	7.46

PARAMETERS ASSOCIATED WITH THE LAST ENTRY INTHE RIGHT HAND COLUMN OF THE TABLE

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE DA	DATE MO	DATE YR	ROOH	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER(NM)	VXOH	VYOH
19 39 33	33	7	1	4	129.77	17	3	74	0.00015	25700.78	20.1422	29.060	89.1 +	3442.6 =	3531.6	0.0460	0.00263

TABLE 6-4

MISSION 1208 CRYSPER PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR WORSE CASE PHOTOGRAPHY OF 7-33% REFLECTANCE TARGETS — 8 MICRONS DEFOCUS, .05 IPS FILM SYNCHRONIZATION ERROR —

(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
	80	8	59	72	81	85	91	95	96	94	89	84	79	72	65
	75	13	83	95	106	111	118	124	126	123	118	113	106	99	88
	70	18	93	106	116	123	131	136	139	136	132	126	118	109	99
	65	23	101	113	125	132	140	145	148	145	140	134	127	116	106
AFT CAMERA	60	27	105	119	131	138	146	152	155	153	148	140	132	122	110
	50	35	112	127	135	143	152	158	161	159	154	147	139	129	116
SSN 011 OSN 378	40	43	117	132	141	151	159	164	168	166	161	153	142	134	121
	30	50	120	135	145	155	164	170	173	171	166	157	146	138	124
	20	56	122	137	147	158	167	173	175	174	168	159	148	139	126
	80	8	53	67	73	77	84	90	96	91	85	79	73	71	66
	75	13	83	93	100	107	114	119	125	120	114	107	101	99	91
	70	18	95	106	114	121	127	133	138	133	128	121	113	111	102
	65	23	103	116	124	131	138	143	146	142	137	131	123	119	110
FORWARD CAMERA	60	27	110	122	131	139	145	150	154	150	145	137	129	125	115
	50	35	117	130	138	145	151	157	160	156	151	144	137	132	121
SSN 011 OSN 358	40	43	122	136	143	152	159	164	167	164	159	151	141	137	125
	30	50	125	139	147	157	164	170	173	169	163	156	145	141	128
	20	56	127	141	149	160	167	173	175	172	166	158	148	142	130

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
	80	8	22.92	12.07	7.95	6.26	5.12	4.53	4.36	4.59	5.20	6.27	8.19	12.02	21.05
	75	13	15.93	8.93	5.96	4.65	3.84	3.41	3.27	3.42	3.84	4.59	5.96	8.61	15.11
	70	18	13.95	7.85	5.32	4.11	3.39	3.03	2.90	3.03	3.38	4.03	5.25	7.60	13.16
	65	23	12.63	7.17	4.86	3.77	3.13	2.80	2.67	2.79	3.11	3.71	4.80	6.99	12.07
AFT CAMERA	60	27	11.79	6.72	4.56	3.54	2.93	2.62	2.50	2.60	2.90	3.49	4.51	6.53	11.32
	50	35	10.69	6.08	4.26	3.30	2.73	2.45	2.34	2.43	2.70	3.23	4.14	5.96	10.37
SSN 011 OSN 378	40	43	9.99	5.68	4.00	3.06	2.55	2.29	2.19	2.27	2.53	3.01	3.96	5.60	9.67
	30	50	9.56	5.47	3.83	2.93	2.44	2.19	2.10	2.17	2.42	2.90	3.79	5.38	9.26
	20	56	9.37	5.38	3.77	2.89	2.39	2.15	2.07	2.14	2.38	2.86	3.74	5.31	9.11
	80	8	25.72	12.84	8.87	6.83	5.51	4.76	4.38	4.76	5.44	6.70	8.81	12.18	20.70
	75	13	16.05	9.14	6.33	4.85	4.00	3.53	3.30	3.52	3.97	4.82	6.29	8.57	14.60
	70	18	13.71	7.86	5.41	4.19	3.51	3.10	2.93	3.10	3.47	4.18	5.46	7.46	12.77
	65	23	12.29	7.03	4.90	3.79	3.17	2.84	2.71	2.85	3.18	3.81	4.95	6.85	11.59
FORWARD CAMERA	60	27	11.33	6.55	4.55	3.52	2.96	2.66	2.53	2.66	2.97	3.57	4.61	6.40	10.84
	50	35	10.22	5.93	4.18	3.26	2.76	2.46	2.36	2.47	2.75	3.29	4.21	5.84	9.92
SSN 011 OSN 358	40	43	9.57	5.53	3.92	3.03	2.54	2.29	2.20	2.30	2.55	3.06	4.00	5.48	9.35
	30	50	9.21	5.31	3.77	2.89	2.43	2.19	2.10	2.19	2.45	2.92	3.82	5.27	9.00
	20	56	9.06	5.23	3.70	2.85	2.40	2.15	2.07	2.16	2.41	2.88	3.75	5.21	8.86

PARAMETERS ASSOCIATED WITH THE LAST ENTRY INTHE RIGHT HAND COLUMN OF THE TABLE

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE DA	DATE MO	DATE YR	RDOH	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER(NM)	VXOH	VYOH
19 39 33	33	7	1	4	129.77	17	3	74	0.00015	25700.78	20.1422	29.060	89.1 +	3442.6 =	3531.6	0.0460	0.00263

TABLE 6-5

MISSION 1208 CRYSPER VEM PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR WORSE CASE PHOTOGRAPHY FOR 2:1 APPARENT CONTRAST OBJECTS
— 8 MICRONS DEFOCUS, .05 IPS FILM SYNCHRONIZATION ERROR —
(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
	80	8	70	78	85	87	92	96	97	95	91	86	82	78	75
	75	13	91	99	107	111	116	120	122	119	116	111	107	101	98
	70	18	101	107	116	120	126	130	132	130	127	122	116	111	106
	65	23	106	115	122	127	132	136	138	136	133	128	123	116	110
AFT CAMERA	60	27	110	118	126	131	136	141	144	142	138	132	127	120	114
	50	35	113	123	130	135	143	147	149	148	144	137	131	124	117
SSN 011 OSN 378	40	43	117	126	134	141	147	151	153	151	148	142	136	127	120
	30	50	119	128	135	144	150	153	155	154	150	144	138	129	121
	20	56	120	129	138	145	151	154	156	155	151	145	138	131	122
	80	8	62	72	75	79	86	91	96	91	86	81	76	78	75
	75	13	92	96	101	106	111	116	120	116	111	106	101	102	100
	70	18	102	107	114	118	122	127	131	127	123	118	112	113	110
	65	23	110	117	121	125	130	134	139	135	130	125	119	119	115
FORWARD CAMERA	60	27	114	121	126	131	135	141	143	140	136	129	124	122	119
	50	35	120	126	132	137	143	146	148	146	141	136	129	127	122
SSN 011 OSN 35A	40	43	123	129	136	143	147	151	153	151	147	141	135	130	124
	30	50	124	132	140	146	151	155	156	154	150	143	137	132	125
	20	56	125	133	141	147	152	156	157	155	151	145	138	134	125

