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C00270 2

Hexagon Sensor Subsystem

SV-9 (SN-012) FLIGHT READINESS REPORT

DIRECTORATE OF SPECIAL PROJECTS
OFFICE OF THE SECRETARY OF THE AIR FORCE

BYE 10305-74

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HEXAGON SENSOR SUBSYSTEM

SV-9 (SN-012)

FLIGHT READINESS REPORT

AUGUST 1974

This report consists of 163 pages.

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FLIGHT READINESS REPORT
SV-9 (SN-012)

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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FLIGHT READINESS REPORT
SV-9 (SN-012)

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INTRODUCTION

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SECTION I

INTRODUCTION

1.1 SUMMARY

Flight focus should be set at 31 microns and 70 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 PBF should be set at 100 microns. The vacuum test data is summarized in Table 1-1.

TABLE 1-1

VACUUM TEST EVENT SUMMARY

		Test Results	
		Forward Camera	Aft Camera
Chamber A			
1414 Film			
	Cross-Track (inch/second)	-.033	.010
	In-Track (inch/second)	.000	.015
	PBF (microns)	32	80
	Peak Resolution (cycles/mm)	189	183
SO-255 Film			
	Cross-Track (inch/second)	.002	.015
	In-Track (inch/second)	.015	.006
	PBF (microns)	62	110
	Peak Resolution (cycles/mm)	115	127
Inter Test Events			
	Aft Camera MC Servo Replaced		
	SCC Box Replaced (13A1)		
	Aft Camera Platen Servo Replaced (2A1)		
	SIA Box Retrofit Incorporated		
	OOAA Box Replaced (1A7)		
First A-2(1A-2) Test			
	Cross-Track (inch/second)	-.035	.049
	In-Track (inch/second)	.009	-.015
	PBF (microns)	23	77
	Peak Resolution (cycles/mm)	195	185

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TABLE 1-1 (CONT'D)

	Test Results	
	Forward Camera	Aft Camera
Inter Test Events		
Platens Removed and Replaced for Shutter Retrofit		
OOAA Box Replaced (1A7)		
Second A-2(2A-2 Test)		
1414 Film		
Cross-Track (inch/second)	-.046	.029
In-Track (inch/second)	.027	-.042
PBF (microns)	30	75
Peak Resolution (cycles/mm)	188	193

NOTES: 1. Mean smear values and peak resolution were taken from the 0° collimators at a Vx/h of .052 radian/second, at 70°F.

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

3. The Aft Camera will be launched with a mixed load of 1414, SO-255, and FE-3916 Films.

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

5. All Chamber A-2 tests were run on 1414 material.

The 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	-3	-3
Cross-Track	1414	3	-3
Cross-Track	SO-255/FE-3916	Δ-15	Δ-15

1.2 SYSTEM IMPROVEMENTS

There were no significant changes or improvements made on SV-9. This system is essentially the same as SV-8.

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1.3 AREAS OF CONCERN

The assembly and testing cycle of SV-9 (SN-012) 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-9, nor should they impact on the system's optical performance.

1.3.1 Ground Test Skin Current

The design improvement that provides 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 results 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 Optical Bar Seal

Degradation of the optical bar performance on the Forward Camera was evidenced by an increase of the optical bar summed error (OBSE) signal during Chamber A-2 testing. The optical bar seal was inspected and contamination was found. The particulates were subjected to a rigorous chemical analysis which revealed the presence of metallic aluminum. Although the Aft Camera did not exhibit an increase in the optical bar torque, the seal was inspected and analysis of the wear products also showed the presence of metallic aluminum. Both seals were cleaned periodically after some run-in and no evidence of increased torque on either camera has been observed. The source of the contamination has been identified as the diaphragm groove in the mounting ring. Revised cleaning procedures will preclude future entrapment of the aluminum particulate. The remaining concern is that the contamination may have accelerated the wear of the silicon dioxide and molybdenum difluoride seal coatings from their respective surfaces at specific locations on the seals. This situation would lead to metal-to-metal contact in the optical bar seal during rotation which could cause further metallic contamination. However, there has been no evidence to support this hypothesis to date. Subsequent to cleaning and several hours of run-in, the OBSE signals have exhibited stable operation with no increase in torque levels. For this reason, the Government will use as is.

1.3.3 Film Drive Dither

Testing has revealed that the SV-9 input and output drive summed error signals have noise components in the 23 to 30 Hz band, which are similar to those observed on SV-8. To date, no evidence of this noise has been observed in the metering capstan summed error (MCSE) signal. While noise is known to be present in the drive servos, transmission mechanisms (electrical and/or mechanical) have not been isolated to preclude this phenomenon from occurring in the metering capstan. This could affect image quality. The flight history of SV-8 has not shown interaction between the drive capstans and the

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metering capstan. For this reason, the Government will use as is.

1.3.4 Metering Capstan Summed Error (MCSE)

Steps in the MCSE signals have been observed periodically on both cameras during the first 30° of photography. This phenomenon appears to be associated with air, velocity, and film roll. The steps only occur in air, at a Vx/h above .044 radian/second, and during runs utilizing film from particular master rolls. It is postulated that the mechanism of this phenomenon is associated with air ingestion between the very low taper film and the focal plane rollers causing a film "lift-off". This in effect causes the focal plane rollers to rotate at a slower rate than the film is moving during ramp-up acceleration. During the first 30° of constant velocity, the metering capstan is still accelerating with respect to the inertia of the lower velocity of the focal plane rollers. When the focal plane rollers finally attain a velocity that matches the film velocity, the metering capstan then adapts, causing the step function increase of the summed error signal. One occurrence of this same characteristic was observed on SV-8 during in-air testing at SCC. There were no steps in the MCSE observed during vacuum testing or the flight of SV-8. Since this phenomenon occurs only in air and is of insufficient magnitude to significantly degrade image quality, the Government will use as is.

1.3.5 Visible Flash During Supply Upload

When the vehicle was powered up to run the servo tests as part of the checkout of the Supply upload, a flash of light was observed in the dark. The film stacks were removed and a complete visual inspection was made of the entire Supply upload area. All outlets and facilities were checked and found to be good. The outer wraps of the film stacks were processed and not fogged. The origin of the light flash could not be found. Continuity checks of the power lines and functional tests have also been performed and still no cause can be determined. For this reason, the Government will use as is.

1.3.6 Contamination

Increased occurrences of contaminants ingested in the flight systems have introduced material damage and heightened the risk of a catastrophic failure. A connector dust cap was discovered in 1207-3. Similar dust caps were discovered in the Re-entry Vehicles of SV-8 and SV-9 in test. Interim special efforts in contamination control were introduced on SV-8. However, upon the return of 1208-1 from orbit, a piece of safety wire was found ingested in the Take-up Assembly film stack which caused film damage. The final closure of the SV-9 Re-entry Vehicles will be performed using these updated procedures.

1.3.6.1 Aft Camera Film Separation

During the Horizontal Pre-ship Test of SV-9, the Aft Camera experienced an undertension emergency shutdown (ESD) while in the rewind mode. When the ellipsoidal shell of the Supply was removed, it was found that the film had separated in the Film Exit Vestibule area. The film stacks were downloaded and the Supply was removed. An investigation revealed the presence of a 3/16" piece of teflon jammed

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between the 4" roller and the housing of the Film Exit Vestibule. Analysis shows that the teflon propagated the film tear upon rewind. The system was thoroughly inspected, cleaned, and vacuumed. Roller alignment checks and torque traces as well as tension sensing data indicate that the system saw no excessive overtension. For this reason, the Government will use as is.

1.3.6.2 Oil Contamination

During the Chamber A-2 test, oil from the jacking mechanism was sprayed on the vehicle. The concern on this item was the problems that could occur if the oil had penetrated into the internal elements of the system. The external surfaces were cleaned following completion of the test and no immediately visual effects have been observed to date. For this reason, the Government will use as is.

1.3.6.3 Chamber A-1 Contamination

The outgassing of dimethyl terephthalate was again observed during the Chamber A-1 testing. It has been determined that this contaminant is not injurious to the optical coatings. The quantity of contaminant was about one-half that found on SV-8. Based upon the successful performance of 1208, the Government will use as is.

1.3.6.4 Missing Film Piece

Following the undertension ESD evaluation that occurred during the SV-9 Horizontal Pre-ship Test, the film stacks were uploaded. During the process of taping the film stack to the leader going into the Mid-section, a tabular piece of the tape about 1/2" x 1 1/4" in dimension was lost. The stacks were downloaded and an extensive search was made for the lost tape. The tape could not be found. The Supply was tumbled, thoroughly cleaned, and vacuumed. The film stacks have been replaced with the backup stacks. Based upon this, the Government considers the system free of this contaminant and will use as is.

1.3.7 Platen Tilt

The evaluation of the Chamber A-2 Forward Camera data indicated a need for 13 to 20 microns of tilt across the slit. The Chamber A data indicated that no tilt was required. The concern is that in the past five satellite vehicles Chamber A-2 testing has indicated a need for additional tilt on the Forward Camera. The post flight analysis of the imagery from these five vehicles has not supported this indication for additional tilt. Therefore, the Government is concerned about any tilt indications, especially on the Forward Camera, arising from Chamber A-2 testing. However, since the ground test data of SV-9 exhibits the same characteristic behavior as the five previous systems which performed successfully on-orbit, the Government will use as is. The Government and the contractor are jointly studying the collimator configuration to determine if there is any problem inherent in the collimator design or implementation.

1.4 WCFO FACTORY TEST FLOW

The overall test flow for SV-9 at WCFO is shown in Figure 1-1. The following paragraphs provide

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ASSEMBLY AND TEST FLOW AT SVIC

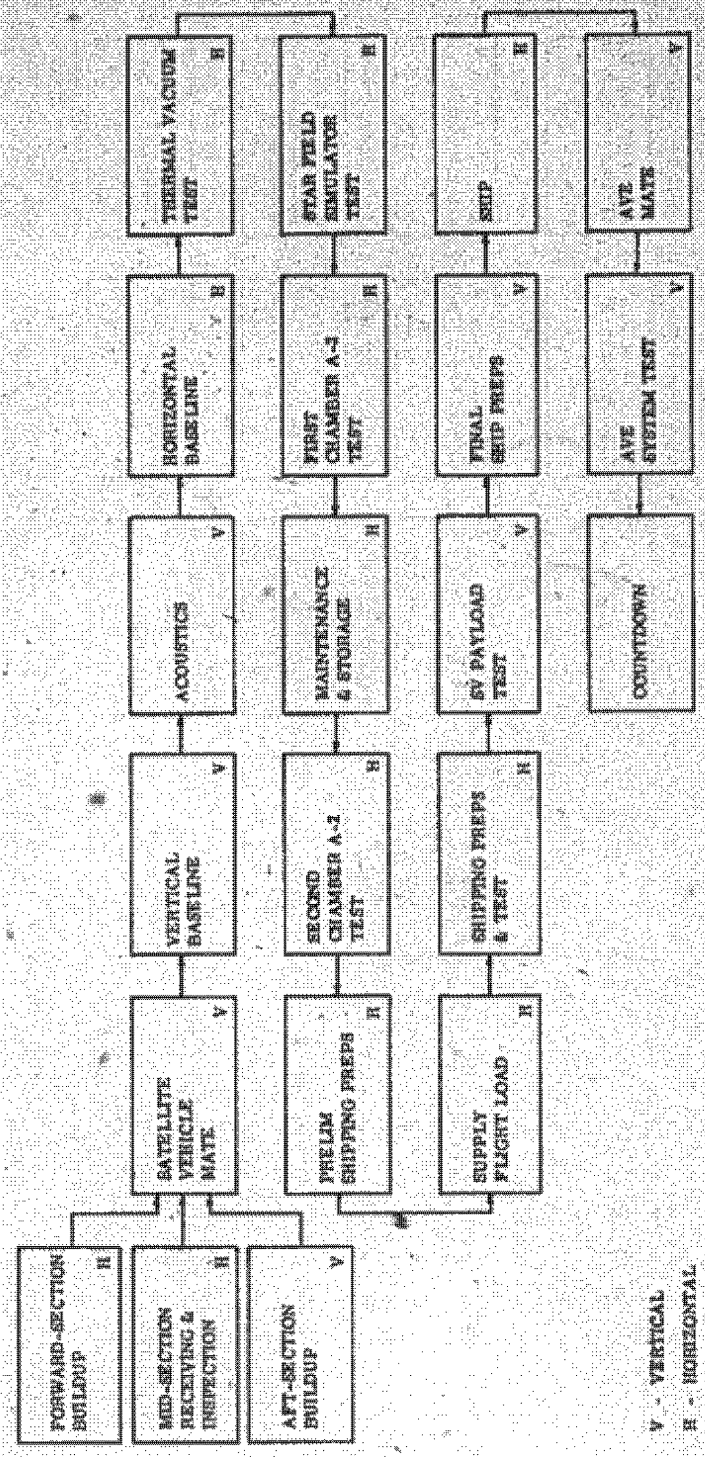


FIGURE 1-1

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brief descriptions of the activities during each of the major tests. Table 1-3 provides the schedule information for the factory flow.

TABLE 1-3

SV-9 MILESTONE SCHEDULE

Activity	Date Completed
1. Forward-section Buildup	19 September 1973
2. Mid-section R & I	3 October 1973
3. SV Mate	13 November 1973
4. Vertical Baseline	13 November 1973
5. Acoustic Test	19 November 1973
6. Horizontal Baseline	27 November 1973
7. Chamber A-1 Test	17 January 1974
8. Star Field Simulator Test	25 January 1974
9. First Chamber A-2 Test (1A-2)	13 February 1974
10. Second Chamber A-2 Test (2A-2)	25 June 1974
11. Preliminary Shipping Preparation	15 August 1974
12. Final Shipping Preparation	8 September 1974
13. Ship	25 September 1974
14. AVE Mate	25 September 1974
15. AVE Systems Test	29 September 1974
16. Countdown	9 October 1974

NOTE: Items 12 thru 16 show projected dates for completion of those activities.

1.4.1 Forward-section Buildup

Buildup and testing were completed on 19 September 1973. Articulator SN-5110 was returned to SSC and replaced with SN-5102 due to a roller-to-base misalignment. Several Take-up rollers were reworked due to improper bearing preloading or alignment. Reverse edge sensor null on the Forward Camera Steerer was out of tolerance. However, it was subsequently accepted after satisfactory SV system tracking testing.

Four retrofits were completed as follows:

A. Builder Roller Full switch disabled in TUA-048, TUA-046, and TUA-040 (Positions 1, 2, and 4).

B. De-orbit solenoid replaced in TUA-040.

C. A15 electronics replaced in TUA-040, TUA-046, and TUA-048.

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D. Radiation detection film packets installed on all Take-ups

Functional testing of the Forward-section film path was accomplished without any significant anomalies.

1.4.2 Mid-section Receiving and Inspection

The Mid-section was received at the West Coast Facility on 30 April 1973. The period from 30 April thru 14 May was devoted to SBAC R&I assembly work. The Looper Tension Sensor retrofit (SV9-2) was completed and the SSC R&I testing commenced on 17 May 1973. The SSC R&I Test concluded on 3 October.

The following anomalies were noted as the result of initial R&I testing:

A. The UCC (8A1) Box SN-5015 was replaced with SN-5017 and the DLF Fuse Module SN-419272 replaced with SN-940381 due to an internal short to the chassis inside the UCC Box.

B. The Power Bus Module (PBM) failed, resulting in the Mid-section primary power dropping to 15.5 volts for several seconds. Engineering analysis subsequently determined that no detrimental effects occurred as a result of the undervoltage condition.

C. The Aft Camera MC Servo (2A3) Box SN-1027 was replaced with SN-1003 due to high residual null which caused saturation of the drive servos during cage sequences.

The Supply was removed on 8 June and shipped to SSC for installation of caging mechanism.

Installation of the Servo Interrupt Assembly (SIA) Harness retrofit was completed on 30 August. A spare SSC (13A1) Box (SN-1012) and OOAA (1A7) Box (SN-5009) were installed on 17 September to replace SN-1017 and SN-5002 respectively which were used on SV-8.

The Supply was returned from SSC, uploaded, and reinstalled into the Mid-section on 21 September, when R&I testing was again started. On 26 September, the Platen Servo (2A1) Box (SN-1024) from the Aft Camera was replaced with SN-1008 as a result of the platen failing to go into recycle. The SIA (2A13) Boxes were also installed on 28 September.

1.4.3 Satellite Vehicle Mate

The mechanical mating of the Mid-section and Forward-section was completed by SBAC on 16 October 1973 after some difficulty due to incorrect shims on the Mid-section.

1.4.4 Vertical Baseline Test

The PDS (14A1) Box (SN-5014) was replaced by SN-5015 prior to performance of the Vertical Baseline Test. The test was begun on 12 November 1973 and completed on 13 November. The following anomalies were noted:

A. Film "stick" at the Aft Camera Supply Seal Door.

B. Shorted Supply Pressure Transducer.

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1.4.5 Acoustic Environment

The vehicle was erected in the Acoustics Chamber and subjected to the acoustic environment on 19 November 1973. No problems were encountered.

1.4.6 Horizontal Baseline Test

Prior to the Horizontal Baseline Test, the Aft Camera Platen Servo (2A1) Box (SN-1008) was temporarily replaced with the box which failed during R&I testing in an attempt to duplicate the failure. The failure did not recur. SN-1008 was reinstalled and the Horizontal Baseline Testing performed and completed on 27 November 1973. No problems were encountered.

The following tasks were performed prior to proceeding into the Thermal Vacuum Chamber Test:

A. Retrofit to incorporate current limiting resistors for protection of the ISCCU (15A1) and MFA (17A1) Boxes if a pressure transducer shorts out. Completed on 2 December 1973.

B. Inspection and functional testing of looper rollers resulting in replacement of two rollers in the Aft Camera Looper. Completed on 30 November 1973.

C. Motor-encoder check on Position 3 (TUA-017A). Completed on 6 December 1973.

D. Removal of the Supply for uploading with SV-7 backup flight stacks, replacement of Supply Pressure Transducer, lubrication of the seal door, and break away torque adjustment. Completed on 10 December 1973.

E. Replacement of Forward Camera Aft Steerer Servo (5A1) Box due to missing connector locking pin. Completed on 14 December 1973.

F. Film tracking tests and film path adjustments to optimize fine path film tracking. Completed on 18 December 1973.

G. Pneumatics and Supply Pressure Transducer calibration tests. Completed on 18 December 1973.

H. Replacement of ISCCU (15A1) Box and DL & F Fuse Module due to overstress from Supply Pressure Transducer failure. Completed on 19 December 1973.

I. Retrofit to install modified ISCCU Box protect cable. Completed on 17 December 1973.

1.4.7 Thermal Vacuum Chamber Test

The vehicle was installed in Chamber A-1 on 10 January 1974 with chamber tests completed on 17 January 1974. No problems were encountered.

1.4.8 Star Field Simulator Test

The Star Field Simulator Test was completed on 25 January 1974 with no problems encountered with the exception of the absence of cage/uncage verify discretes caused by a blown fuse in the DLF (16A1) Box. The Pneumatics Module (SN-5013) was removed and replaced with SN-5014, with installation and calibration completed on 28 January 1974.

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Evaluation of film retrieved after the Chamber A-1 test indicated excessive fogging on several portions from both cameras. This was attributed to defective emulsion batches. Therefore, photography was avoided during subsequent testing on film segments which were from the "bad" master rolls.

1.4.9 Chamber A-2 Photographic Tests

The in-air tests were completed on 5 February 1974. Pumpdown began on 6 February 1974 with vacuum and post-vacuum tests completed on 13 February 1974. Due to a cyclical torque increase observed on the Forward Camera Optical Bar Drive Servo, the pneumatic seal on the optical bar was inspected, cleaned, tested, and residue samples taken from both optical bars for analysis. Subsequent analysis and special run-in tests conducted at SSC indicate that the residue found on the SV-9 seal essentially contains the same components as that found in the residue collected from the special tests. Therefore, no further action is being pursued.

Fiber optics bundles from the 500 Hz Flasher (3A3) Boxes to both platens were reworked on 15 March 1974 to repair broken fibers, damaged during the optical bar seal inspection and cleaning operations.

The UCC (8A1) Box (SN-5017) was removed and found to have an internal short to the chassis on an input 28 volt power line, which caused the blown fuse module on the DLF (16A1) Box. This box was returned to SSC where the failure was verified.

Due to a failure during TCA vibration testing at SCC, the torsion rod support bracket in the aft articulator on the Aft Camera was removed and replaced.

1.4.10 Maintenance and Storage

The following tasks were accomplished during the maintenance and storage period:

A. Replacement of both 7A1 electronics boxes in Position 4, TUA-040.

B. Inspection of 7A1 electronics puller blocks in Position 3, TUA-17A.

C. Replacement of torsion rod support brackets in Forward Camera frame articulator and forward film path on both cameras.

D. Installation of SN-5015 UCC (8A1) Box.

E. Contamination test on Pneumatics Module.

F. Disabled Interchangeable Filter Distribution Control Box (ICF/DCB).

G. Replacement of SN-940399 Fuse Module on DLF Box with SN-940397.

H. Tests performed to validate all the actions (Tasks A thru G above).

1.4.11 Second Chamber A-2 Photographic Test

On 24 May 1974, the decision was made to retrofit the slit and shutter springs in all platen assemblies. Retest requirements for this retrofit included a second Chamber A-2 test.

The in-air runs were completed on 20 June 1974. During these runs, the airborne film-to-bar

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sync signal was observed to be breaking up on both cameras. The OOAA Box was subsequently changed and this problem was alleviated. Chamber pumpdown began on 21 June 1974 and post vacuum tests were completed on 25 June 1974.

During the retrieval activity, an AGE cable was inadvertently connected to the Position 4 Take-up, resulting in the application of 110 volts AC facility power to the Take-up. TUA-040 was subsequently replaced with TUA-024A which had previously been installed in Position 1 of SV-10.

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

TABLE 1-4

HARDWARE CHANGES AT SVIC FACILITY

CHANGE	DATE	REASON	REVERIFICATION
1. ARTICULATOR (MR 64394) OLD 5110 NEW 5102	5/14/73	EXIT ROLLER ALIGNMENT OUT OF TOLERANCE.	REPLACE AND CONDUCT R&I.
2. TUA-046-A15 FWD-OLD 334 NEW 306 AFT-OLD 318 NEW 313	6/14/73	RETROFIT TUA-026.	FEWO T46-006.
3. TUA-040-A15 FWD-OLD 337 NEW 309 AFT-OLD 336 NEW 322	7/17/73	RETROFIT TUA-026.	FEWO T40-006.
4. TUA-048-A15 FWD-OLD 325 NEW 041 AFT-OLD 326 NEW 045	8/2/73	RETROFIT TUA-026.	FEWO T48-005.
5. UCC BOX (8A1) (MR 64395)	5/22/73	INTERNAL SHORT TO CHASSIS.	FEWO SV9-007.
6. FUSE MODULE (MR 64396) OLD 419272 NEW 940381	5/18/73	SHORTED UCC BOX BLEW FUSE.	FEWO SV9-008.
7. M SERVO (2A3) (MR 64414) OLD 1027 NEW 1003	5/24/73	TACH NULL TOO HIGH.	MRB 0787, FEWO SV9-017.

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TABLE 1-4 (CONT'D)

	CHANGE	DATE	REASON	REVERIFICATION
8.	PDS (14A1) OLD 5017 NEW 5014	6/8/73	SUSPECTED RELAY LOT (MO 559).	MRB 0788. FEWO SV9-017.
9.	SCC (13A1) (DR-8-38) OLD 1017 NEW 1012	9/5/73	SWAP WITH SV-8.	FEWO SV9-016.
10.	P SERVO (2A1) (MR 64502) OLD 1024 NEW 1023	9/21/73	NO PLATEN RECYCLE.	FEWO SV9-021.
11.	P SERVO (2A1), (MD 614) OLD 1023 NEW 1008	9/26/73	SHELF LIFE REQUIREMENTS, MD 614.	FEWO SV9-012.
12.	SIA BOXES (2A13) FWD-NEW 5006 AFT-NEW 5007	9/26/73	SERVO INTERRUPT RETROFIT SV9-3.	FEWO SV9-014.
13.	OOAA (1A7) OLD 5002 NEW 5009	10/2/73	SWAP WITH SV-8 (MR 64501-SV8).	FEWOs SV9-025 & SV9-026.
14.	PDS (14A1), (MD 626) OLD 5014 NEW 5015	10/28/73	UPDATED TO SV-11 CONFIGURATION.	FEWO SV9-027.
15.	ROLLERS, B-SIDE LOOPER (MR 64547) OLD 484 AND 538 NEW 2002 AND 2022	11/29/73	EXCESSIVE RADIAL RUNOUT.	FEWO SV9-037.
16.	SU PRESSURE TRANSDUCER (MR 64546) OLD 5017 NEW 5024	11/28/73	SHORTED.	FEWO SV9-053.
17.	STR SERVO (5A1) (DR9-033) OLD 5065 NEW 5058	12/14/73	TRI-LOCK PIN MISSING FROM J4.	FEWO SV9-047.
18.	CABLE ASSEMBLY (2W150)	12/6/73	WIRES TO PINS 15 15 & 28 MISSING (RETROFIT SV9-8).	FUNCTIONAL TEST PCOW.

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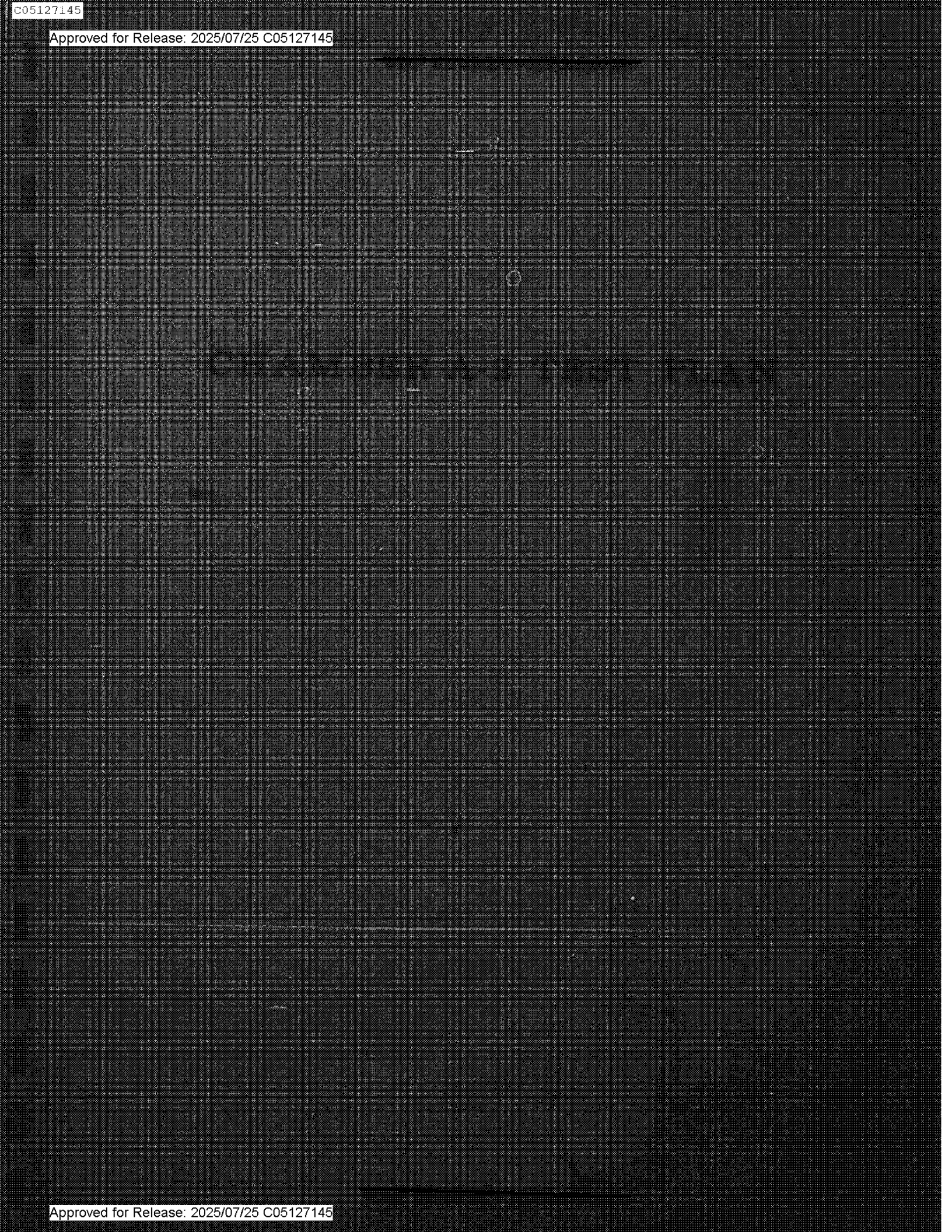
TABLE 1-4 (CONT'D)

	CHANGE	DATE	REASON	REVERIFICATION
19.	ISCCU BOX (15A1) (MR 64546) OLD 5016 NEW 5018	12/18/73	OVERSTRESSED WHEN SU PRESSURE TRANSDUCER SHORTED.	FEWO SV9-043.
20.	FUSE MODULE (MR 64546) OLD 940381 NEW 940399	12/19/73	SU PRESSURE TRANSDUCER SHORTED CAUSING THE FUSE TO BLOW.	FEWO SV9-043.
21.	PNEUMATICS MODULE (MR 64577) OLD 5013 NEW 5014	1/25/74	MODEL DIR PM 642.	FEWO SV9-054.
22.	UCC BOX (8A1) (MR 64580) OLD 5017 NEW 5015	2/21/74	INTERNAL SHORT TO CHASSIS.	FEWO SV9-77.
23.	EIGHT TORSION ROD BRACKETS (DR9-071)	3/18/74	OVERSTRESSED DURING TCA VIBRATION TEST (DBY MR5447).	FEWO SV9-77.
24.	7A1 ELECTRONICS BOX IN TUA-040A OLD 307 NEW 045	5/8/74	POSSIBLE OVERSTRESS (MD TUA-049).	FEWO SV9-77.
25.	7A1 ELECTRONICS BOX IN TUA-040B OLD 309 NEW 323	5/8/74	POSSIBLE OVERSTRESS (MD TUA-049).	FEWO SV9-77.
26.	FUSE MODULE (MR 64580) OLD 940399 NEW 940397	5/9/74	SHORTED UCC BOX BLEW FUSE.	FEWO SV9-77.
27.	OOAA BOX OLD SN-5009 NEW SN-5010	6/21/74	FBS BREAKING UP.	FEWO SV9-086.
28.	TAKE-UP OLD SN-40 NEW SN-24A	6/29/74	APPLIED 110 VOLTS AC TO SN-40.	FEWO SV9-90.
29.	TAKE-UP OLD SN-17A NEW SN-40	7/29/74	BRAKE FAILURE.	FEWO SV9-106.

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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-9 was subjected to two Chamber A-2 tests. The details of these tests are discussed in Sections IV and V of this report.

In conjunction with the standard Chamber A-2 testing, a special series of resolution tests at various vehicle pitch angles and platen tilts of ±16 microns were performed on the 1A-2 test. These tests were made on Runs 225 thru 312. The Chamber A-2 test sequences are listed in Table 2-1. The details and results of these platen tilt tests are discussed in Section V of this report.

The purpose of the second A-2 test was to evaluate any changes that may have occurred as a result of removing the platens for shutter retrofit.

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 verify system operation in the final configuration when vacuum testing is completed. For this reason, the third portion of the test is a second in-air test conducted after having reconfigured the sensor to the flight condition.

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

2.3 COLLIMATOR TARGETS

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

2.4 TEST SEQUENCE

The 1A-2 test was a standard test sequence, and included extra runs for the platen tilt test. The 2A-2 test was an abbreviated test; for a listing of these test sequences, see Table 2-2.

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TABLE 2-1

FIRST 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
255	K	.052	.303	-1.0	30	0	144	Dis	Continuous
258	K	.052	.303	-2.0	30	0	144	Dis	Continuous
259	K	.052	.303	-2.5	30	0	144	Dis	Continuous
262	K	.052	.303	1.0	30	0	144	Dis	Continuous
266	K	.052	.303	2.0	30	0	144	Dis	Continuous
267	K	.052	.303	2.5	30	0	144	Dis	Continuous
271	K	.052	.303	0	30	0	144	Dis	Continuous
275	K	.052	.303	-1.0	30	0	144	Dis	Continuous
278	K	.052	.303	-2.0	30	0	144	Dis	Continuous
279	K	.052	.303	-2.5	30	0	144	Dis	Continuous
282	K	.052	.303	1.0	30	0	144	Dis	Continuous
286	K	.052	.303	2.0	30	0	144	Dis	Continuous
287	K	.052	.303	2.5	30	0	144	Dis	Continuous
290	K	.052	.303	0	30	0	144	Dis	Continuous
296	K	.052	.303	-1.0	30	0	144	Dis	Continuous
299	K	.052	.303	-2.0	30	0	144	Dis	Continuous
300	K	.052	.303	-2.5	30	0	144	Dis	Continuous
304	K	.052	.303	1.0	30	0	144	Dis	Continuous
306	K	.052	.303	2.0	30	0	144	Dis	Continuous
309	K	.052	.303	2.5	30	0	144	Dis	Continuous
312	K	.052	.303	0	30	0	144	Dis	Continuous

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CHAMBER A-2 TARGET RETICLE

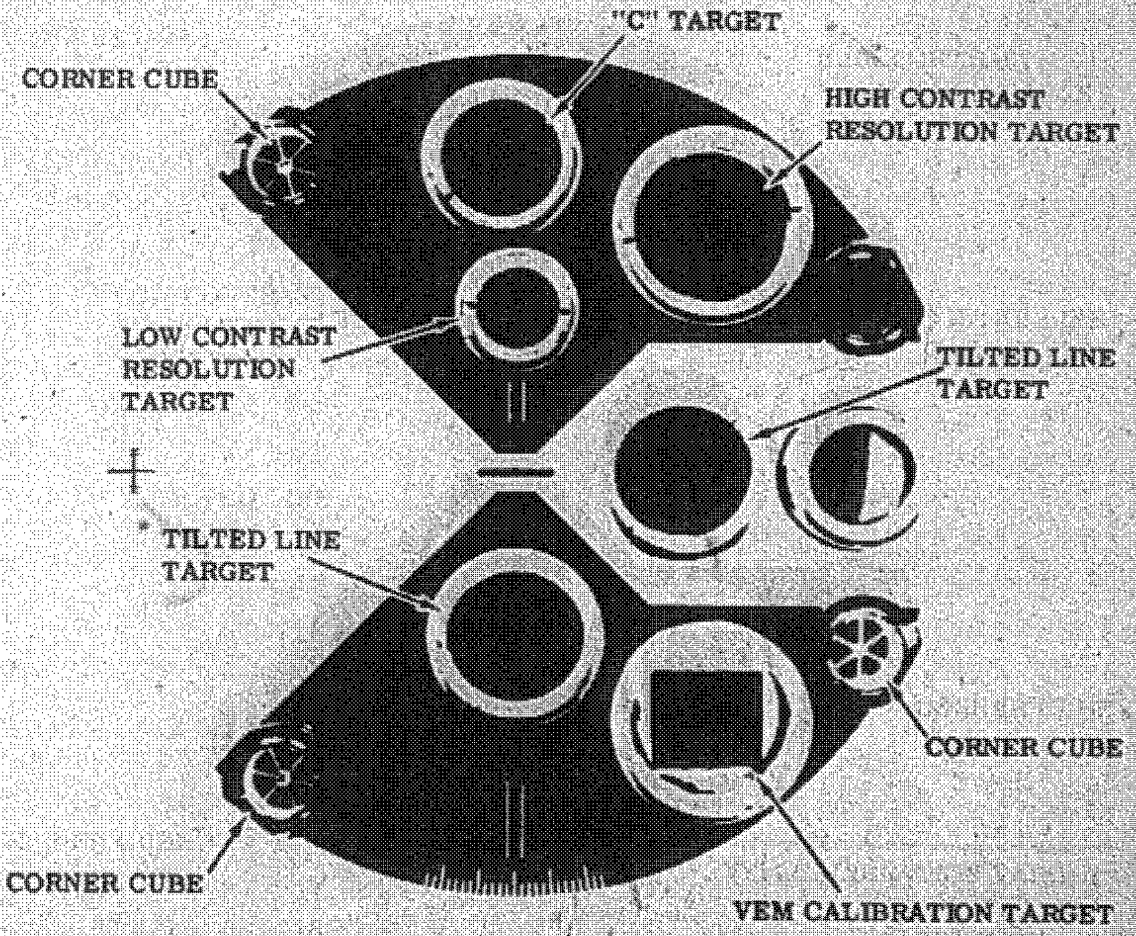


FIGURE 2-1

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TABLE 2-2

SECOND 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
576	K	.052	.303	-1.0	30	0	144	Dis	Continuous
579	K	.052	.303	-2.0	30	0	144	Dis	Continuous
582	K	.052	.303	-2.5	30	0	144	Dis	Continuous
586	K	.052	.303	1.0	30	0	144	Dis	Continuous
589	K	.052	.303	2.0	30	0	144	Dis	Continuous
593	K	.052	.303	2.5	30	0	144	Dis	Continuous
596	K	.052	.303	0	30	0	144	Dis	Continuous
599	C	.036	.910	0	90	0	10	Dis	Flash
600	V	.052	.910	0	30	0	144	Ena	Flash
601	M	.044	.910	0	90	0	77	Ena	Flash
602	R	.052	.910	0	90	0	33	Ena	Flash
605	K	.052	.303	0	30	0	144	Dis	Continuous
609	N	.044	.910	0	30	0	33	Ena	Flash
610	P	.052	.910	0	30	0	33	Ena	Flash
611	N	.044	.910	0	30	0	33	Ena	Flash
612	P	.052	.910	0	30	0	33	Ena	Flash

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SYSTEM ACCEPTANCE

PERFORMANCE

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SECTION III

SYSTEM RESOLUTION PERFORMANCE

3.1 INTRODUCTION

The Chamber A-2 readiness test data evaluation for 1414 Film has determined that the SV-9 Camera System is capable of satisfactory resolution performance for this mission. The two cameras have essentially-equivalent performance of approximately 190 cycles/mm in-track and 160 cycles/mm cross-track 2:1 contrast tribar resolution. Resolution testing for this vehicle was five times more extensive than usual due to the incorporation of two different platen tilt conditions along with a baseline and verification in the initial test plan. The second Chamber A-2 test, run after platen retrofit, verified the resolution performance across the field.

Based on the results of this resolution testing, the system was determined to be photographically ready for launch with no further chamber testing recommended. The resolution tests were as follows:

A. Resolution as a function of field angle.

B. Resolution as a function of slit width.

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

D. Resolution variability.

3.2 TEST PARAMETERS

The SV-9 optical bar sets are 030 in the Forward Camera and 033 in the Aft Camera. Each camera is equipped with an In-flight Changeable Filter (ICF) Assembly outfitted with equivalent W-12 and W-2E3 glass filters. The complete Readiness Test Plan is given in Table 2-1. For resolution-related testing, only the nadir collimator imagery was analyzed.

A major portion of the resolution performance analysis was devoted to Seq K, a four part series of 28 test runs made in the stereo mode. This sequence utilized IMC disabled, .303" slit width, and a Vx/h of .052 radian/second.

Seq K_1 was a baseline nominal platen tilt, K_2 was a 16 micron retreat platen tilt condition, (8" from the platen pivot point), K_3 was a 32 micron advance platen tilt (16 micron advance from nominal) and K_4 was a return to the nominal tilt setting for verification. In the second Chamber A-2 test, only the nominal platen tilt condition was tested; this is identified as Seq K_5. Throughout the report, these portions are referred to as the PRE-TILT (PRE), RETREAT (RET), ADVANCE (ADV), POST-TILT (POST), and the second Chamber A-2 (2A-2) conditions. Each portion of Seq K utilized the vehicle pitch configuration to sample the field at seven locations: 0°, $\pm$1°, $\pm$2°, and $\pm$2.5 degrees.

At each field location, a thru focus run was generated with nine different platen positions in 6 micron increments covering a 48 micron dynamic range. Test target images were replicated 20 times for the

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central platen positions and 10 times for the extreme platen positions. The incorrect footage measurements during Chamber 1A-2 despooling for film flatness measurements from CV runs resulted in the loss of some film for resolution data analysis. This missing film totally impacted on the Aft/0° POST condition, as well as partially affecting the Forward/-1° PRE, Forward/-1° RET, Aft/1° RET, Forward/-1° ADV, and Aft/1° ADV conditions. Some 2A-2 film from TR 582 was inadvertently left at WCFO with the film used for flatness measurements. This film was processed and read by WCFO for expediency in evaluating the data.

One test run from both Chamber A-2 tests was retained for processing and evaluation by WCFO. This was used for the Aft/0° POST tribar assessment in place of the missing film. The identifications of each test run along with the platen position ranges are given in Tables 3-1 and 3-2. Sign conventions used for the vehicle pitch testing are given in Table 3-3.

Two minor aspects of resolution performance analysis were carried out with Seqs J and L. The effects of wide slit width (.615") on resolution were examined with mono operations on the Forward (Seq JA) and the Aft (Seq JB) Cameras. Using the same Vx/h as the narrow slit width baseline (Seq K), these two test runs used 60° scan lengths centered at 15° Forward and -15° Aft and operated mono to conserve film while acquiring imagery from both nadir and field collimators. A normal thru focus run with 0° vehicle pitch was generated on each camera.

Examination of the differences in resolution and focus between the W-12 and W-2E3 Filters was made on Seq L. This stereo mode operation employed 90°/0° frames with a .044 radian/second Vx/h and a .259" slit width. Replicate frames were collected at fixed platen positions of 25 microns Forward and 75 microns Aft (both near optimum) for both filters.

3.3 TEST RESULTS

3.3.1 Resolution as a Function of Field Angle

Seq K in-track and cross-track thru focus resolution data plots for the seven field angles are given in Figures 3-1 thru 3-5 for the Forward Camera and 3-6 thru 3-10 for the Aft Camera. Each camera has a group of five plots corresponding to the primary test conditions: PRE, RET, ADV, POST, 2A-2. The resolution data points are those average values printed out by program RESOLUTE as read and input by AFSPPF personnel. The test tribars were read from the original negative by single readers.