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
	80	8	19.45	11.11	7.63	6.10	5.03	4.48	4.32	4.54	5.11	6.12	7.88	11.12	18.24
	75	13	14.53	8.59	5.88	4.68	3.91	3.51	3.38	3.53	3.93	4.65	5.93	8.39	13.65
	70	18	12.81	7.72	5.34	4.22	3.53	3.18	3.05	3.18	3.52	4.17	5.32	7.47	12.34
	65	23	11.93	7.10	4.98	3.93	3.30	2.98	2.86	2.98	3.29	3.88	4.95	7.00	11.57
AFT CAMERA	60	27	11.32	6.74	4.73	3.74	3.15	2.82	2.70	2.81	3.10	3.70	4.71	6.65	10.92
	50	35	10.56	6.25	4.42	3.49	2.91	2.63	2.52	2.61	2.89	3.46	4.41	6.20	10.27
SSN 011 OSN 378	40	43	9.92	5.94	4.21	3.28	2.76	2.50	2.40	2.49	2.74	3.25	4.15	5.91	9.77
	30	50	9.62	5.77	4.09	3.17	2.67	2.42	2.34	2.42	2.66	3.15	4.03	5.74	9.49
	20	56	9.53	5.73	4.01	3.14	2.65	2.41	2.33	2.40	2.65	3.13	4.00	5.63	9.42
	80	8	21.78	12.02	8.59	6.65	5.42	4.73	4.36	4.73	5.38	6.55	8.51	11.19	18.23
	75	13	14.48	8.84	6.26	4.89	4.08	3.63	3.42	3.63	4.08	4.88	6.26	8.33	13.33
	70	18	12.71	7.73	5.44	4.29	3.63	3.26	3.08	3.25	3.62	4.31	5.55	7.34	11.87
	65	23	11.56	6.97	5.00	3.97	3.35	3.02	2.85	2.99	3.36	3.99	5.10	6.85	11.09
FORWARD CAMERA	60	27	10.89	6.58	4.74	3.73	3.17	2.83	2.72	2.85	3.16	3.78	4.82	6.52	10.45
	50	35	9.97	6.12	4.36	3.44	2.90	2.64	2.54	2.65	2.94	3.47	4.47	6.08	9.83
SSN 011 OSN 35A	40	43	9.52	5.80	4.13	3.22	2.75	2.49	2.39	2.50	2.76	3.28	4.18	5.79	9.42
	30	50	9.27	5.62	3.95	3.13	2.65	2.40	2.32	2.41	2.67	3.17	4.04	5.63	9.20
	20	56	9.20	5.57	3.91	3.10	2.62	2.38	2.31	2.40	2.65	3.14	4.00	5.51	9.15

PARAMETERS ASSOCIATED WITH THE LAST ENTRY INTHE RIGHT HAND COLUMN OF THE TABLE

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE DA	DATE MO	DATE YR	RDOH	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER(NM)	VXOH	VYOH
19 39 33	33	7	1	4	129.77	17	3	74	0.00015	25700.78	20.1422	29.060	89.1 *	3442.6 *	3531.6	0.0460	0.00263

SECTION VII

ELECTROMECHANICAL ANALYSIS

7.1 INTRODUCTION

The electromechanical (EM) evaluation reported in this section was derived from telemetry data from the tests run at the West Coast Facility using MACFACT, GOTCHA, 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 angles 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 platen position modulation command is incorrect for the first frame for certain scan angle/scan center combinations. This is due to a late PSW-Not signal from the SCC box. The PSW-Not signal will normally occur at 69.5° (Forward OB) once the Forward/Aft enable signal has been generated by the SCC. However, for the first frame the signal occurs in conjunction with the first Forward 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.

TABLE 7-1

SCAN MODES AFFECTED BY LATE PSW-NOT SIGNAL

Scan Center (degrees)	Scan Angle (degrees)			
	30	60	90	120
-45	Aft			
-30	Aft	Aft		
-15	Aft	Aft	-	
0	-	-	-	-
15	Forward	Forward	-	
30	Forward	Forward		
45	Forward			

NOTE: Dashes denote scan modes not affected.

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

7.3 START/STOP TIMES

The start/stop times for SV-8 were evaluated from the data in Sequences V and W of the Chamber A-2 vacuum test. Table 7-2 summarizes the results of the start/stop time evaluation.

TABLE 7-2

START/STOP TIMES

(seconds)

Parameter	Seq V (Vx/h of .0519) Nominal	Seq V (Vx/h of .0519) Measured	Seq W (Vx/h of .0442) Nominal	Seq W (Vx/h of .0442) Measured	Seq 12-2 (Vx/h of .0278) Measured
TOBACC	11.53	11.51	9.82	9.88	-
TFSU	10.95	10.74	9.33	9.31	-
TBC	0.26	0.28	0.31	0.31	-
T 1 + T 2 (VI Enabled)	-	1.42	-	1.28	-
T 1 + T 2 (VI Disabled)	-	-	-	-	.85
T3	-	0.62	-	0.58	-
2RWV/A	2.18	2.09	2.18	2.07	-
T 1-0	-	6.18	-	7.23	-
T 2-1	-	8.58	-	10.19	-
T 3-2	10.42	10.39	8.71	8.62	-
T 4-3	10.42	9.88	6.86	6.32	-
T 5-4	0.56	0.34	0.56	0.34	-

NOTES:
1. TOBACC is the time for the OB velocity command to go from 0 to final run value.
2. TFSU is the time for the SU velocity command to go from 0 to final run value.
3. TBC is the time from metering capstan (MC) tachometer transition start to first shutter open on the Forward Camera. The values shown have been increased by .03 seconds to account for the early shutter open on the first frame.
4. T 1 is the delay between OBs on-command and OB velocity tach start.
5. Note: Before determining T 2, verify that the OBs have reached constant velocity prior to FTs on. T 2 is the delay between film transports (FTs) on-command and SU velocity is commanded to start.
6. T 3 is the time from constant SU velocity command to MC transition. There is no clear cut nominal value for T 1, T 2, or T 3. The sum of T 1 and T 2 should be used as a guide for setting TDELTA OB and TDELTA FT in the TUNITY data base. Note: These times for T 1 and T 2 are calculated with Verification Interlock Enable. Another set of values for T 1 and T 2 are required with the Verification Interlock Disabled.

7. 2RWV/A is the duration of the rewind as indicated by the SU velocity command.
8. T 1-0 is the time from FTs off-command until the SU velocity command begins its ramp down. Nominal values are not obtainable.
9. T 2-1 is the time from OB off-command until OB velocity tach begins its ramp-down. Nominal values are not obtainable.
10. T 3-2 is the duration of the OB velocity tach ramp-down to 18 degrees per second.
11. T 4-3 is the time the OBs remain at 18 degrees per second.
12. T 5-4 is the time from end of 18 degrees per second until the OBs have stopped.

7.4 SLIT WIDTH

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

TABLE 7-3

SLIT WIDTH DATA

(inches)

	Forward Camera		Aft Camera	
Command	Telemetry Reading	Film Measurement	Telemetry Reading	Film Measurement
.080	.080	.080	.080	.080
.150	.150	.150	.150	.150
.281	.280	.280	.277	.276
.525	.522	.528	.522	.525
.910	.901	.905	.901	.900
.525	.527	.535	.527	.530
.281	.280	.280	.280	.280
.150	.147	.150	.149	.150
.080	.080	.080	.080	.080

7.5 LATERAL SEPARATION FOCUS SENSOR (LSFS)

The LSFS calibration curves for Mission 1208 are shown in Figures 7-1 and 7-2. The ground test curves, which are the basis for the flight calibration, are also shown. This data was obtained from Seq 5 of the Chamber A-1 test at a Vx/h of .044, 62°F with IMC enabled. The companion curves showing LSFS bias as a function of temperature based on the Chamber A tests are shown in Figure 7-3. The bias curves are referenced to zero at 62°F, which corresponds to the calibration temperature.

The orbital calibration curves reflect a predicted gravity release of 10 microns for the Forward and 14 microns for the Aft Camera.

The slopes of the calibration curves at the plane of best focus (PBF) are approximately 2.52 microns/count for the Forward Camera and 2.06 microns/count for the Aft.

7.6 OPTICAL BAR ANGULAR VELOCITY SCALING TO Vx/h

The optical bar velocity has been consistently 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-2. The data shows max/min percentage velocity errors (measured versus commanded) calculated from 0-180° pulses.

TABLE 7-4

CHAMBER A-2 OPTICAL BAR VELOCITY SCALING
DATA CALCULATED FROM 0° - 180° PULSES
(percent)

Sequence	Vx/h (radians/second)	Forward Optical Bar		Aft Optical Bar	
		Maximum	Minimum	Maximum	Minimum
F	.036	.334	.286	.334	.286
Q	.036	.334	.286	.334	.286
L	.044	.369	.297	.369	.297
W	.044	.369	.297	.369	.297
H	.052	.344	.243	.344	.243
V	.052	.344	.243	.344	.243

FORWARD CAMERA LSFS CALIBRATION CURVES

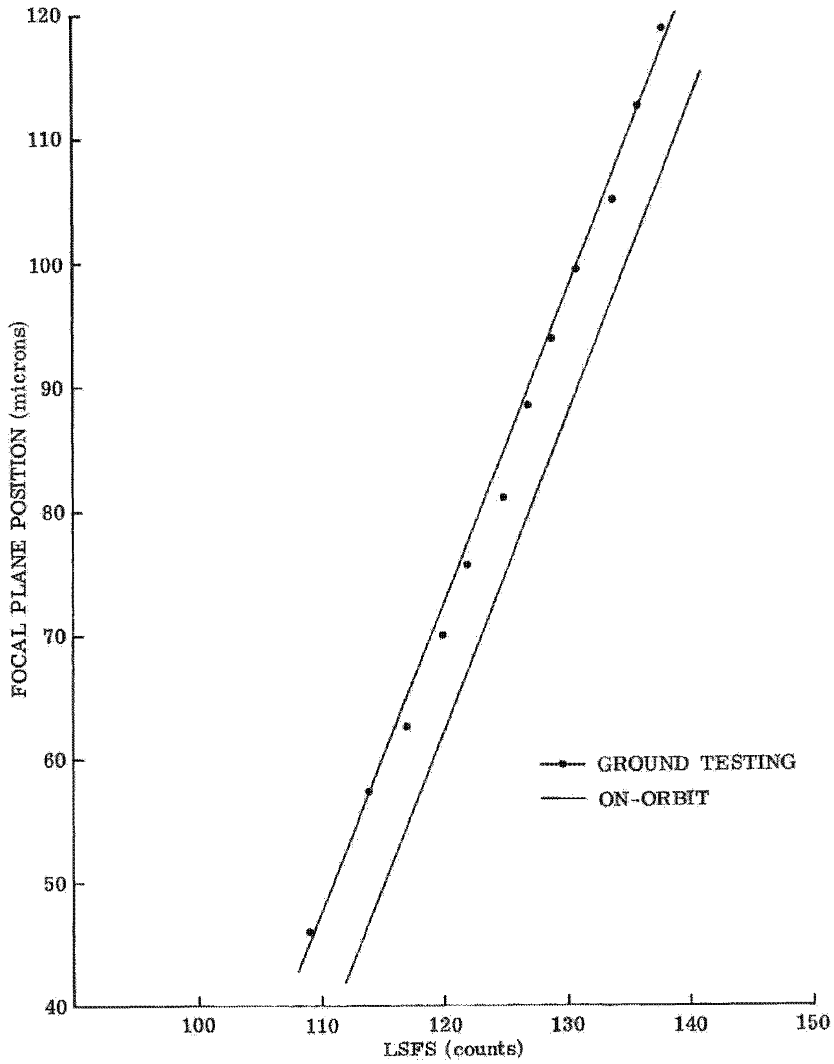


FIGURE 7-1

AFT CAMERA LSFS CALIBRATION CURVE

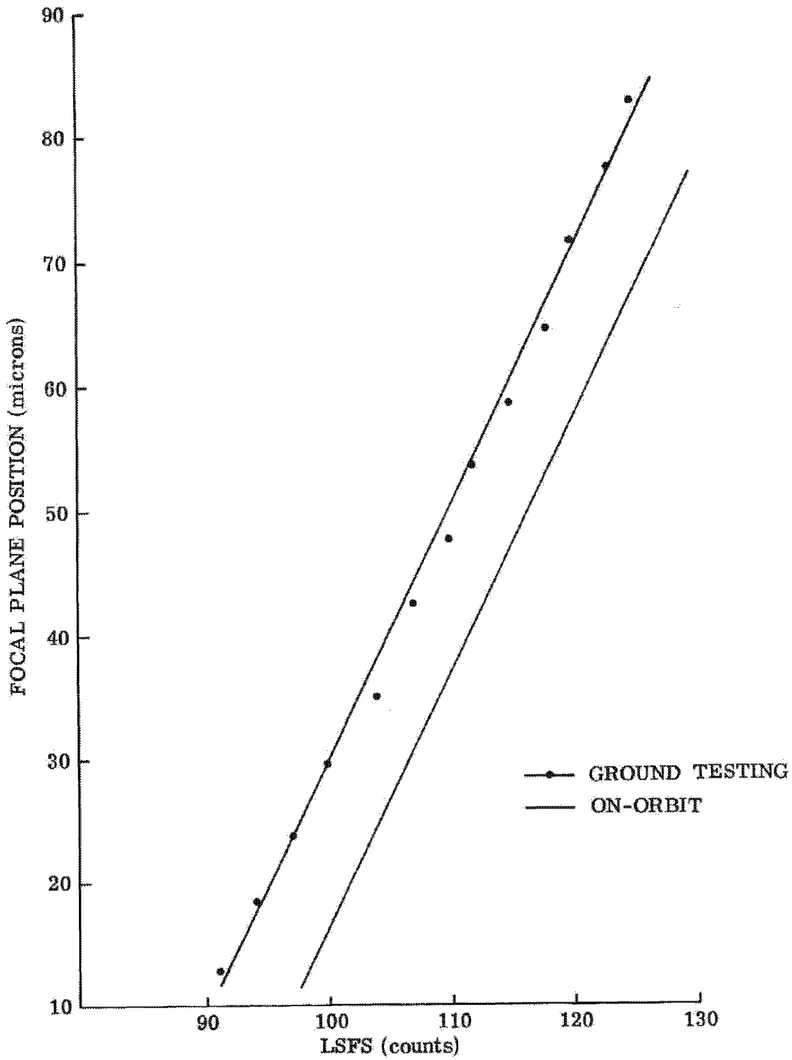
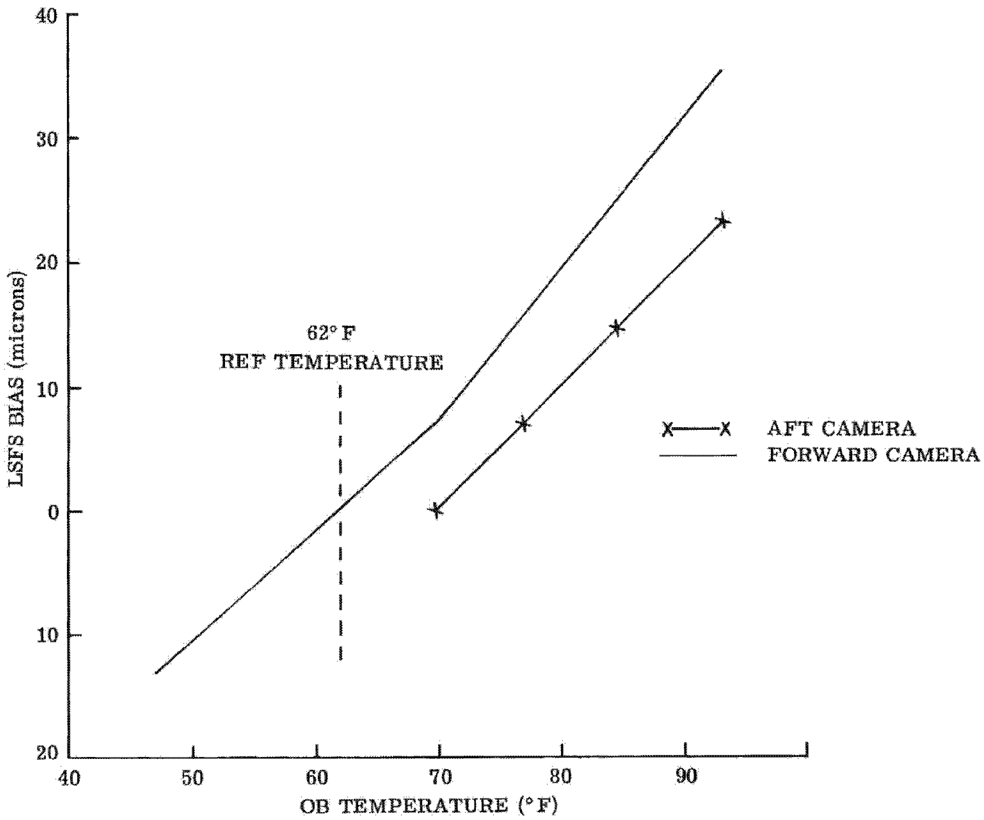


FIGURE 7-2

LSFS TEMPERATURE BIAS PROFILE



NOTE: FPP is corrected as a function of temperature by algebraically adding the LSFS bias value, at the measured OB temperature, to the 62° F calibration curve.