Peak resolution (R_{max}) values and position of best focus (PBF) were determined from this data using a subjective smoothing technique. This data is tabulated in Tables 3-4 and 3-5 for the Forward Camera and Aft Camera, respectively. These PBFs are indicated on Figures 3-1 thru 3-10 by vertical tick marks on the respective plots. Geometric mean data is included in the tables for completeness but is omitted from the figures. This data is not the mean of the in-track and cross-track R_{max} and PBF values as such, but is the R_{max} and PBF values resulting directly from the geometric mean resolution

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TABLE 3-1

CHAMBER 1A-2 RESOLUTION TEST SUMMARY

Sequence	Test Run	Vehicle Pitch (degrees)	Platen Position Range (microns) Forward	Aft
K_1	259	-2.5	-8/40	40/88
	258	-2.0	1/40	40/88
	255	-1.0	1/49	51/99
	271	0	7/55	57/105
	262	1.0	1/49	51/99
	266	2.0	-8/40	40/88
	267	2.5	-8/40	40/88
K_2	300	-2.5	-21/27	36/84
	299	-2.0	-21/27	36/84
	296	-1.0	-6/42	42/90
	312	0	1/49	51/99
	304	1.0	-8/40	42/90
	308	2.0	-13/35	29/77
	309	2.5	-13/35	29/77
K_3	279	-2.5	3/51	44/92
	278	-2.0	3/51	44/92
	275	-1.0	7/55	57/105
	290	0	14/62	64/112
	282	1.0	9/57	58/106
	286	2.0	-4/44	53/101
	287	2.5	-4/44	53/101
K_4	320	-2.5	-8/40	40/88
	319	-2.0	-8/40	40/88
	316	-1.0	1/49	51/99
	323	0	1/49	51/99
	335	1.0	1/49	51/99
	338	2.0	-8/40	40/88
	342	2.5	-8/40	40/88
K_5	350	0	1/49	51/99

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TABLE 3-1 (CONT'D)

Sequence	Test Run	Vehicle Pitch (degrees)	Platen Position Range (microns) Forward	Aft
JA	330	0	1/49	-
JB	329	0	-	51/99
L	326	0	W-12 Frames 001-013, 025-033, 046-053	W-12 Frames 001-010, 022-030, 043-053
			W-2E Frames 016-023, 036-043	W-2E Frames 013-020, 033-040

TABLE 3-2

CHAMBER 2A-2 RESOLUTION TEST SUMMARY

Sequence	Test Run	Vehicle Pitch (degrees)	Platen Position Range (microns) Forward	Aft
K_5	582	-2.5	1/49	38/86
	579	-2.0	3/51	42/90
	576	-1.0	9/57	53/101
	596	0	12/60	58/106
	586	1.0	9/57	55/103
	589	2.0	-1/47	44/92
	593	2.5	-8/40	38/86
K_{11}	605*	0	12/60	58/106

NOTE: The asterisk (*) denotes WCFO baseline.

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TABLE 3-3

PITCH/FIELD SIGN CONVENTIONS

(degrees)

Vehicle Pitch (degrees)	Forward Camera		Aft Camera	
	0° Scan	37° Scan	0° Scan	37° Scan
-2.5	2.5	NA	-2.5	NA
-2.0	2.0	NA	-2.0	NA
-1.0	1.0	NA	-1.0	NA
0	0	2.0	0	-2.0
1.0	-1.0	1.0	1.0	-1.0
2.0	-2.0	0	2.0	0
2.5	-2.5	-0.5	2.5	0.5

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.

thru focus plots.

This resolution data at the various field locations reveals several noteworthy aspects of camera system performance. Although the data is noisy, more often than not the curves assume essentially the same characteristic thru focus curve shape. This corresponds to approximately a 20% loss in average resolution with a 16 micron platen position offset from the peak location. In-track resolution is superior to cross-track resolution in a manner dependent upon relative platen position. At peak resolution, the difference is 11% on the average, this decreases with increasing defocus. It is also evident that both cameras exhibit astigmatism at the minus field positions where the cross-track focus is shorter than in-track. The most severe example is at the -2° field position. Measurements of astigmatism in Chamber D average approximately 4 microns (cross-track shorter) across the field for both cameras. The reason for this discrepancy is unknown.

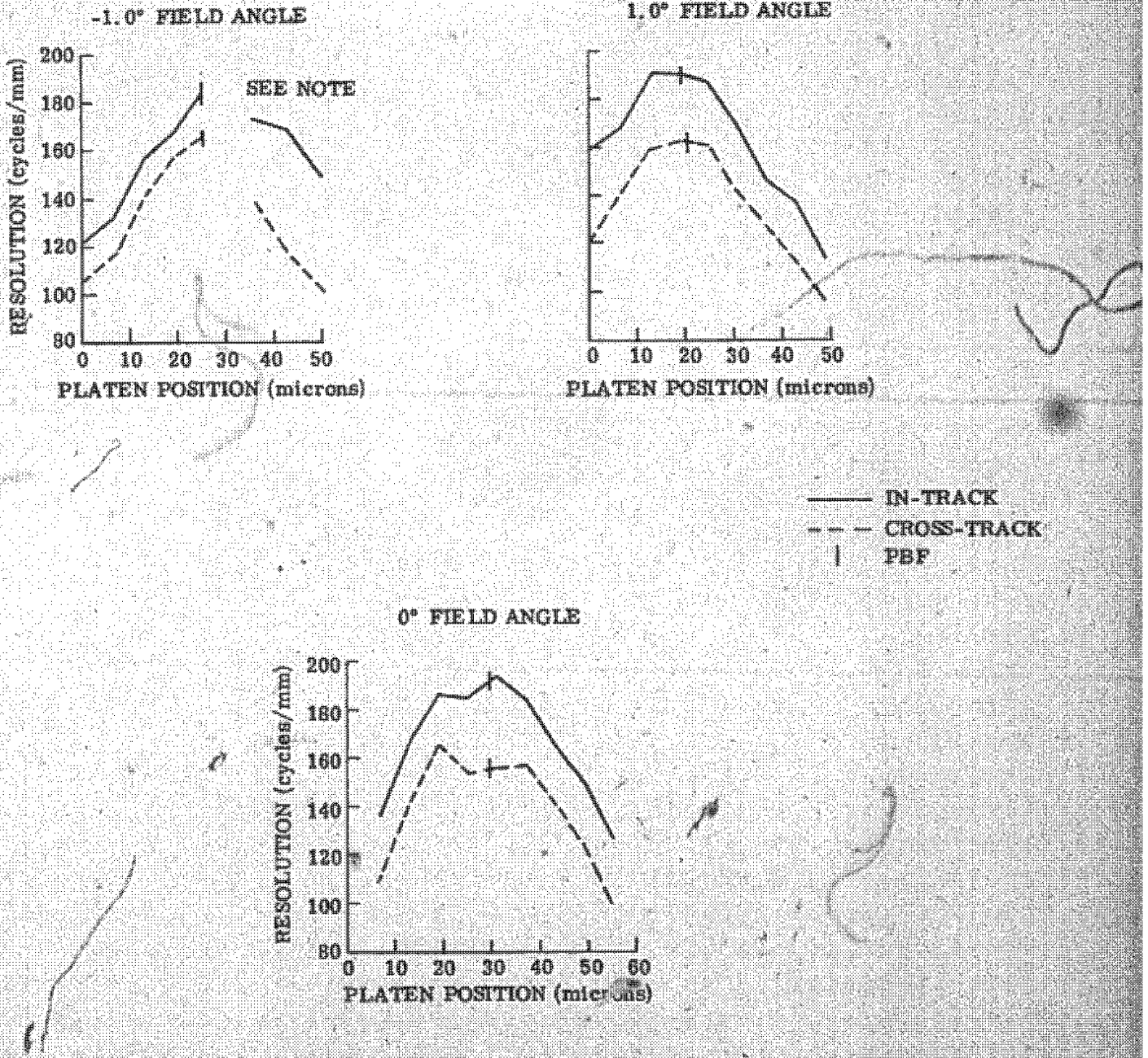
During the later stages of the 2A-2 data evaluation, there was some concern about a possible suppression of cross-track resolution. Nadir position test photography from both the original baseline (1A-2 data) as well as the second test (2A-2) was read at SSC by three independent SSC readers. These results, in comparison with the original AFSPPF data, are shown in Figure 3-11. The data is summarized in Table 3-6. From this data, it is apparent that the 2A-2 cross-track resolution suppression of approximately 14% is reader dependent.

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FORWARD CAMERA RESOLUTION THRU FOCUS CURVES

AT PRE-TILT CONDITION



NOTE: This film was missing, see paragraph 3.2 for further explanation.

FIGURE 3-1

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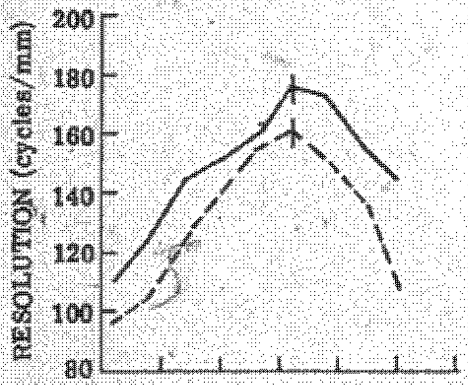
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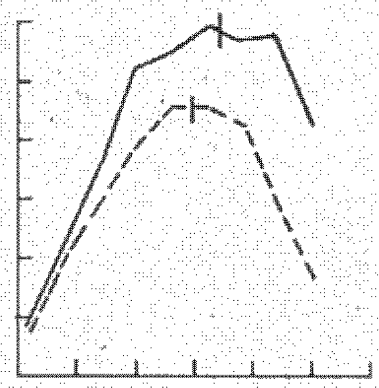
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FORWARD CAMERA RESOLUTION THRU FOCUS CURVES AT PRE-TILT CONDITION (CONT'D)

-2.5° FIELD ANGLE

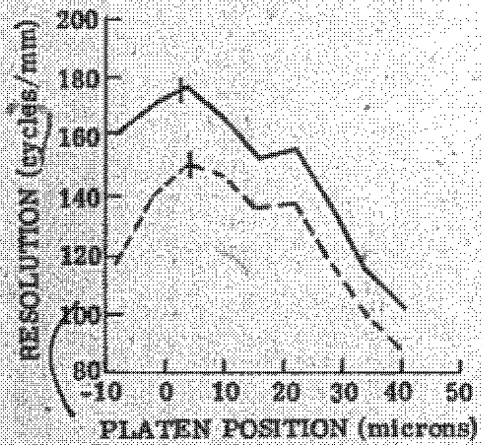


-2.0° FIELD ANGLE

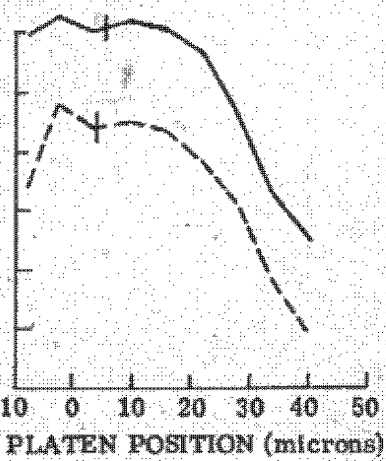


IN-TRACK
CROSS-TRACK
PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



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FORWARD CAMERA RESOLUTION THRU FOCUS CURVES
AT RETREAT TILT CONDITION

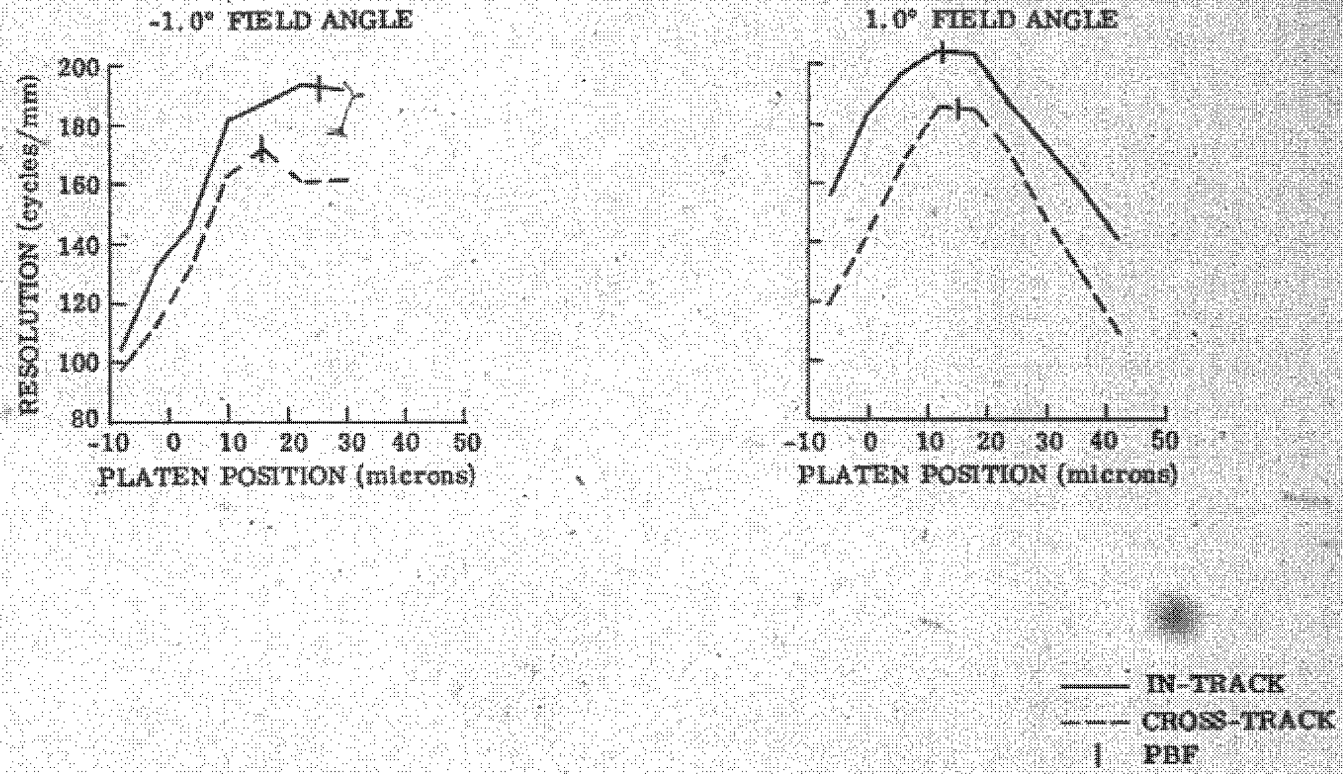


FIGURE 3-2

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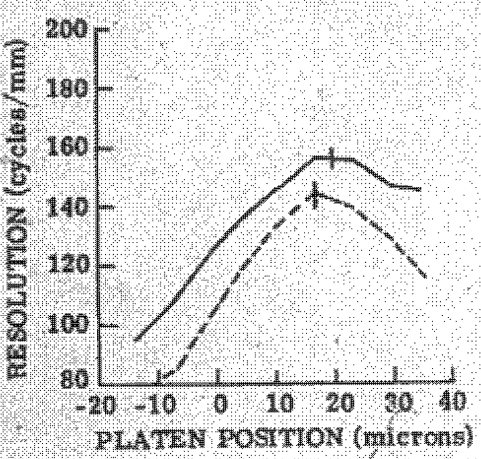
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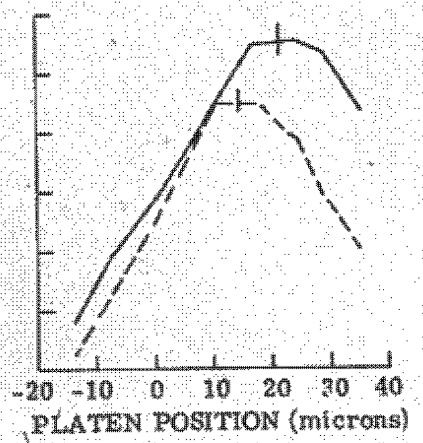
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FORWARD CAMERA RESOLUTION THRU-FOCUS CURVES AT RETREAT TILT CONDITION (CONT'D)

-2.5° FIELD ANGLE

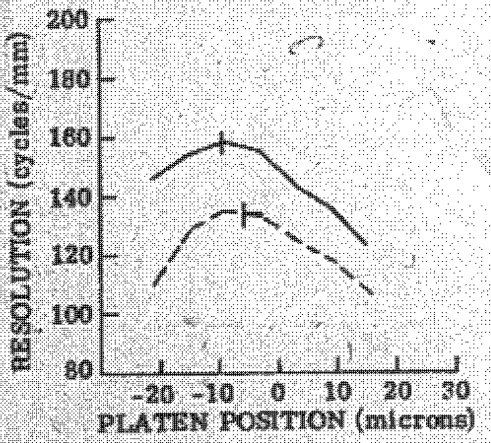


-2.0° FIELD ANGLE

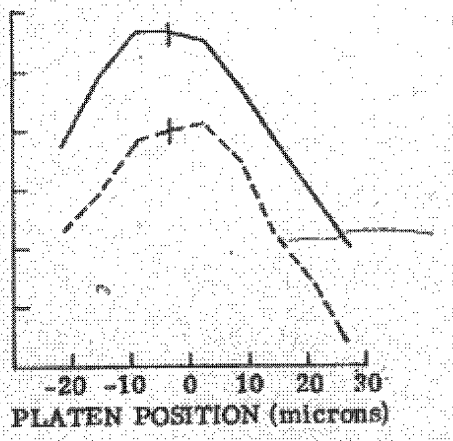


——— IN-TRACK
– – – CROSS-TRACK
| PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



BYE 15303-74

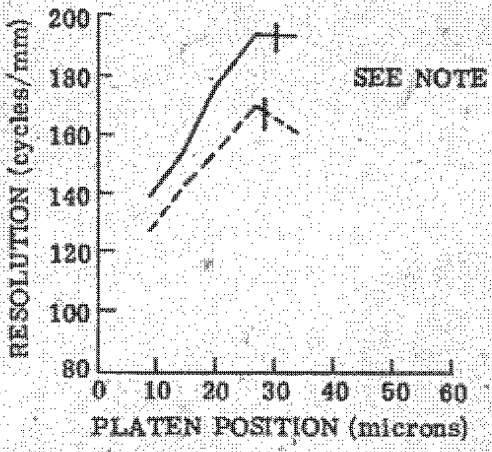
Handle via Byeman
Controls Only

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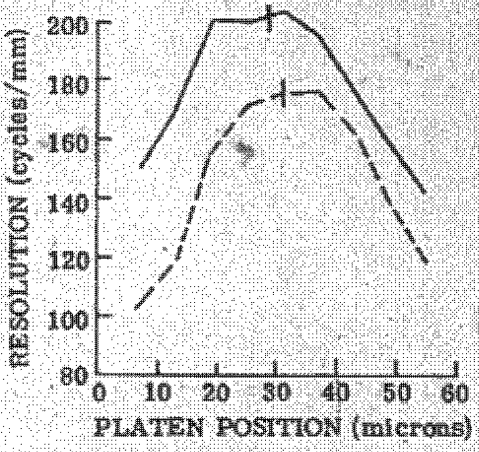
C05127145
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FORWARD CAMERA RESOLUTION THRU FOCUS CURVES
AT ADVANCED TILT CONDITION

-1.0° FIELD ANGLE

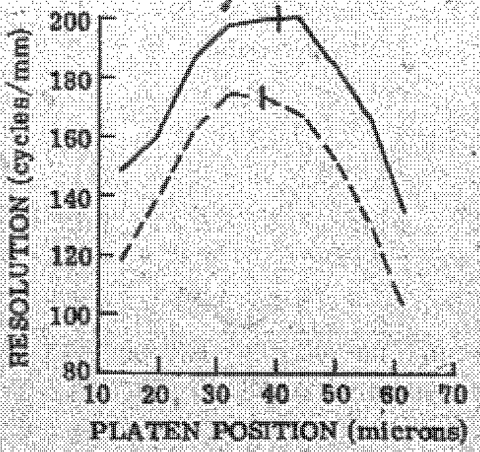


1.0° FIELD ANGLE



—— IN-TRACK
– – – CROSS-TRACK
·|· PBF

0° FIELD ANGLE



NOTE: This film was missing, see paragraph 3.2 for further explanation.

FIGURE 3-3

Handle via Byeman
Controls Only

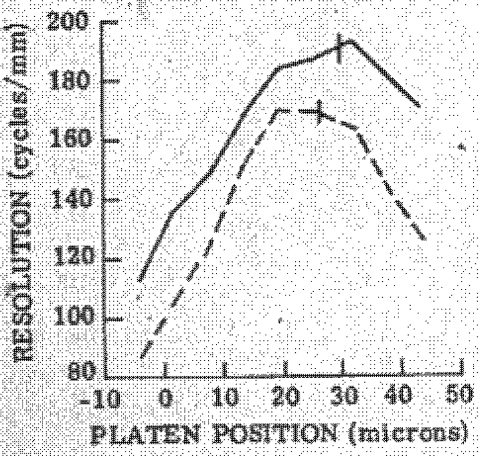
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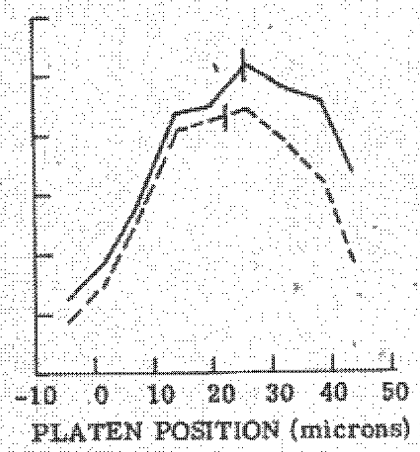
FLIGHT READINESS REPORT
SV-9 (SN-012)

FORWARD CAMERA RESOLUTION THRU FOCUS CURVES AT ADVANCED TILT CONDITION (CONT'D)

-2.5° FIELD ANGLE

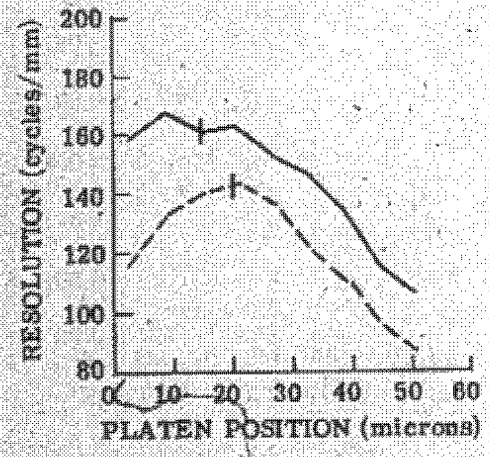


-2.0° FIELD ANGLE

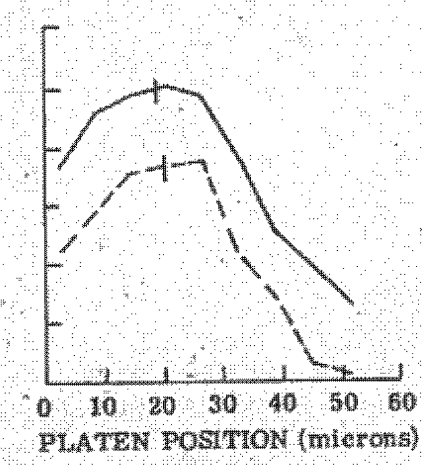


IN-TRACK
CROSS-TRACK
PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



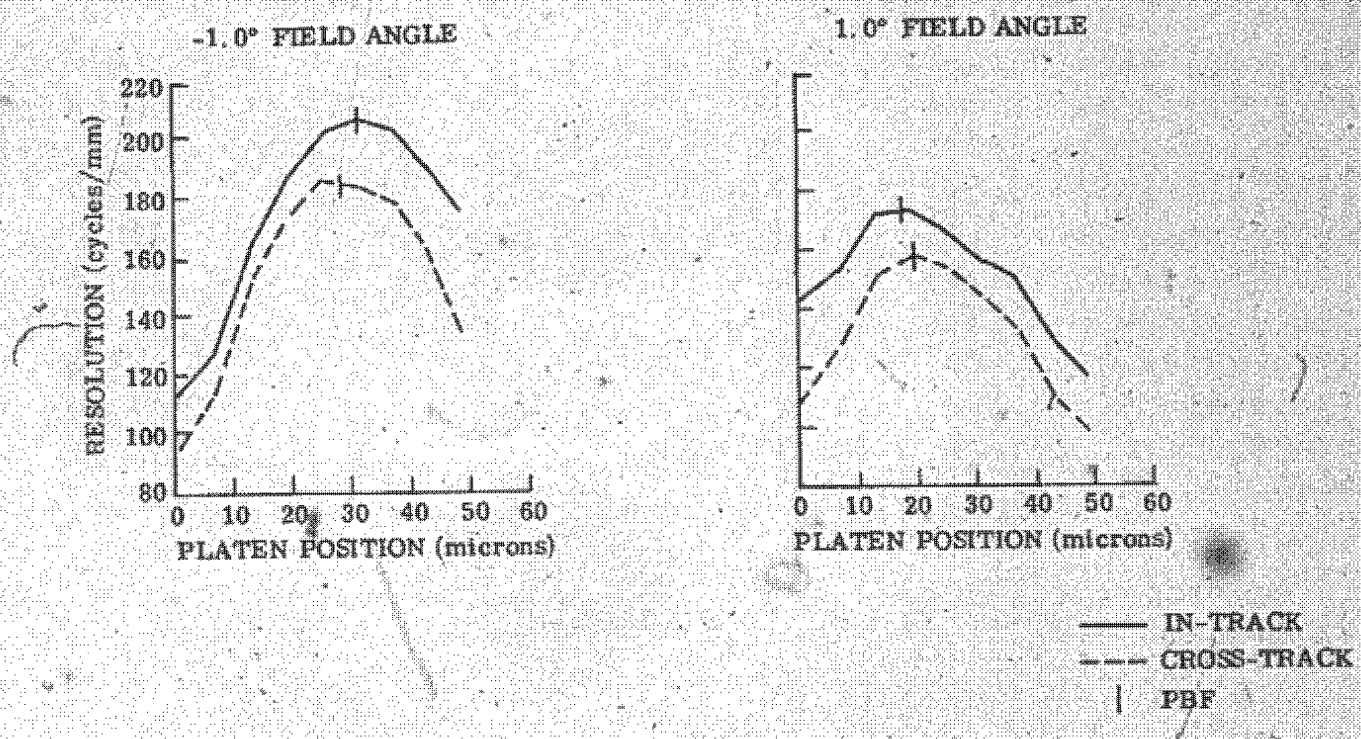
BYE 15303-74

Handle via Byeman
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FLIGHT READINESS REPORT
SV-9 (SN-012)

FORWARD CAMERA RESOLUTION THRU FOCUS CURVES
AT POST-TILT CONDITION



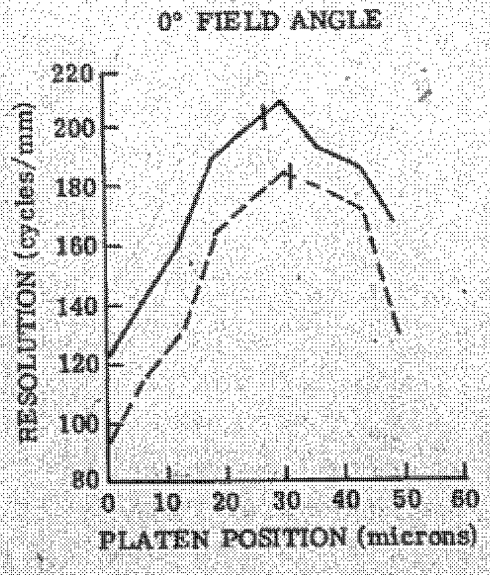


FIGURE 3-4

BYE 15303-74

Handle via Byeman
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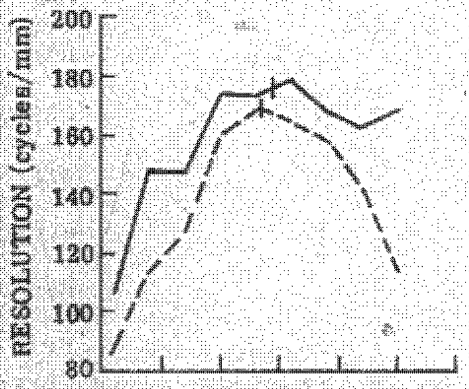
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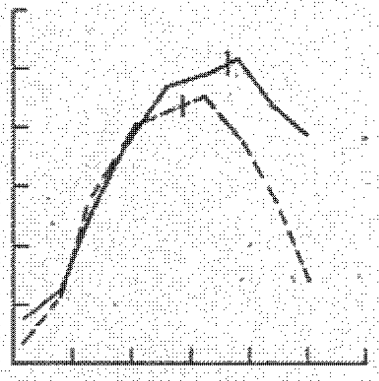
FLIGHT READINESS REPORT
SV-9 (SN-012)

FORWARD CAMERA RESOLUTION THRU FOCUS CURVES AT POST-TILT CONDITION (CONT'D)

-2.5° FIELD ANGLE

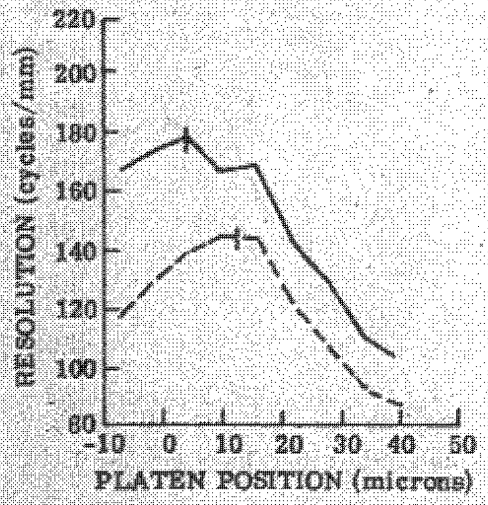


-2.0° FIELD ANGLE

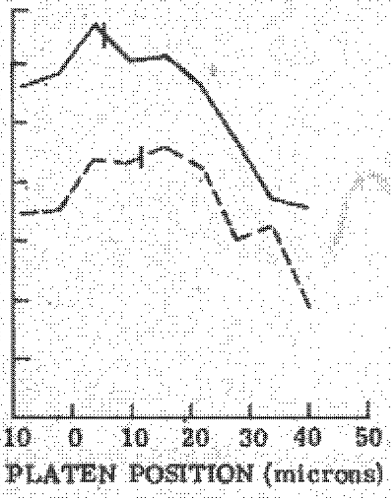


—— IN-TRACK
– – – CROSS-TRACK
| PBF

2.5° FIELD ANGLE



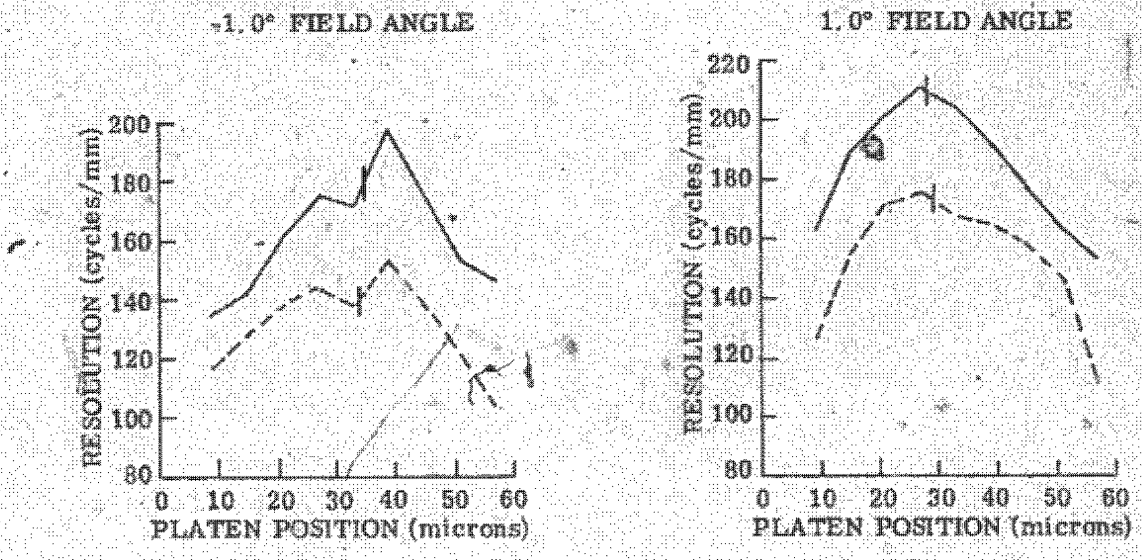
2.0° FIELD ANGLE



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FORWARD CAMERA RESOLUTION THRU FOCUS CURVES
AT 2A-2 CONDITION



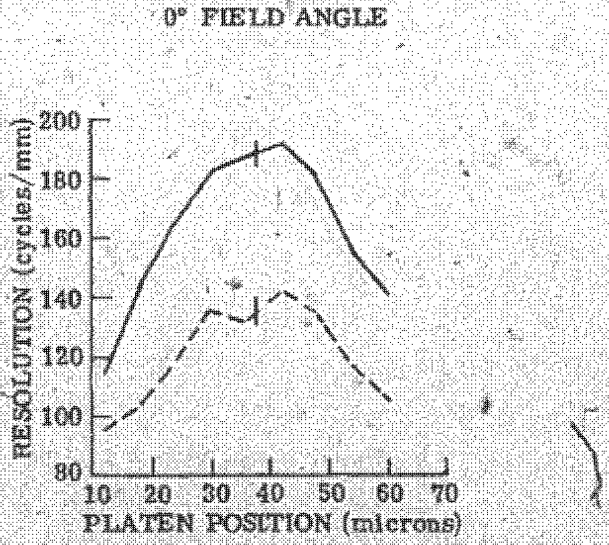


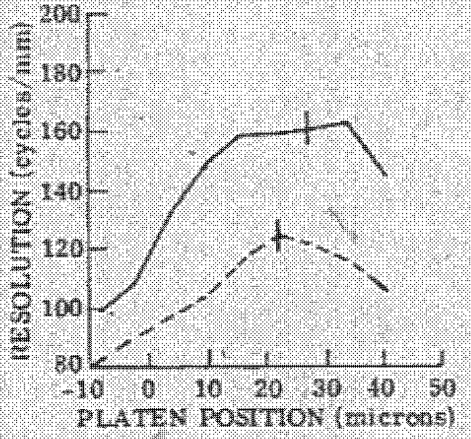
FIGURE 3-5

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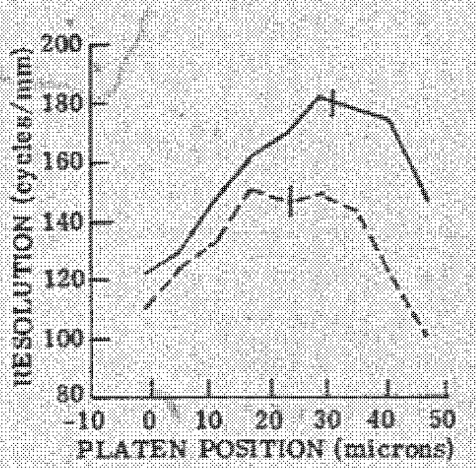
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FORWARD CAMERA RESOLUTION THRU FOCUS CURVES AT 2A-2 CONDITION (CONT'D)

-2.5° FIELD ANGLE

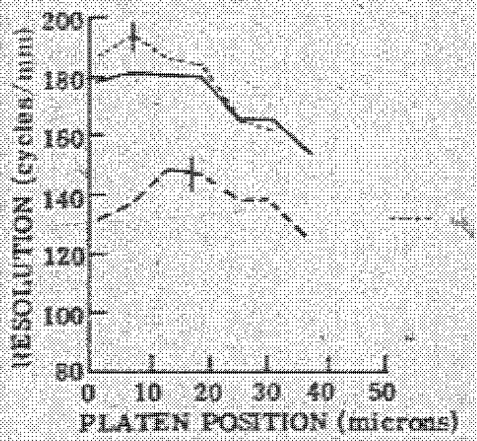


-2.0° FIELD ANGLE

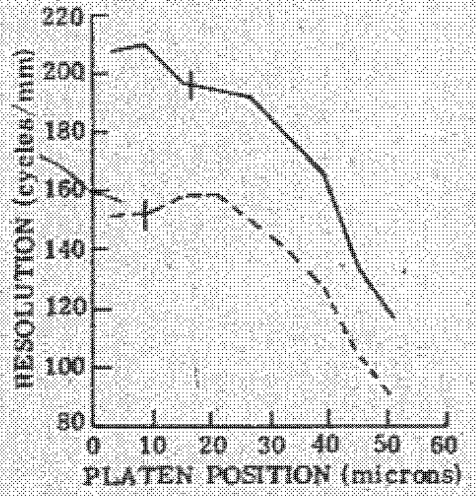


——— IN-TRACK
– – – CROSS-TRACK
------ REREAD
| PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



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TABLE 3-4

SMOOTHED CURVE PEAK RESOLUTION VALUES AT NOMINAL TILT

(cycles/mm)

Field Angle (degrees)		Forward Camera — Initial (IA-2)			Verify (IA-2)			Repeat (IA-2)			Retrace Tilt (IA-2)			Advance Tilt (IA-2)			All Camera —
		GM	XT	T1	GM	XT	T1	GM	XT	T1	GM	XT	T1	GM	XT	T1	
-2.5	Rad	265	256	274	342	326	358	562	538	586	365	348	380	370	354	386	259
	T	174	166	182	202	192	212	379	362	396	238	226	250	241	229	253	180
	XT	157	149	165	184	175	193	344	328	360	216	205	227	219	208	230	163
	GM	163	155	171	191	181	201	357	341	373	225	214	236	228	216	240	169
-2.0	Rad	262	252	272	335	319	351	586	560	612	378	360	396	383	366	400	268
	T	172	164	180	206	196	216	396	378	414	250	238	262	253	241	265	188
	XT	155	147	163	184	175	193	360	344	376	227	216	238	230	219	241	171
	GM	161	153	169	191	181	201	373	357	389	236	225	247	239	228	250	177
-1.0	Rad	271	262	280	348	332	364	610	584	636	393	375	411	398	381	415	279
	T	178	170	186	212	202	222	408	390	426	258	246	270	261	249	273	194
	XT	161	153	169	191	181	201	373	357	389	236	225	247	239	228	250	177
	GM	167	159	175	198	188	208	387	371	403	245	234	256	248	237	259	184
0	Rad	279	270	288	358	342	374	628	602	654	405	387	423	410	393	427	288
	T	184	176	192	218	208	228	420	402	438	266	254	278	269	257	281	200
	XT	167	159	175	198	188	208	387	371	403	245	234	256	248	237	259	184
	GM	173	165	181	205	195	215	401	385	417	254	243	265	257	246	268	191
-1.0	Rad	289	278	298	370	354	386	650	624	676	419	401	437	424	407	441	298
	T	190	182	198	226	216	236	434	416	452	275	263	287	278	266	290	206
	XT	173	165	181	205	195	215	401	385	417	254	243	265	257	246	268	191
	GM	179	171	187	212	202	222	415	399	431	263	252	274	266	255	277	198
-2.0	Rad	299	288	308	382	366	398	672	646	698	433	415	451	438	421	455	308
	T	196	188	204	234	224	244	448	430	466	284	272	296	287	275	299	213
	XT	179	171	187	212	202	222	415	399	431	263	252	274	266	255	277	198
	GM	185	177	193	219	209	229	429	413	445	272	261	283	275	264	286	205
-2.5	Rad	309	298	318	394	378	410	694	668	720	447	429	465	452	435	469	318
	T	202	194	210	242	232	252	462	444	480	293	281	305	296	284	308	220
	XT	185	177	193	219	209	229	429	413	445	272	261	283	275	264	286	205

NOTES: 1. One asterisk (*) denotes part of Seq X_1, Versatec processed, and read by WCFO.
2. Two asterisks (**) denote film missing.
3. Three asterisks (***) denote rereading of film roll on a later date.

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TABLE 3-5

SMOOTHED CURVE PBF VALUES AT NOMINAL TILT

(microns)

Field Angle (degrees)	— Forward Camera — Initial (1A-2) Run	LT	XT	GM	Verify (1A-2) Run	LT	XT	GM	Repeat (2A-2) Run	LT	XT	GM	Retest Tilt (1A-2) Run	LT	XT	GM	Advance Tilt (1A-2) Run	LT	XT	GM	— Aft Camera — Run	LT	XT	GM	Repeat (2A-2) Run	LT	XT	GM	Retest Tilt (1A-2) Run	LT	XT	GM	Advance Tilt (1A-2) Run	LT	XT	GM
-2.5	267	23	23	23	342	24	19	20	533	31	24	25	309	20	14	17	287	30	26	34	239	67	61	63	342	74	70	71	309	65	60	64	279	70	66	67
-2.0	266	22	19	20	338	24	17	21	535	27	22	26	308	22	14	18	288	28	24	29	238	79	62	70	573	79	66	71	298	70	65	66	278	78	67	71
-1.5	263	25	20	25	335	21	18	25	536	38	28	27	304	24	16	20	282	33	28	38	235	81	73	77	576	83	78(?)	78	296	73	68	68	275	85	79	84
-1.0	271	28	23	28	333	27	21	29	576	38	33	37	312	29	21	31	273	37	31	39	271	79	83	82	596	81	76	79	312	72	71	71	290	90	80	92
0	255	17	19	16	316	16	13	17	576	28	33	37	296	14	15	15	278	18	20	18	282	90	76	84	589	67	64	67	334	68	70	70	282	99	88	88
1.0	238	6	4	5	319	5	12	8	573	9(?)	17	15	292	-3	-3	-3	279	15	20	17	286	82	80	81	589	67	64	67	308	55	53	55	286	82	80	81
2.0	239	3	4	5	330	4	11	6	583	7(?)	17	17	290	-9	-7	-9	279	15	20	17	287	76	77	75	593	64	62	64	309	48	50	47	287	76	77	75
2.5	259	3	4	5	330	4	11	6	583	7(?)	17	17	290	-9	-7	-9	279	15	20	17	287	76	77	75	593	64	62	64	309	48	50	47	287	76	77	75

NOTES: 1. One asterisk (*) denotes part of Seq K_2, Versamat processed, not read by WCFO.
2. Two asterisks (**) denote film missing.
3. Three asterisks (***) denote rereading of test run at a later date.
4. The question marks (?) denote questionable data.