FIGURE 7-3

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

The metering capstan summed error (MCSE) signals and film-to-bar synchronization (FBS) signals were used during WCFO testing to assess the expected photographic performance. Table 7-5 on page 7-9 is a tabulation of the mean value and standard deviation of both signals obtained from three in-air Chamber A-2 tests. The FBS signals (P451 and P452) follow the nominal expected profiles reasonably well, except during the settling time.

7.8 PLATEN PERFORMANCE

Table 7-6 presents the max, min, 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 in-air sequences from Chamber A-2 tests and are 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)

Camera	Factor	Seq M	Seq Q	Seq R
Forward	Maximum	7.8	9.8	7.8
	Minimum	-9.9	-9.9	-11.8
	Mean	-3.8	-3.7	-3.8
	STDV	3.8	4.1	4.2
Aft	Maximum	11.7	13.7	11.7
	Minimum	-7.9	-5.9	-9.9
	Mean	3.2	3.8	2.5
	STDV	5.0	4.9	5.2

7.9 FINE TENSION SENSOR PERFORMANCE

The differential fine tension sensors have been limit checked by MACFACT at $\pm .1$ pound for all WCFO testing done on SV-8. The Forward and Aft Camera differential tension always reports 100% within tolerance.

Table 7-7 shows the average, for nine frames, of the differential tension sensor readings across the format on a run with a Vx/h of .044. The readings are derived from the GOTCHA output which displays the maximum tension value for each 15° of format.

TABLE 7-5

FILM-TO-BAR SYNCHRONIZATION FROM CHAMBER A-2 TEST

(inch/second)

Seq	Scan Angle/ Scan Center (degrees)	Vx/h (radians/second)	Parameter	Forward Camera MCSE	Forward Camera FBS	Aft Camera MCSE	Aft Camera FBS
Q	90/0	.036	Mean	-.002	.007	.001	.003
			STDV	.014	.023	.011	.018
M	90/0	.044	Mean	-.013	.015	-.010	-.002
			STDV	.014	.038	.013	.023
R	90/0	.052	Mean	-.028	.018	-.025	.002
			STDV	.016	.046	.014	.030

TABLE 7-7

DIFFERENTIAL TENSION FOR CHAMBER A-2, SEQ M AT Vx/h OF .044

Scan Sector (degrees)	Forward Camera (Frames 003-011) Maximum (pounds)	Aft Camera (Frames 003-011) Maximum (pounds)
-60 . . . -45	-	-
-45 . . . -30	.064	.027
-30 . . . -15	.000	.007
-15 . . . 0	.000	.007
0 . . . +15	.000	.007
+15 . . . +30	.000	.007
+30 . . . +45	.000	.007
+45 . . . +60	-	-

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 indicated that the frame length and interframe spaces are within specifications.

7.11 STEERER PERFORMANCE

SV-8 steerer performance has been satisfactory as indicated by proper tracking during the WCFO test cycle. Rewinds of up to 76 inches/second were demonstrated during Chamber A testing and proper steering was observed throughout all testing phases. Table 7-8 lists the average steerer position values in PCM counts during various runs in vacuum. This data can be compared with flight data to assist in film tracking evaluations.

TABLE 7-8

AVERAGE STEERER POSITIONS

(PCM counts)

Scan Angle/ Scan Center (degrees)	Vx/h (radians/second)	Forward Camera Take-up	Forward Camera Film Path	Aft Camera Take-up	Aft Camera Film Path
120/0	.052	128	130	131	129
120/0	.048	128	130	126	122
120/0	.044	127	123	129	124
90/-15	.018	125	116	120	120
90/15	.027	127	119	125	121
60/-30	.036	130	119	131	121
60/30	.036	129	118	130	138
30/-45	.052	125	119	130	121
30/45	.052	119	118	131	121
30/-15	.052	120	116	122	131
30/15	.052	128	133	121	133

7.12 METERING CAPSTAN SETTLING TIME

The settling time for SV-8 was determined by examining the FBS signal from 10 frames of both cameras from Chamber A-2 Sequences V and W. The results are summarized as follows:

A. Seq W (Vx/h of .044)

(1) Forward Camera

The film-to-bar error was less than .05 inch/second by shutter open on all frames.

(2) Aft Camera

The film-to-bar error was less than .05 inch/second by shutter open on all but one frame. On that frame, the error was .136 inch/second for one data sample 1.16° after shutter open.

B. Seq V (Vx/h of .052)

(1) Forward Camera

The film-to-bar error was less than .05 inch/second by shutter open on all but one frame. On that frame, the error was .053 inch/second for one data sample 1.69° after shutter open.

(2) Aft Camera

The film-to-bar error was less than .05 inch/second by shutter open on all frames.

7.13 METERING CAPSTAN FOURIER ANALYSIS

MACFACT results and SSTC strip charts show that the MCSE signal for both cameras contains relatively insignificant resonances throughout the Vx/h range from .036 to .054 radians/second. Standard deviations and harmonic amplitudes are small in comparison to previous systems. Therefore, Fourier analyses were performed on only one frame for each camera at a typical flight Vx/h value (.04699). Figure 7-4 shows the MCSE signal and corresponding line spectra. Table 7-9 is a tabulation of spikes versus frequency.

The maximum amplitude spike occurred at approximately 94 Hz for both cameras and was approximately .0039 inch/second. SV-7 had maximum amplitude spikes of approximately .011 inch/second at 120 Hz. Other relatively small spikes occur at approximate multiples of 25 Hz.

TABLE 7-9

SPECTRUM CHARACTERISTICS

Forward Camera (Frame 069)		Aft Camera (Frame 066)	
Frequency (Hz)	Amplitude (inch/sec)	Frequency (Hz)	Amplitude (inch/sec)
24	.0014	30	.0015
58	.0013	57	.0016
80	.0019	75	.0014
94	.0039	94	.0038
146	.0010	169	.0011

MCRECON was run for five frames on each camera from the same test sequence used for Fourier analysis. Figure 7-5 shows the predicted smear for Frames 069 (Forward) and 066 (Aft). Table 7-10 is a tabulation of mean values and standard deviations for smear (ΔS) and FBS error.

TABLE 7-10

MCRECON OUTPUT FOR SMEAR AND FBS ERROR

	ΔS (microns)		FBS Error (inch/second)	
	Mean	Standard Deviation	Mean	Standard Deviation
Fr 069 (Fwd)	-.0020	1.455	.0193	.0400
Fr 066 (Aft)	-.2768	1.341	.0092	.0194
Fwd (5 Frames Avg)	.0181	1.380	.0180	.0385
Aft (5 Frames Avg)	-.230	1.401	.0083	.0191

HARMONIC CONTENT FROM FOURIER ANALYSIS

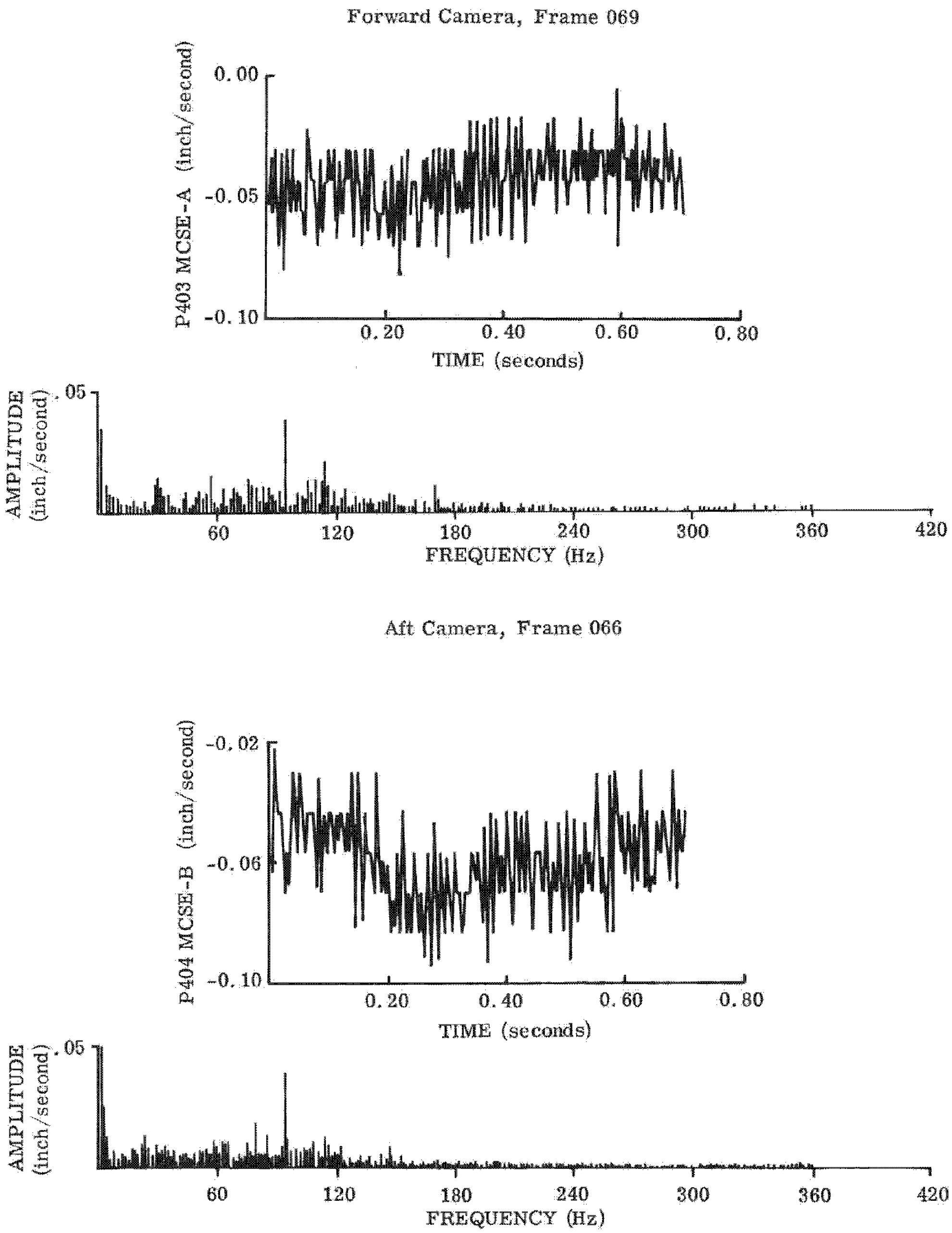
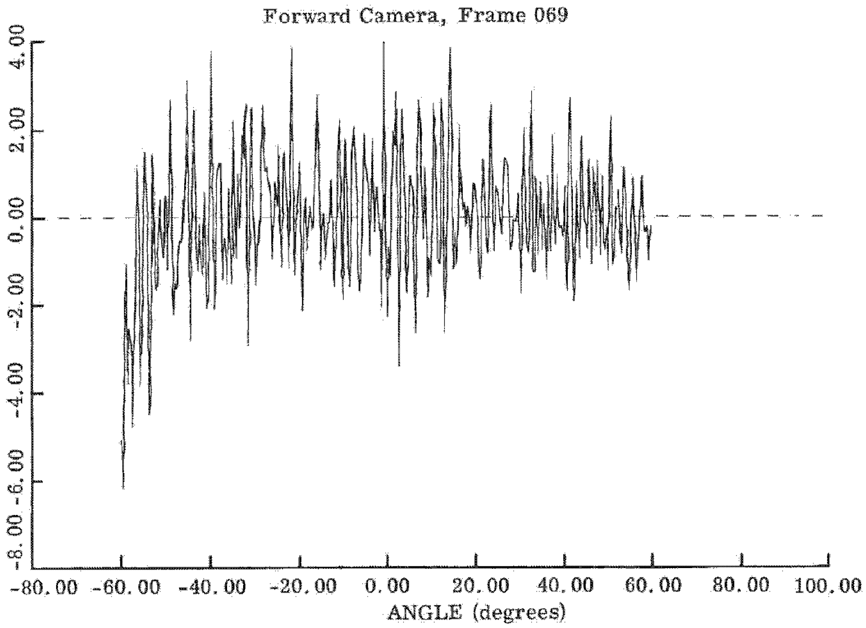


FIGURE 7-4

PREDICTED SMEAR FROM MCRECON PROGRAM



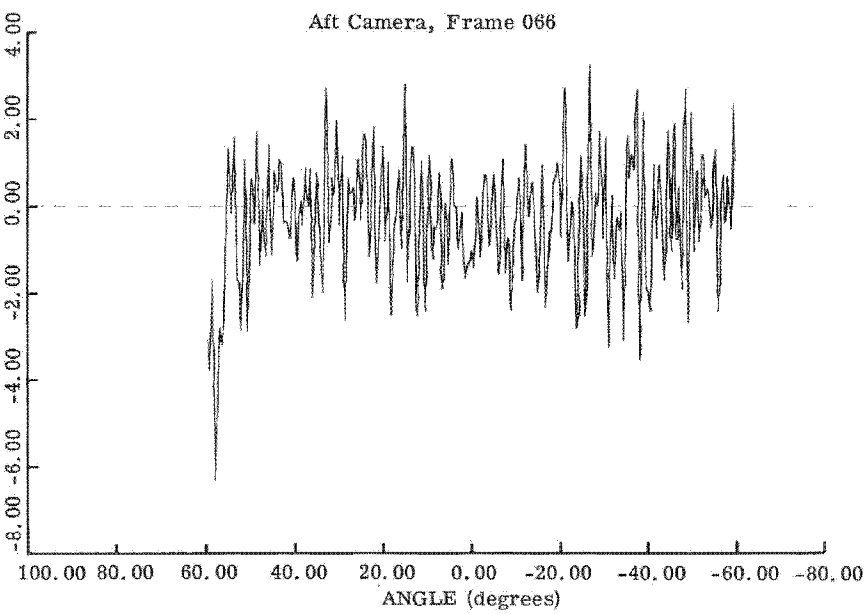


FIGURE 7-5

7.14 AUGIE PERFORMANCE EVALUATION CRITERIA

The metering capstan summed errors, input and output fine tensions, 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 outputs 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 preflight mode generation cycle. The following criteria was used to establish the limits for those performance evaluation parameters listed:

A. Forward Camera Metering Capstan Summed Error (P403)

The mean for P403 was derived from several Chamber A-2 test sequences. One hundred and twelve PCM counts (2.22 volts) was selected as the most representative mean value. The mean shift as the result of changing variables in the test sequence (i.e., scan length, Vx/h, Vy/h, OOAA bias, etc.) was determined to be 2 PCM counts. The mean standard deviation for the representative test sequences was .016 inch/second. This results in a three sigma equivalent to .048 inch/second which converts into 4 PCM counts. Therefore, to set the limits for P403 in the AUGIE the mean shift was added to the three sigma to obtain a 6 PCM count tolerance (.120 volt), see Table 7-11.

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 test variables was determined to be 2 PCM counts. The mean standard deviation for the test sequences was .014 inch/second. This results in a three sigma equivalent to .042 inch/second which converts into 4 PCM counts. Therefore, to set the limits for P404 in the AUGIE the mean shift was added to the three sigma to obtain a 6 PCM count tolerance (.120 volt), see Table 7-11.

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 7-11.