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AFT CAMERA RESOLUTION THRU FOCUS CURVES AT PRE-TILT CONDITION

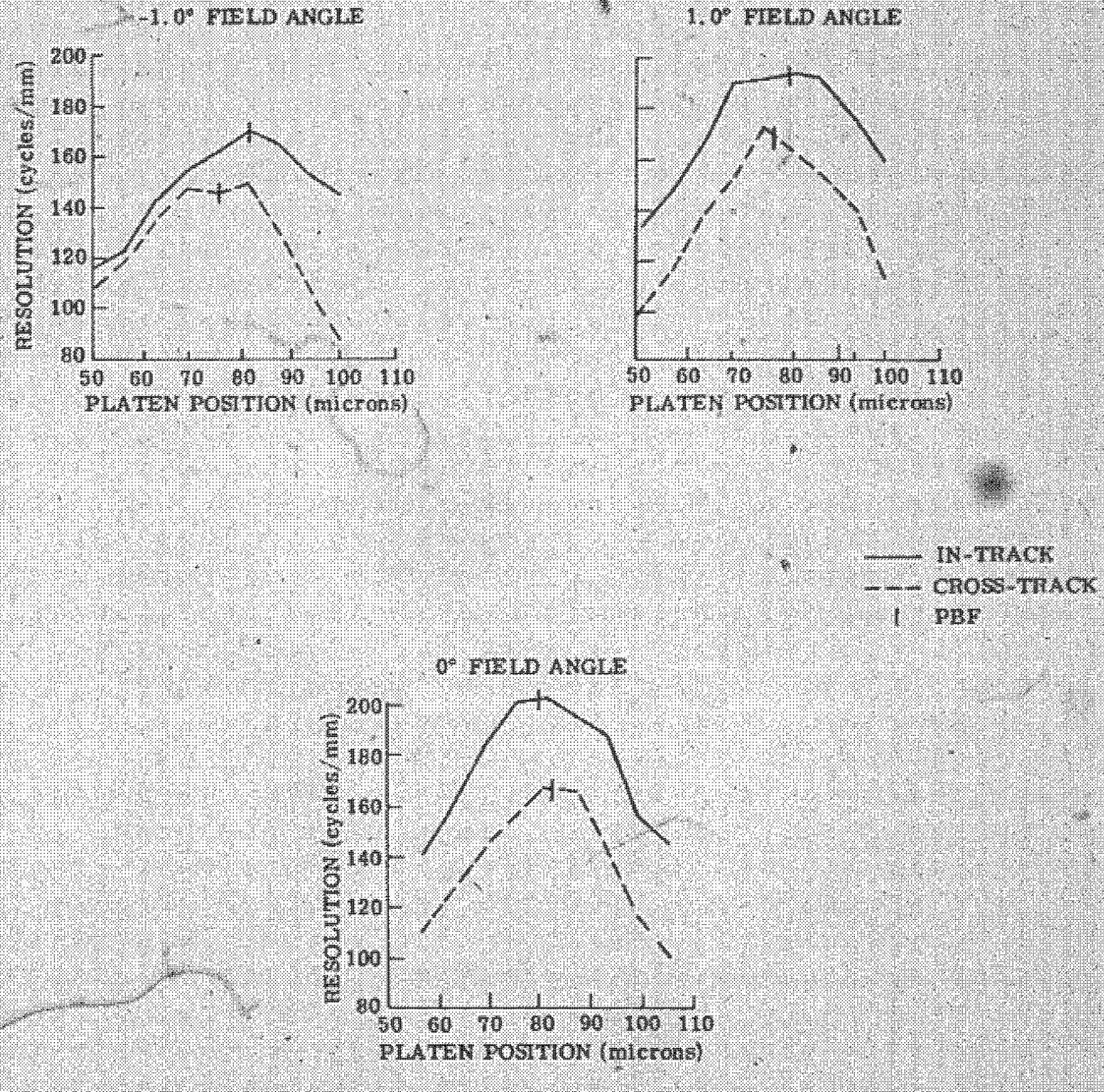
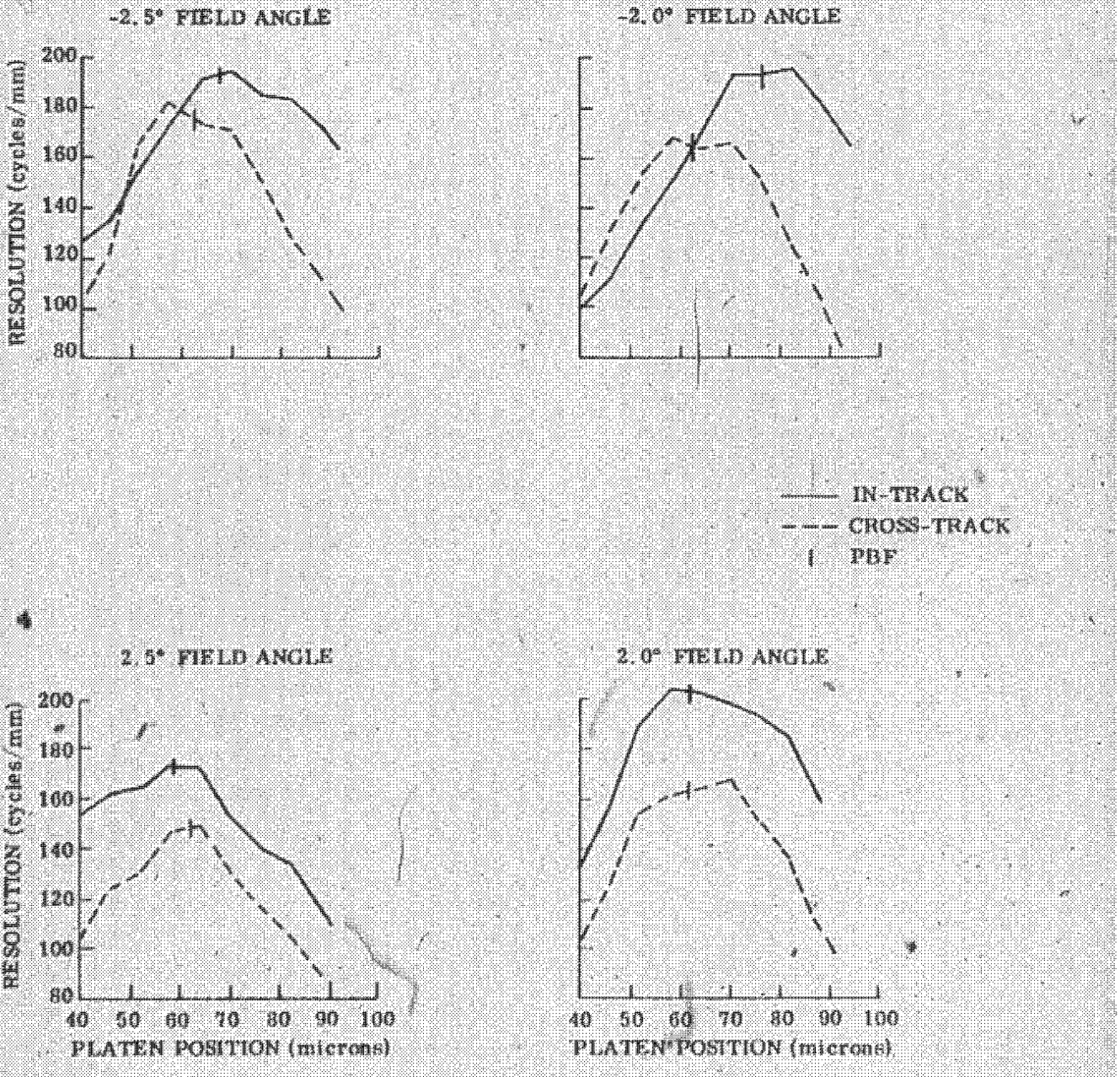


FIGURE 3-6

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AFT CAMERA RESOLUTION THRU FOCUS CURVES AT PRE-TILT CONDITION (CONT'D)



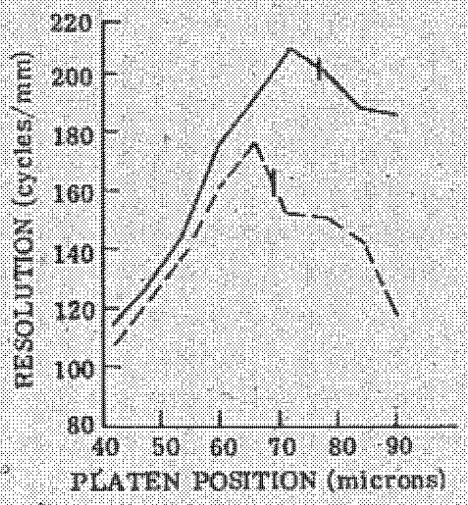
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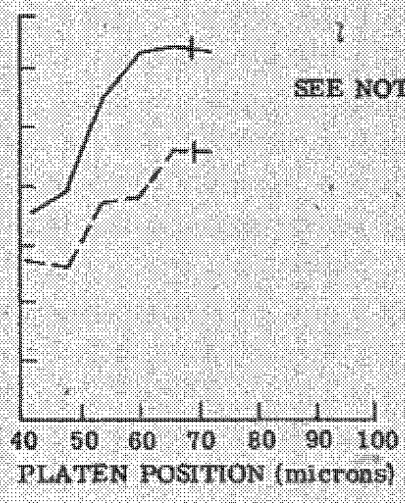
FLIGHT READINESS REPORT
SV-9 (SN-012)

AFT CAMERA RESOLUTION THRU FOCUS CURVES
AT RETREAT TILT CONDITION

-1.0° FIELD ANGLE

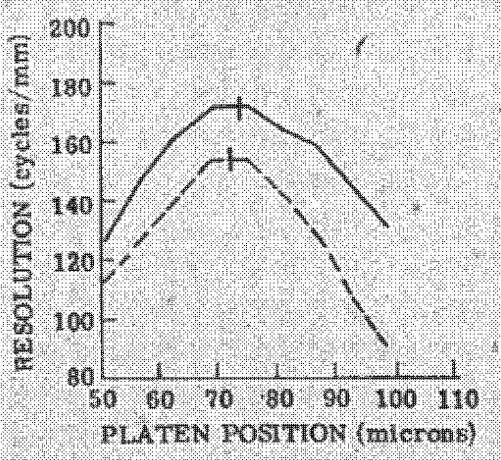


1.0° FIELD ANGLE



—— IN-TRACK
– – – – CROSS-TRACK
I PBF

0° FIELD ANGLE



NOTE: This film was missing, see paragraph 3.2 for further explanation.

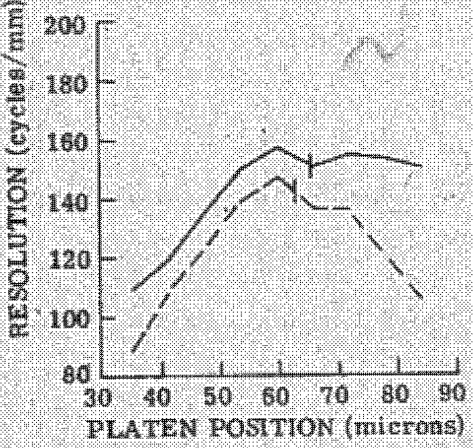
FIGURE 3-7

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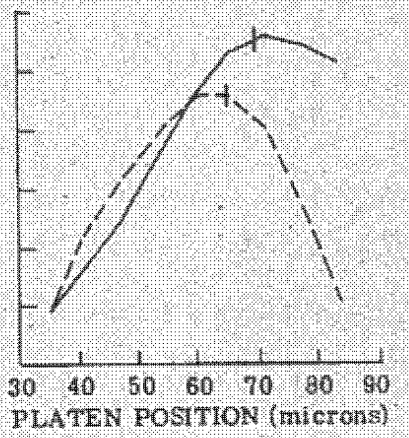
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AFT CAMERA RESOLUTION THRU FOCUS CURVES AT RETREAT TILT CONDITION (CONT'D)

-2.5° FIELD ANGLE

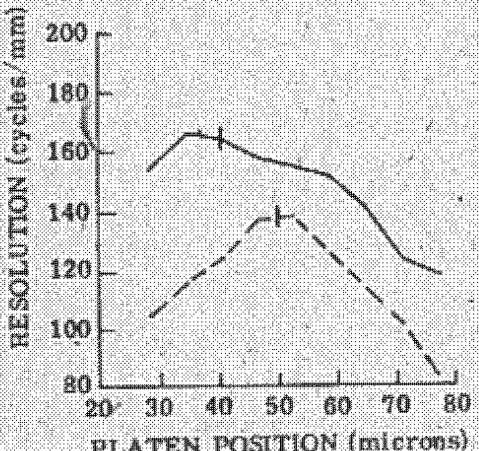


-2.0° FIELD ANGLE

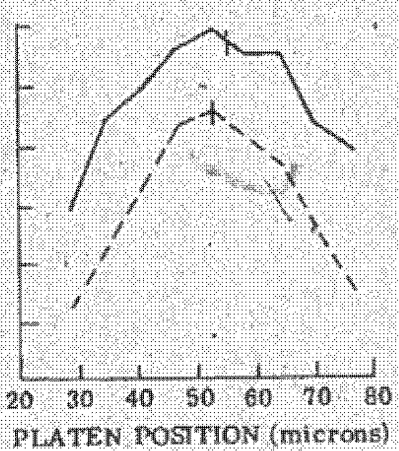


IN-TRACK
CROSS-TRACK
PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



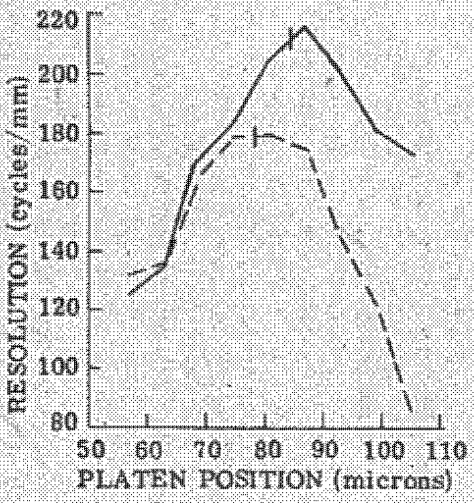
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AFT CAMERA RESOLUTION THRU FOCUS CURVES

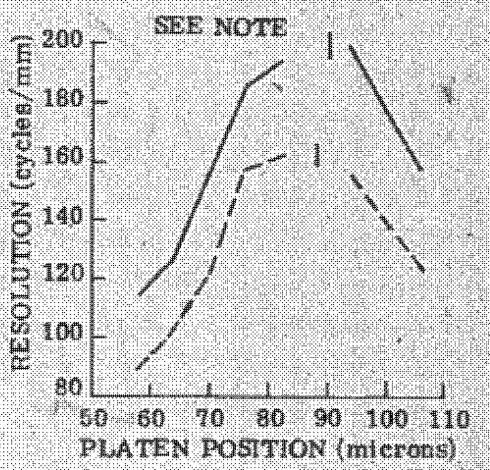
AT ADVANCED TILT CONDITION

-1.0° FIELD ANGLE



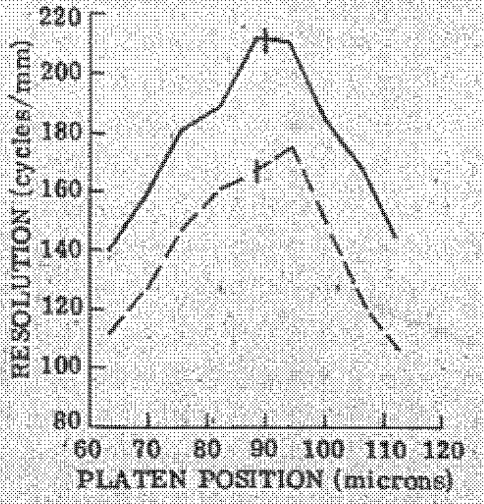
1.0° FIELD ANGLE

SEE NOTE



——— IN-TRACK
– – – CROSS-TRACK
| PBF

0° FIELD ANGLE



NOTE: This film was missing, see paragraph 3.2 for further explanation.

FIGURE 3-8

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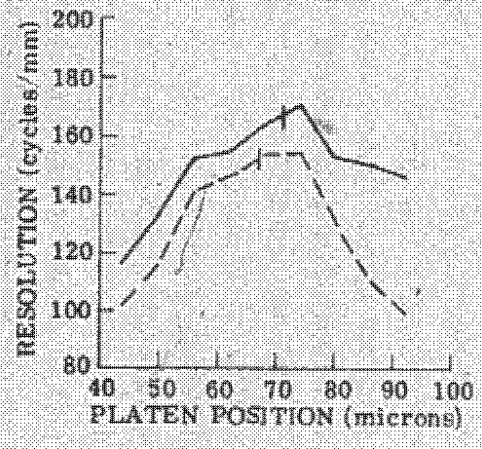
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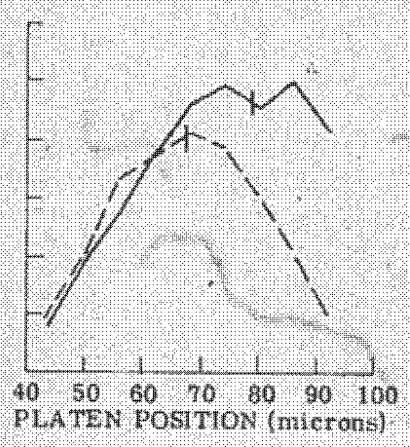
FLIGHT READINESS REPORT
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AFT CAMERA RESOLUTION THRU FOCUS CURVES AT ADVANCED TILT CONDITION (CONT'D)

-2.5° FIELD ANGLE

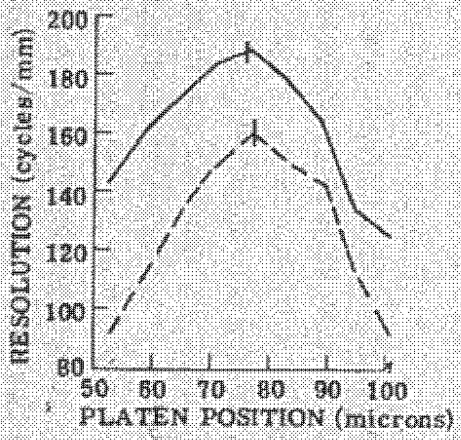


-2.0° FIELD ANGLE

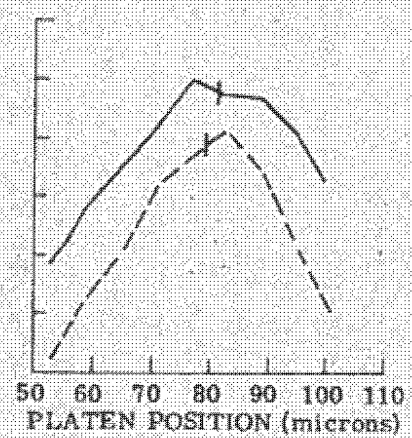


——— IN-TRACK
– – – CROSS-TRACK
| PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



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AFT CAMERA RESOLUTION THRU FOCUS CURVES
AT POST-TILT CONDITION

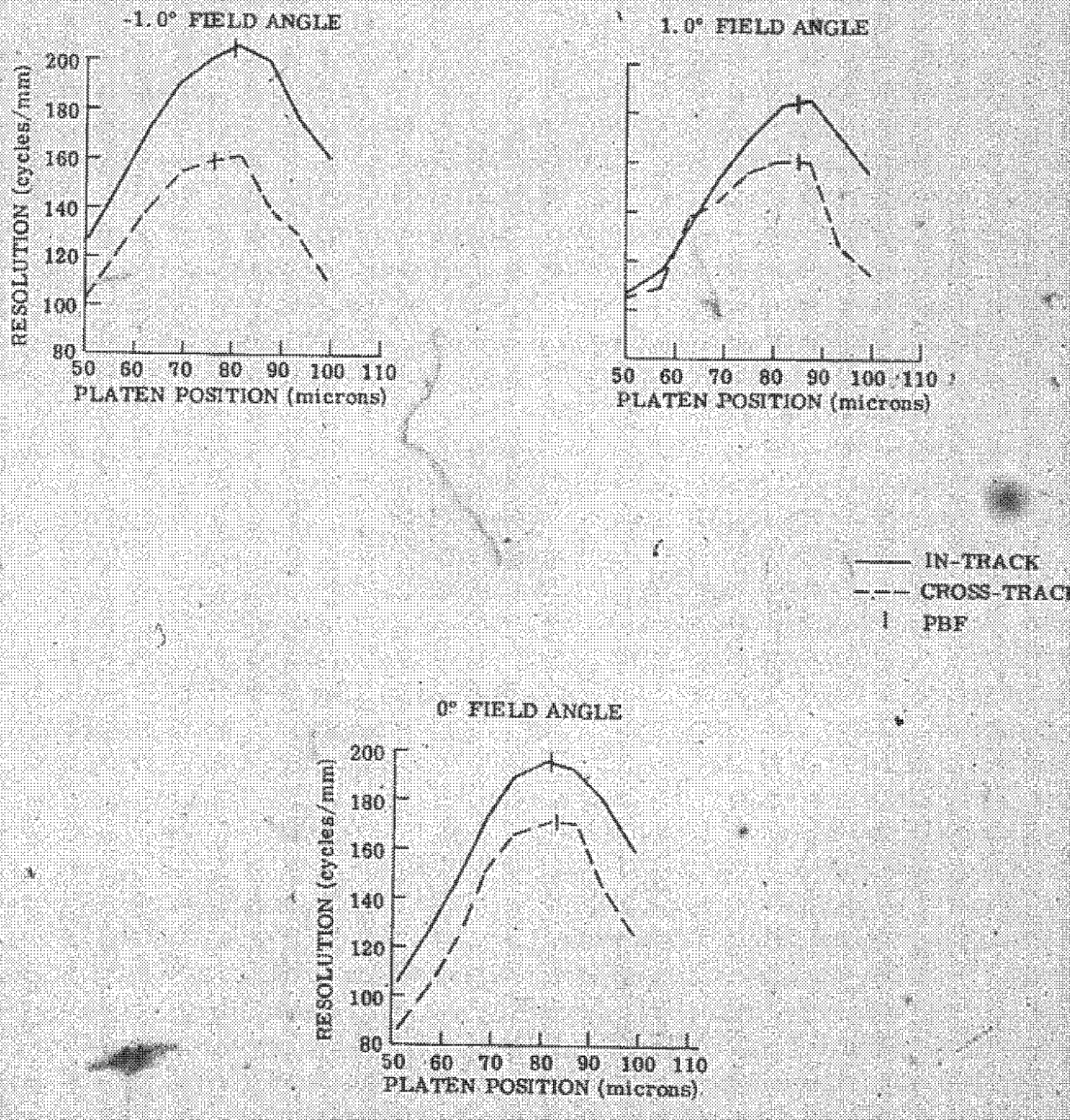


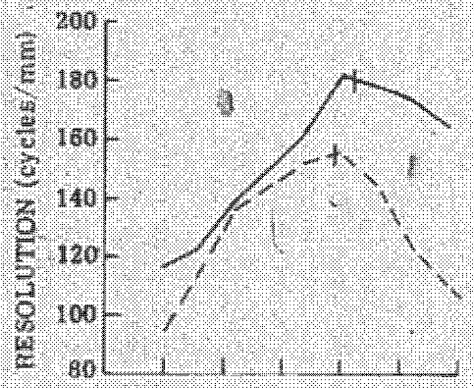
FIGURE 3-9

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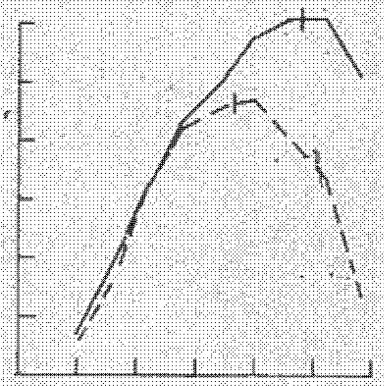
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AFT CAMERA RESOLUTION THRU FOCUS CURVES AT POST-TILT CONDITION (CONT'D)

-2.5° FIELD ANGLE

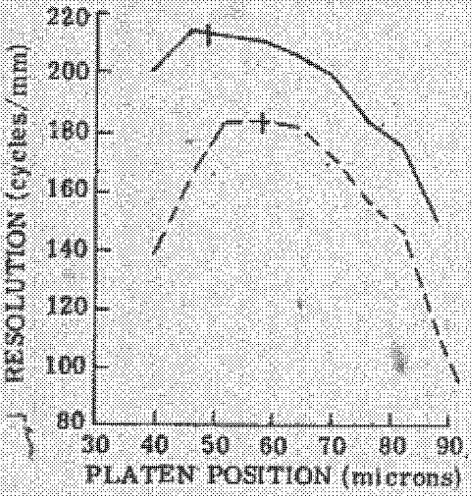


-2.0° FIELD ANGLE

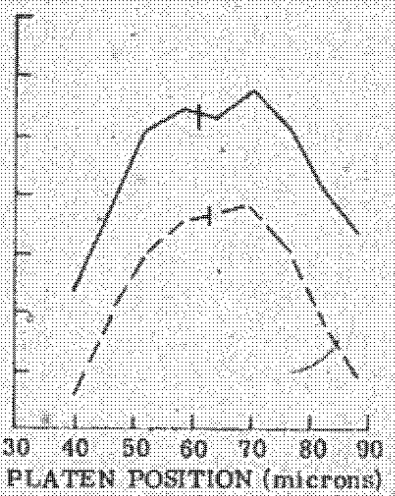


IN-TRACK
CROSS-TRACK
PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



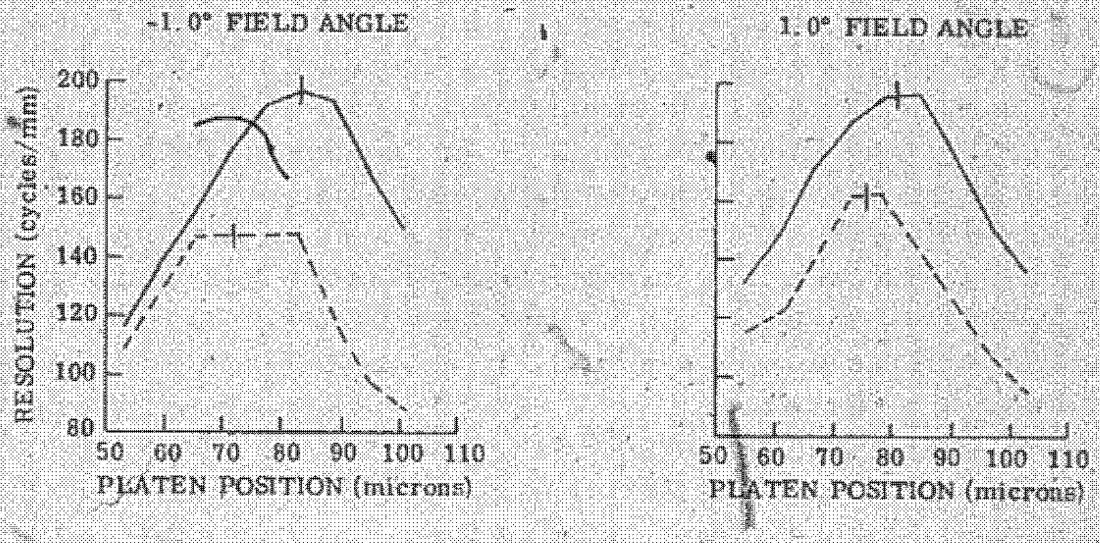
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AFT CAMERA RESOLUTION THRU FOCUS CURVES

AT 2A-2 CONDITION



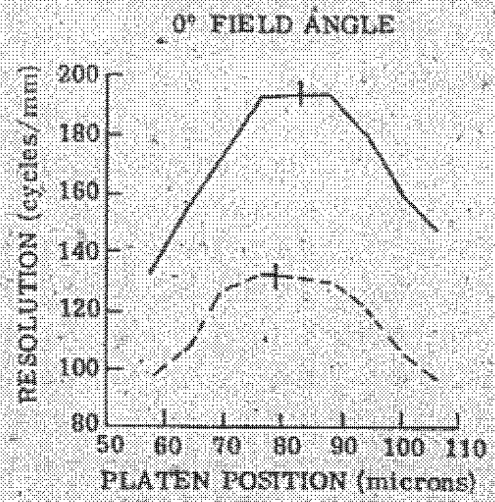


FIGURE 3-10

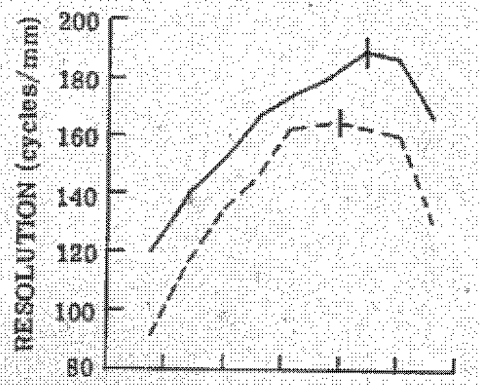
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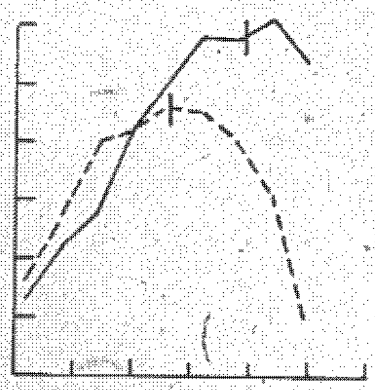
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AFT CAMERA RESOLUTION THRU FOCUS CURVES
AT 2A-2 CONDITION (CONT'D)

-2.5° FIELD ANGLE

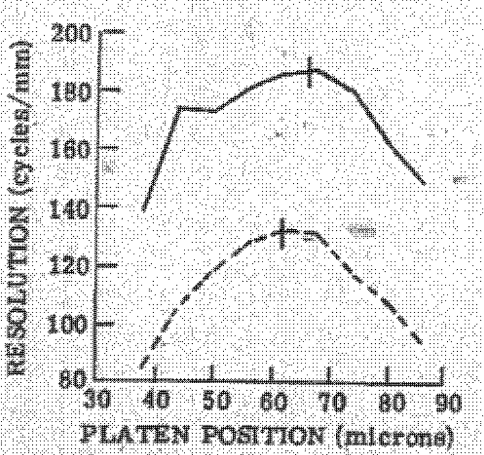


-2.0° FIELD ANGLE

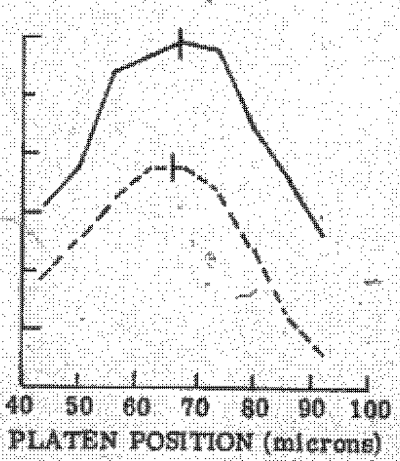


IN-TRACK
CROSS-TRACK
PBF

2.5° FIELD ANGLE



2.0° FIELD ANGLE



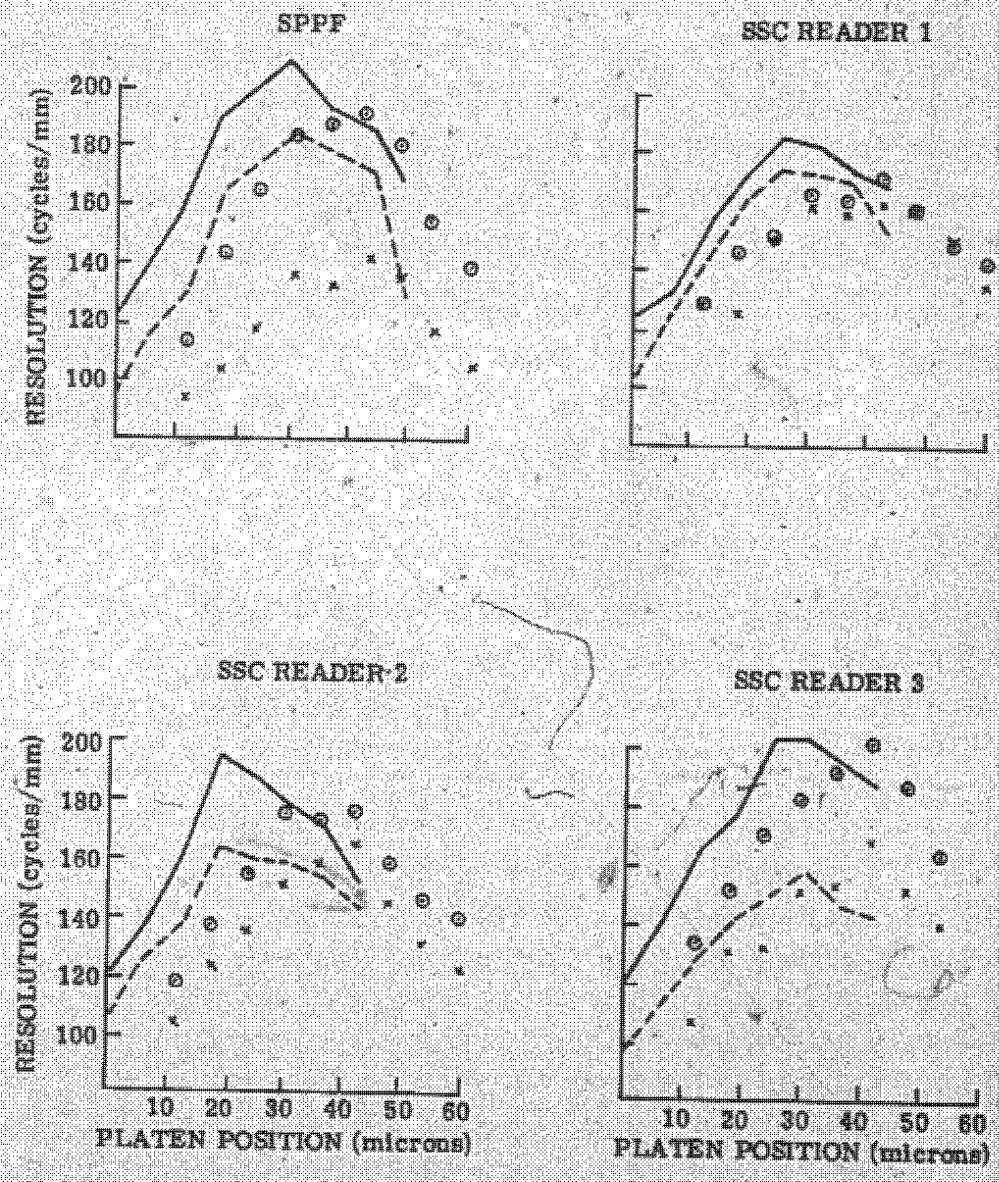
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READER COMPARISON OF RESOLUTION BETWEEN 1A-2 AND 2A-2 TESTS

FORWARD CAMERA



LEGEND

1A-2 DATA
SEQ K,RUN 323
—— IN-TRACK
– – – CROSS-TRACK

2A-2 DATA
SEQ K,RUN 598
⊙ IN-TRACK
× CROSS-TRACK

FIGURE 3-11

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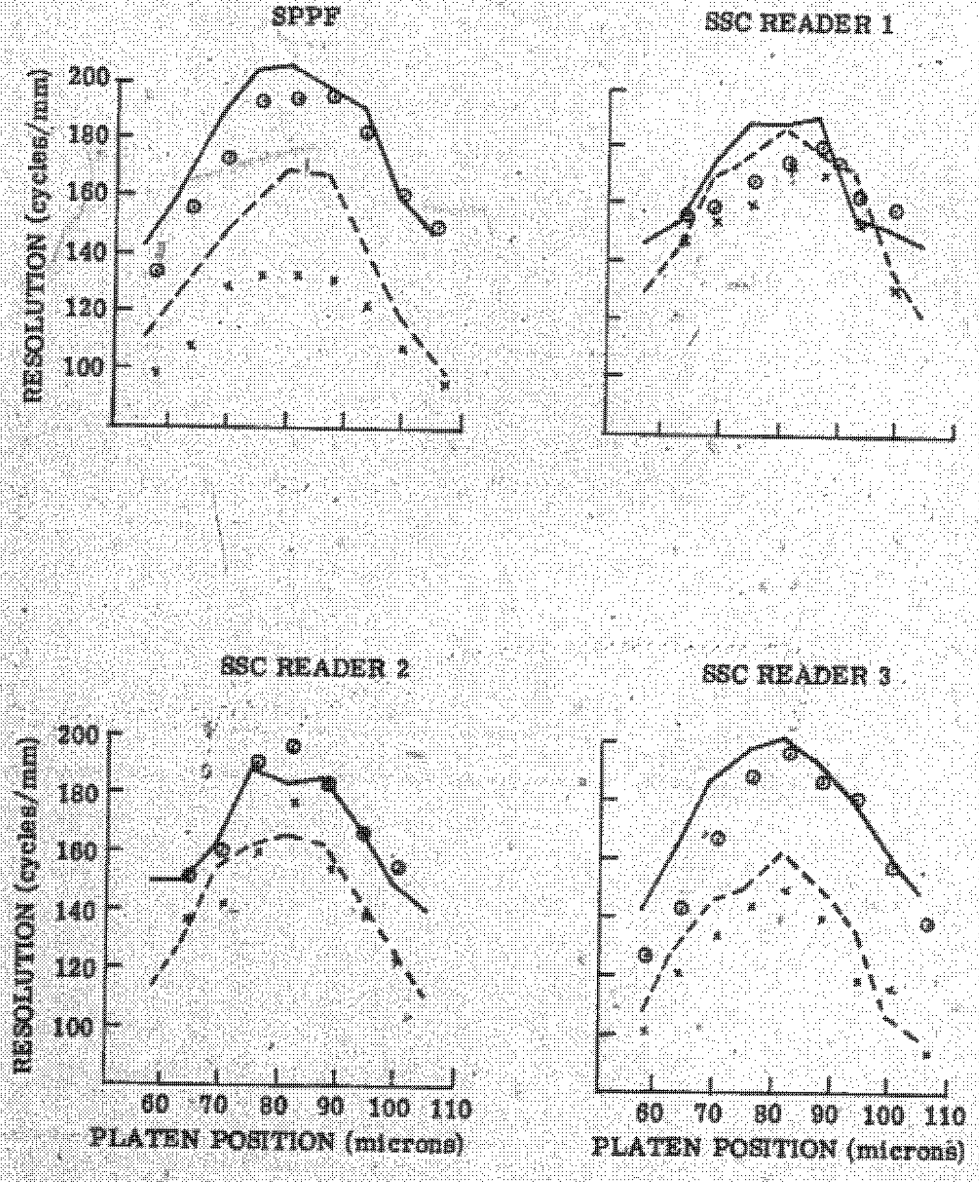
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READER COMPARISON OF RESOLUTION BETWEEN 1A-2 AND 2A-2 TESTS (CONT'D)

AFT CAMERA



LEGEND

1A-2 DATA
SEQ K, RUN 271
—— IN-TRACK
– – – CROSS-TRACK

2A-2 DATA
SEQ K, RUN 596
⊙ IN-TRACK
x CROSS-TRACK

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FLIGHT READINESS REPORT
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TABLE 3-6

COMPARISON OF RESOLUTION DATA BETWEEN 1A-2 AND 2A-2 TESTS

— Forward Camera —

Subject		Test	SPPF	SSC Reader 1	SSC Reader 2	SSC Reader 3
R_{max}	IT	1A-2	206	186	185	204
		2A-2	193	173	179	196
	XT	1A-2	183	177	160	156
		2A-2	142	167	164	163
PBF	IT	1A-2	29	28	26	29
		2A-2	39	39	36	41
	XT	1A-2	32	30	27	32
		2A-2	41	39	38	41

— Aft Camera —

R_{max}	IT	1A-2	204	189	186	202
		2A-2	197	176	194	197
	XT	1A-2	169	183	167	161
		2A-2	135	169	173	150
PBF	IT	1A-2	81	81	82	81
		2A-2	84	85	82	82
	XT	1A-2	83	82	80	81
		2A-2	79	85	81	81

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Peak resolution across the format, regardless of the platen position, is expected to fall off slightly as one moves away from nadir due to calculated losses in modulation transfer in the field. Plots A and B in Figure 3-12 present the geometric mean peak resolution on both cameras for the seven field positions tested using data from the PRE-TILT baseline and the 2A-2 Test. From these plots, it is clear that the data for any single vehicle pitch series will not behave as expected. However, with five vehicle pitch series to compare, a definite pattern emerges for both cameras in the five-test average, see Plot C on this figure. Both cameras show a best geometric mean resolution of 180 cycles/mm at the 1° field angle, with significant fall off only at the ±2.5° field positions (13% Forward and 6% Aft).

Average peak resolution data across the format for the accumulated five Chamber A-2 tests affords an assessment of the resolution error budget. Table 3-7 provides this data for the five Seq K tests. Mean, standard deviation, and ratio of standard deviation to mean are included. This summarizes the data given in Table 3-4. The sigma-to-mean ratio for the Forward Camera cross-track direction is slightly greater than that for the Aft, resulting in geometric mean resolution variability of 8% and 6 percent.

TABLE 3-7

AVERAGE PEAK RESOLUTION SUMMARY FROM FIVE TESTS

	Forward Camera			Aft Camera		
	Mean (cycles/mm)	Standard Deviation	Percent Error	Mean (cycles/mm)	Standard Deviation	Percent Error
In-Track	187	14	7.5	191	14	7.3
Cross-Track	161	15	9.3	161	12	7.5
Geometric Mean	173	14	8.1	175	11	6.3

Actual expected 2:1 contrast resolution profiles across the format for a variety of platen positions are given for both cameras in Figures 3-13 and 3-14. The positions were chosen to encompass the platen setting that gives the best overall performance. This data is also given in tabular form, see Tables 3-8 and 3-9. These assessments were made directly from Figure 3-5 for the Forward Camera and Figure 3-10 for the Aft, using extrapolation of curves where necessary. Based on this analysis, the Forward Camera platen setting for optimum performance occurs at 30 microns. The optimum platen setting for the Aft Camera occurs at 75 microns. This shows that there is no large trade-off from peak performance required on either camera to balance the fields.