D. Platen Photo Summed Error (P411, P412)

The mean was determined to be 126 PCM counts (2.50 volts) for both cameras. The limits in AUGIE were set to the budgeted platen photo summed error tolerance. Test sequences from Chamber A-2 showed that the performance is consistently within 100% using the budgeted tolerance, see Table 7-11.

E. Forward Camera Optical Bar Summed Error (P501)

The Forward Camera OB summed error mean was established from strip chart evaluation of several test sequences. The mean for the Forward Camera was 108 PCM counts (2.14 volts). The

TABLE 7-11

AUGIE ON-ORBIT SYSTEM CALIBRATION LOG

Parameter	Camera	Data Nominal Volts	Data Nominal Eng Units	Tolerance Volts	Tolerance Eng Units	Nomenclature
Metering Capstan Summed Error	Fwd	2.22	0.0 ips	.120	.0800 ips	P403
	Aft	2.24	0.0	.120	.0800	P404
Input Fine Tension	Fwd	2.50	0.0 lbs	.280	.104 lbs	P703
	Aft	2.50	0.0	.280	.104	P708
Platen Photo Summed Error	Fwd	2.50	0.0 arc-sec	.260	25.7 arc-sec	P411
	Aft	2.50	0.0	.260	25.7	P412
Optical Bar Summed Error	Fwd	2.14	0.0 rad/sec	1.00	.00383 rad/sec	P501
	Aft	2.16	0.0	1.00	.00383	P502

tolerance allowed is 50 PCM counts which is large enough to prevent excessive reporting resulting from the effect of chute pressure on the OB summed error. However, 50 PCM counts is significantly tighter than the budgeted tolerance, see Table 7-11.

F. Aft Camera Optical Bar Summed Error

The Aft Camera OB summed error mean was established from strip chart evaluation of several test sequences. The mean for the Aft Camera was 109 PCM counts (2.16 volts). The same tolerance was used as for P501, see Table 7-11.

7.15 ON-ORBIT ADJUSTMENT ASSEMBLY (OOAA)

The OOAA calibration tests consisted of Chamber A-2 Sequences V and W. Skew commands of 0, ± 5, and ± 15 steps and V_f commands of 0, ± 5, 10, and -21 steps were executed in these sequences. The results of these modulation commands are summarized in Figures 7-6 thru 7-9 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 - FBS CALIBRATION