With the platen positions chosen for optimum trade-off, average geometric mean 2:1 contrast resolution across the format is expected to be approximately 165 cycles/mm for both cameras. Because the experimental errors in measuring chamber test resolution is on the order of ±8% on the Forward Camera and ±6% on the Aft, an average range of 150 to 180 cycles/mm and 155 to 175 cycles/mm

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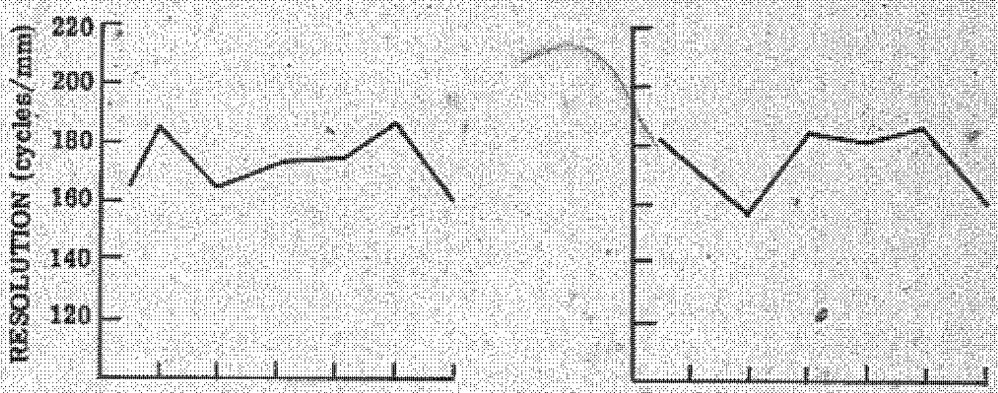
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PEAK GEOMETRIC MEAN RESOLUTION ACROSS THE FIELD

FORWARD CAMERA AFT CAMERA

— A - PRE-TILT BASELINE TEST —



— B - 2A-2 FINAL TEST —



— C - AVERAGE FROM FIVE TESTS —

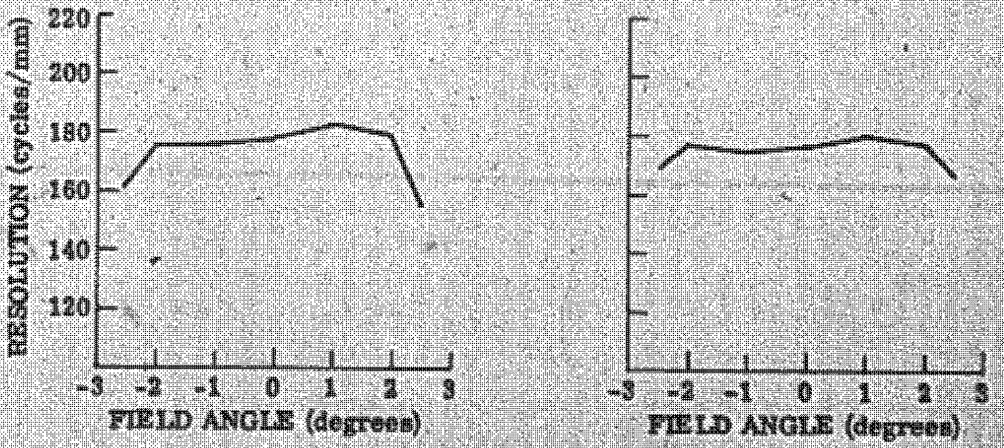


FIGURE 3-12

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2A-2 TEST

FORWARD CAMERA RESOLUTION THRU FOCUS PROFILES

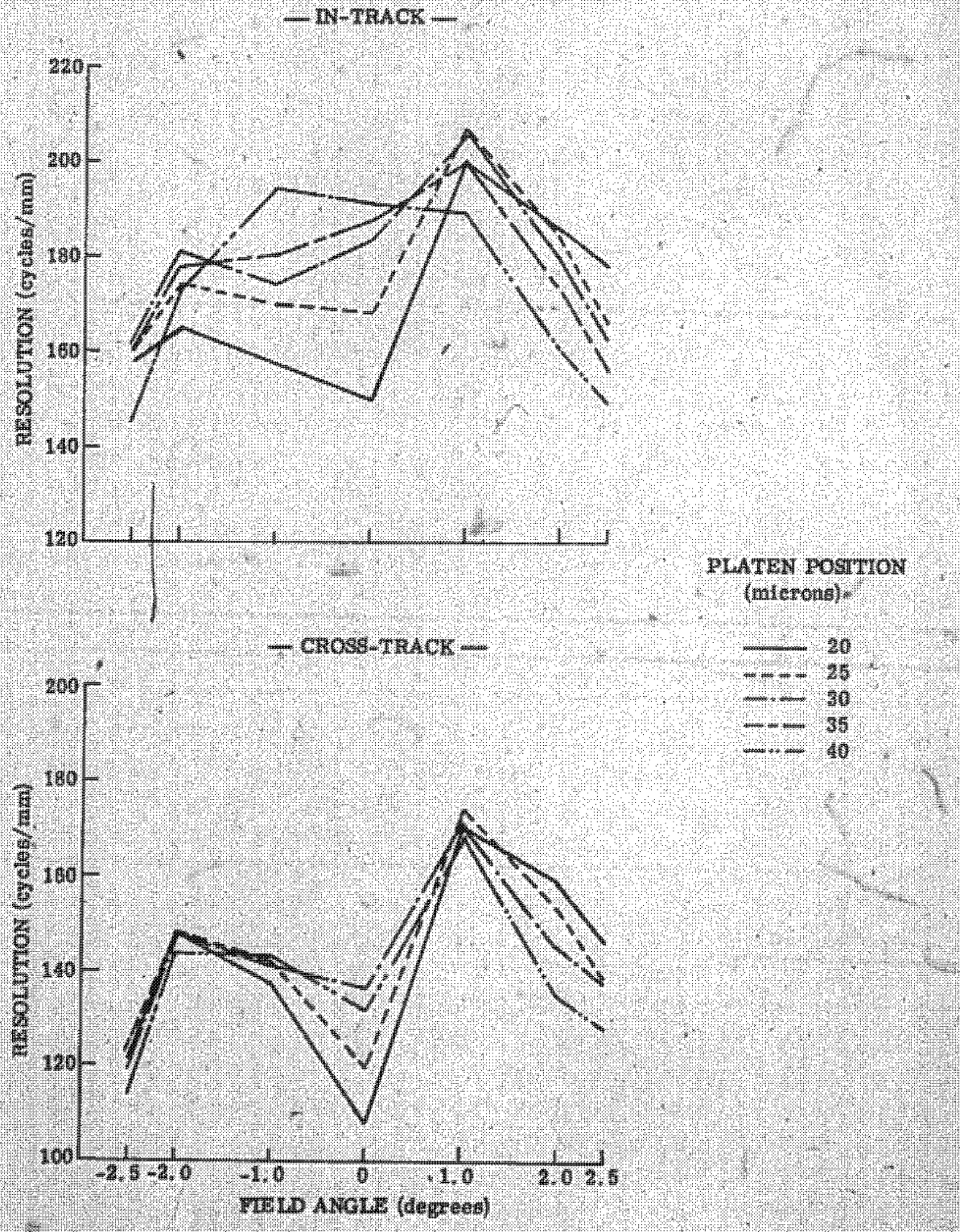


FIGURE 3-13

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2A-2 TEST

AFT CAMERA RESOLUTION THRU FOCUS PROFILES

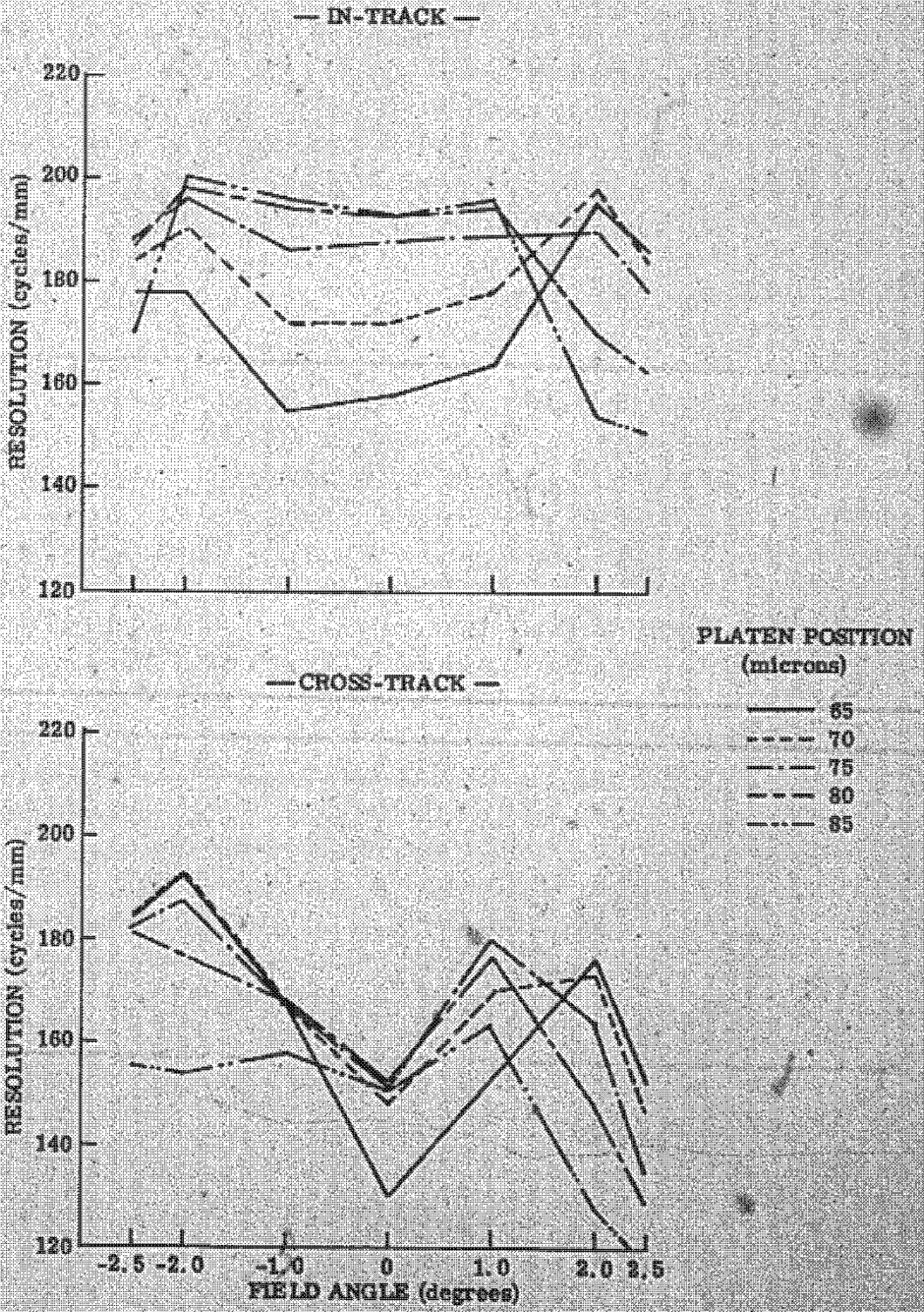


FIGURE 3-14

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TABLE 3-8

FORWARD CAMERA RESOLUTION PROFILES FROM 2A-2 TEST

(cycles/mm)

Platen Position (microns)	In-Track — Field Angle (degrees)							Cross-Track — Field Angle (degrees)							Average ± 1σ
	-2.5	-2.0	-1.0	0	1.0	2.0	2.5	-2.5	-2.0	-1.0	0	1.0	2.0	2.5	
10	149	144	136	108*	168	204	184	104	132	120	93	130	153	148	150 ± 32
15	157	157	143	130	187	190	182	114	147	130	99	155	158	148	164 ± 23
20	158	165	158	150	200	180	178	122	148	137	108	170	159	148	171 ± 18
25	160	174	170	168	207	184	166	123	148	142	120	174	153	138	170 ± 16
30	162	181	174	183	206	180	163	120	148	141	135	171	145	138	178 ± 15
35	159	178	180	187	200	173	158	114	144	143	132	168	135	128	176 ± 15
40	145	174	194	191	189	160	149*	107	126	150	138	183	123	120*	172 ± 21
45	130*	156	174	187	176	194	141*	95*	106	138	138	158	104	110*	157 ± 23
50	118*	135*	157	173	165	120	130*	87*	91*	125	128	147	91	99*	143 ± 22

NOTE: One asterisk (*) denotes that it is an extrapolated value.

~~TOP SECRET-HEXAGON~~
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TABLE 3-9

AFT CAMERA RESOLUTION PROFILES FROM 2A-2 TEST

(cycles/mm)

Platen Position (microns)	— In-Track — Field Angle (degrees) -2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average ± 1σ	— Cross-Track — Field Angle (degrees) -2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average ± 1σ
55	165	142	122	120*	132	183	179	149 ± 27	145	161	115	95*	115	142	128	128 ± 22
60	172	164	140	140	148	191	184	163 ± 21	159	164	130	101	120	152	131	137 ± 23
65	178	178	155	158	164	196	186	174 ± 15	164	172	147	110	133	156	132	145 ± 21
70	184	190	172	172	178	198	184	183 ± 10	165	172	147	128	160	158	127	149 ± 17
75	188	196	186	188	189	190	178	188 ± 5	162	167	147	131	160	144	115	147 ± 19
80	187	198	194	193	195	170	163	186 ± 14	161	156	148	132	167	128	108	141 ± 19
85	170	200	196	193	196	154	151	180 ± 21	135	134	138	131	143	108	96	126 ± 17
90	153*	189	187	188	179	140	140*	168 ± 23	110*	100	115	127	128	96	84*	109 ± 17
95	135*	177*	169	176	159	125*	130*	153 ± 22	87*	73*	98	120	112	87*	72*	93 ± 18

NOTE: One asterisk (*) denotes that it is an extrapolated value.

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respectively is implied.

The geometric mean resolution as a function of field angle for both cameras at their respective PBFs (Figures 3-13 and 3-14) is shown in Plot B of Figure 3-12. With the exception of the -2.5° field position on the Forward Camera and the 2.5° field position on the Aft, resolution performance across the field is within the respective error budget. Therefore, performance on-orbit is expected to be essentially flat with only minor losses at the previously mentioned field positions.

3.3.2 Resolution as a Function of Slit Width

By combining Seq J with comparable test runs in Seq K, resolution performance at a Vx/h of .052 can be examined for both wide slit (.615") and narrow slit (.303") conditions. Exposure differences were accounted for by adjustment of collimator illumination levels. Comparative thru focus data from these two tests are given in Figures 3-15 and 3-16. For both the in-track and cross-track directions, the Forward Camera tribar response as measured thru focus is identical for the wide and narrow slit conditions. This comparison for the Aft Camera gives the same results, but not as clearly.

There is no loss in performance at peak resolution by opening the slit by a factor of two. There is a loss indicated for minimum defocus in-track only, but this could be attributed to experimental error. Regardless, this evaluation concludes that wide slit utilization (anticipated on Mission 1209) will not induce significant losses in resolution level. This does not agree with Acceptance testing (both the initial and post-platen change verification), which suggested a 10% loss at .6" as compared to the .3" slit.

3.3.3 Resolution Comparison Between Chambers A and A-2

Comparisons of resolution performance were made using those thru focus tests that occurred at similar field positions in the two chambers, see Figures 3-17 and 3-18. Both sets of data represent 2:1 contrast average tribar readings by individual AFSPPF personnel. The 0° field position comparison was chosen to normalize the A and 1A-2 sets of data to one another with respect to platen position. Comparison in the field relies on the 45° and 55° collimators in Chamber A and the appropriate POST vehicle pitch positions in Chamber 1A-2. In four of the six comparisons, the resolution levels are quite comparable. The Aft Camera -2° and 2.5° field positions reveal suppressed resolution levels during the Chamber A thru focus test.

Table 3-10 gives the PBFs determined at three field positions for both cameras in Chambers A and A-2. Tribar and line diagnostics are compared separately. In three of the six comparisons, no matter how they are made, PBF agreement is within the five micron budget. The only thing that is consistent with these two sets of data is that the plus field positions (2° Forward and 2.5° Aft) are significantly shorter in focus (-9 microns Forward and -13 microns Aft) in Chamber A-2. Thus for SV-9 chamber testing, there is a consistent trend for the plus field on both cameras to focus closer to the lens during Readiness versus Acceptance testing. Immediately subsequent to SN-012 Acceptance, collimator

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FORWARD CAMERA RESOLUTION DEPENDENCY ON SLIT WIDTH

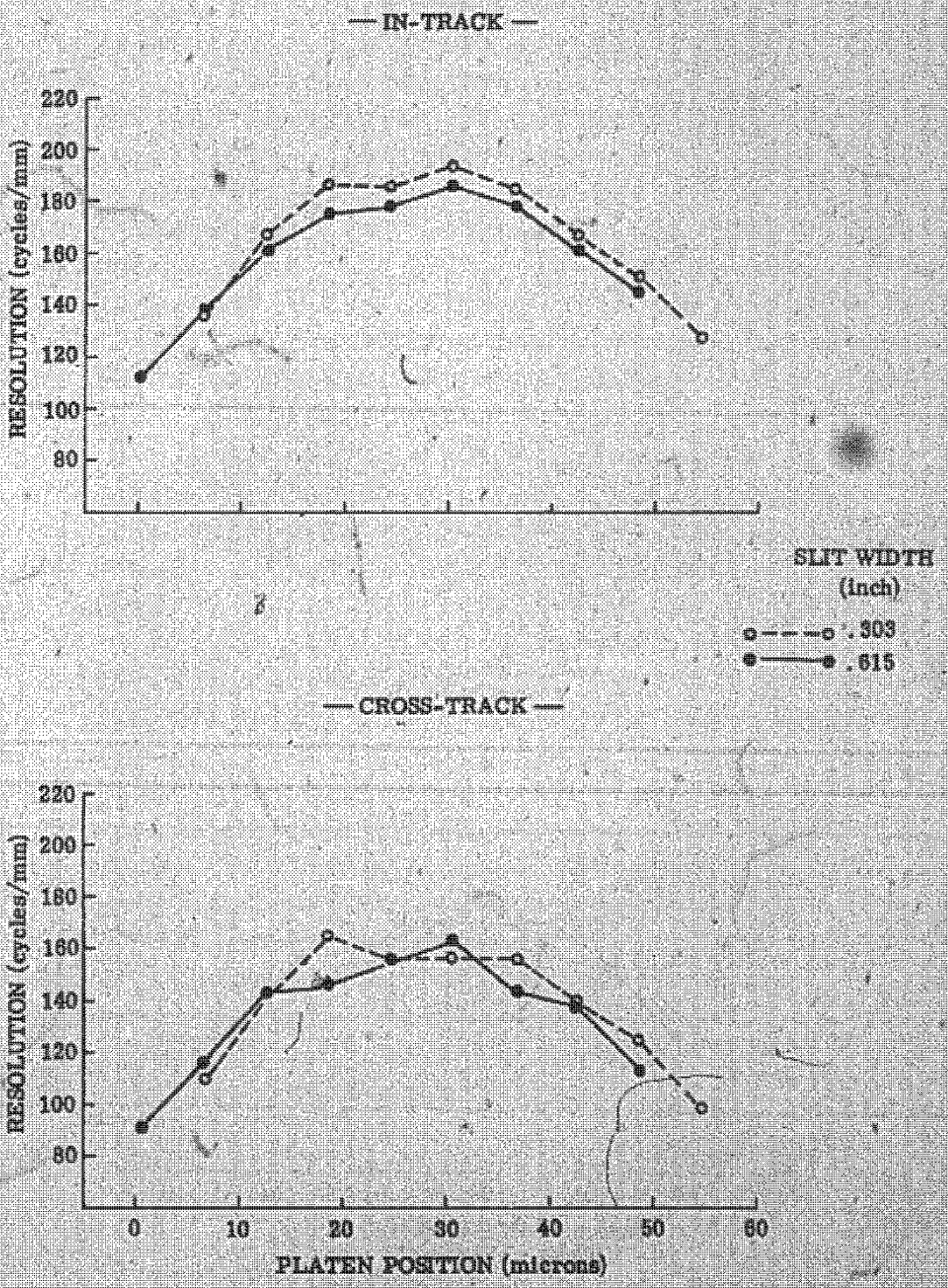


FIGURE 3-15

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AFT CAMERA RESOLUTION DEPENDENCY
ON SLIT WIDTH

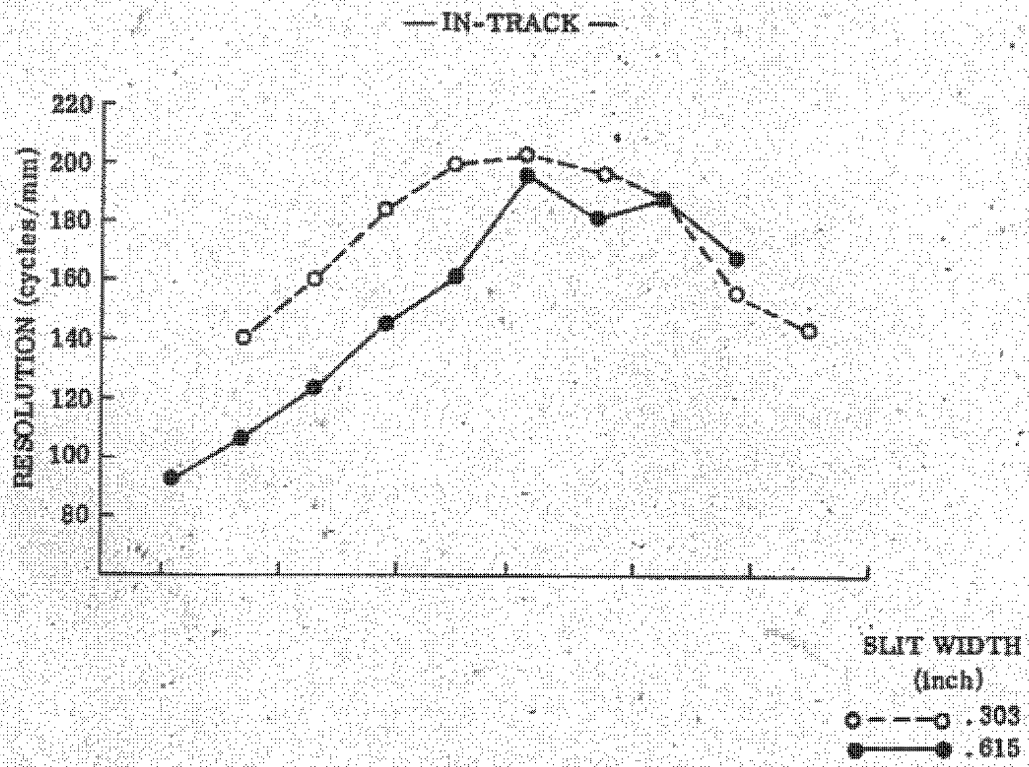


FIGURE 3-16

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

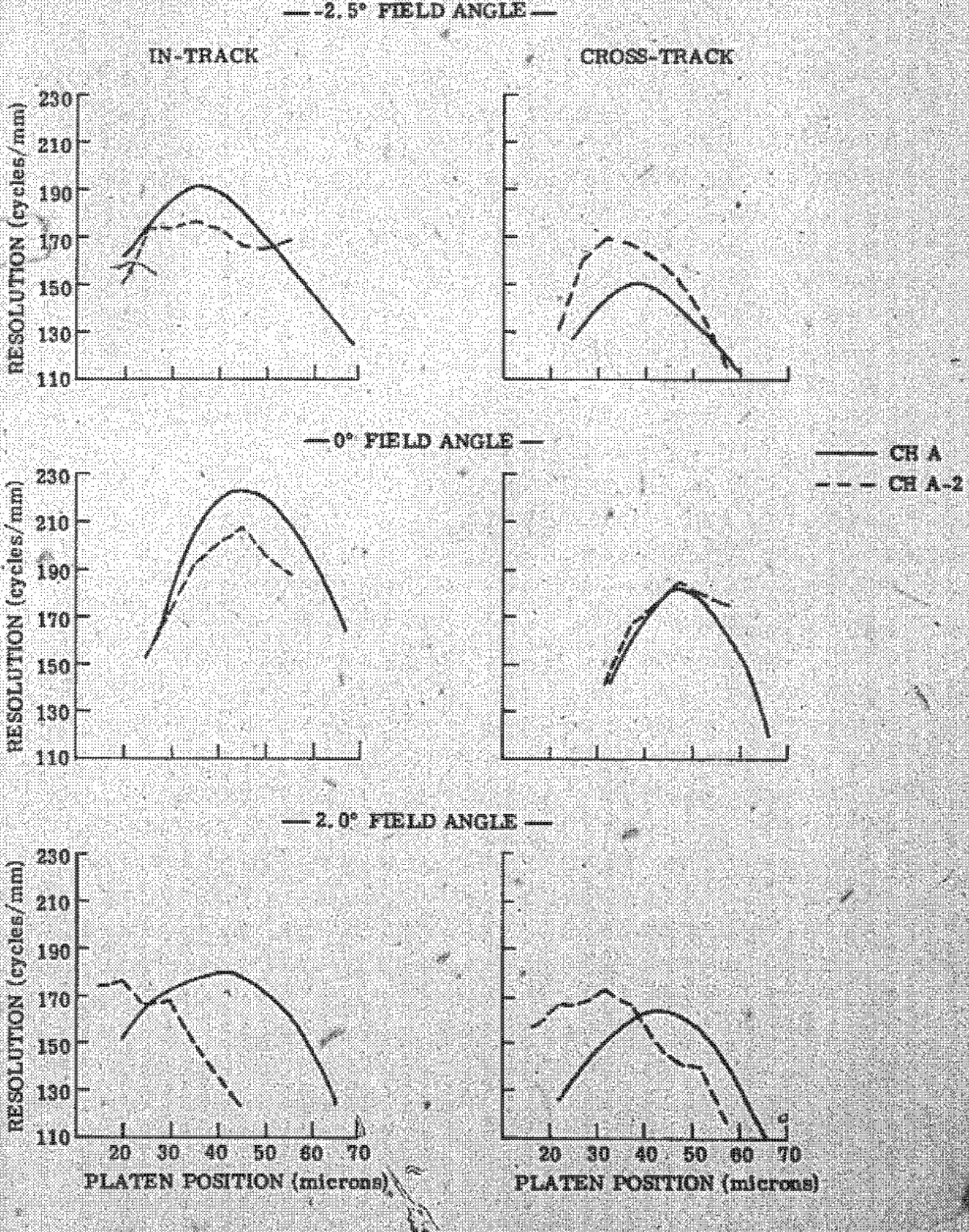


FIGURE 3-17

~~TOP SECRET-HEXAGON~~

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

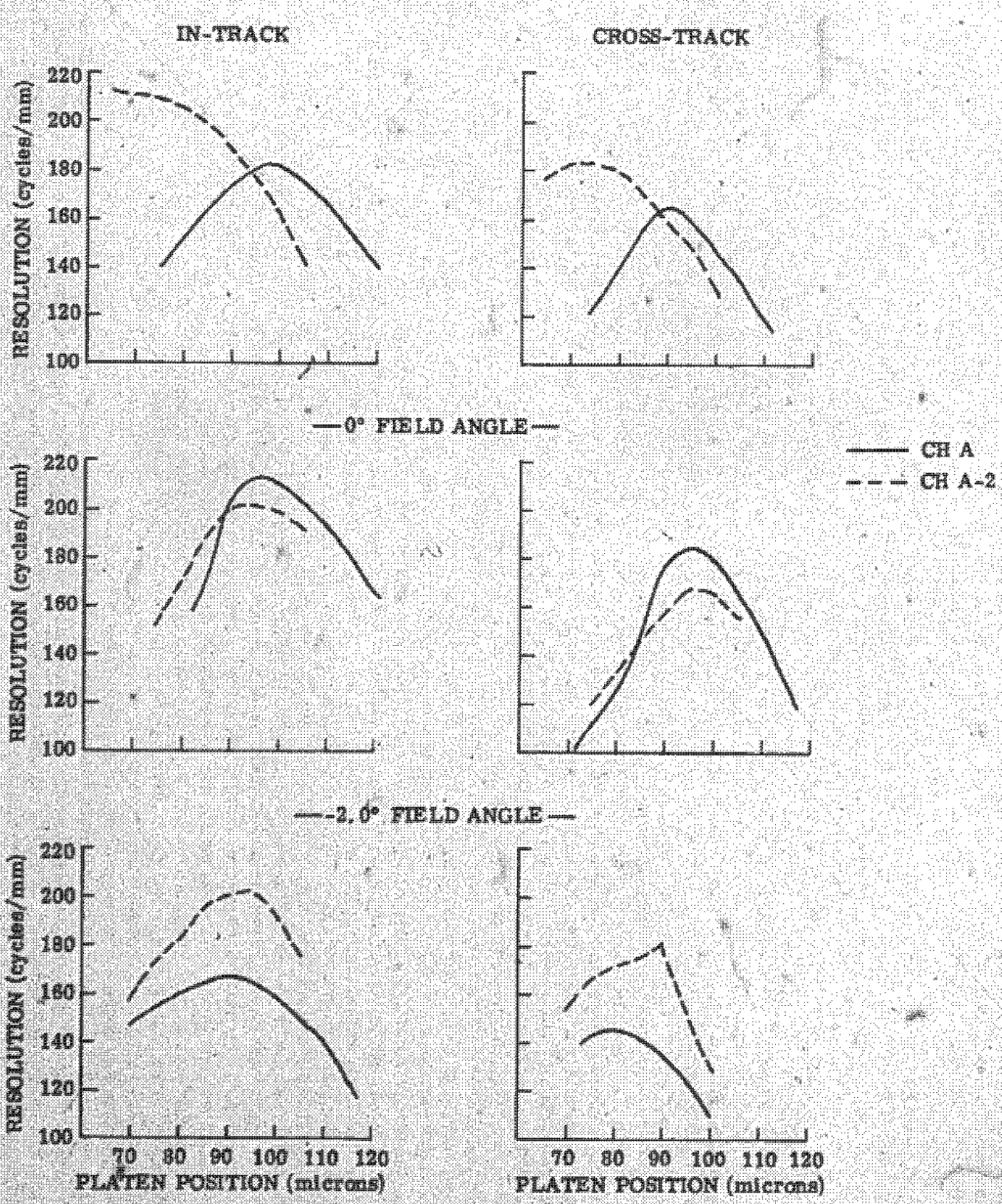


FIGURE 3-18

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modifications were made in Chamber A.

TABLE 3-10

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

Camera	Field Angle (degrees)	Ch A-2 Expectation Based on Ch A Data		Ch A-2 Actuals	
		Tribars	Lines	Tribars	Lines
Forward	-2.5	20	20	22	21
	0	32	39	29	28
	2.0	14	14	5	5
Aft	-2.0	62	73	69	71
	0	80	84	82	83
	2.5	74	72	60	61

3.3.4 Variability of Resolution

A measure of image quality variability in terms of the 2:1 contrast 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 five platen positions about and including 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 PRE pitch and wide slit test sequences for both the in-track and cross-track resolution data (see Table 3-11), and verified with the 2A-2 data. The PRE-TILT sequence was used because of the missing data on the Aft Camera POST sequence. The variability for both cases was spot checked and found to be identical. Both cameras have about an 8% variability at each of the test field positions. This figure compares well with the 8% resolution level error budget assessment made in paragraph 3.3.1.

For the wide (.615") slit case, resolution data from both cameras was found to exhibit a slightly higher variability than that found with the .303" slit at nadir. This increased variability manifested itself only in the in-track direction (9% versus 6% in both cases). No change in variability was detected in the cross-track direction.

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TABLE 3-11

COEFFICIENT OF RESOLUTION VARIATION BETWEEN THE 1A-2 AND 2A-2 TESTS

— Vx/h of .052, Slit Width of .303" —

Field Angle (degrees)	Forward Camera In-Track	Forward Camera Cross-Track	Aft Camera In-Track	Aft Camera Cross-Track
2.5	.10/.08	.11/.10	.08/.06	.09/.07
2.0	.08/.10	.07/.10	.08/.09	.08/.08
1.0	.09/.10	.08/.11	.09/.08	.06/.09
0.0	.06/.09	.10/.09	.06/.06	.09/.06
-1.0	.07/.08	.08/.09	.08/.09	.09/.08
-2.0	.09/.09	.09/.08	.07/.11	.08/.10
-2.5	.08/.09	.09/.09	.07/.10	.08/.09
Average	.08/.09	.09/.09	.08/.08	.08/.08

— Vx/h of .052, Slit Width of .615" (1A-2 Only) —

0.0	.09	.10	.09	.08

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

3.4 CONCLUSIONS

A. Both cameras have an essentially equivalent geometric mean peak resolution performance of approximately 180 cycles/mm at 2:1 contrast.

B. For a fixed platen position for optimum performance balanced across the field, the 2:1 contrast average resolution is expected to be approximately 165 cycles/mm for both cameras.

C. Resolution across the format for both cameras is expected to be essentially flat as measured by visual edge matching of the mission photography.

D. The error budget associated with Chamber A-2 determination of SV-9 resolution levels averages ±6 percent. The PBF error budget is approximately 5 microns.

E. The average difference between in-track and cross-track resolution at peak focus is 11 percent.

F. Astigmatism on both cameras, consistent across the field in Chamber D, is evident only at minus field positions at which cross-track tends to focus shorter than in-track.

G. Neither camera is expected to lose significant resolution under the wide .6" slit as compared to

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the narrow .3" slit conditions.

H. After the platen retrofit, the Aft Camera showed essentially no focus change, while the Forward Camera showed approximately a +8 micron bias across the field. Resolution performance was not affected by the platen change.

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FILM SYNCHRONIZATION TESTS

[redacted]

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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

(inch/second)

	Collimator Position (degrees)			
Direction	-45	0	37	55
— Forward Camera —				
In-Track	.040	-.002	-.031	-.042
Cross-Track	-.021	-.038	-.030	-.019
— Aft Camera —				
In-Track	.041	-.002	-.034	-.043
Cross-Track	-.018	-.035	-.032	-.016

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-9 film. All sync-flash data in this

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report has been corrected for these measured rotations.

4.4 OOAA CALIBRATION EVALUATION

The results of the OOAA calibration sequences performed during the Chamber 1A-2 and 2A-2 vacuum tests are presented in Tables 4-2 and 4-3 and Figures 4-1 thru 4-6. 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 from the 1A-2 test, and at Vx/h value of .052 at the 0° scan position from the 2A-2 test.

Figures 4-1 and 4-4 are plots of the 0° and 37° scan position data from the 1A-2 test. Figures 4-5 and 4-6 are plots of the 0° position from the 2A-2 test. Straight lines have been fitted to the points using the least squares technique. The equations of these best fit straight lines 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 test results. The mean smear as calculated from the FIDAP Program from the 2A-2 test shows good correlation between the OOAA calibration test curves and the theoretical curves.

A comparison of the OOAA data from the 1A-2 and 2A-2 chamber tests shows that as a result of the platen removal, the Forward Camera skew angle changed by 25 arc-seconds, while the Aft Camera skew changed by 15 arc-seconds. Both the Forward and Aft film velocity showed no change at the zero bias position and small changes over the full range of OOAA test settings.

The OOAA intercepts at 0° from the 2A-2 test indicates that an in-track adjustment of -3 command counts and a cross-track adjustment of +3 command counts is necessary on the Forward Camera. On the Aft Camera, a -3 command count adjustment is required for both in-track and cross-track.

The scaling for the in-track data is slightly smaller than nominal. The Forward Camera scaling is 1.8% to 2.0% lower than nominal, while the Aft is 4.9% to 5.2% lower. The cross-track scale factors are also smaller than nominal. The Forward Camera deviates from nominal by 0% to 6% and the Aft by 0% to 2.4%. These deviations from the theoretical curves are not critical over the range of OOAA setting.

4.5 SYNC ERROR MEASUREMENT SUMMARY

Tables 4-4 thru 4-7 present the summary of the SV-9 film synchronization performance from the Chamber A and Chamber 1A-2 and 2A-2 tests. The following are significant observations and analyses relating to the film synchronization.

4.5.1 Chamber A Versus Chamber A-2 Comparison

No significant difference was noted between the Chamber A and Chamber A-2 mean image motion of the Forward Camera.

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TABLE 4-2

PHOTOGRAPHIC MEAN ERROR VERSUS COMMAND FROM COAA CALIBRATION SEQUENCE

Nominal Vx/h	COAA Command Skew	COAA Command Velocity	Forward Camera 1A-2 0° Collimator IT	Forward Camera 1A-2 0° Collimator XT	Forward Camera 1A-2 37° Collimator IT	Forward Camera 1A-2 37° Collimator XT	Forward Camera 2A-2 0° Collimator IT	Forward Camera 2A-2 0° Collimator XT	Aft Camera 1A-2 0° Collimator IT	Aft Camera 1A-2 0° Collimator XT	Aft Camera 1A-2 37° Collimator IT	Aft Camera 1A-2 37° Collimator XT	Aft Camera 2A-2 0° Collimator IT	Aft Camera 2A-2 0° Collimator XT
.052	15	-20	.146	-.309	.165	-.372	.169	-.344	-.137	-.259	-.201	-.265	-.176	-.228
	10	10	.103	.114	.125	.108	.136	.111	-.110	.187	-.161	.143	-.140	.197
	5	5	.060	.040	.088	.022	.085	.032	-.072	.099	-.114	.086	-.077	.105
	0	0	.009	-.035	.038	-.038	.040	-.043	-.015	.049	-.068	-.011	-.035	.049
	-5	-5	-.035	-.073	-.017	-.115	-.007	-.124	.030	-.037	-.019	-.062	.017	-.029
	-10	-10	-.083	-.157	-.065	-.157	-.057	-.179	.075	-.092	.029	-.148	.072	-.101
	-15	-15	-.132	-.229	-.098	-.231	-.104	-.273	.129	-.138	.067	-.193	.107	-.153
.044	15	-20	.124	-.270	.138	-.268	-.129	-.232	-.169	-.240				
	10	10	.089	.098	.108	.104	-.091	.128	-.150	.096				
	5	5	.054	.032	.068	.010	-.049	.079	-.108	.045				
	0	0	.010	-.015	.026	-.008	.012	.022	-.057	.002				
	-5	-5	-.031	-.078	-.009	-.103	.020	-.027	-.025	-.057				
	-10	-10	-.071	-.161	-.063	-.165	.066	-.081	.018	-.114				
	-15	-15	-.111	-.196	-.098	-.201	.103	-.132	.062	-.190				

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

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TABLE 4-3

COAA CALIBRATION SEQUENCE BEST-FIT LINEAR EQUATIONS

FOR THE 0° COLLIMATOR

Camera	Nominal Vx/h	Direction	1A-2 Best-Fit Equation	1A-2 Correlation Coefficient	2A-2 Best-Fit Equation	2A-2 Correlation Coefficient
Forward	.052	In-Track	Y = .0094X +.011	.999	Y = .0095X +.037	.997
		Cross-Track	Y = .0134X -.023	.997	Y = .0160X -.041	.999
	.044	In-Track	Y = .0079X +.009	.999		
		Cross-Track	Y = .0121X -.025	.997		
Aft	.052	In-Track	Y = -.0081X -.014	.995	Y = -.0086X -.031	.999
		Cross-Track	Y = .0140X +.031	.992	Y = .0136X +.045	.998
	.044	In-Track	Y = -.0077X -.013	.998		
		Cross-Track	Y = .0116X +.020	.994		

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.

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1A-2 TEST

FORWARD CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 0° SCAN POSITION

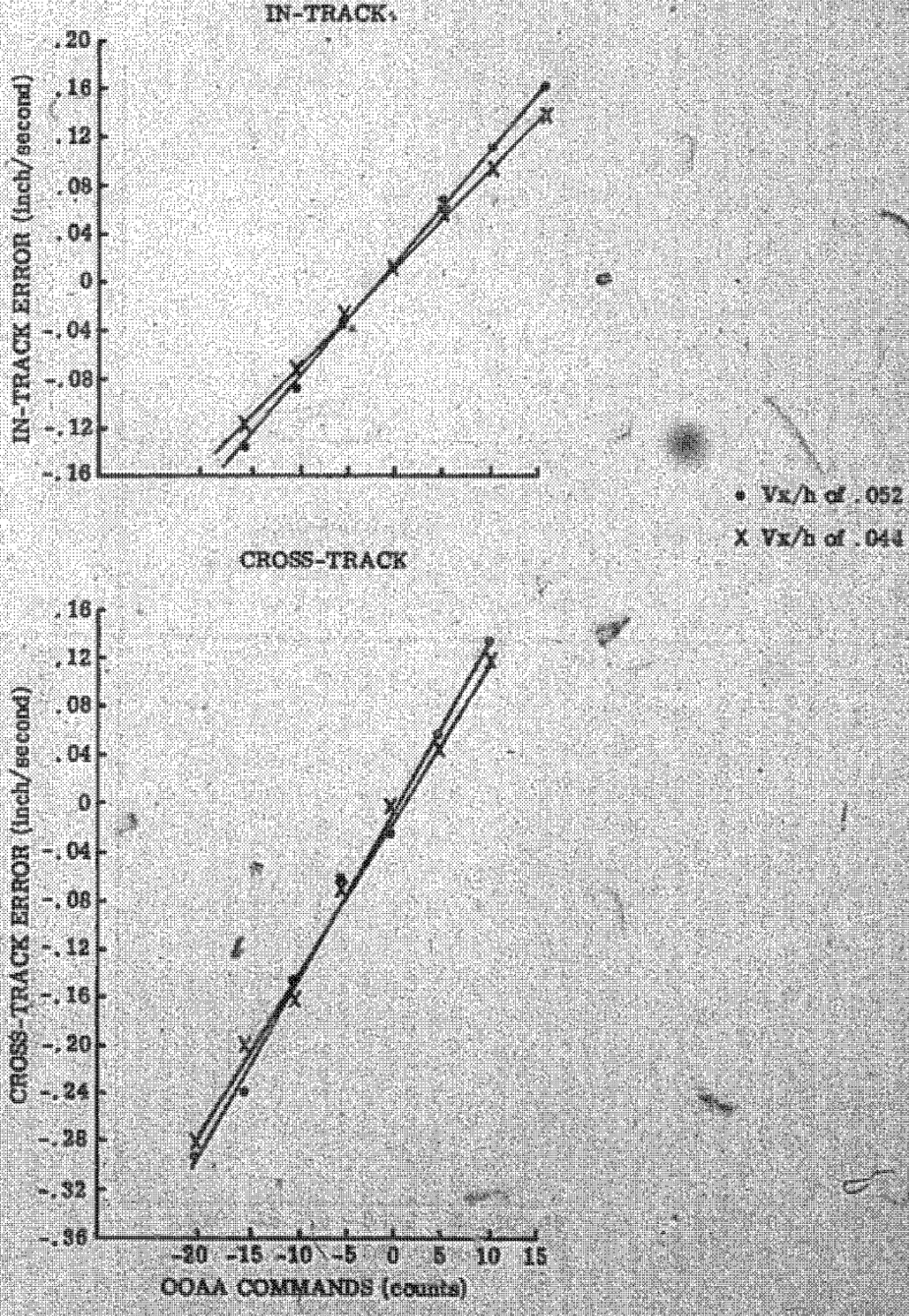


FIGURE 4-1

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1A-2 TEST

FORWARD CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 37° SCAN POSITION

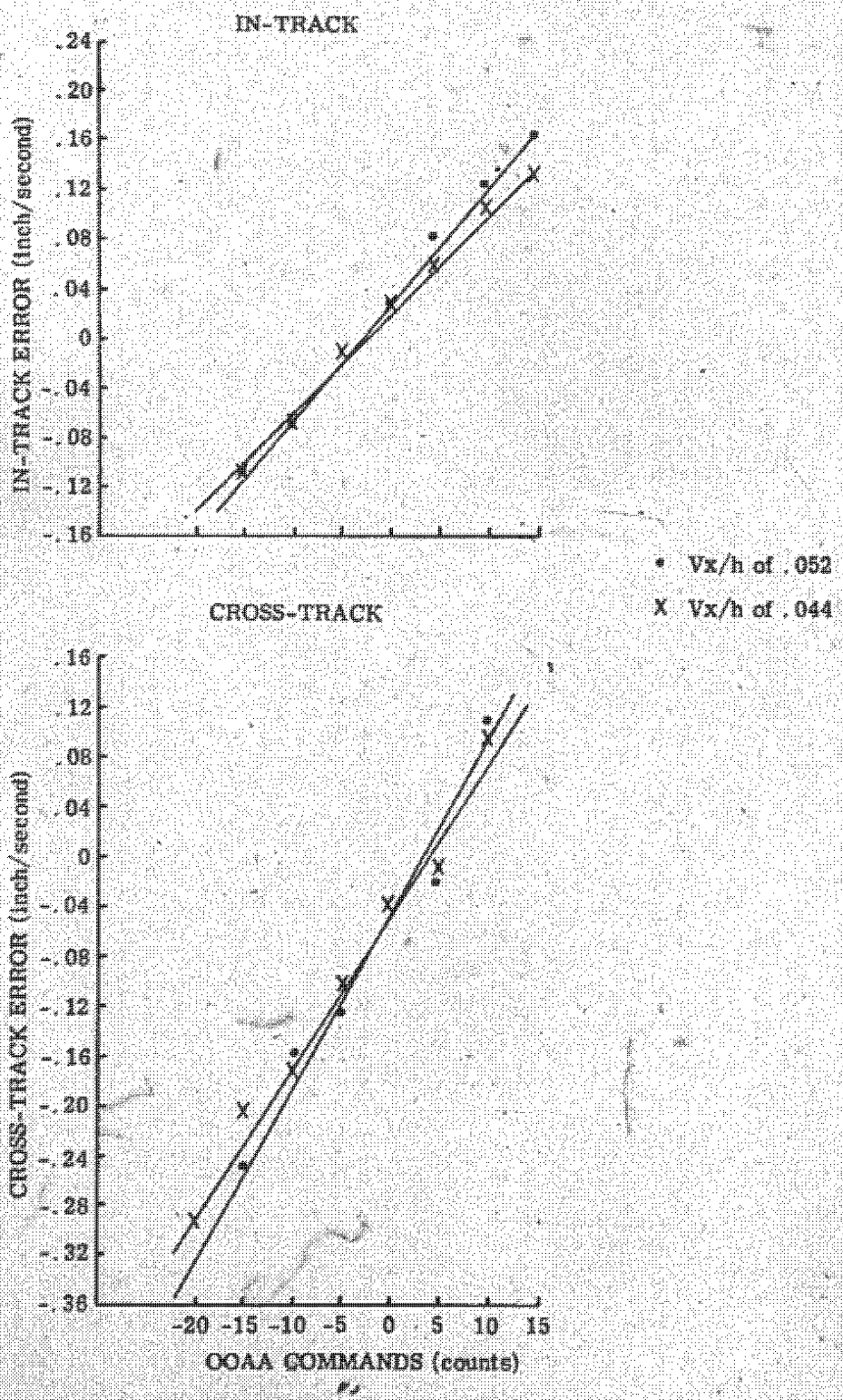


FIGURE 4-2

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FLIGHT READINESS REPORT
SV-9 (SN-012)

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

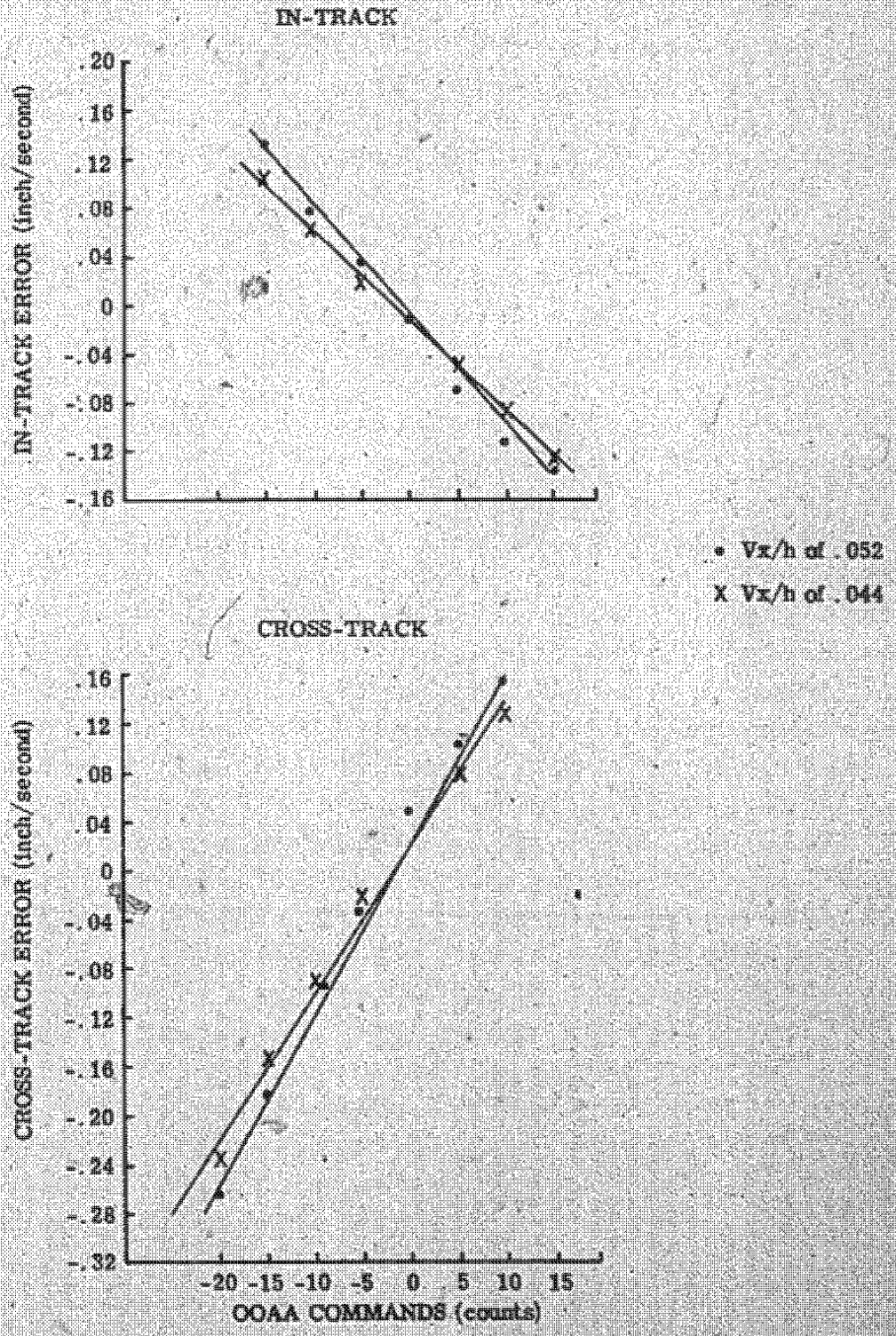


FIGURE 4-3

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FLIGHT READINESS REPORT
SV-9 (SN-012)

1A-2 TEST

AFT CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 37° SCAN POSITION

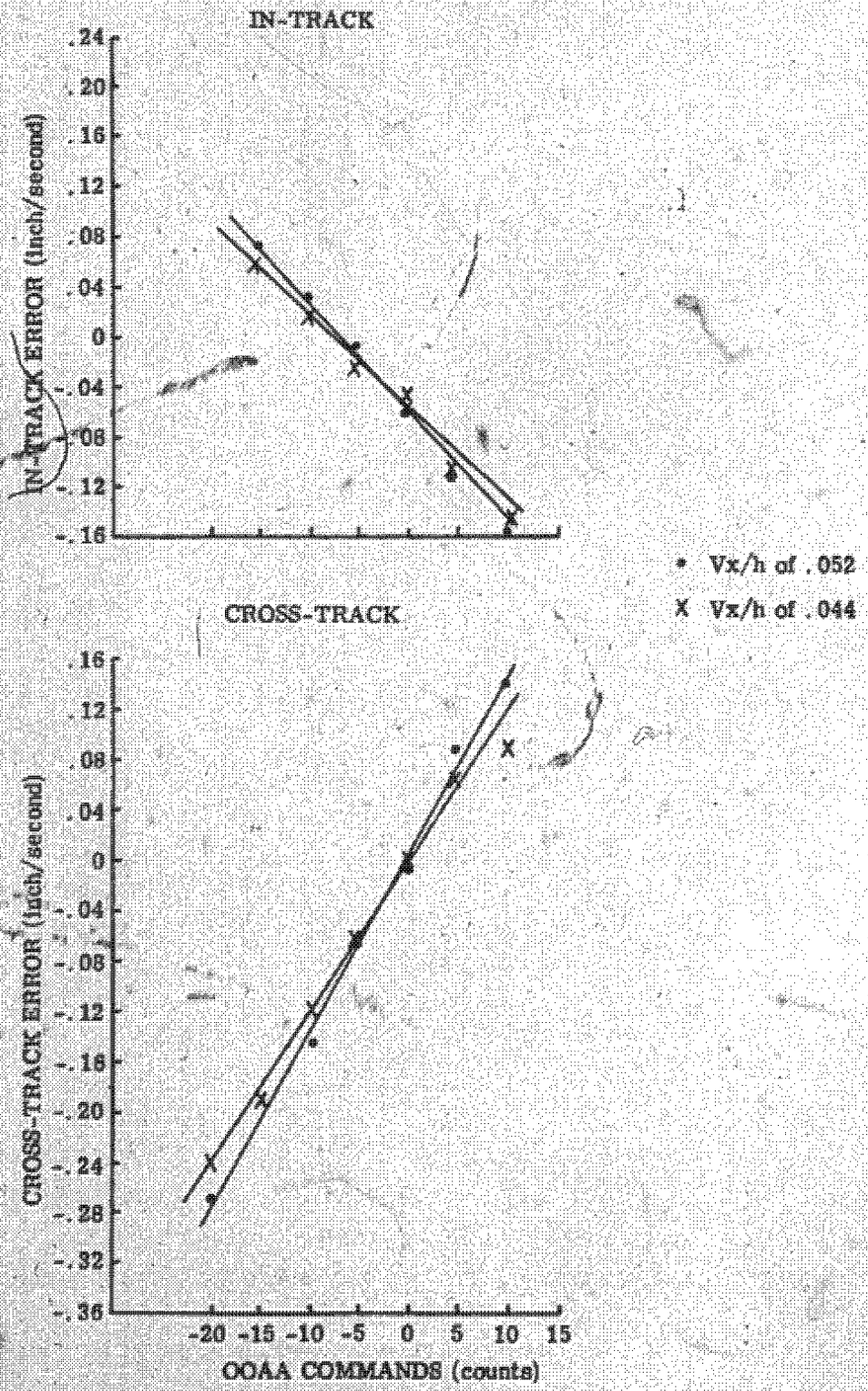


FIGURE 4-4

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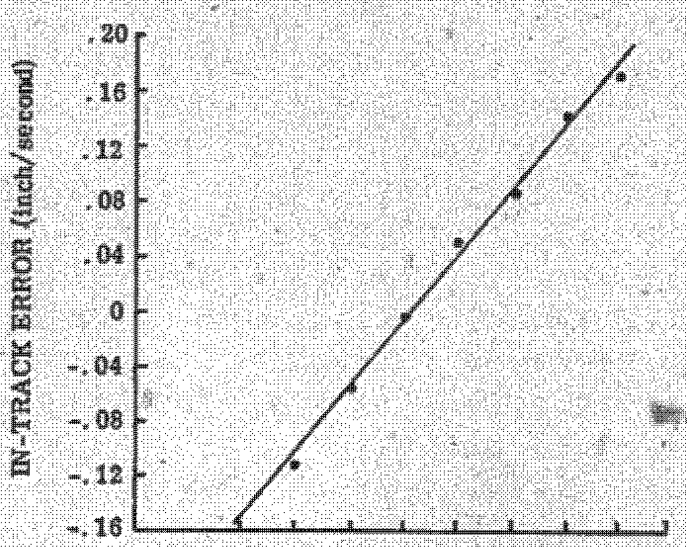
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2A-2 TEST

FORWARD CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 0° SCAN POSITION

IN-TRACK



* Vx/h of .052

CROSS-TRACK

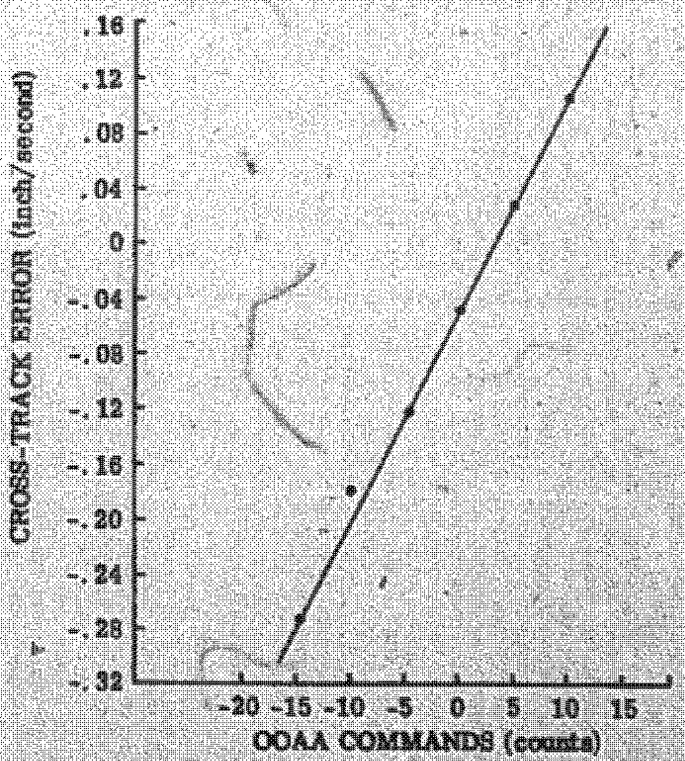


FIGURE 4-5

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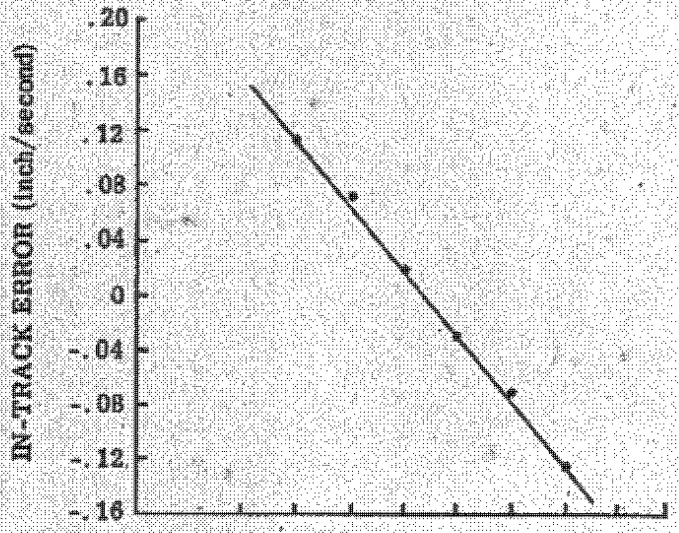
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2A-2 TEST

AFT CAMERA MEASURED MEAN SMEAR VERSUS OOAA COMMAND

AT 0° SCAN POSITION

IN-TRACK



• Vx/h of .052

CROSS-TRACK

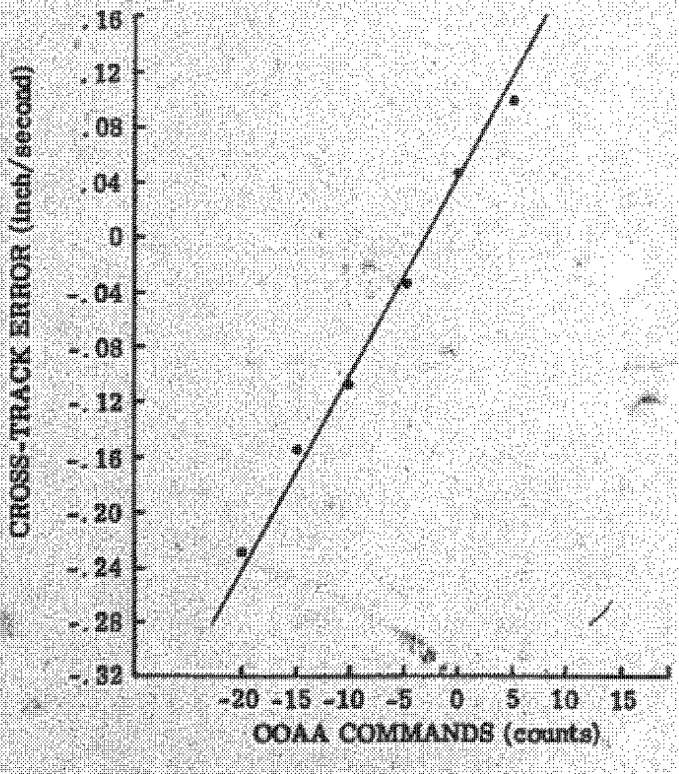


FIGURE 4-6

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TABLE 4-4

FILM SYNCHRONIZATION ERROR SUMMARY

(inch/second)

Temperature 70°F — FORWARD CAMERA — IMC Enabled

Nominal Vs/h	Direction	0° COLLIMATOR								
		Spec	Chamber A Vac Accept		Chamber A-2					
			SSC	SPPF	1A-2 Vac Box In	Post 1A-2 Box Out	Post 1A-2 Box In	2A-2 Vac Box In	Post 2A-2 Box In	Post 2A-2 Box Out
.052	IN-TRACK MEAN	±.050	.009	.000	.009	.013	.014	.027	.038	.033
	IN-TRACK TWO SIGMA	.050		.032	.024	.027	.036	.030	.018	.025
	CROSS-TRACK MEAN	±.050		-.033	-.035	-.045	-.036	-.046	-.021	-.025
	CROSS-TRACK TWO SIGMA	.100		.070	.037	.036	.045	.051	.040	.045
.044	IN-TRACK MEAN	±.050	-.004	-.012	.010	.028	.021	.025	.021	.024
	IN-TRACK TWO SIGMA	.050		.035	.024	.049	.030	.025	.024	.025
	CROSS-TRACK MEAN	±.050		-.033	-.015	-.046	-.039	-.030	-.050	-.050
	CROSS-TRACK TWO SIGMA	.100		.067	.059	.045	.047	.046	.033	.038
.036	IN-TRACK MEAN	±.035	-.006	-.012	.001	.009				
	IN-TRACK TWO SIGMA	.037		.046	.028	.032				
	CROSS-TRACK MEAN	±.045		-.038	-.034	-.017				
	CROSS-TRACK TWO SIGMA	.098		.045	.042	.029				

* 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.

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TABLE 4-5

FILM SYNCHRONIZATION ERROR SUMMARY

(inch/second)

Temperature 70°F | FORWARD CAMERA | IMC Enabled

Nominal Vx/h	Direction	37° COLLIMATOR						
		Spec	Chamber A Vac Accept		Chamber A-2			
			SSC	SPPF	1A-2 Vac Box In	Post 1A-2 Box Out	Post 1A-2 Box In	2A-2 Vac Box In
.052	IN-TRACK MEAN	±.050		-.009	.028	.022	.035	.042
	IN-TRACK TWO SIGMA	.050		.040	.032	.030	.034	.028
	CROSS-TRACK MEAN	±.050		-.039	-.038	-.042	-.047	-.028
	CROSS-TRACK TWO SIGMA	.100		.045	.052	.051	.045	.060
.044	IN-TRACK MEAN	±.050		.000	.032	.024	.028	.038
	IN-TRACK TWO SIGMA	.050		.027	.040	.037	.027	.029
	CROSS-TRACK MEAN	.050		-.024	-.039	-.035	-.047	-.037
	CROSS-TRACK TWO SIGMA	.100		.059	.043	.039	.047	.048
.036	IN-TRACK MEAN	±.045		-.006	.028	.029		
	IN-TRACK TWO SIGMA	.037		.023	.024	.030		
	CROSS-TRACK MEAN	±.045		-.020	-.027	-.023		
	CROSS-TRACK TWO SIGMA	.098		.040	.055	.047		

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.

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TABLE 4-6

FILM SYNCHRONIZATION ERROR SUMMARY

(inch/second)

Temperature 70°F — AFT CAMERA — IMC Enabled

Nominal Vx/h	Direction	0° COLLIMATOR								
		Spec	Chamber A Vac Accept SSC	Chamber A Vac Accept SPPF	Chamber A-2 1A-2 Vac Box In	Chamber A-2 Post 1A-2 Box Out	Chamber A-2 Post 1A-2 Box In	Chamber A-2 2A-2 Vac Box In	Chamber A-2 Post 2A-2 Box In	Chamber A-2 Post 2A-2 Box Out
.052	IN-TRACK MEAN	±.050	.006	.015	-.015	-.014	-.011	-.043	-.014	-.026
	IN-TRACK TWO SIGMA	.050		.028	.027	.018	.020	.024	.032	.025
	CROSS-TRACK MEAN	±.050		.010	.049	.032	.043	.029	.028	.030
	CROSS-TRACK TWO SIGMA	.100		.050	.031	.046	.046	.047	.030	.032
.044	IN-TRACK MEAN	±.050	-.003	.005	-.012	.003	-.007	-.032	-.017	-.012
	IN-TRACK TWO SIGMA	.050		.036	.017	.019	.018	.019	.025	.020
	CROSS-TRACK MEAN	±.050		.037	.022	.026	.019	.038	.033	.030
	CROSS-TRACK TWO SIGMA	.100		.034	.037	.038	.038	.049	.041	.028
.036	IN-TRACK MEAN	±.035	-.002	.004	-.016	-.006				
	IN-TRACK TWO SIGMA	.037		.026	.024	.017				
	CROSS-TRACK MEAN	±.045		.019	.005	.035				
	CROSS-TRACK TWO SIGMA	.098		.051	.049	.031				

* 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.

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TABLE 4-7

FILM SYNCHRONIZATION ERROR SUMMARY

(inch/second)

Temperature 70°F — AFT CAMERA — IMC Enabled

Nominal Vx/h	Direction	37° COLLIMATOR						
		Spec	Chamber A Vac Accept		Chamber A-2			
			SSC	SPPF	1A-2 Vac Box In	Post 1A-2 Box Out	Post 1A-2 Box In	2A-2 Vac Box In
.052	IN-TRACK MEAN	±.050		-.045	-.066*	-.059*	-.064*	-.090*
	IN-TRACK TWO SIGMA	.050		.024	.034	.028	.024	.022
	CROSS-TRACK MEAN	±.050		.006	-.011	-.007	-.008	-.001
	CROSS-TRACK TWO SIGMA	.100		.063	.054	.036	.044	.043
.044	IN-TRACK MEAN	±.050		-.035	-.057*	-.052*	-.051*	-.076
	IN-TRACK TWO SIGMA	.050		.023	.027	.021	.037	.034
	CROSS-TRACK MEAN	.050		.005	.002	.002	.018	.024
	CROSS-TRACK TWO SIGMA	.100		.045	.055	.047	.040	.042
.036	IN-TRACK MEAN	±.045		-.032	-.053*	-.041		
	IN-TRACK TWO SIGMA	.037		.020	.020	.021		
	CROSS-TRACK MEAN	±.045		.028	-.001	.004		
	CROSS-TRACK TWO SIGMA	.098		.055	.046	.029		

* 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.

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On the Aft Camera, a change was noted in both the in-track and cross-track mean errors. The differences in the measured values between the two tests were .03 inch/second in-track and .037 inch/second in the cross-track direction. The in-track change went from positive (Chamber A) to negative (Chamber A-2) but did not result in a large error. The cross-track error increased in the positive direction. The fact that the Aft Camera MC Servo, Aft Camera Platen Servo, and the system OOAA & SCC Box were replaced can account for these mean error changes.

4.5.2 Flight Configuration Test

No change in the mean image motion errors of either camera was noted when comparing data from post Chamber 2A-2 vacuum tests with the IMC disable box removed (box-out) to the box-in test.

4.6 ON-ORBIT IMAGE MOTION ERROR PREDICTIONS

The predictions of SV-9 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 4-7 and 4-8. These figures were developed by the algebraic combination of the most recent sync-flash data with the orbital image motion errors. This error data is corrected for both gravity and "C" target rotation, and is listed in Table 4-8. Note that the predictions include the effect of the recommended OOAA adjustments in Figures 4-7, 4-8, and Table 4-8.

4.7 CONCLUSIONS AND RECOMMENDATIONS

A. With a nominal OOAA setting, the Forward Camera mean errors are all within specification, while the Aft Camera meets specification with the exception of the in-track mean at the 37° scan position. This out-of-specification condition is not expected to seriously degrade performance.

B. Even though the mean smear values at 0° for both cameras are within specification, the following OOAA changes are recommended to further reduce the mean smear errors.

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

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

C. A velocity adjustment derived from the acceptance test of -15 command counts from flight nominal is recommended for both SO-255 and FE-3916 materials. This cross-track velocity adjustment assumes the mechanical characteristics of the FE-3916 material are similar to SO-255.

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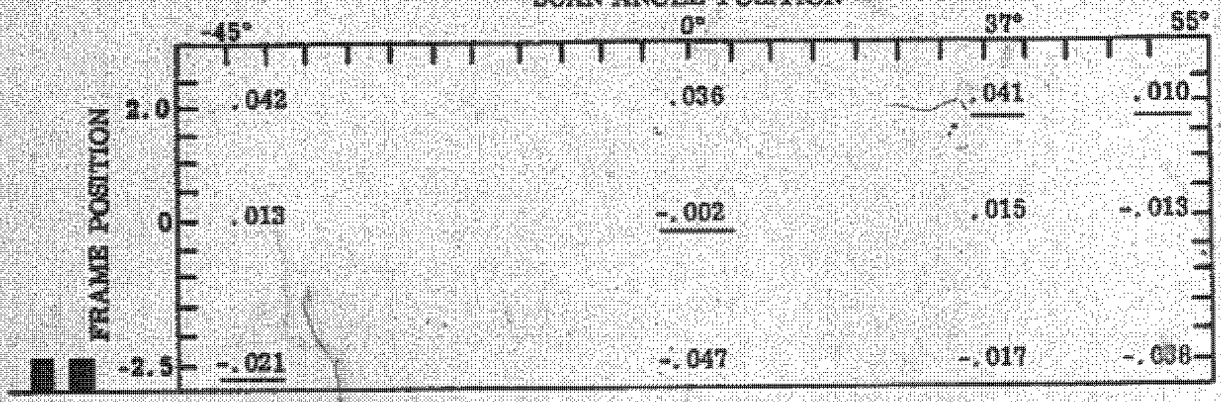
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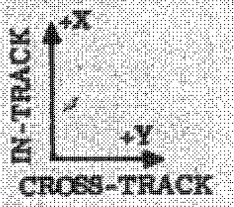
FORWARD CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION

(Vx/h of .052)

IN-TRACK

SCAN ANGLE POSITION

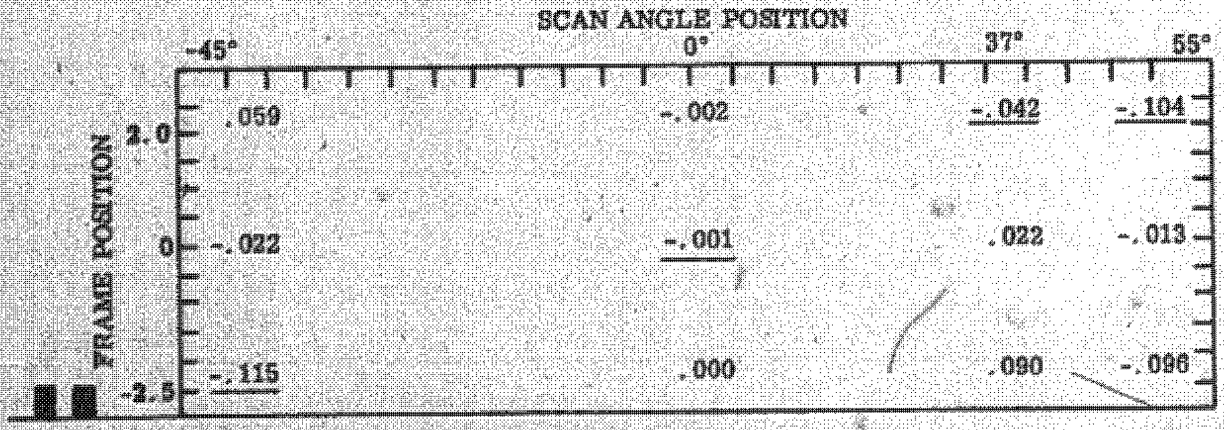




FILM TRAVEL

CROSS-TRACK

SCAN ANGLE POSITION



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

FIGURE 4-7

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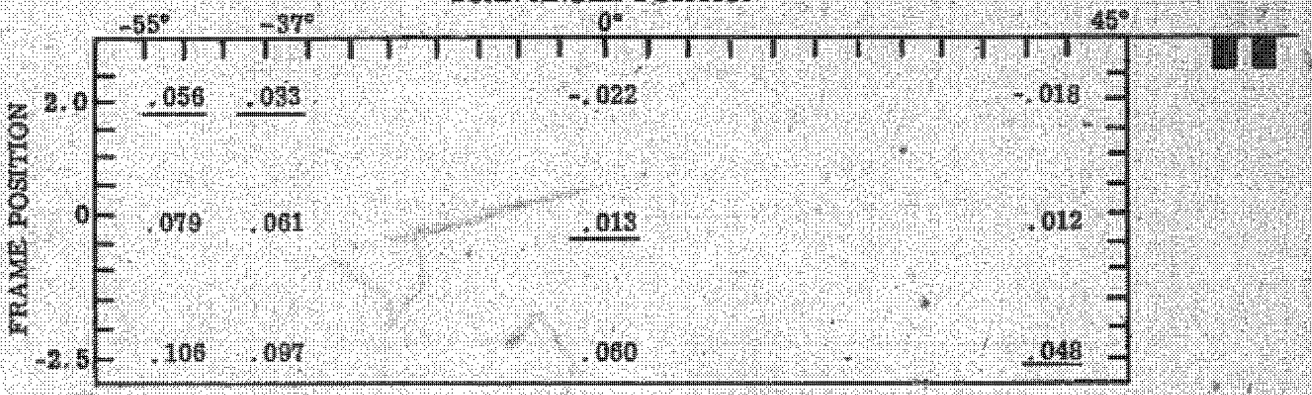
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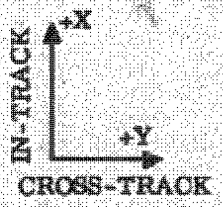
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AFT CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION

(Vx/h of .052)

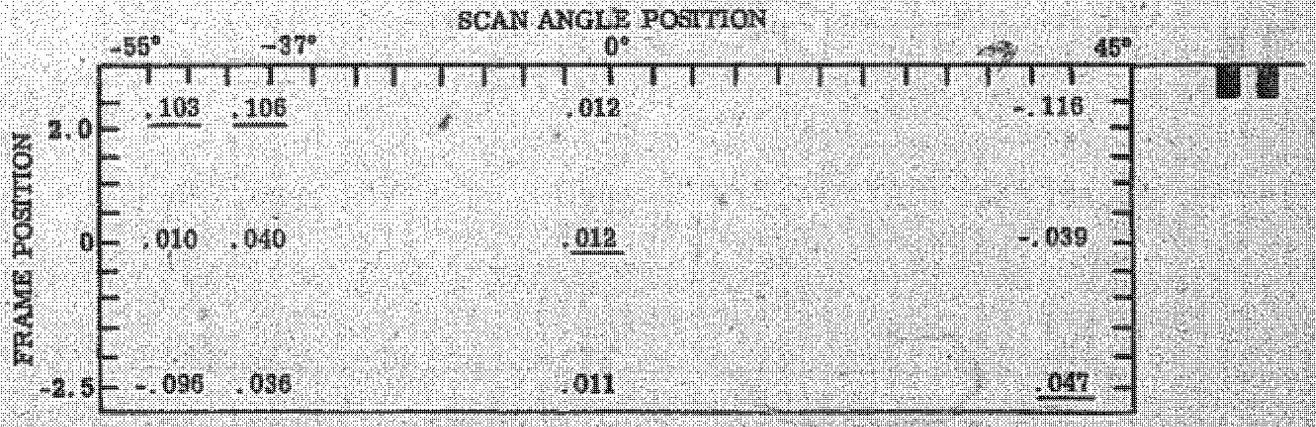
IN-TRACK





FILM TRAVEL

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 inch/second.
5. Values include the effect of the recommended OOAA adjustment.

FIGURE 4-8

BYE 15809-74

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TABLE 4-8

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

(inch/second)

Forward Camera

	IN-TRACK						CROSS-TRACK					
SCAN ANGLE (DEGREES)	-45	0	37	55	-45	0	-45	0	37	55	-45	0	37	55
FRAME POSITION (DEGREES)	2.0	2.0	2.0	2.0	0	3	0	3	0	0	-2.5	-2.5	-2.5	-2.5
SMEAR ERROR	.038	.027	.044	.015	-.068	-.046	+.023	+.052	.038	.027	.044	.016	-.068	-.046	-.023	-.052
ORBITAL FIXED PHOTO	.033	.038	.026	.023	.382	-.001	-.096	-.097	.004	.003	0	0	-.033	-.045	-.032	-.027	-.042	.001	.038	.103
ORBITAL RESULTANT	.071	.065	.070	.039	.014	-.047	-.057	-.149	.042	.027	.044	.016	-.067	-.046	-.023	-.058	-.008	-.018	.012	-.009	-.160	-.043	.045	.051
RECOMMENDED ODAR BIAS	-.029	-.028	-.029	.029	.045	.043	.045	.045	-.022	-.029	-.029	-.029	.042	.045	.045	.045	-.029	-.029	-.029	-.029	.045	.043	.043	.045
RESULTANT	.042	.036	.041	.010	.059	-.002	-.012	-.104	.013	-.002	-.015	-.013	-.322	-.301	.322	-.313	-.021	-.041	-.017	-.038	-.113	0	.010	.096

Aft Camera

	IN-TRACK						CROSS-TRACK					
SCAN ANGLE (DEGREES)	45	0	-37	-55	45	0	-37	-55	45	0	-37	-55	45	0	-37	-55
FRAME POSITION (DEGREES)	2.0	2.0	2.0	2.0	0	0	0	0	0	0	0	0	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
SMEAR ERROR	.041	.042	.090	.162	-.041	-.029	-.031	-.025	.041	.042	.090	.102	-.041	-.029	-.024	-.001	-.025	.041	.042	.090	.102	-.041	-.029	-.031	-.025
ORBITAL FIXED PHOTO	+.030	+.035	-.028	-.017	-.076	0	+.006	+.007	0	0	0	0	.006	.001	0	0	-.006	.030	+.035	-.028	-.017	-.076	0	+.006	+.007
ORBITAL RESULTANT	.011	.007	.062	.005	-.117	-.029	.005	-.062	.041	.042	.090	.108	-.080	-.029	-.029	-.001	-.031	.077	.089	.126	.135	.006	+.006	+.002	+.137
RECOMMENDED ODAR BIAS	-.029	-.029	-.029	.029	.041	.041	.041	.041	-.029	-.029	-.029	-.329	.041	.041	.041	.041	.041	-.029	-.029	-.029	-.029	.041	.041	.041	.041
RESULTANT	-.018	+.022	.033	.056	-.116	.012	.016	.103	.012	+.013	+.061	.079	-.039	.012	.049	.012	.010	.048	.060	.097	.106	.047	.011	.036	.096

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

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FLIGHT FOCUS

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SECTION V

FLIGHT FOCUS

5.1 INTRODUCTION

The recommended focus settings for the 1414 Film portion of Mission 1209 are 31 microns for the Forward and 70 microns for the Aft Camera. Conventional color film (SO-255) and an experimental color infrared film (FE-3916) will be included as part of the Aft Camera payload. For these thicker-film portions of the mission, the Aft focus should be set at 100 microns. The data and rationale for these focus recommendations are documented in this section; also included is an analysis of platen tilt adequacy and the filter change effect on focus.

5.2 PLATEN TILT ASPECTS

5.2.1 Introduction

As described in Section III, thru focus test runs were conducted at seven field locations across the nadir format for each of five platen tilt conditions: nominal, 16 microns retreat from nominal, 16 microns advance from nominal, nominal verification in 1A-2, and then a repeat nominal verification in 2A-2. This entire test array was evaluated via tribar reading, see Figures 3-1 thru 3-10 and Tables 3-4 and 3-5. Line analysis was also carried out, but only at the three nominal tilt sequences, (K_1, K_4, and K_5). Most of the data from this testing is well-behaved. In the final analysis, the Readiness Team concluded that both camera platens are set with adequate tilt to achieve optimum resolution performance across the format.

5.2.2 Pre-tilt Nominal Baseline

PBF profiles across the format were assessed via tribars and lines for both cameras, the two sets of data were compared on an absolute basis in Table 5-1. Comparison between the two diagnostics suggests that for the Aft Camera in-track direction, there is an average +7 microns bias in the line-determined PBFs. In the other three cases, agreement is within a 5 micron error budget.

Normalized at nadir, relative PBF profiles from these tribar and line determinations are compared separately for the two cameras and two target orientations, see Figure 5-1. Close agreement between the two independent PBF profile determinations is clearly evident. Figure 5-2 presents plots of the Forward and Aft Camera average profiles with the "historical average" profiles from the four preceding Chamber A-2 vehicle pitch tested systems. This figure shows that there is a reasonable agreement between SV-9 and the combined average response of systems SV-8, SV-7, SV-6, and SV-5 which were tested in the same manner.