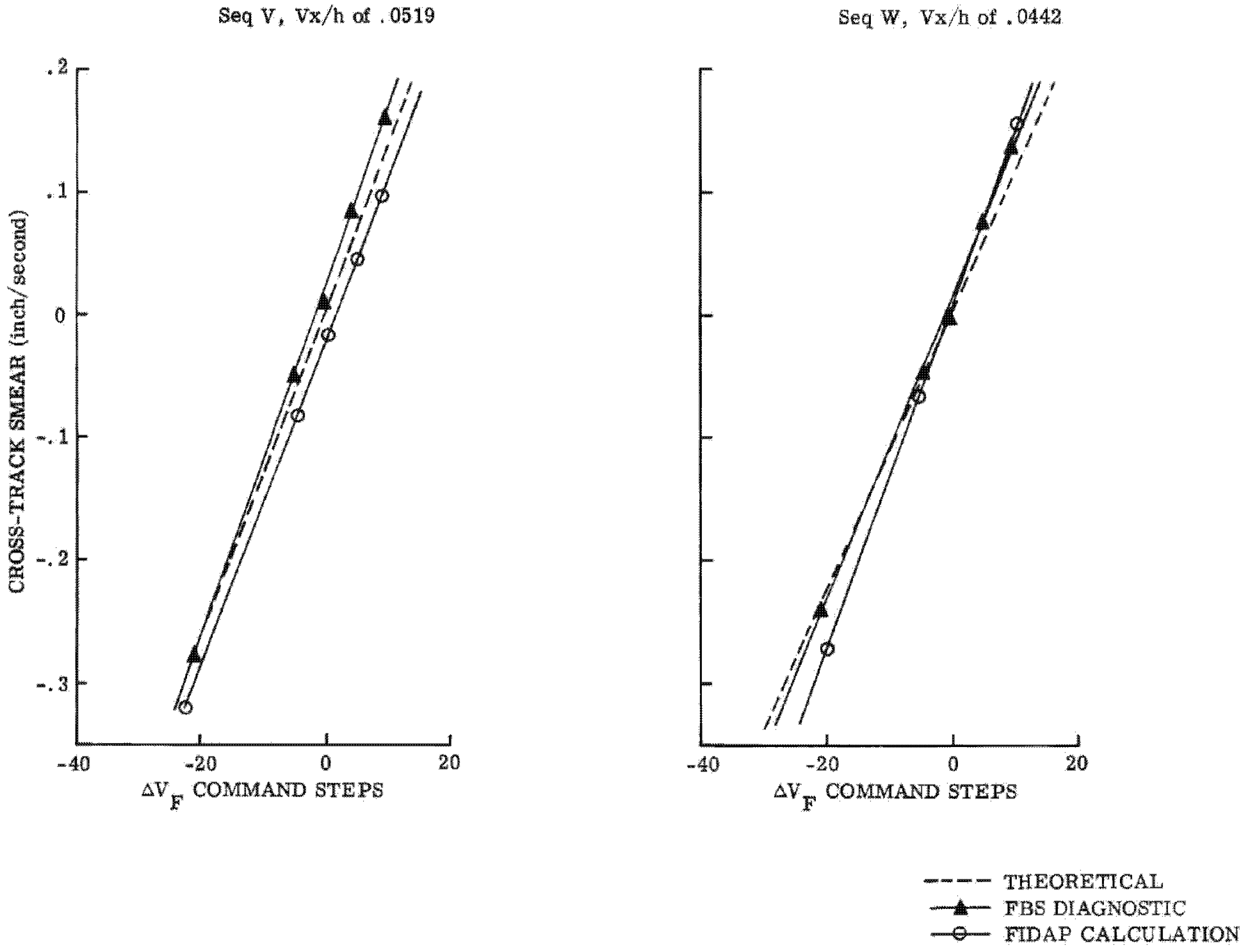


FIGURE 7-6

Approved for Release: 2025/06/18 C05137281

CHAMBER A-2, AFT CAMERA OOAA - FBS CALIBRATION

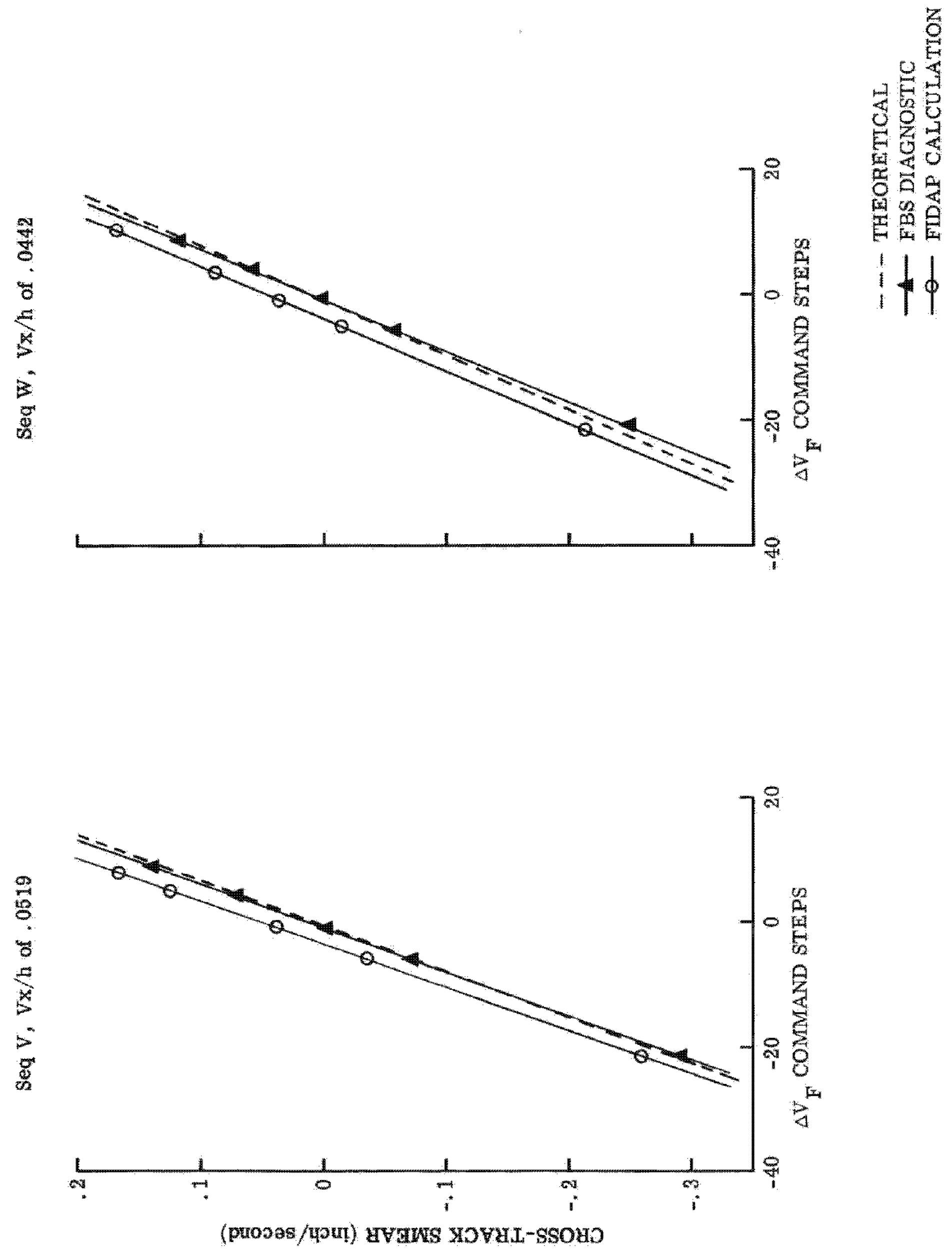


FIGURE 7-7

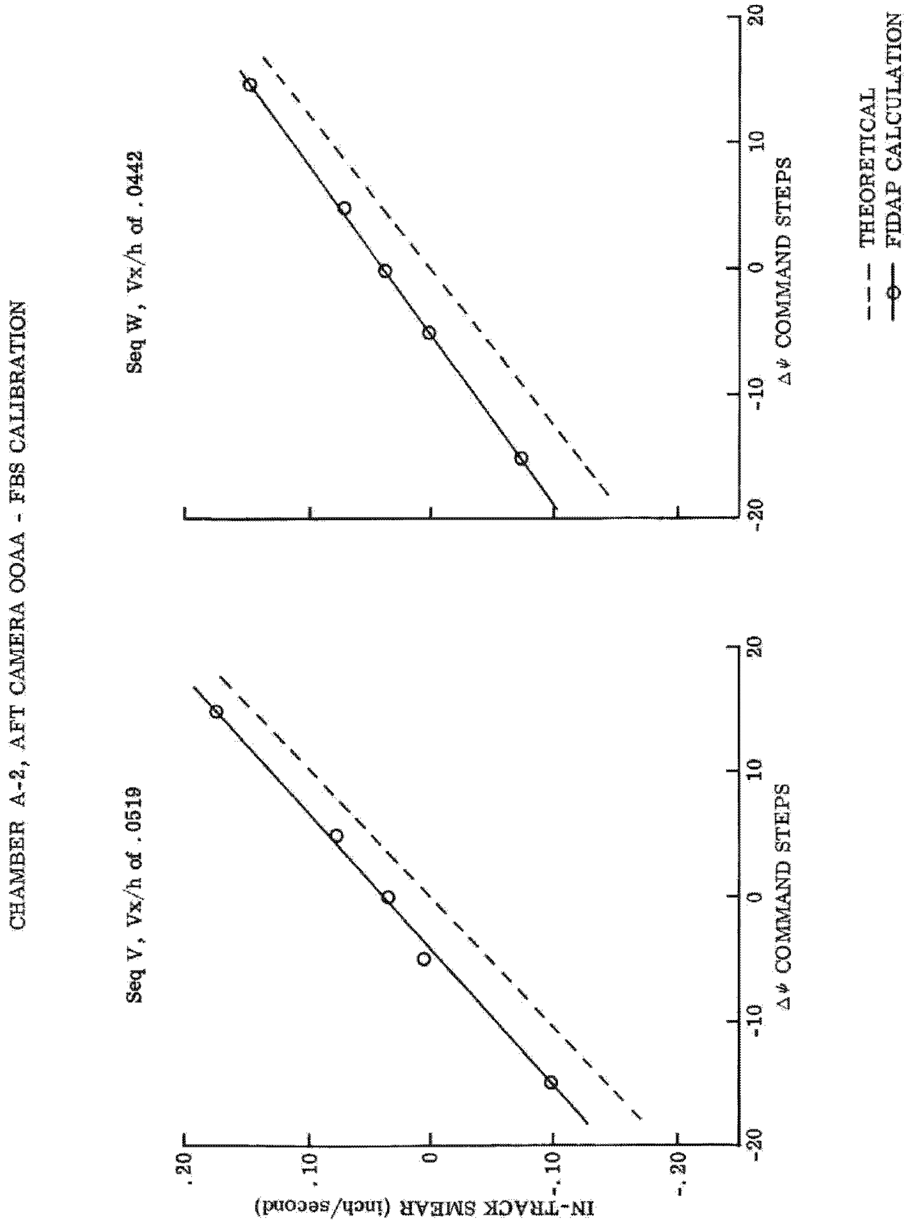

CHAMBER A-2, AFT CAMERA OOAA - FBS CALIBRATION
Seq V, Vx/h of .0519
Seq W, Vx/h of .0442
IN-TRACK SMEAR (inch/second)
.20
.10
0
-.10
-.20
Δψ COMMAND STEPS
-20
-10
0
10
20
THEORETICAL
FIDAP CALCULATION