5.2.3 Retreat Platen Tilt

For the next series of vehicle pitch test runs, the platen tilt was retreated 16 microns (8 command counts) across the full 8", which is an 8 micron retreat at center format. PBF profiles were determined

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TABLE 5-1

TRIBAR AND LINE PBFs AT BASELINE, NOMINAL TILT

(microns)

Camera	Field Angle (degrees)	Run	In-Track			Cross-Track		
			Tribars	Lines	Diff	Tribars	Lines	Diff
Forward	-2.5	267	22	26	+4	22	16	-6
	-2.0	266	23	24	+1	19	16	-3
	-1.0	262	25	27	+2	25	22	-3
	0	271	29	28	-1	29	28	-1
	1.0	255	17	19	+2	19	15	-4
	2.0	258	6	6	0	4	5	+1
	2.5	259	3	6	+2	4	7	-2
Aft	-2.5	259	67	80	+13	61	65	+4
	-2.0	258	76	84	+8	62	65	+3
	-1.0	255	81	83	+2	75	71	-4
	0	271	79	85	+6	83	80	-3
	1.0	262	79	86	+7	77	77	0
	2.0	266	61	73	+12	62	64	+2
	2.5	267	59	61	+2	61	61	0

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LINE AND TRIBAR PBF PROFILES FOR PRE-TILT CONDITION

FORWARD CAMERA

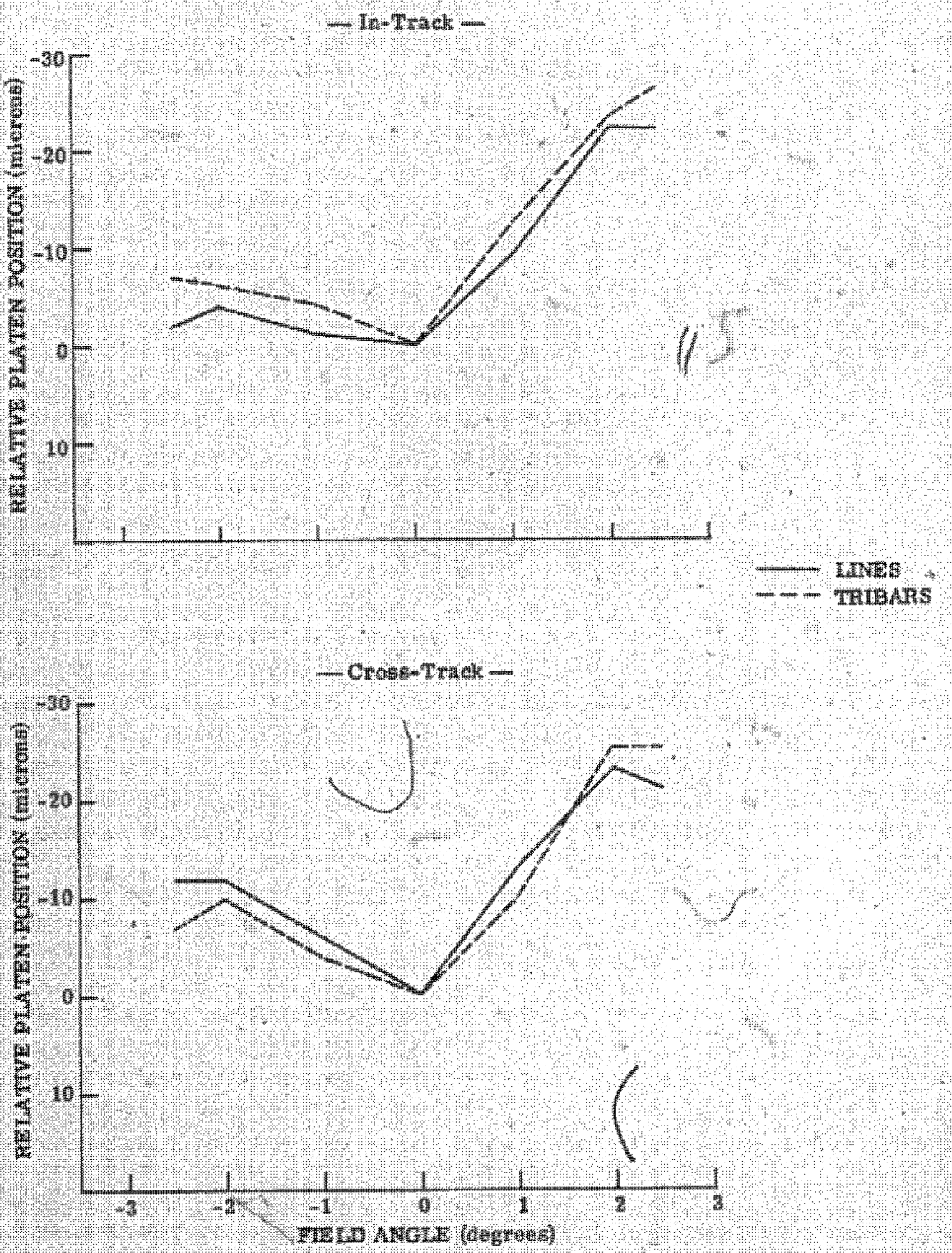


FIGURE 5-1

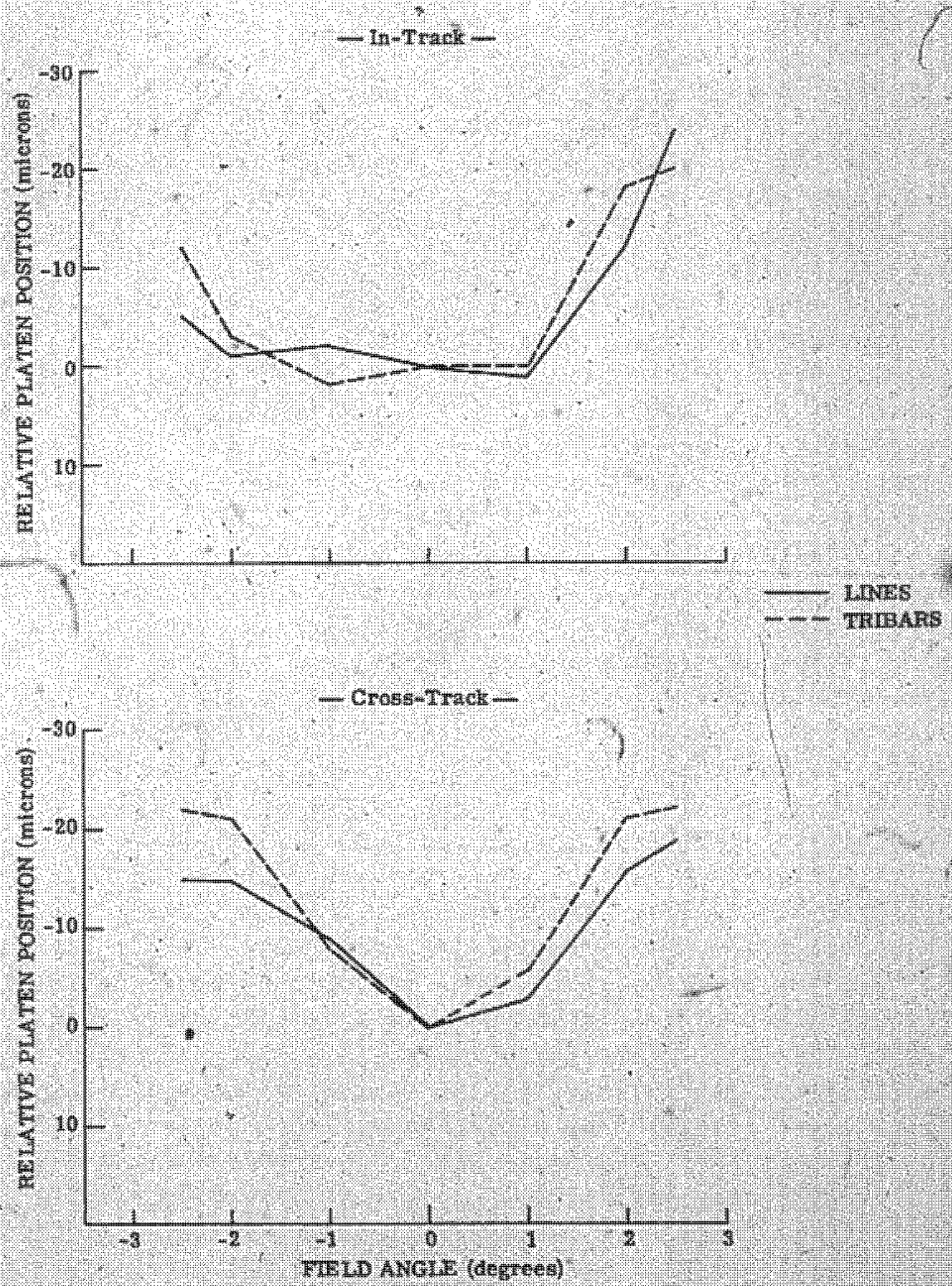
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LINE AND TRIBAR PBF PROFILES FOR PRE-TILT CONDITION (CONT'D)

AFT CAMERA

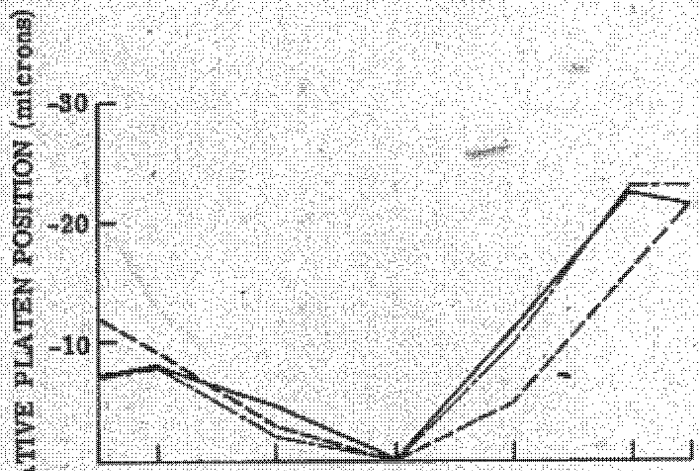


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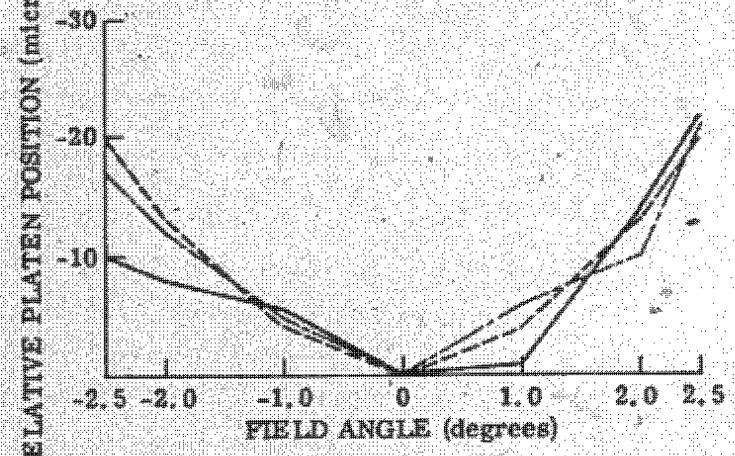
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PRE-TILT PBF COMPARISON WITH HISTORICAL AVERAGES

FORWARD CAMERA



AFT CAMERA



—·— GEOMETRIC MEAN OF TRIBARS

——— AVERAGE BETWEEN IN-TRACK AND CROSS-TRACK LINES

– – – HISTORICAL AVERAGE

FIGURE 5-2

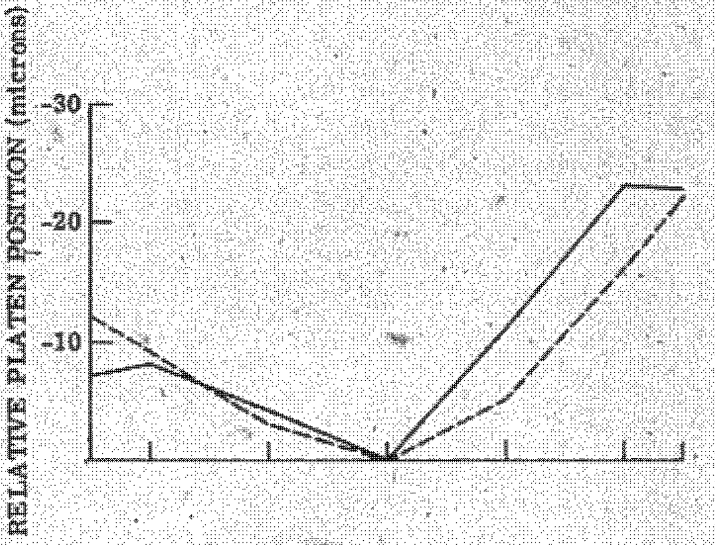
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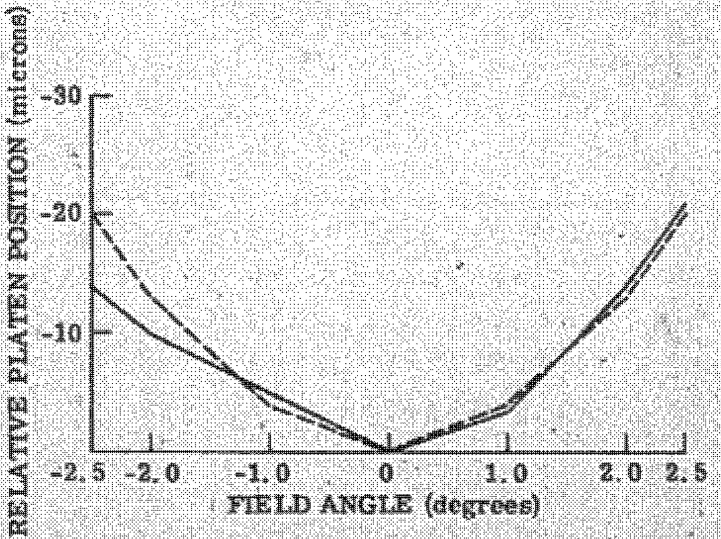
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PRE-TILT PBF COMPARISON WITH HISTORICAL AVERAGES (CONT'D)

FORWARD CAMERA



AFT CAMERA



——— AVERAGE OF LINE AND TRIBAR (IN-TRACK AND CROSS-TRACK) PBFs

– – – HISTORICAL AVERAGE

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from the thru focus resolution data (Figures 3-2 and 3-7). These measured profiles are compared to expectations in Figures 5-3 and 5-4. Two such comparisons are offered. On a relative defocus basis, predictions were made from the historical average, see Figure 5-2. On an absolute platen position basis, predictions were made from the geometric mean tribar data actually taken under the baseline nominal tilt condition (Figure 5-2). For both cameras, the agreement between actual data and both types of predictions is excellent.

5.2.4 Advance Platen Tilt

For the third portion of Seq K, platen tilt was advanced 32 microns (16 microns from nominal) across the full 8 inches. Comparable predictions and resolution analyses (Figures 3-3 and 3-8) were made for this condition; the PBF profiles are given in Figures 5-5 and 5-6 for the Forward and Aft Cameras respectively. Once again, agreement between expectation and measurement was excellent.

Tribar diagnostic PBF profiles for the three tilt conditions are presented in Figure 5-7. From this figure, it is evident that the PBF profile response to the 16 micron platen tilt changes is photographically detectable. For the Aft Camera, the nominal tilt condition is clearly the best balanced. Although the 16 micron advance tilt condition is the best balanced for the Forward Camera, the nominal tilt condition is the one that agrees best with the previous systems flown. No imbalance in image quality distribution across the Forward Camera format has been detected in Missions 1205 thru 1208. Therefore, a consistent mission performance historical reference is considered to be more judicial than a balanced condition which may be only true for the laboratory test conditions.

Another view of the platen tilt retreat-to-advance test is shown in Figure 5-8 where the dashed line represents a 32 micron full field tilt. The plotted data is the actual displacement in resolution-determined PBFs for the Forward and Aft Cameras. The platen responded as directed within a 5 micron photographic tolerance.

5.2.5 Post-tilt Nominal Verification

With the two platen tilt tests completed, it was necessary to verify the return of the platens to nominal tilt. As with the pre-tilt nominal, both tribar and line diagnostics were used to assess the PBF profiles. Comparison between the two sets of data on an absolute basis is given in Table 5-2. As with Table 5-1, tribar and line determinations are substantially the same except for the Aft Camera in-track case where the lines have an average +7 microns bias with respect to the tribars.

On a relative defocus basis, these two independent determinations are plotted in Figure 5-9. Although agreement in PBF profiles is not as close as in the pre-tilt condition, the post-tilt data is substantially verified by the two independent diagnostics, with the exception of the Forward Camera cross-track condition. In this condition, the relative field balance is essentially the same but the tribars indicate a slightly higher degree of field curvature than do the lines. PBF profiles determined

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FORWARD CAMERA PBF PROFILES FOR RETREAT TILT CONDITION

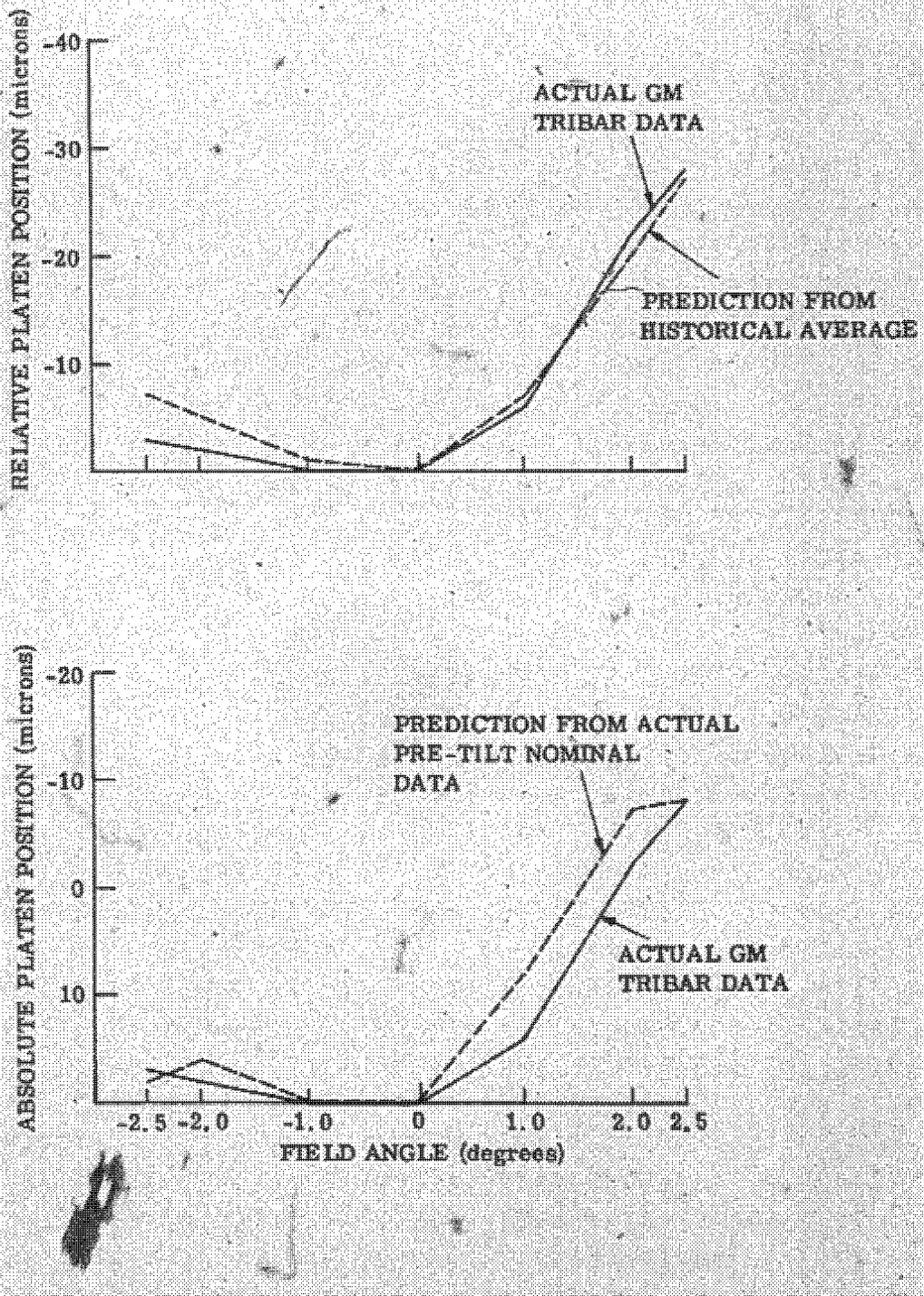


FIGURE 5-3

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AFT CAMERA PBF PROFILES FOR RETREAT TILT CONDITION

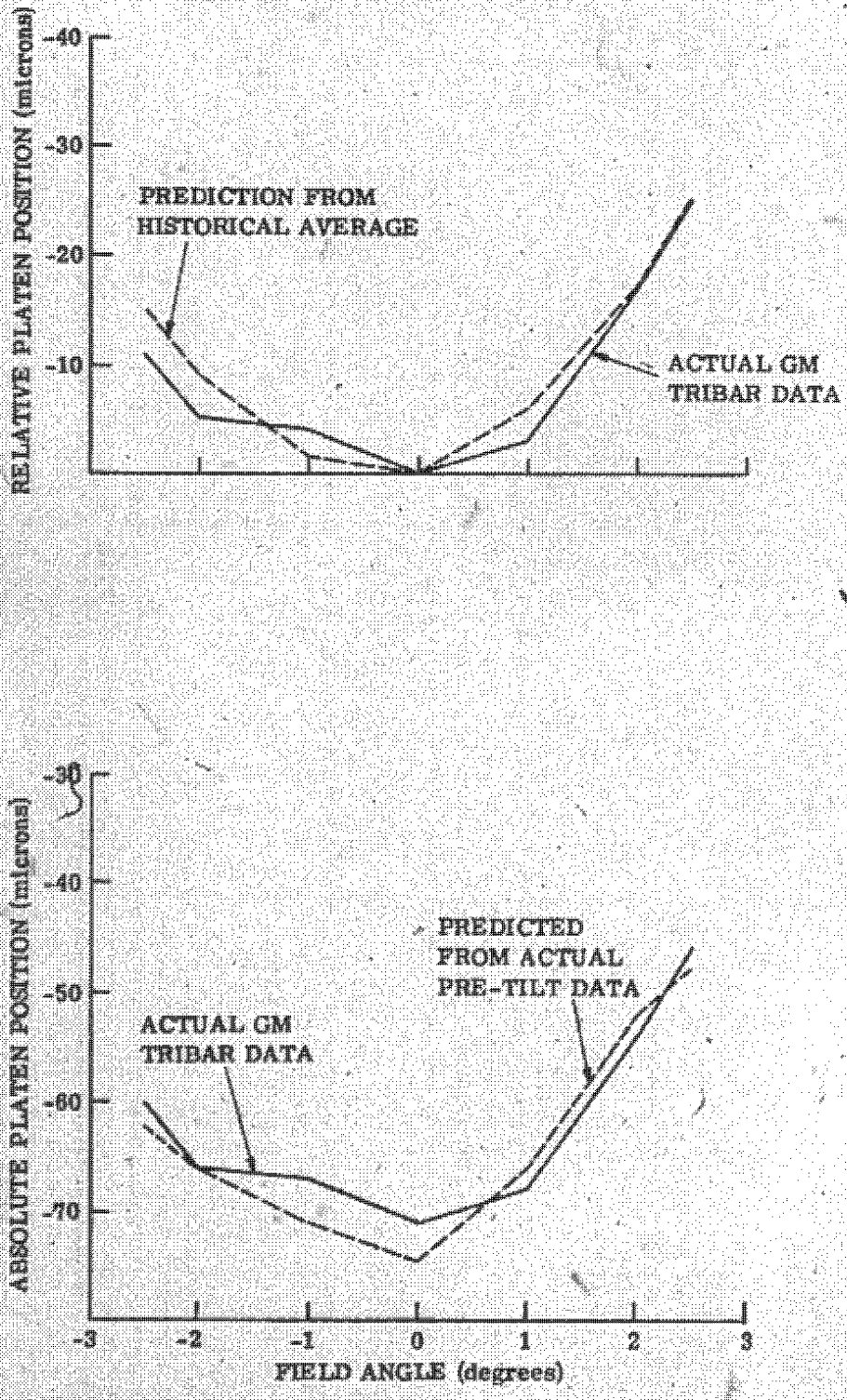


FIGURE 5-4

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FORWARD CAMERA PBF PROFILES FOR ADVANCED TILT CONDITION

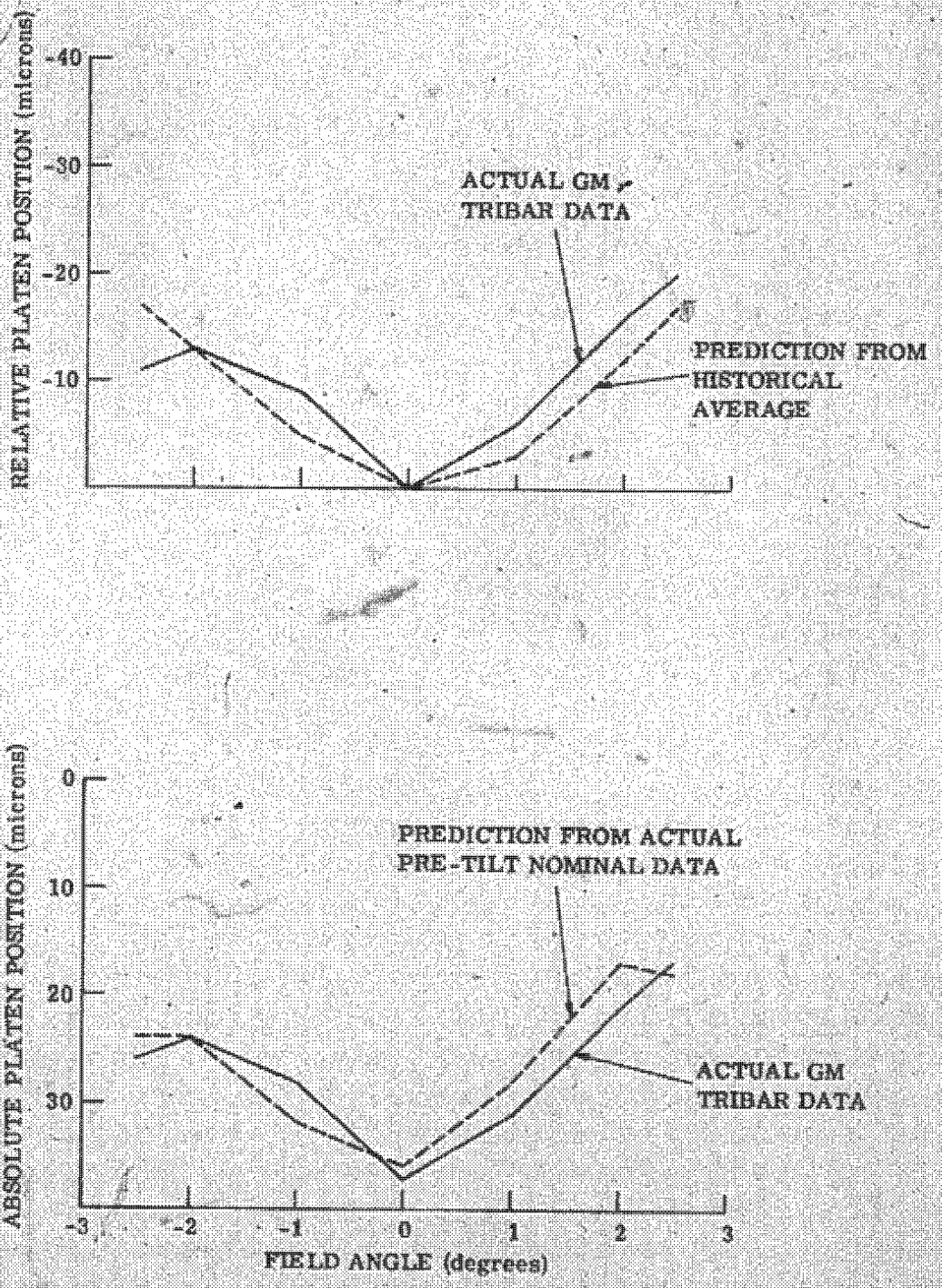


FIGURE 5-5

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AFT CAMERA PBF PROFILES FOR ADVANCED TILT CONDITION

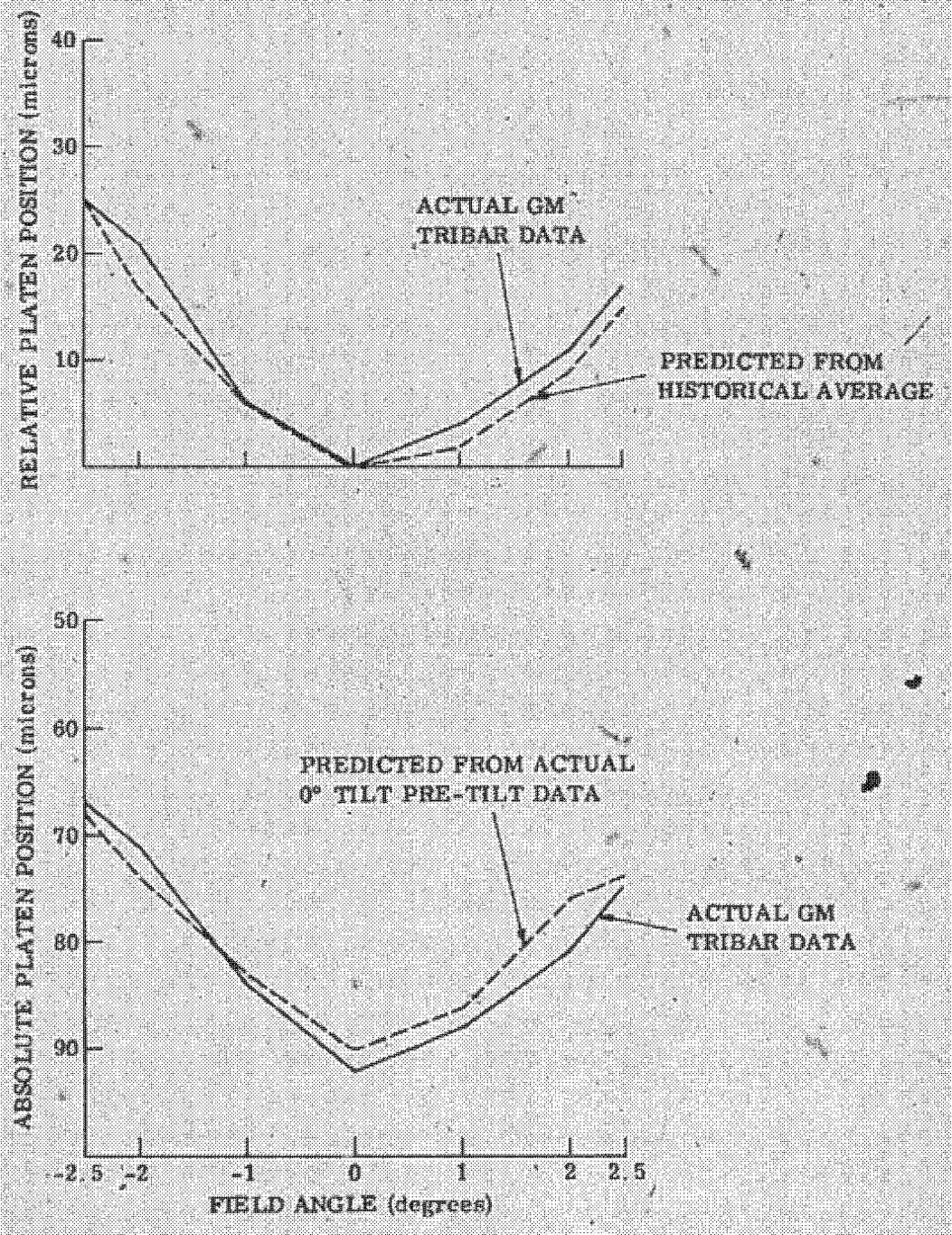


FIGURE 5-6

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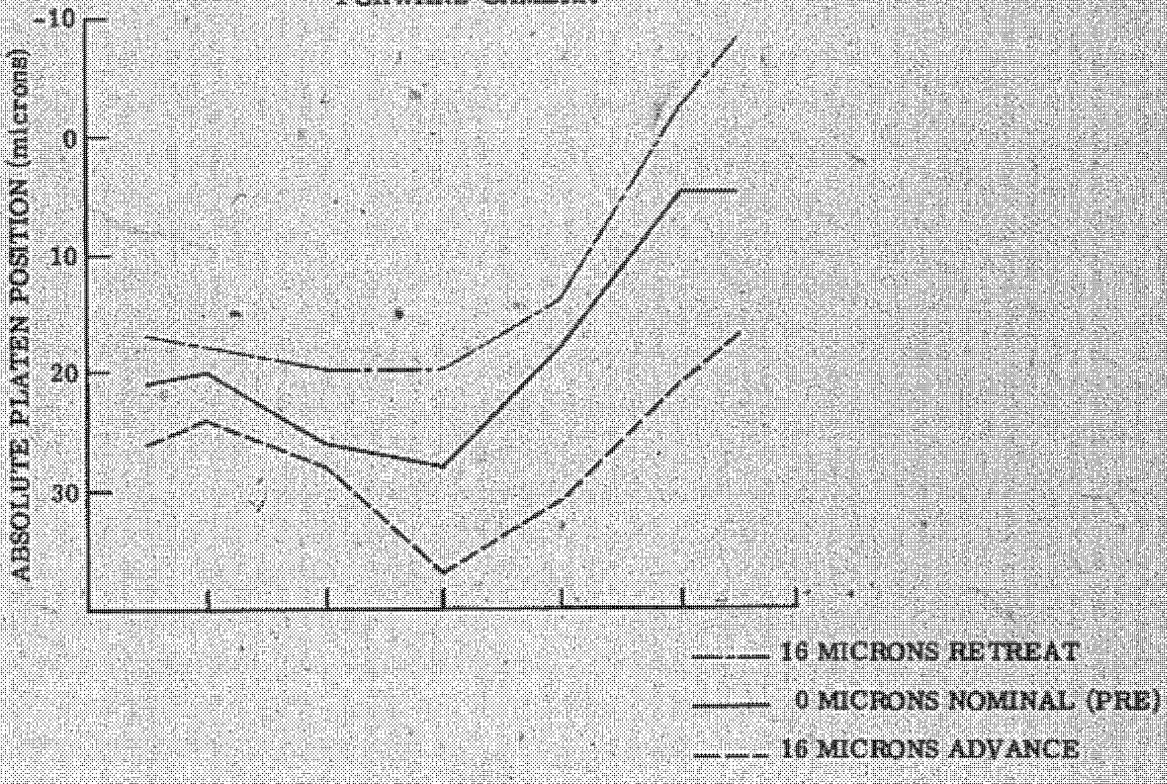
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PLATEN TILT COMPARISONS

(Tribars Only)

FORWARD CAMERA



AFT CAMERA

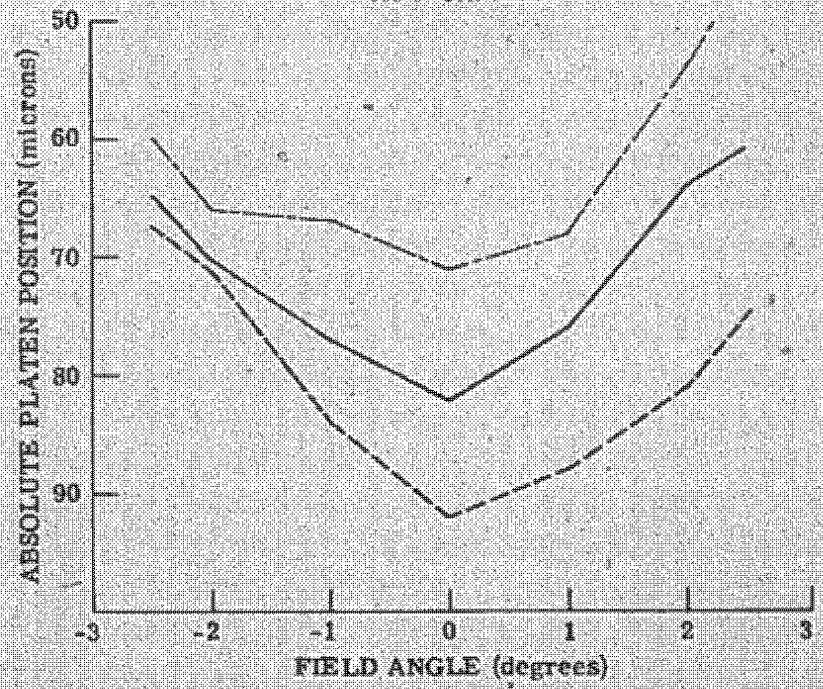


FIGURE 5-7

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DISPLACEMENT COMPARISON BETWEEN ADVANCE AND RETREAT

PLATEN TILT ON BOTH CAMERAS

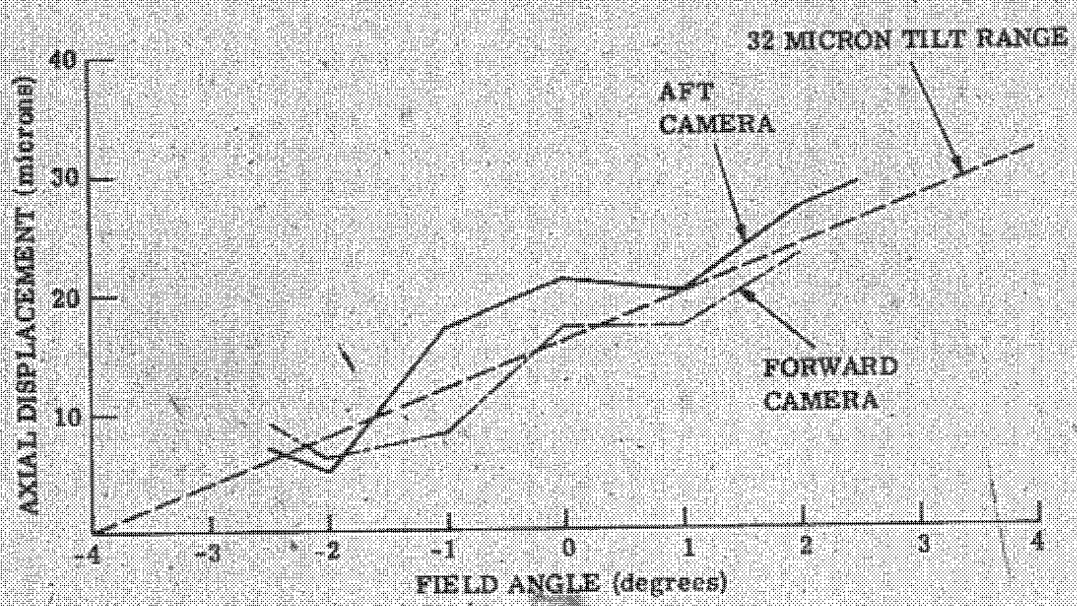


FIGURE 5-8

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FLIGHT READINESS REPORT
SV-9 (SN-012)

TABLE 5-2

TRIBAR AND LINE PBFs AT VERIFICATION NOMINAL TILT

(microns)

Camera	Field Angle (degrees)	Run	In-Track Tribars	In-Track Lines	In-Track Diff	Cross-Track Tribars	Cross-Track Lines	Cross-Track Diff
Forward	-2.5	342	19	27	+8	16	21	+5
	-2.0	338	24	25	+1	17	17	0
	-1.0	335	31	31	0	28	24	-4
	0	328	27	27	0	31	25	-6
	1.0	316	16	21	+5	19	22	+3
	2.0	319	5	8	+3	12	10	-2
	2.5	320	4	6	+2	11	10	-1
Aft	-2.5	320	71	83	+12	69	65	-4
	-2.0	319	78	85	+7	66	68	+2
	-1.0	316	85	89	+4	80	79	-1
	0	323*	82	85	+3	83	81	-2
	1.0	335	80	84	+4	76	76	0
	2.0	338	63	74	+11	64	63	-1
	2.5	342	53	60	+7	58	60	+2

NOTES: 1. The asterisk (*) denotes that the TR-323 Film was missing.
2. Tribar PBFs are from TR-350, the WCFO Versamat processed baseline.
3. Line PBFs are from TR-326, Seq L, the filter change experiment.

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FLIGHT READINESS REPORT
SV-9 (SN-012)

LINE AND TRIBAR PBF PROFILES FOR POST-TILT CONDITION

FORWARD CAMERA

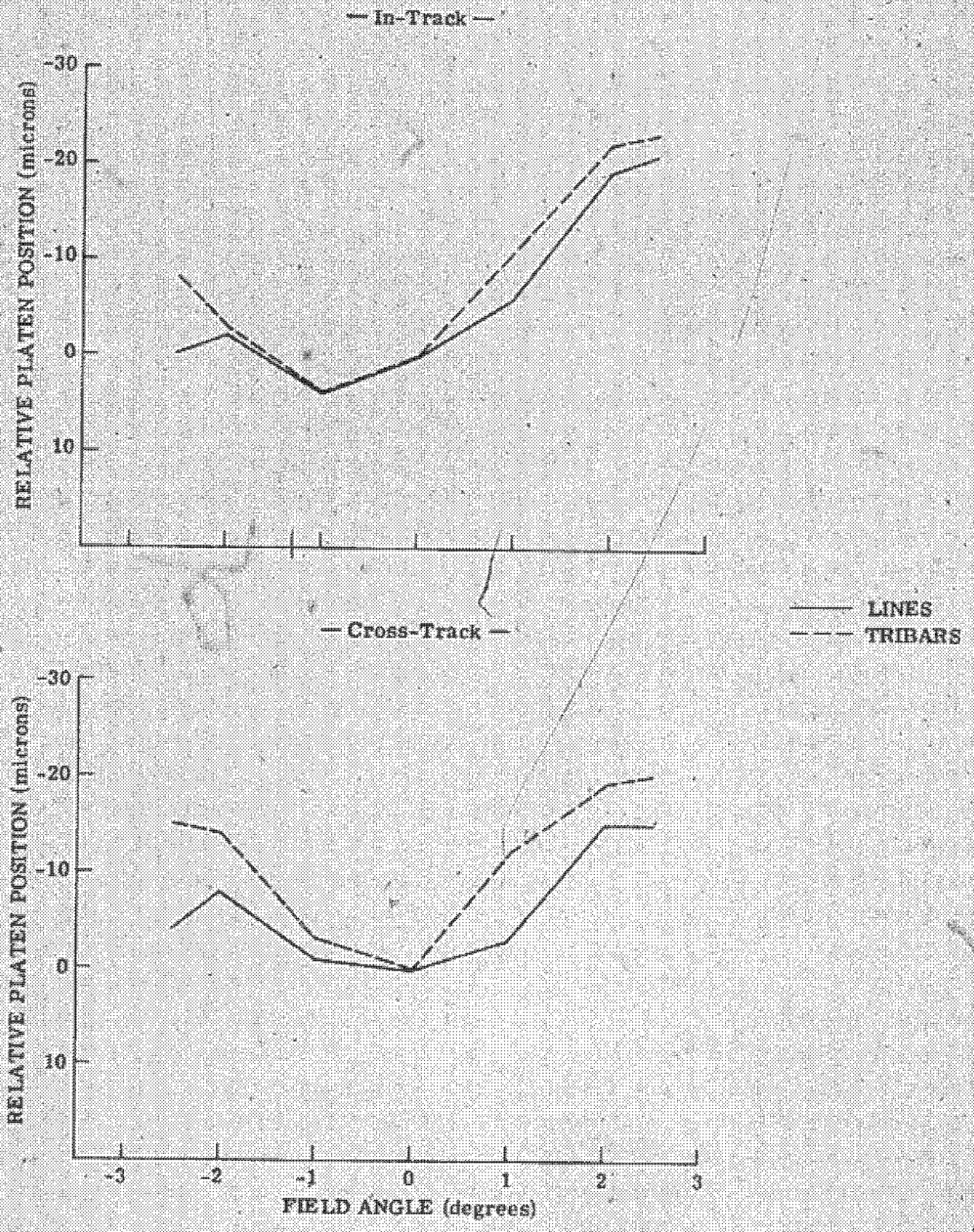


FIGURE 5-9

BYE 15303-74

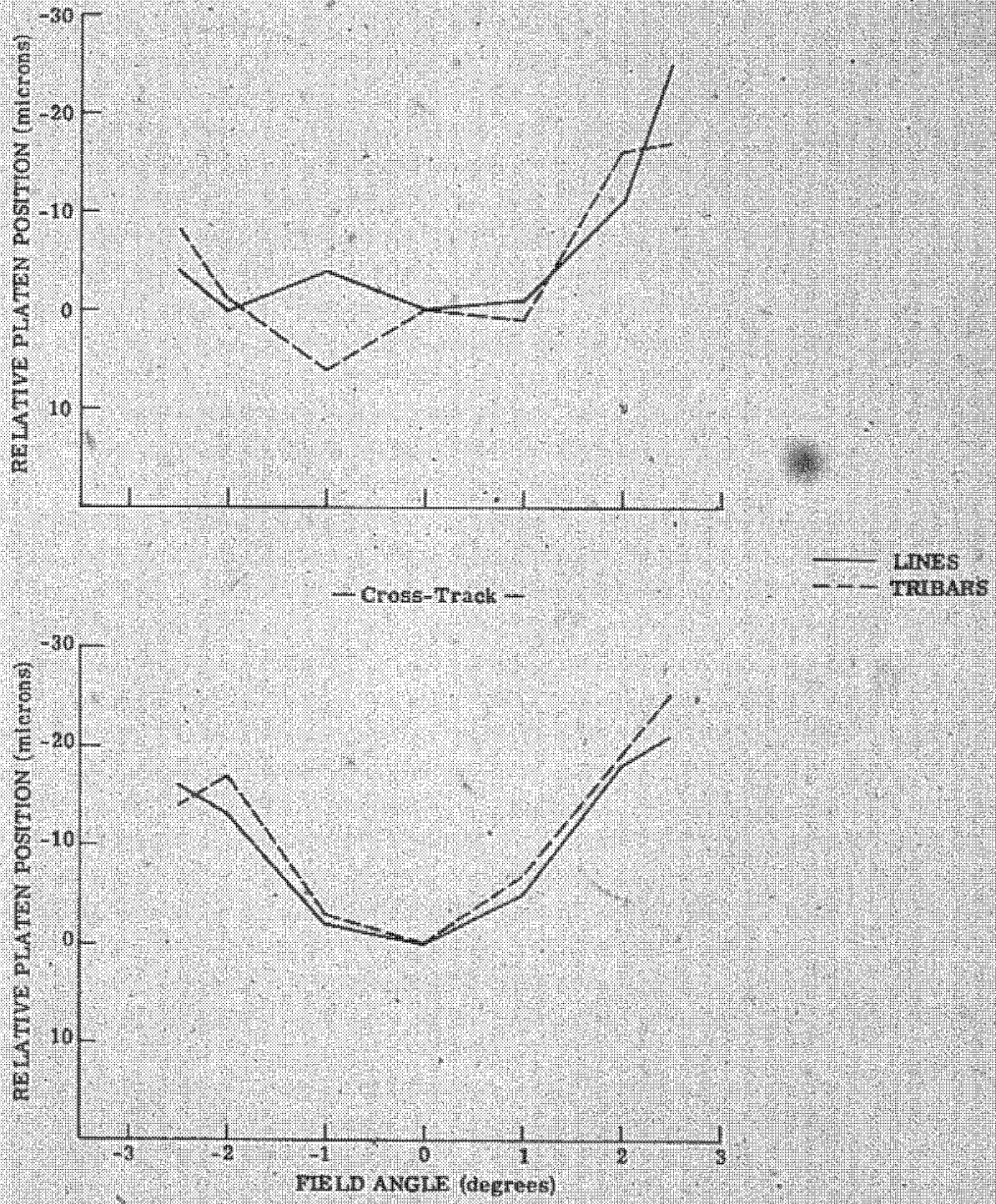
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LINE AND TRIBAR PBF PROFILES FOR POST-TILT CONDITIONS (CONT'D)

AFT CAMERA



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from tribars and lines separately and combined (averaged) are plotted against the historical averages for the Forward and Aft Cameras, see Figure 5-10.