FIGURE 7-8

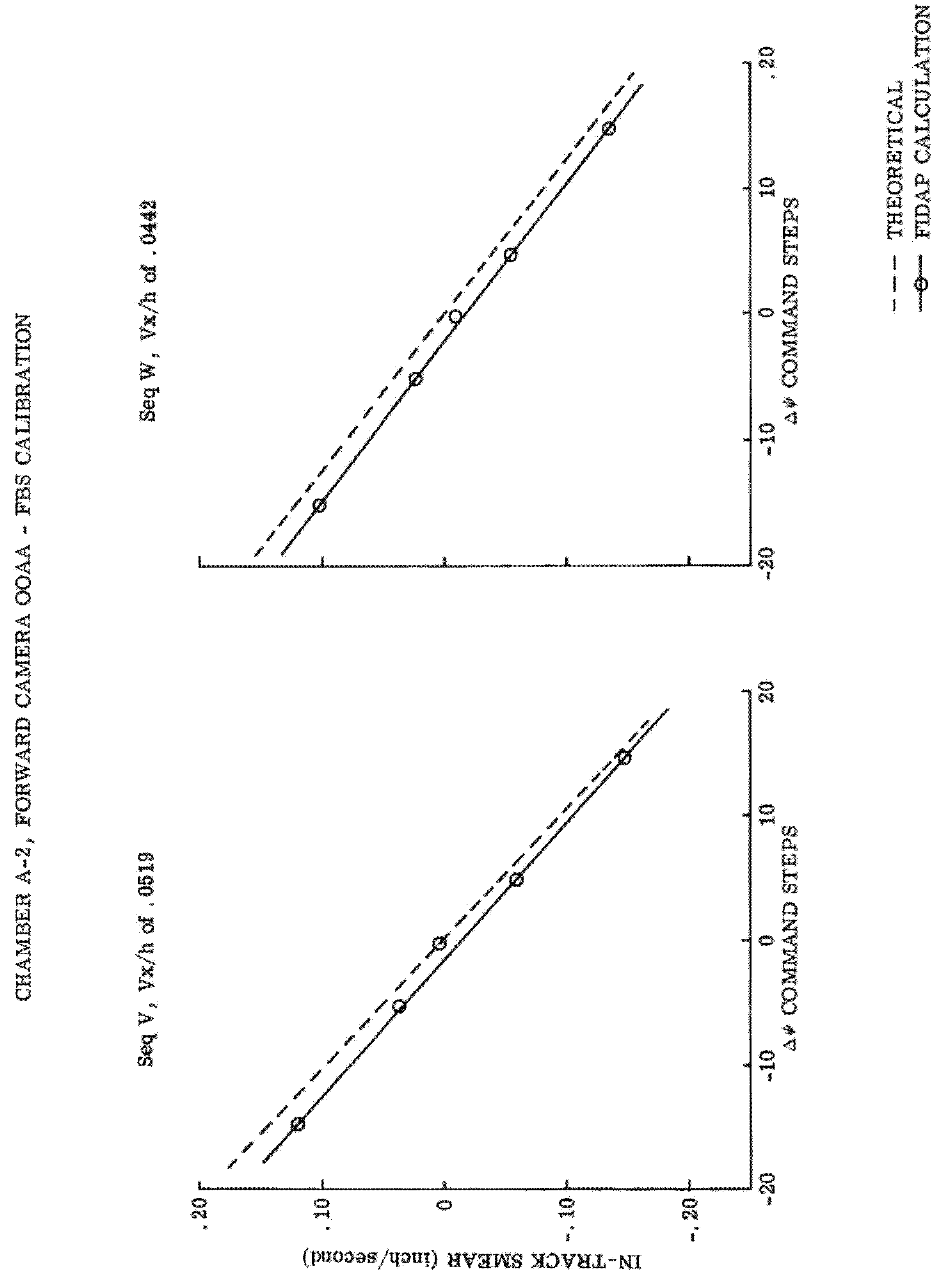

CHAMBER A-2, FORWARD CAMERA OOAA - FBS CALIBRATION
Seq W , Vx/h of .0442
Seq V , Vx/h of .0519
IN-TRACK SMEAR (inch/second)
.20
.10
0
-.10
-.20
-20
-10
0
10
20
Δψ COMMAND STEPS
THEORETICAL
FIDAP CALCULATION

FIGURE 7-9

SECTION VIII

PHYSICAL CHARACTERISTICS

8.1 EVALUATION RESULTS

8.1.1 Film Markings

The material was generally clean, with only a few scratches and abrasions being noted. Both the Forward and Aft Camera material exhibited some roller, "air-bar", low density dendritic static, and tarantula-type corona discharge markings. The Aft Camera appeared to be affected by a greater number of tarantula-type corona discharge markings than the Forward. The frequency of occurrence was similar to SV-7. The Forward Camera had relatively few static discharge marks.

8.1.2 Ancillary Data

The format markings including the scan angle, time track, SVT word, and start-of-frame/start-of-operations marks appear bright and well within specified size. The time track marks are of good quality and suitable for film velocity mensuration.

8.1.3 Fine Film Path Tracking

The index dot-to-film edge tracking measurements from the Chamber A-1 material (SO-255 only both cameras), were made on nearly all scan mode/scan center combinations using various Vx/h values. The tests were made utilizing rewind constants which ranged from -5 to -76 inches/second.

The A-1 test runs indicated only minor tracking variations on the Forward Camera. These variations ranged from 2.1mm to 2.3mm from the film edge and had a mean value of 2.2mm. However, the Aft Camera indicated a larger variation in tracking for the various scan modes, and in general tracked somewhat lower than the Forward Camera. Tracking variations ranged from 1.2mm to 2.5mm with a mean of 1.8mm.

Measurements of distances were made from Chamber A-2 material on Frames 001 thru 010 and 101 thru 110. The purpose was to verify whether there were beginning-of-operation tracking disturbances caused by film start-up, see Table 8-1. A comparison of past systems is shown in Table 8-2.

Both cameras indicate consistent tracking during the entire operation, deviating from the average tracking by only .1mm on the Forward Camera and .3mm on the Aft.

Tracking data obtained from the Horizontal Preship Test indicated that the Forward Camera average tracking for SV-8 is identical to SV-7, while the Aft Camera average tracking is somewhat lower than SV-7.

TABLE 8-1

FILM TRACKING MEASUREMENTS

(millimeters)

— Forward Camera —

	Scan Angle/Scan Center (degrees)				
Frame	60/15 (Vx/h of .052)	90/0 (Vx/h of .052)	90/0 (Vx/h of .044)	30/0 (Vx/h of .052)	30/0 (Vx/h of .052)
001	2.2	2.1	2.1	2.2	2.2
002	2.3	2.2	2.0	1.8	2.4
003	2.2	2.1	1.9	1.9	2.1
004	2.1	2.0	1.9	2.0	2.0
005	2.1	2.0	2.0	2.0	2.3
006	2.2	2.0	2.0	2.0	2.5
007	2.1	2.0	2.1	2.0	2.5
008	2.2	2.1	2.0	1.8	2.1
009	2.2	2.1	1.9	2.0	2.0
010	2.1	2.1	2.0	2.0	2.0
101	1.9	2.0	2.0	2.1	1.9
102	1.9	2.0	2.1	2.0	1.9
103	1.9	2.0	1.8	2.1	1.9
104	2.0	2.1	2.1	2.2	2.0
105	1.9	2.2	2.1	2.0	1.9
106	1.9	1.9	2.1	2.1	1.9
107	1.9	1.9	2.0	2.1	2.0
108	1.9	2.0	2.1	2.0	2.1
109	1.9	2.0	2.0	2.0	2.1
110	1.9	1.9	2.0	2.1	2.1
Average	2.0	2.0	2.0	2.0	2.1

TABLE 8-1 (CONT'D)

— Aft Camera —

	Scan Angle/Scan Center (degrees)				
Frame	60/-15 (Vx/h of .052)	90/0 (Vx/h of .052)	90/0 (Vx/h of .044)	30/0 (Vx/h of .052)	30/0 (Vx/h of .052)
001	2.7	3.0	2.7	3.3	3.2
002	2.5	2.7	2.8	3.1	2.9
003	2.7	3.0	2.6	2.9	3.1
004	2.7	2.9	2.7	3.0	3.4
005	2.6	3.0	2.7	2.9	3.2
006	2.7	2.7	2.8	3.0	3.1
007	2.6	2.8	2.7	3.4	3.2
008	2.7	3.0	2.7	3.3	3.2
009	2.8	2.8	2.7	3.0	3.1
010	2.7	3.0	2.9	3.2	3.1
101	2.7	2.8	2.7	2.9	2.9
102	2.7	2.8	2.6	2.7	3.1
103	2.7	2.9	2.5	2.7	3.1
104	2.5	3.0	2.7	3.0	3.0
105	2.7	2.9	2.8	3.0	3.0
106	2.7	2.8	2.7	3.1	3.0
107	2.8	2.8	2.7	2.8	3.0
108	2.6	2.9	2.8	2.9	3.0
109	2.7	2.8	2.7	3.2	2.9
110	2.6	2.9	2.6	3.1	2.9
Average	2.7	2.9	2.7	3.0	3.0

8.2 CONCLUSIONS

A. All the markings (format ancillary data) are of proper size, density, location, and within specifications.

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

C. Neither camera shows any tracking problems associated with the start-of-operations.

TABLE 8-2

TRACKING COMPARISON OF RECENT SYSTEMS
AS MEASURED IN THE HORIZONTAL PRESHIP TEST
(millimeters)

— Forward Camera —

System	Scan Angle/Scan Center (degrees)								
	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	NA	2.3	2.1	2.0	2.1	2.0	2.1	2.1	2.1

— Aft Camera —

System	30/30	60/15	90/15	30/30	60/15	90/15	120/0	120/0	Average
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	NA	2.5	2.0	2.0	2.6	2.0	2.1	2.0	2.1

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.