The Forward Camera post-tilt data is in closer proximity to the historical average (< 5 microns for every data point) than is the pre-tilt data. Taken together, the Forward Camera platen tilt is producing the same PBF profiles as the average of the four previous systems. For the Aft Camera, both pre-tilt and post-tilt profiles are the same as the historical average except for the -2.5° field position, which differs by 6 microns and 10 microns respectively. This data point, especially in the post-tilt verification, gives an impression of imbalance which, taken by itself, can be misleading.

5.2.6 Repeat Nominal in 2A-2

Following the platen retrofit, Seq K test runs were conducted with the vehicle pitch configuration for the nominal platen tilt condition only. PBF profiles across the format were assessed via tribars and lines independently. This data is given in Table 5-3. Again, as with the 1A-2 data (Tables 5-1 and 5-2), the two diagnostics agree on the average within a 5 micron budget.

Although the average difference does not exceed the budget for the Aft in-track case, the plus bias is still evident. On a relative defocus basis, the tribar and line determined profiles are plotted in Figure 5-11. As in the previous two examples, the curves are in substantial agreement except for the Forward Camera in-track at the +2.0° and +2.5° field positions. The tribar data for these two field positions is questionable. These field positions do not follow the expected fall off for a thru focus test and thus would lead to choosing PBF values closer to the lens. As with the 1A-2 data (Figures 5-2 and 5-10, comparison with historical averages illustrates the well behaved characteristics of SV-9 test data, see Figure 5-12. Therefore, both cameras exhibit platen tilt measurements that agree favorably with the historical averages. Since image quality across the format measured from previous mission photography has been well balanced, it is expected that the same will be true for Mission 1209.

5.2.6 Summary

In perspective with all the Seq K platen tilt experimental data previously described, no improvement of photographically detectable significance can be made with either camera's platen tilt. This is evident in Figure 5-13, where the nominal platen tilt condition is shown for both cameras via the actual PBF profiles as measured in three separate tests (K_1, K_4, and K_5). The two diagnostics (lines and tribars) and two target orientations (in-track and cross-track) are isolated to produce four independent assessments of the three sets of data for each camera.

In the Aft Camera comparisons, there is good agreement between all three independent tests. This includes the data taken after platen retrofit. It is quite clear that the cross-track profiles are symmetrically balanced while the in-track profiles show a 15 micron imbalance with plus field closer to the lens. In the Forward Camera comparisons, both sets of 1A-2 data show profiles that are in good

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POST-TILT PBF COMPARISON WITH HISTORICAL AVERAGES

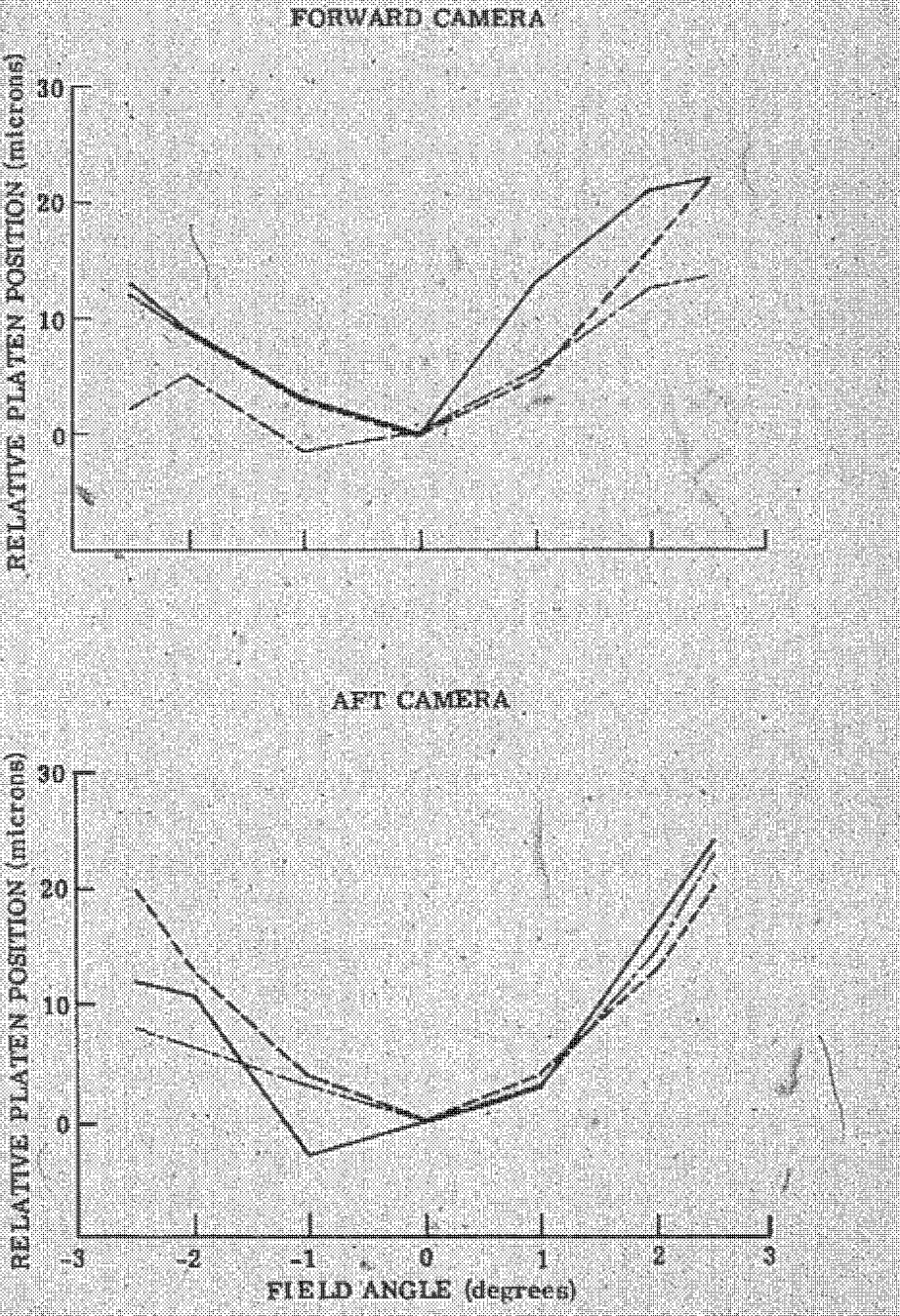


FIGURE 5-10

BYE 15303-74

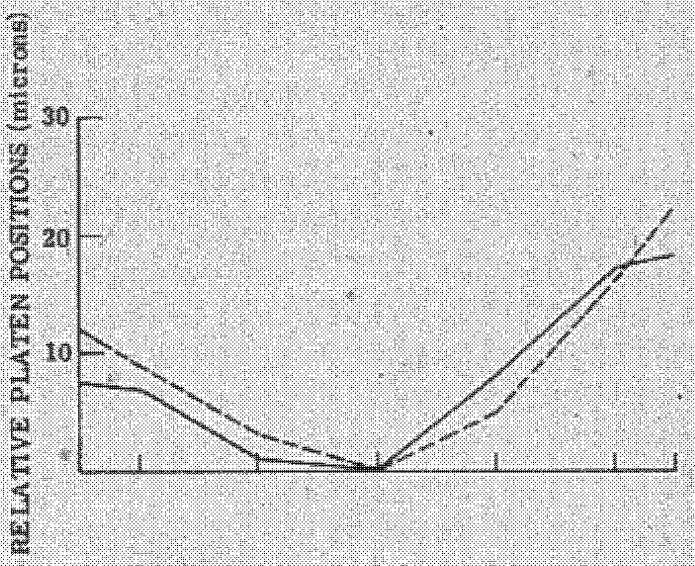
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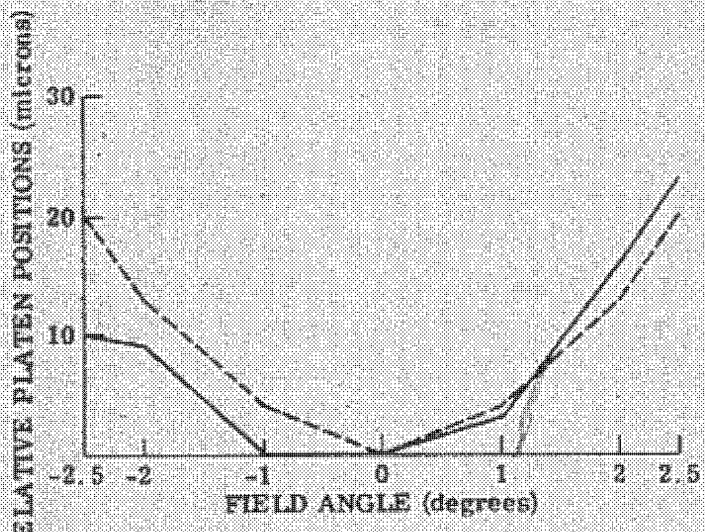
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POST-TILT PBF COMPARISON WITH HISTORICAL AVERAGES (CONT'D)

FORWARD CAMERA



AFT CAMERA



——— AVERAGE OF LINE AND TRIBAR (IN-TRACK AND CROSS-TRACK) PBFs

– – – – HISTORICAL AVERAGE

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TABLE 5-3

TRIBAR AND LINE PBFs AT 2A-2 NOMINAL TILT
(microns)

Camera	Field Angle (degrees)	Run	In-Track Tribars	In-Track Lines	In-Track Diff	Cross-Track Tribars	Cross-Track Lines	Cross-Track Diff
Forward	-2.5	593	27	28	+1	22	23	+1
	-2.0	589	31	30	-1	24	18	-6
	-1.0	586	35	35	0	34	28	-6
	0	596	38	35	-3	38	32	-6
	1.0	576	28	31	+3	29	26	-3
	2.0	579	9*	17	+8*	17	13	-4
	2.5	582	7*	22	+15*	17	16	-1
Aft	-2.5	582	74	76	+2	70	66	-4
	-2.0	579	79	85	+6	66	65	-1
	-1.0	576	83	88	+5	72*	70	-2*
	0	596	83	85	+2	79	78	-1
	1.0	586	81	89	+8	76	76	0
	2.0	589	67	77	+10	66	64	-2
	2.5	593	66	66	0	62	64	+2

NOTE: The asterisk (*) denotes questionable data.

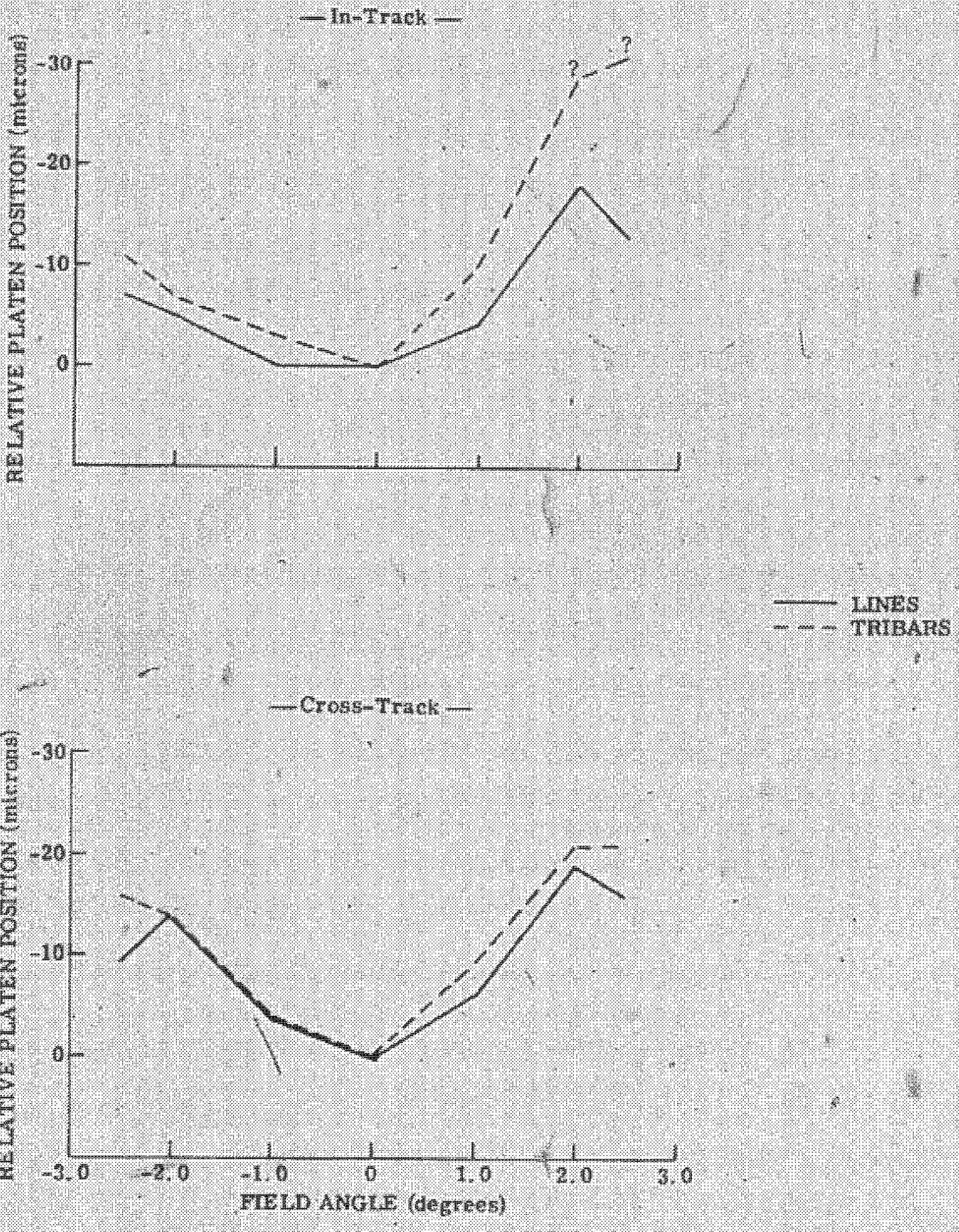
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LINE AND TRIBAR PBF PROFILES FOR 2A-2 CONDITION

FORWARD CAMERA



NOTE: The question marks (?) denote questionable data.

FIGURE 5-11

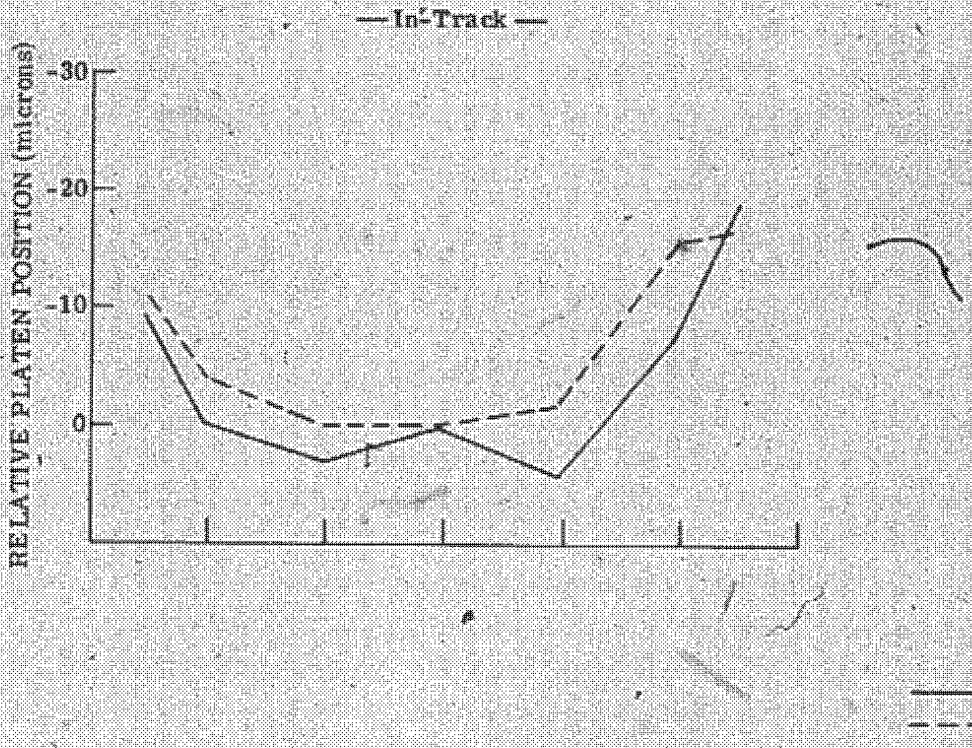
Handle Via Byeman
Controls Only

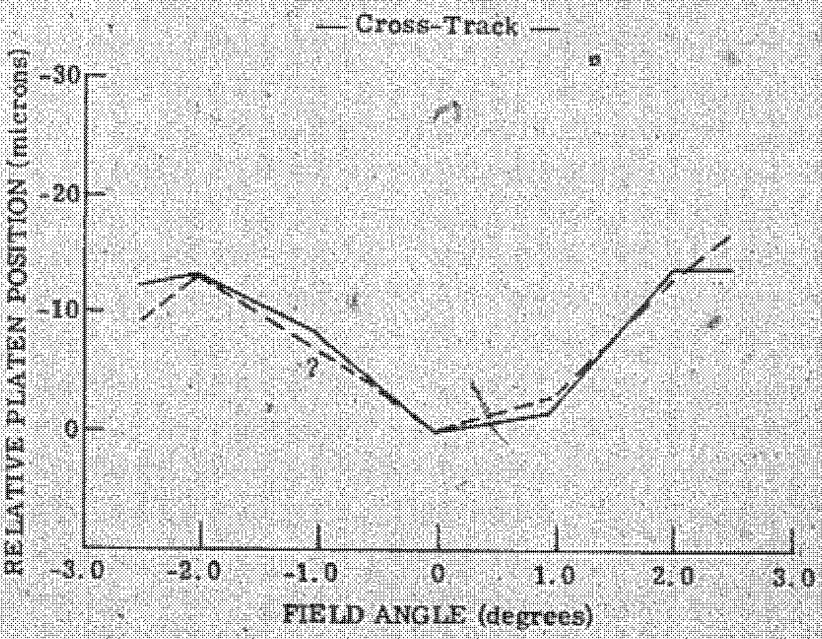
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LINE AND TRIBAR PBF PROFILES FOR 2A-2 CONDITION (CONT'D)

AFT CAMERA





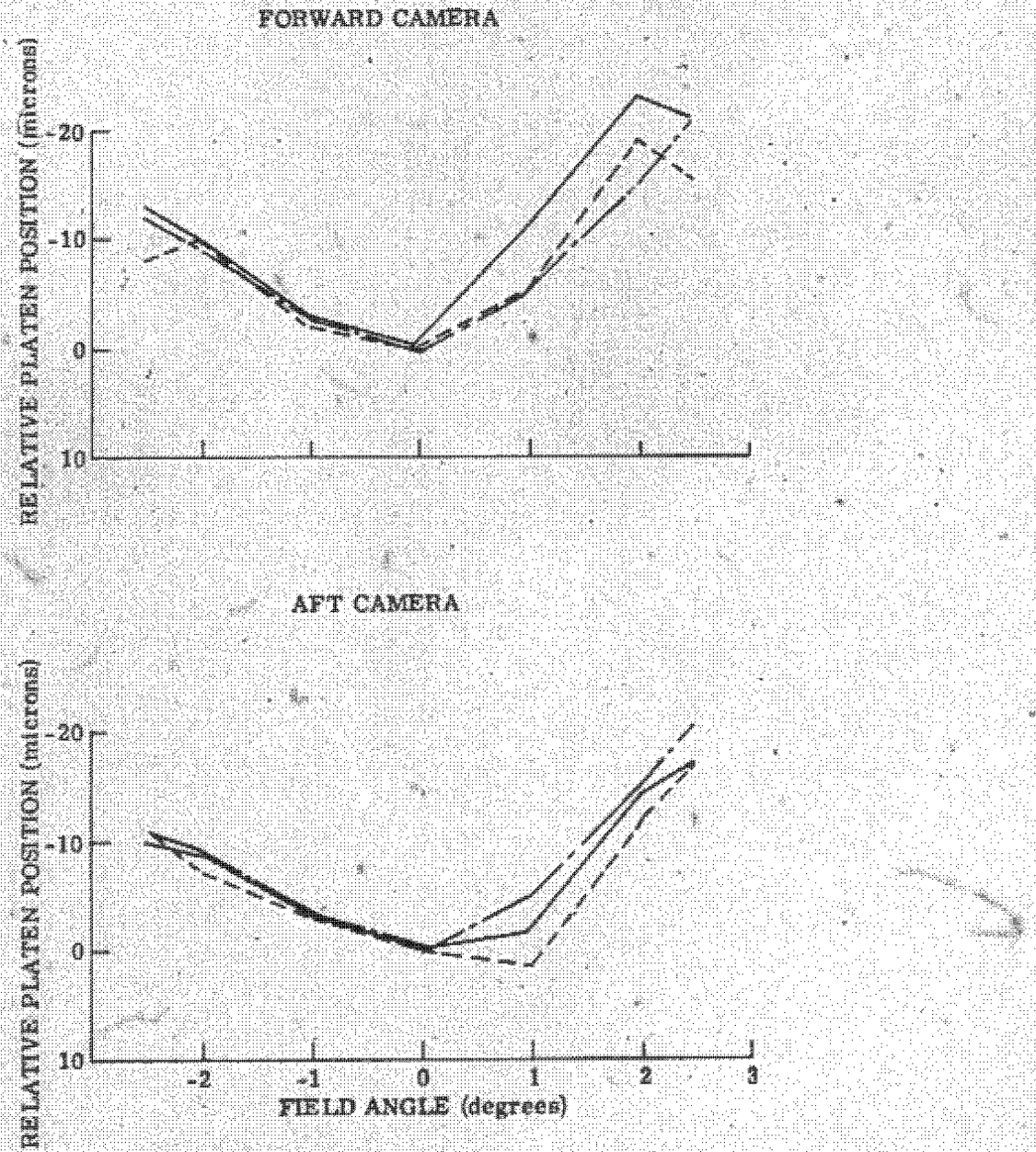
NOTE: The question mark (?) denotes questionable data.

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2A-2 PBF COMPARISON WITH HISTORICAL AVERAGES



——— AVERAGE BETWEEN IN-TRACK AND CROSS-TRACK LINES
——— GEOMETRIC MEAN OF TRIBARS
— — — HISTORICAL AVERAGE

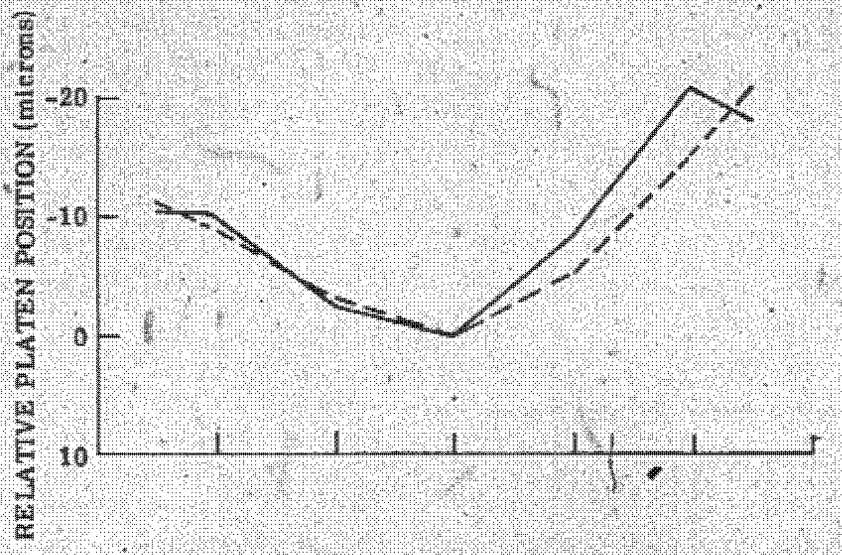
FIGURE 5-12

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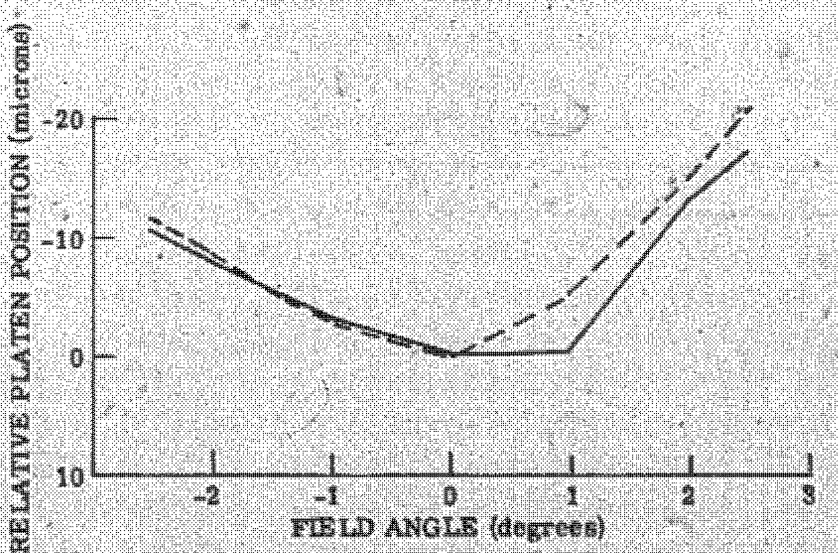
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2A-2 PBF COMPARISON WITH HISTORICAL AVERAGES (CONT'D)

FORWARD CAMERA



AFT CAMERA



——— AVERAGE OF LINE AND TRIBAR (IN-TRACK AND CROSS-TRACK) PBSs
— — — HISTORICAL AVERAGE

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COMPARISON OF THREE INDEPENDENT TESTS OF NOMINAL PLATEN TILT

FORWARD CAMERA

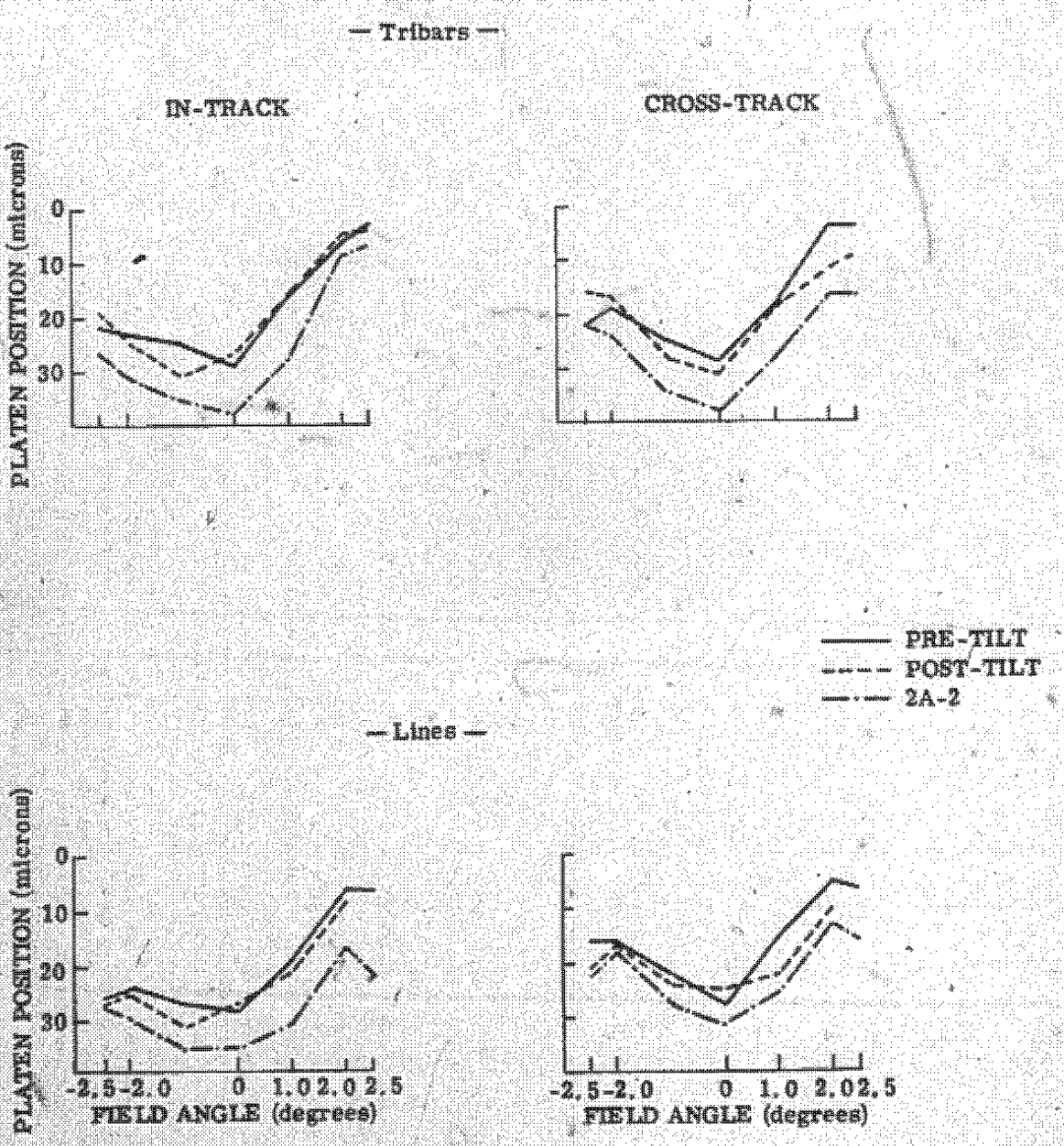


FIGURE 5-13

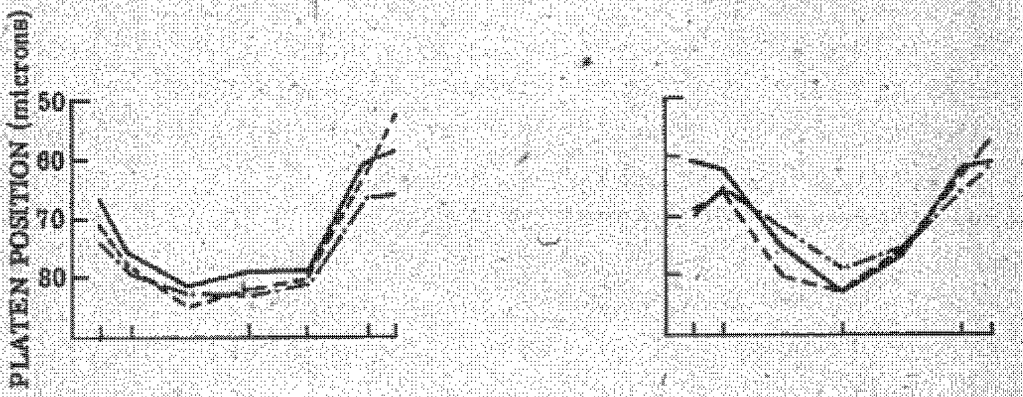
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COMPARISON OF THREE INDEPENDENT TESTS OF NOMINAL PLATEN TILT (CONT'D)

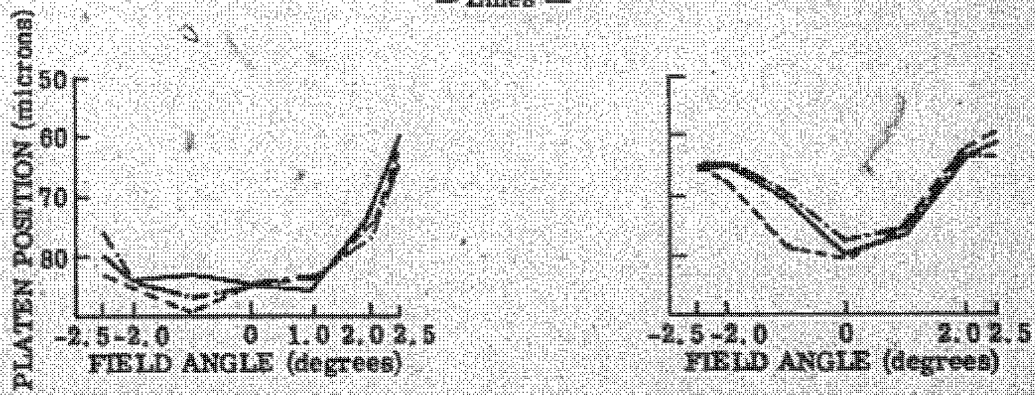
AFT CAMERA

— Tribars —



——— PRE-TILT
— — — POST-TILT
—·— 2A-2

— Lines —



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agreement. Imbalance (measured over the 5" of vehicle pitch collimator imagery) is on the order of 20 microns in-track and 13 microns cross-track. Test data from 2A-2 exhibits a distinct bias of approximately +7 microns. Whether or not this bias is uniform across the field is difficult to discern with a 5 micron error budget. The indication is that there is a just detectable (5 microns) change in platen tilt, with the imbalance changed to 15 microns in-track and 7 microns cross-track.

5.3 FILTER CHANGE EFFECT ON FOCUS

Both cameras are equipped with ICFs allowing a choice between two filters, a Wratten 12 or Wratten 2E3. Seq L (1A-2) was run to determine if changes in either resolution performance level or PBF occur when a change in filter is made. Test parameters were a Vx/h of .044 and a slit width of .259" with the IMC disabled. The test results showed that no significant change in resolution or focus occurred when switching from one filter to the other.

Replicate frames were acquired with each filter in place at platen positions of 25 and 75 microns for the Forward and Aft Cameras respectively. These platen settings are adequately close to the verified 1A-2 nadir peaks (28 microns Forward and 82 microns Aft). No significant change in the 2:1 contrast mean resolution performance was found for either camera with the different filters, see Table 5-4. Microdensitometry of the line targets from the same frames was done using the FOCMO Program to determine PBFs for each filter. Again, no significant difference was found between the filters for either camera, see Table 5-5.

5.4 SELECTION OF LAUNCH PLATEN POSITIONS

Based upon the resolution performance analysis in Section III, optimally balanced field performance is at platen settings of 30 microns for the Forward and 75 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 1209 will provide an average photographic acquisition altitude of approximately 85 NM. This difference requires a correction of 14 microns, see Figure 5-14.

B. Prior to SV-9 the effects of gravity on focus had been attributed to a spherical deformation of the folding flat. Interferometric measurements of the optical bars established changes in 0° astigmatism from the vertical to horizontal position. This change would allow for a computation of focus shift from a 1G to gravity-free environment. In recent testing of optical bars, a direct measurement of this focus shift was implemented. The first complete TCA to have its OBs measured is the one in SV-9. If only the direct measurement of focus shift were used, the gravity release corrections for OB Set 030 (Forward Camera) would be 8 microns and for OB Set 033 (Aft Camera) it would be 14 microns. Using the old method of spherical flat deformation, the corrections would be 15 and 19 microns for the Forward and Aft Cameras respectively. Several other optical bars have had similar focus change measurements made.

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TABLE 5-4

COMPARISON OF RESOLUTION LEVELS BETWEEN THE TWO FILTERS

(cycles/mm)

	Forward Camera (0°)				Aft Camera (0°)		
Frames (Filter)	IT	XT	Sample Size	Frames (Filter)	IT	XT	Sample Size
1-13 (W-12)	204	176	13	1-10 (W-12)	179	153	10
16-23 (W-2E3)	194	175	8	13-20 (W-2E3)	190	161	8
25-33 (W-12)	203	180	9	22-30 (W-12)	181	151	9
26-43 (W-2E3)	199	160	8	33-40 (W-2E3)	182	143	8
46-53 (W-12)	185	170	8	43-53 (W-12)	178	139	11
Average (W-12)	197	175		Average (W-12)	179	148	
Average (W-2E3)	197	168		Average (W-2E3)	186	152	

TABLE 5-5

COMPARISON OF LINE DETERMINED FOCUS BETWEEN THE TWO FILTERS

(microns)

		In-Track		Cross-Track	
Camera	Filter	PBF	σ	PBF	σ
Forward	W-12	29	$\pm$3.4	26	$\pm$2.1
	W-2E3	28	$\pm$3.6	26	$\pm$3.2
Aft	W-12	85	$\pm$2.4	81	$\pm$0.9
	W-2E3	82	$\pm$2.6	77	$\pm$1.4

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FOCUS AS A FUNCTION OF ALTITUDE AND SCAN ANGLE

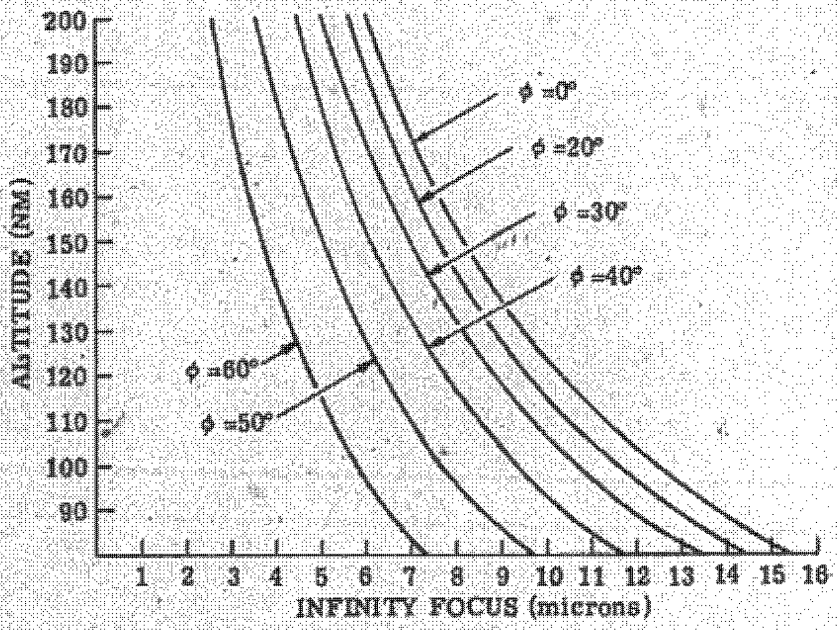


FIGURE 5-14

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Generally, they all show less of a correction than would be predicted from the spherical deformation theory. Eight of the ten bars show a focus change of 9 ±2 microns; however, the wavefront changes range from .067 to .162. In other words, using the measured focus along with the astigmatism change would yield an equation of focus shift of $\Delta F = \delta\lambda$ (84). The old theory would be expressed as $\Delta F = \delta\lambda$ (137). That is, less of a focus correction is calculated for the new method versus the old. Applying the new method to the SV-7 optical bars which needed no on-orbit focus changes, and even though only the wavefront was measured, the recommended gravity corrections would be 8 microns for the Forward Camera and 12 microns for the Aft Camera. The actual corrections used on SV-7 were 12 and 16 microns for the Forward and Aft Cameras respectively. The difference for both cameras is 4 microns and would probably be undetected using the visual edge matching evaluation technique. The differences for SV-9 are 7 and 5 microns (Forward and Aft). This would certainly be detectable in the Forward Camera. The purpose of the above discussion is to show the impact of using either of the two methods on SV-9 focus setting. Since four of the last six optical bars have been set correctly for on-orbit operation and the use of the old theory in setting SV-9 flight focus would have minor impact on photographic performance, it is the opinion of the Flight Readiness Team that a focus correction of 15 microns for the Forward Camera and 19 microns for the Aft should be used. The choice of the two methods should be evaluated for future OBs until sufficient data is gathered to confirm one method.

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 microns deviation and the Aft 0° collimator was monitored at 0 microns.

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 5-6 presents these factors for SV-9.

5.5 CONCLUSIONS AND RECOMMENDATIONS

A. Launch platen positions should be 31 microns on the Forward Camera and 70 microns on the Aft Camera for 1414 Film.

B. During the color film portions of the mission, the Aft Camera platen position should be changed to 100 microns.

C. Changing filters on either camera with 1414 Film causes no effective focal shift.

D. Both cameras have adequate platen tilt for optimum resolution performance across the format.

E. Both cameras focus plus field shorter in Chamber A-2 than in Chamber A.

F. The platen tilt experiment was successful insofar as it demonstrated the ability to track platen tilt with existing photographic test methodology. There is no need at this time to repeat the test procedure with SV-10 testing.

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G. Platen retrofit introduced no change in PBF across the format with the Aft Camera. However, it did introduce a plus bias of approximately 7 microns with the Forward Camera, more being introduced at plus field than minus field.

TABLE 5-6

LAUNCH FOCUS SETTING FACTORS

(microns)

Factor	Forward Camera	Aft Camera
Platen Position for Best Resolution Across Field From Readiness Test Data	30	75
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	31	70

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ON-ORBIT PERFORMANCE ESTIMATES

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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.

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

(3) It is for only one focus position.

6.2 CRYSPER CONCEPTS

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

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

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

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

In order to accommodate both the engineering and intelligence needs for resolution predictions, two separate CRYSPER runs are made. The engineering run uses an average haze condition and the nominal CORN tribar target reflectances of 7-33%. 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

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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 1209

A series of CRYSPER runs have been made to estimate the performance from Mission 1209. 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 an October 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.

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TABLE 6-1

MISSION 1209 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)

AFT CAMERA
SSN 012 OSN 338

LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
80	1	47	53	56	59	64	69	74	74	74	73	71	68	61
75	7	54	58	62	68	71	78	83	83	83	83	82	77	69
70	12	70	77	80	85	91	98	109	108	109	106	101	96	87
65	17	90	98	103	109	116	124	131	131	130	128	124	116	106
60	22	103	113	119	127	136	142	149	148	147	144	139	131	119
55	26	114	125	132	140	148	155	161	161	159	156	150	141	127
45	36	126	139	148	157	165	171	176	175	172	168	161	150	135
35	45	134	149	158	167	175	182	186	184	181	175	167	156	141
25	53	140	156	166	176	183	189	192	190	185	179	171	160	145
15	61	144	160	172	181	188	193	196	193	189	183	174	163	147

FORWARD CAMERA
SSN 012 OSN 304

LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
80	1	57	64	66	69	71	74	75	77	79	80	80	77	70
75	7	62	68	71	73	76	80	84	85	87	88	89	87	80
70	12	77	84	88	92	95	99	103	105	107	108	108	104	98
65	17	96	105	110	114	118	122	127	128	130	131	131	127	118
60	22	109	119	125	129	135	138	142	143	144	146	145	141	130
55	26	119	130	137	146	144	148	152	153	154	155	155	150	139
45	36	136	148	155	157	159	162	165	165	167	168	169	163	152
35	45	148	160	166	168	169	171	172	173	174	176	177	172	160
25	53	156	169	175	176	176	176	176	177	179	180	181	176	165
15	61	160	173	179	179	179	180	179	180	182	183	184	179	168

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

AFT CAMERA
SSN 012 OSN 338

LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
80	1	29.69	16.75	11.74	9.14	7.46	6.38	5.81	5.95	6.44	7.45	9.83	13.18	21.05
75	7	25.28	14.78	10.31	8.00	6.80	5.63	5.06	5.19	5.56	6.59	7.99	11.53	19.81
70	12	18.79	10.98	7.82	6.03	4.96	4.26	3.89	3.98	4.32	4.97	6.22	8.77	15.27
65	17	14.27	8.40	5.97	4.60	3.81	3.32	3.05	3.13	3.40	3.93	4.95	7.01	12.13
60	22	12.08	7.08	5.02	3.88	3.21	2.82	2.63	2.70	2.94	3.41	4.32	6.14	10.39
55	26	10.69	6.26	4.43	3.43	2.85	2.52	2.37	2.43	2.65	3.08	3.91	5.59	9.47
45	36	9.25	5.39	3.79	2.94	2.46	2.20	2.08	2.15	2.35	2.75	3.50	5.08	8.66
35	45	8.40	4.88	3.44	2.67	2.24	2.01	1.91	1.98	2.18	2.55	3.25	4.66	8.03
25	53	7.87	4.57	3.21	2.50	2.11	1.90	1.82	1.89	2.08	2.45	3.12	4.47	7.64
15	61	7.68	4.44	3.10	2.42	2.05	1.85	1.78	1.85	2.03	2.39	3.05	4.36	7.46

FORWARD CAMERA
SSN 012 OSN 304

LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
80	1	24.61	13.67	10.00	7.89	6.69	6.01	5.72	5.74	6.05	6.81	8.35	11.35	20.03
75	7	21.88	12.77	9.12	7.23	6.13	5.39	5.02	5.03	5.31	5.98	7.27	9.94	17.10
70	12	17.04	10.01	7.12	5.63	4.76	4.25	3.97	4.01	4.23	4.78	5.83	8.00	13.57
65	17	13.41	7.83	5.55	4.40	3.74	3.35	3.14	3.20	3.40	3.84	4.68	6.47	10.95
60	22	11.42	6.73	4.78	3.80	3.23	2.91	2.76	2.81	2.99	3.38	4.15	5.70	9.64
55	26	10.21	6.03	4.28	3.42	2.93	2.65	2.52	2.57	2.74	3.10	3.77	5.23	8.81
45	36	8.58	5.08	3.63	2.94	2.54	2.32	2.23	2.28	2.43	2.74	3.33	4.61	7.72
35	45	7.63	4.55	3.27	2.66	2.32	2.14	2.07	2.11	2.25	2.54	3.08	4.24	7.04
25	53	7.08	4.23	3.06	2.50	2.20	2.03	1.99	2.02	2.16	2.44	2.95	4.05	6.69
15	61	6.87	4.12	2.98	2.44	2.15	1.99	1.93	1.98	2.12	2.39	2.89	3.96	6.55

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

TARGET LATITUDE D M S	REFLECTANCE HIGH	LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI- MUTH	DATE D	R	Y	RDOR	INERTIAL VELOCITY FPT/SEC	SATELLITE LAT (DEGREES)	LONG	SAT ALT (NMI)	DRIATE SATELLITE EARTH RADIUS (NMI)	YKOM TO EARTH CENTER (NMI)	YKOM
14 45 11	33	7	1	4	144.94	13	10	74	0.00014	25732.13	15.1479	27.707	89.7	+ 3443.1	= 3528.9	0.0478	0.00283

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TABLE 6-2

MISSION 1209 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	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
LAT	SUN													
80	1	50	54	44	51	54	58	61	61	61	59	57	53	45
75	7	59	67	51	55	60	65	70	70	69	68	65	60	49
70	12	54	62	67	72	77	83	88	88	87	86	82	77	66
65	17	68	79	85	91	96	104	109	109	108	104	100	93	81
60	22	80	91	97	103	110	116	121	120	118	115	110	103	90
55	26	88	99	106	113	119	125	129	129	127	124	118	110	97
45	36	98	109	117	124	131	136	140	139	136	132	126	117	106
35	45	106	116	125	132	139	144	147	146	143	138	131	124	111
25	53	110	123	129	137	144	148	151	148	146	141	134	127	114
15	61	113	129	132	140	147	151	153	152	149	144	136	129	116

AFT CAMERA
SSN 012 OSN 30R

80	1	36	44	51	56	58	60	62	63	64	63	62	59	50
75	7	49	53	58	62	64	67	70	71	72	73	71	67	57
70	12	59	68	73	76	83	84	87	88	89	89	87	84	73
65	17	76	84	90	94	98	102	104	107	108	108	107	100	89
60	22	85	96	102	106	111	116	117	118	118	117	118	111	99
55	26	93	104	111	114	119	122	125	125	126	126	125	120	105
45	36	106	118	126	127	129	130	132	133	133	134	133	130	118
35	45	116	129	133	134	136	136	137	138	139	139	142	137	125
25	53	123	136	138	140	140	140	141	142	143	143	145	141	129
15	61	124	139	142	143	143	143	142	144	144	143	148	144	131

FORWARD CAMERA
SSN 012 OSN 30A

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

	SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
LAT	SUN													
80	1	46.94	22.80	15.05	10.86	8.78	7.58	7.04	7.22	7.76	9.14	11.44	14.90	21.39
75	7	34.46	18.46	12.57	8.87	7.04	6.07	6.01	6.16	6.70	7.79	9.89	14.94	27.58
70	12	24.43	13.13	9.17	7.15	5.87	5.08	4.64	4.76	5.18	6.02	7.68	11.01	20.15
65	17	18.48	10.41	7.24	5.96	4.97	3.95	3.46	3.76	4.09	4.84	6.15	8.87	15.91
60	22	15.63	8.83	6.19	4.79	3.93	3.46	3.24	3.38	3.66	4.25	5.42	7.80	12.89
55	26	13.81	7.93	5.53	4.25	3.52	3.13	2.93	3.03	3.32	3.88	4.96	7.19	12.42
45	36	11.41	6.85	4.80	3.70	3.09	2.75	2.62	2.70	2.97	3.48	4.49	6.41	11.00
35	45	10.66	6.25	4.38	3.38	2.83	2.54	2.48	2.50	2.75	3.24	4.13	5.86	10.17
25	53	10.02	5.80	4.13	3.19	2.68	2.42	2.32	2.40	2.64	3.11	3.98	5.60	9.67
15	61	9.79	5.66	4.03	3.12	2.62	2.37	2.28	2.39	2.59	3.05	3.90	5.49	9.46

AFT CAMERA
SSN 012 OSN 30R

80	1	38.13	19.40	13.05	9.64	8.13	7.29	6.94	7.02	7.49	8.96	10.68	13.19	27.76
75	7	29.97	16.16	11.15	8.17	7.11	6.38	6.00	6.07	6.41	7.27	9.01	12.90	23.71
70	12	22.18	12.33	8.66	6.76	5.67	4.98	4.68	4.75	5.05	5.82	7.19	10.81	18.12
65	17	17.37	9.72	6.79	5.35	4.68	4.00	3.78	3.84	4.10	4.67	5.76	8.20	14.94
60	22	14.77	8.36	5.86	4.63	3.89	3.51	3.34	3.40	3.64	4.14	5.09	7.26	12.71
55	26	13.14	7.50	5.28	4.20	3.60	3.21	3.06	3.13	3.35	3.81	4.68	6.55	11.61
45	36	11.09	6.37	4.53	3.64	3.15	2.88	2.77	2.83	3.04	3.45	4.16	5.76	9.90
35	45	9.67	5.63	4.10	3.32	2.93	2.67	2.59	2.64	2.83	3.21	3.84	5.30	8.84
25	53	8.98	5.25	3.85	3.14	2.75	2.55	2.49	2.54	2.71	3.07	3.68	5.09	8.55
15	61	8.73	5.11	3.76	3.07	2.70	2.50	2.45	2.49	2.66	3.01	3.60	4.94	8.38

FORWARD CAMERA
SSN 012 OSN 30A

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

TARGET LATITUDE D M S	REFLECTANCE HIGH	LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE D	M	Y	KOOM	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	LONG	SAT ALT (NMI)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER (MMI)	VXOH	VYOH
14 40 11	20	10	L	4	144.94	13	10	74	0.00014	25722.13	19.1479	27.707	89.7 +	3443.1 =	3532.9	0.0478	0.00281

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TABLE 6-3

MISSION 1209 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)

	SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
LAT	SUN													
80	1	57	59	61	65	69	74	79	79	79	79	79	80	77
75	7	60	62	64	67	72	77	84	84	84	84	83	82	80
70	12	74	78	80	85	93	96	103	103	103	103	102	98	94
65	17	95	98	102	107	112	119	125	126	125	124	122	119	112
60	22	108	114	116	121	127	133	139	139	138	137	134	130	122
55	26	117	123	126	132	138	143	149	148	147	146	142	137	131
45	36	128	134	138	144	149	154	158	157	155	153	149	143	136
35	45	133	140	144	150	156	161	164	163	160	157	152	146	138
25	55	137	144	149	155	160	164	167	165	162	158	154	147	140
15	61	139	146	152	158	163	167	169	167	164	160	155	149	141

AFT CAMERA

SSN 012 OSN 339

80	1	70	73	74	74	76	79	80	82	85	90	93	94	93
75	7	64	72	73	74	76	80	83	85	88	90	92	93	92
70	12	83	86	89	91	93	96	100	102	104	106	108	107	106
65	17	101	103	109	111	114	117	121	122	124	127	129	129	124
60	22	113	119	122	123	126	129	133	134	136	137	140	140	134
55	26	121	126	131	132	136	137	140	140	142	145	147	146	143
45	36	137	142	145	144	145	146	148	149	151	153	156	155	152
35	45	144	151	153	152	151	152	152	154	155	158	161	161	157
25	55	152	157	158	157	155	155	154	156	157	160	163	163	159
15	61	155	160	161	159	158	161	160	161	161	162	165	165	161

FORWARD CAMERA

SSN 012 OSN 334

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

	SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
LAT	SUN													
80	1	24.58	15.00	10.61	8.32	6.88	5.94	5.43	5.60	6.01	6.84	8.37	11.18	18.23
75	7	22.47	13.87	10.00	7.84	6.41	5.57	4.97	5.13	5.51	6.28	7.75	10.65	17.13
70	12	17.92	10.74	7.85	6.07	5.02	4.37	3.97	4.07	4.38	5.01	6.18	8.59	14.06
65	17	13.48	8.36	6.01	4.71	3.93	3.45	3.19	3.26	3.53	4.05	5.07	6.90	11.48
60	22	11.56	7.00	5.14	4.06	3.39	3.01	2.81	2.88	3.12	3.59	4.47	6.17	10.26
55	26	10.46	6.35	4.68	3.64	3.06	2.73	2.57	2.647	2.86	3.30	4.12	5.71	9.34
45	36	9.09	5.68	4.08	3.21	2.71	2.44	7.32	2.39	2.61	3.02	3.78	5.29	8.41
35	45	8.44	5.20	3.77	2.97	2.52	2.27	2.17	2.24	2.45	2.85	3.58	4.98	8.17
25	55	8.04	4.95	3.58	2.83	1.40	2.18	2.09	2.17	2.38	2.77	3.48	4.84	7.91
15	61	7.92	4.88	3.51	2.77	2.38	2.14	2.07	2.14	2.34	2.73	3.43	4.78	7.79

AFT CAMERA

SSN 012 OSN 334

80	1	19.98	12.23	9.01	7.12	6.28	5.67	5.40	5.39	5.61	6.06	7.16	9.67	15.12
75	7	19.58	12.03	8.88	7.09	6.07	5.38	5.04	5.26	5.29	5.98	6.99	9.29	14.79
70	12	15.99	9.76	7.07	5.67	4.85	4.58	4.09	4.12	4.33	4.84	5.81	7.86	12.57
65	17	12.68	7.84	5.61	4.52	3.88	3.50	3.31	3.37	3.59	3.98	4.74	6.39	10.40
60	22	11.35	6.73	4.91	3.88	3.42	3.10	2.94	3.00	3.18	3.57	4.28	5.78	9.34
55	26	10.24	6.11	4.46	3.63	3.14	2.84	2.71	2.78	2.96	3.32	3.98	5.36	8.59
45	36	8.42	5.29	3.88	3.19	2.79	2.57	2.47	2.52	2.68	3.01	3.60	4.86	7.78
35	45	7.72	4.91	3.56	2.94	2.59	2.40	2.34	2.37	2.53	2.83	3.38	4.53	7.19
25	55	7.26	4.64	3.37	2.80	2.48	2.31	2.27	2.30	2.43	2.74	3.28	4.38	6.93
15	61	7.11	4.49	3.30	2.79	2.44	2.28	2.19	2.22	2.34	2.71	3.23	4.31	6.84

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

TARGET LATITUDE D M S	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE D M Y	RDOM	INERTIAL VELOCITY FT/SEC	SATELLITE LAT	SATELLITE LONG DEGREES	SAT ALT	ORBATE EARTH RADIUS	SATELLITE TO EARTH CENTER KMI	SYNH	NYTH
14 40 11	20	10	L	4	144.94	13 10 74	0.00014	25722.13	15.1478	27.787	89.7	+ 3443.1	+ 3528.9	0.0478	0.00281

BYE 15303-74

Handle via Byeman Controls Only

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TABLE 6-4

MISSION 1209 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)

	SCAN		-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	LAT	SUN													
	80	1	48	54	56	59	64	69	74	74	74	73	72	69	62
	75	7	54	59	62	66	70	76	82	83	83	83	82	78	71
	70	12	73	79	82	86	91	97	105	105	105	105	104	100	91
	65	17	96	103	107	111	117	123	131	131	131	131	130	126	116
AFT CAMERA	60	22	113	123	126	131	136	142	148	149	149	150	149	144	132
	55	26	128	138	141	148	150	155	160	161	162	163	162	157	144
SSN 012 DSN 338	45	36	144	155	158	161	165	169	173	173	173	174	173	165	156
	35	46	154	166	166	171	174	177	180	180	179	180	179	176	162
	25	53	161	174	176	178	180	182	185	183	183	183	182	179	167
	15	61	167	180	181	183	185	186	188	187	186	186	186	184	171
	80	1	57	63	65	67	70	72	73	73	76	77	77	75	65
	75	7	61	67	69	72	74	77	81	82	85	86	86	85	79
	70	12	76	82	86	89	92	95	98	99	102	103	103	103	96
	65	17	95	102	106	108	111	115	118	118	120	121	122	122	116
FORWARD CAMERA	60	22	108	115	118	121	123	125	128	129	131	133	133	134	129
	55	26	118	124	127	129	131	133	135	136	138	139	140	141	137
SSN 012 DSN 304	45	36	134	139	140	141	141	141	143	143	145	148	150	152	150
	35	46	149	148	148	147	146	145	145	146	149	153	156	158	157
	25	53	152	155	154	152	149	148	147	148	151	155	158	161	162
	15	61	154	159	157	155	152	150	149	150	153	157	160	164	164

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

	SCAN		-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	LAT	SUN													
	80	1	28.92	16.59	11.82	9.14	7.48	6.41	5.86	5.99	6.46	7.42	9.25	12.94	22.91
	75	7	24.86	14.57	10.38	8.00	6.57	5.67	5.13	5.18	5.58	6.38	7.91	11.10	19.12
	70	12	18.02	10.67	7.69	6.00	4.98	4.31	3.92	4.00	4.31	4.92	6.08	8.48	14.30
	65	17	13.41	7.95	5.75	4.52	3.78	3.32	3.06	3.13	3.36	3.83	4.71	6.52	11.15
AFT CAMERA	60	22	11.04	6.53	4.75	3.76	3.17	2.82	2.63	2.69	2.89	3.28	4.02	5.57	9.52
	55	26	9.56	5.68	4.15	3.31	2.81	2.53	2.38	2.43	2.61	2.93	3.62	4.99	8.51
SSN 012 DSN 338	45	36	8.11	4.83	3.56	2.86	2.45	2.22	2.17	2.17	2.34	2.66	3.25	4.48	7.61
	35	46	7.33	4.37	3.24	2.61	2.25	2.06	1.98	2.03	2.19	2.49	3.04	4.13	6.95
	25	53	6.84	4.09	3.04	2.48	2.14	1.96	1.90	1.96	2.11	2.40	2.94	3.96	6.63
	15	61	6.60	3.96	2.99	2.49	2.08	1.92	1.86	1.91	2.07	2.35	2.87	3.87	6.45
	80	1	24.60	14.14	10.20	8.06	6.85	6.16	5.88	5.91	6.23	7.02	8.60	11.84	20.27
	75	7	22.19	12.99	9.28	7.36	6.28	5.55	5.18	5.21	5.48	6.16	7.50	10.26	17.53
	70	12	17.48	10.22	7.32	5.80	4.92	4.42	4.17	4.22	4.45	5.01	6.09	8.24	13.74
	65	17	13.53	8.06	5.81	4.63	3.96	3.57	3.39	3.46	3.68	4.14	5.02	6.74	11.01
FORWARD CAMERA	60	22	11.53	6.95	5.05	4.07	3.51	3.19	3.04	3.09	3.28	3.71	4.49	6.01	9.73
	55	26	10.19	6.10	4.61	3.73	3.22	2.94	2.82	2.88	3.06	3.45	4.18	5.55	8.93
SSN 012 DSN 304	45	36	8.70	5.40	4.00	3.27	2.87	2.66	2.57	2.63	2.80	3.12	3.79	4.96	7.81
	35	46	7.79	4.89	3.67	3.03	2.69	2.51	2.49	2.49	2.63	2.93	3.50	4.60	7.18
	25	53	7.24	4.59	3.49	2.88	2.58	2.42	2.38	2.41	2.55	2.83	3.37	4.42	6.84
	15	61	7.04	4.48	3.39	2.83	2.54	2.39	2.35	2.38	2.51	2.79	3.32	4.33	6.70

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

TARGET LATITUDE D M S	REFLECTANCE HIGH	LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI- MUTH	DATE D M Y	ADOR	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	LONG	SAT ALT (NMI)	ORBATE EARTH RADIUS	SATELLITE TO EARTH CENTER (NMI)	VKCH	VYIM
14 40 11	33	7	1	4	144.94	15 10 74	0.00014	25722.13	15.1479	27.707	89.7 +	3443.1 =	3532.9	0.0478	0.00281

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TABLE 6-5

MISSION 1209 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)

	SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
LAT	SUN													
80	1	58	60	62	65	69	73	78	79	79	80	80	81	79
75	7	61	63	66	67	71	77	83	85	86	84	84	84	81
70	12	77	81	81	85	93	95	102	105	103	104	104	102	99
65	17	102	104	104	109	113	118	125	125	126	126	129	126	122
AFT CAMERA 60	22	118	123	123	125	129	133	138	139	140	142	144	144	136
55	26	130	136	135	136	139	143	147	148	149	152	154	154	149
SSN 012 OSN 330 45	36	146	149	147	148	150	152	156	155	156	158	160	161	157
35	45	153	156	154	154	154	156	158	158	159	161	163	165	160
25	53	157	162	158	158	158	158	159	159	160	161	164	164	161
15	61	161	165	162	160	160	160	161	161	161	163	166	169	164
80	1	70	72	73	73	74	77	78	80	83	87	90	92	92
75	7	68	71	72	73	75	77	81	82	85	87	89	91	91
70	12	82	84	87	88	93	93	95	96	99	101	104	104	105
65	17	100	102	104	105	107	109	112	113	115	117	120	124	123
FORWARD CAMERA 60	22	112	119	115	114	116	118	120	121	123	125	128	133	132
55	26	120	122	122	121	121	122	124	125	127	130	133	137	142
SSN 012 OSN 306 45	36	125	134	131	130	128	128	129	130	132	135	138	144	150
35	45	143	139	136	134	131	130	130	131	134	137	141	147	154
25	53	148	144	139	136	133	132	131	132	134	138	142	148	156
15	61	151	146	141	137	134	135	134	135	138	139	143	150	157

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

	SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
LAT	SUN													
80	1	24.09	14.85	10.76	8.38	6.96	6.02	5.51	5.62	6.02	6.63	8.32	11.01	17.80
75	7	22.12	13.74	10.06	7.84	6.48	5.61	5.05	5.16	5.53	6.24	7.68	10.37	16.74
70	12	17.11	10.45	7.72	6.03	5.02	4.39	4.00	4.09	4.38	4.96	6.04	8.25	13.41
65	17	12.63	7.88	5.80	4.63	3.91	3.46	3.20	3.27	3.50	3.95	4.77	6.42	10.59
AFT CAMERA 60	22	10.57	6.51	4.87	3.93	3.35	3.01	2.82	2.88	3.08	3.45	4.16	5.59	9.22
55	26	9.35	5.73	4.33	3.52	3.03	2.74	2.60	2.65	2.85	3.17	3.81	5.10	8.20
SSN 012 OSN 338 45	36	7.98	5.03	3.82	3.12	2.71	2.48	2.38	2.43	2.60	2.92	3.51	4.66	7.47
35	45	7.37	4.65	3.54	2.91	2.54	2.34	2.26	2.31	2.48	2.78	3.35	4.42	7.07
25	53	7.00	4.41	3.37	2.78	2.45	2.26	2.19	2.26	2.42	2.72	3.27	4.30	6.85
15	61	6.85	4.31	3.30	2.73	2.40	2.23	2.17	2.23	2.38	2.68	3.21	4.23	6.72
80	1	19.94	12.37	9.14	7.44	6.40	5.75	5.34	5.53	5.77	6.24	7.39	9.67	15.23
75	7	19.81	12.23	8.99	7.22	6.19	5.65	5.20	5.22	5.46	6.37	7.24	9.53	14.92
70	12	16.10	9.99	7.26	5.85	5.02	4.82	4.29	4.35	4.56	5.08	6.07	8.10	12.67
65	17	12.78	8.07	5.88	4.77	4.12	3.74	3.56	3.62	3.84	4.31	5.12	6.66	10.48
FORWARD CAMERA 60	22	11.13	6.95	5.19	4.25	3.70	3.39	3.25	3.32	3.51	3.92	4.66	6.06	9.47
55	26	10.15	6.40	4.81	3.96	3.47	3.19	3.07	3.12	3.31	3.69	4.40	5.71	8.63
SSN 012 OSN 306	45	8.60	5.62	4.28	3.56	3.15	2.93	2.84	2.90	3.07	3.42	4.06	5.22	7.81
35	45	7.87	5.21	3.99	3.34	2.99	2.79	2.73	2.77	2.94	3.26	3.96	4.94	7.34
25	53	7.44	4.96	3.83	3.22	2.89	2.72	2.67	2.71	2.87	3.18	3.76	4.80	7.11
15	61	7.29	4.87	3.78	3.19	2.87	2.84	2.60	2.64	2.79	3.16	3.72	4.75	7.02

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

TARGET LATITUDE D M S	REFLECTANCE HIGH	LOW	TARGET SUN TYPE	HAZE COND	SOLAR AZI-MUTH	DATE D M Y A C R	RDOM	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	LONG	SAT ALT (NMI)	OBLATE EARTH RADIUS (NMI)	SATELLITE TO EARTH CENTER (NMI)	VEDH	VTTH
14 40 11	20	10	1	4	144.94	13 10 74	0.00014	25722.13	15.1479	27.707	83.7	3443.1	3523.9	0.0478	0.00281

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ELECTROMECHANICAL ANALYSIS

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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.

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7.3 'TUNITY/OPERATIONAL SOFTWARE DATA BASE INPUTS

Table 7-2 summarizes SV-9 inputs to the 'TUNITY data base.

TABLE 7-2

'TUNITY/OPERATIONAL SOFTWARE DATA BASE INPUTS

Input	Forward	Aft
1. OB Stow Angle (degrees)	179	179
2. OB Start Uncertainty (seconds)	0.3	0.3
3. FT Start Uncertainty (seconds)		
VI Enable	1.7	1.7
VI Disable	0.6	0.6
4. OB Acceleration (radians/sec^2)	0.286	0.286
5. FT Acceleration (inches/sec^2)	4.59	4.59
6. Focal Length (inches)	60.004	59.990
7. Optical Lens Number	030	033
8. Plane of Best Focus (microns)	31	70
9. PBF Altitude (NM)	85	85
10. Lift-off Filter Configuration	W-12	W-12
11. OOAA Orbital Nominals		
Cross-Track	+3	-3
In-Track	-3	-3
12. On-axis On-orbit Image Motion Error Predictions		
Cross-Track (inch/second)	37° .022	.040
	0° -.001	.012
	45° -.023	-.040
In-Track (inch/second)	37° .015	.061
	0° -.002	.013
	45° .009	.012
13. Frame Lengths	See Table 7-7	
14. Interframe Spacing		
15. PN Use Rate (pounds/min) A2 = .0249		
16. First Frame Early Shutter Open From 5" Mark to Start of Image (inches)	6.1	6.6

NOTE: The on-orbit image motion error predictions (Item 12) include the recommended OOAA adjustments.

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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	.079	.077	.079	.080
.150	.152	.150	.150	.150
.281	.283	.280	.283	.285
.525	.522	.524	.522	.528
.910	.901	.900	.901	.898
.525	.527	.530	.527	.534
.281	.277	.276	.277	.280
.150	.147	.146	.148	.148
.080	.080	.079	.079	.078

7.5 LATERAL SEPARATION FOCUS SENSOR (LSFS)

The LSFS calibration curves for Mission 1209 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, 65°F with IMC Enabled. A companion curve based on Chamber A tests showing LSFS bias as a function of temperature for the Aft OB is shown in Figure 7-3. Bias data was not obtained for the Forward OB. The bias curve for the Aft OB is referenced to zero at 65°F, which corresponds to the calibration temperature.

The orbital calibration curves reflect a predicted gravity release of -15 microns for the Forward Camera and -19 microns for the Aft Camera.

The slopes of the calibration curves at the plane of best focus (PBF) are approximately 1.56 microns/count for the Forward Camera and 2.16 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

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1A-2 TEST

FORWARD CAMERA LSFS CALIBRATION CURVE AT 65° F

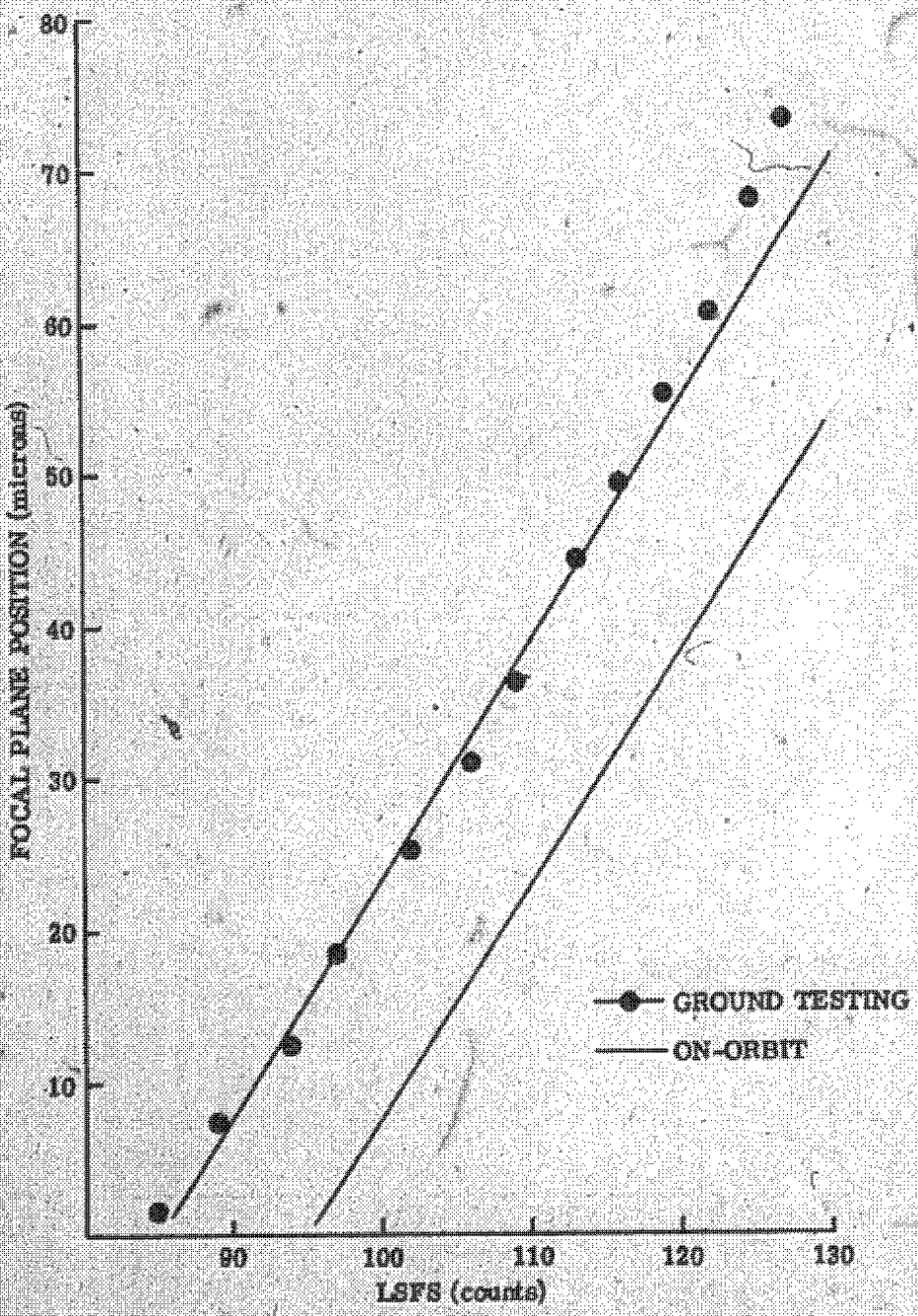


FIGURE 7-1

BYE 15303-74

Handle via Byeman
Controls Only

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1A-2 TEST

AFT CAMERA LSFS CALIBRATION CURVE AT 65°F

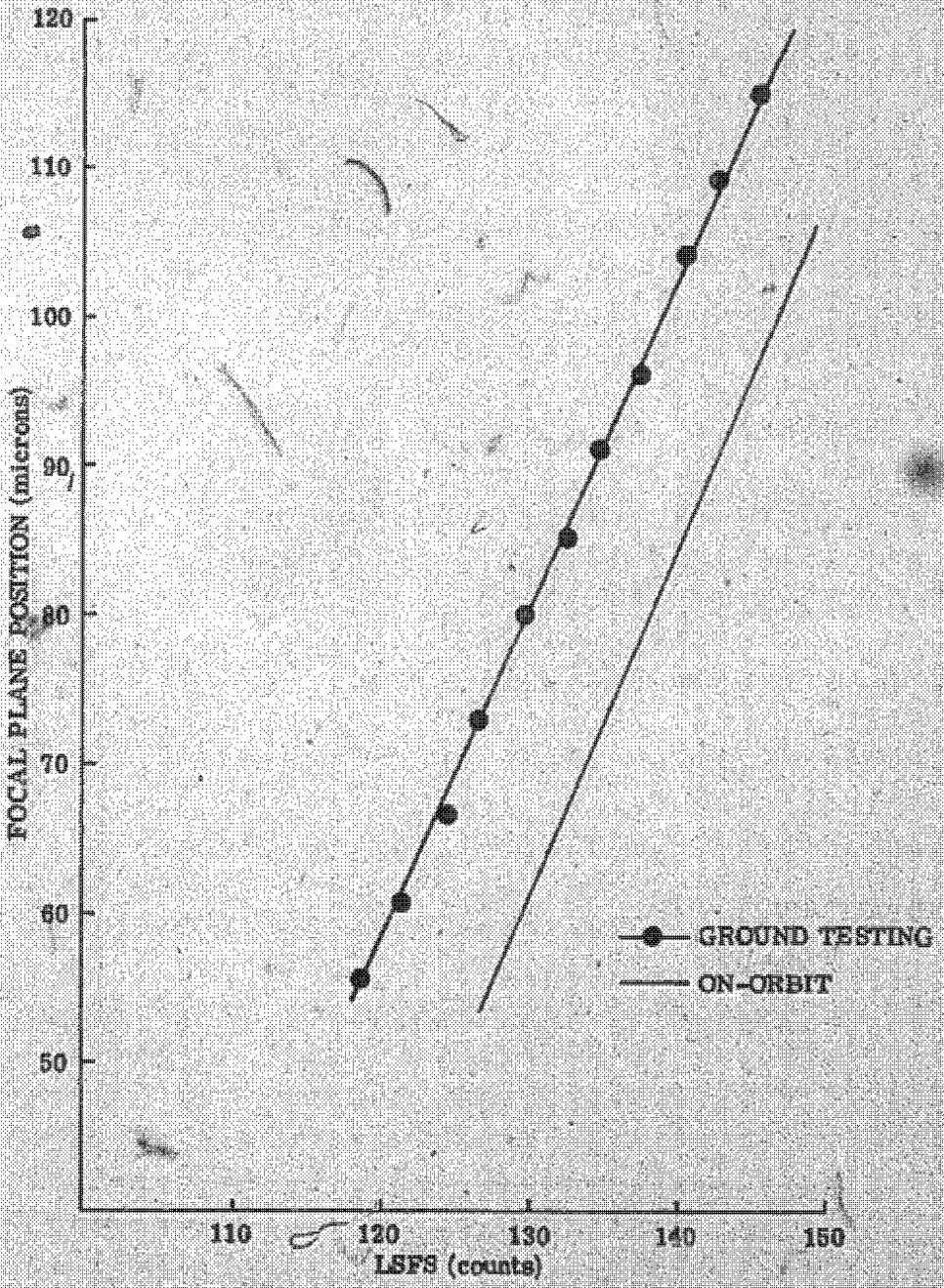
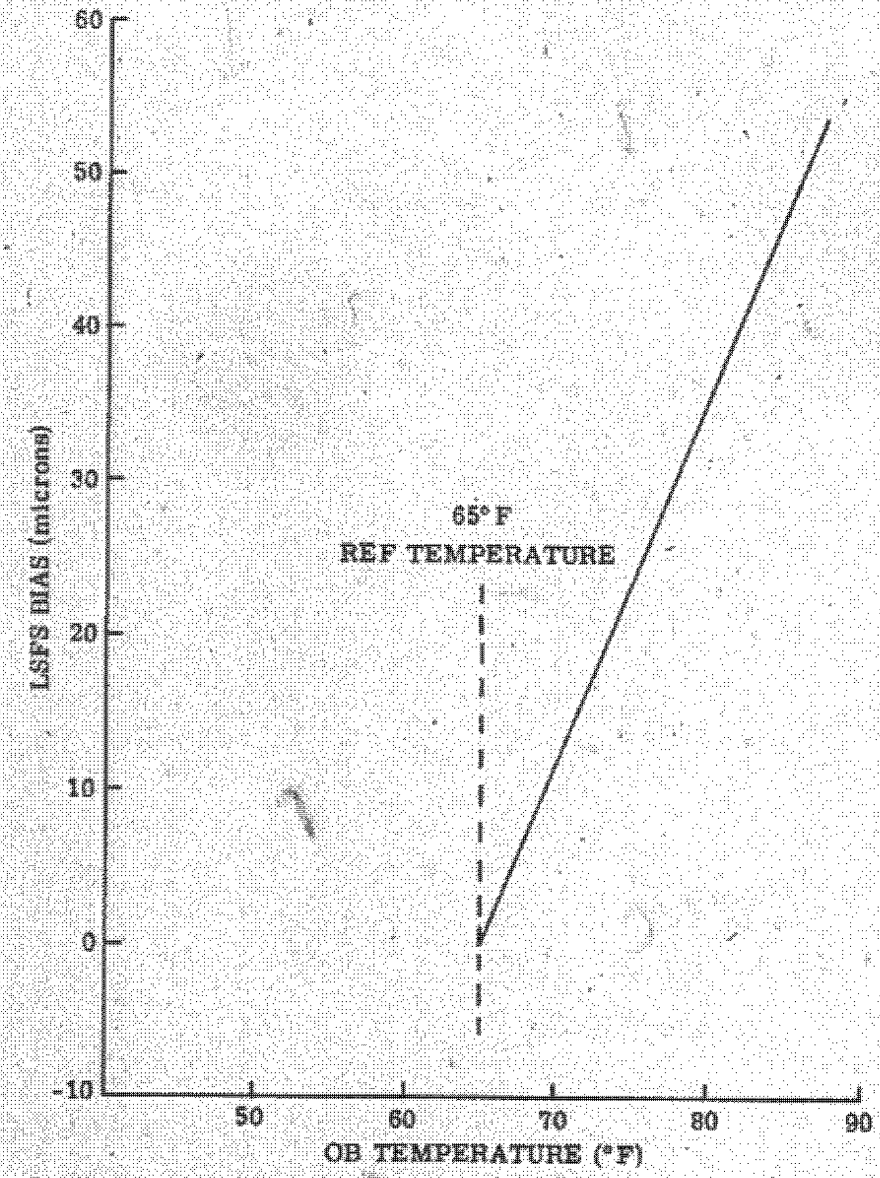


FIGURE 7-2

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AFT CAMERA 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 65°F calibration curve for the Aft OB only.

FIGURE 7-3

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tests run at the WCFO Facility.

Table 7-4 on page 7-8 is a tabulation of optical bar velocity scaling data obtained from tests conducted in Chamber A-1. The data shows maximum/minimum percentage velocity errors (measured versus commanded) calculated from the 0-180° pulses.

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 the two Chamber A-2 tests. The FBS signals (P451 and P452) follow the nominal expected profiles reasonably well.

7.8 PLATEN PERFORMANCE

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

The data is based on three sequences from Chamber A-1 tests and 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 8-4	Seq 8-5	Seq 8-6
Forward	Maximum	9.8	11.7	11.7
	Minimum	-7.9	-7.9	-7.9
	Mean	-1.1	-1.2	-1.3
	STDV	3.6	3.6	3.8
Aft	Maximum	15.7	15.7	15.7
	Minimum	-9.9	-11.8	-11.8
	Mean	-0.2	-0.5	-0.6
	STDV	5.1	5.5	5.6

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TABLE 7-4

CHAMBER A-1 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
S-3	.036	.334	.286	.334	.285
S-4	.044	.369	.297	.369	.297
S-5	.048	.328	.242	.328	.242
S-6	.052	.344	.248	.344	.243

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TABLE 7-5

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

(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
M	90/0	.044	Mean	.011	.044	.013	-.006
			STDV	.015	.018	.021	.024
R	90/0	.052	Mean	.003	.004	-.001	.000
			STDV	.018	.024	.016	.018

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7.9 FINE TENSION SENSOR PERFORMANCE

The differential fine tension sensors have been limit checked by MACFACT at ±1 pounds for all WCFO testing done on SV-9. The Forward and Aft Camera differential tension always reported within tolerance.

7.10 FRAME LENGTH AND INTERFRAME SPACING

The EM data indicates that the frame lengths and interframe spaces meet the specified requirements. Measurements made on the retrieved film indicated that the frame length and interframe spaces are within specified requirements. Table 7-7 reflects frame length and interframe spacing data obtained from the Horizontal Baseline Test.

7.11 STEERER PERFORMANCE

SV-9 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-1 testing and proper steering was observed. Table 7-8 lists the average Steerer position values in PCM counts during various vacuum runs. 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		Aft Camera	
		Take-up	Film Path	Take-up	Film Path
120/0	.052	125	122	135	125
120/0	.048	127	122	133	125
120/0	.044	127	122	130	122
90/-15	.018	127	125	136	127
90/15	.027	127	125	135	125
60/-30	.036	122	122	133	122
60/30	.036	127	122	133	125
30/-45	.052	127	127	133	125
30/45	.052	122	122	133	127
30/-15	.052	122	127	135	127
30/15	.052	133	127	133	136

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TABLE 7-7

SUMMARY OF FRAME LENGTH AND INTERFRAME SPACING

(inches)

Subsystem Command & Control	Seq	Scan Angle (degrees)	Frame Length	Interframe
— Forward Camera —				
No. 1	12-1	30	31.42	2.73
	11-1	60	62.78	2.77
	15	90	94.22	2.66
	11-2	120	125.72	2.76
No. 2	22-1	30	31.37	2.82
	21-1	60	62.78	2.84
	25	90	94.29	2.79
	21-2	120	125.68	2.84
— Aft Camera —				
No. 1	12-1	30	31.42	2.97
	11-1	60	62.75	3.02
	15	90	94.27	2.79
	11-2	120	125.59	2.97
No. 2	22-1	30	31.35	2.79
	21-1	60	62.75	2.78
	25	90	94.28	2.62
	21-2	120	125.59	2.74

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FLIGHT READINESS REPORT
SV-9 (SN-012)

7.12 METERING CAPSTAN SETTLING TIME

The settling time for SV-9 was determined by examining the FBS signal from 10 frames of both cameras from Chamber A-1 Sequences 8-4 and 8-5. The results are summarized as follows:

A. Seq 8-4 (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 exceeded .05 inch/second by shutter open on one frame. On that frame, the error was .051 inch/second for one data sample 1.16° after shutter open.

B. Seq 8-5 (Vx/h of .048)

(1) Forward Camera

The film-to-bar error exceeded .05 inch/second by shutter open on two frames. On those frames, the error was .056 inch/second for one data sample .7° 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 systems tested prior to the servo modifications which was incorporated on all vehicles effective with SV-8. This modification is known as the MC settling time improvement. Therefore, Fourier analysis was performed on four frames for each camera at a Vx/h value of .0479 radians/second. Frames 011 thru 014 were taken from Chamber A-1 test, Run 116, Seq 8-5, at a scan angle of 120 degrees. Figures 7-4 and 7-5 show the MCSE signal and corresponding line spectrums for typical frames. Table 7-9 is a tabulation of characteristic spikes versus frequency. Although the characteristic signatures for a given camera are similar from frame-to-frame, they are not identical. The Forward Camera consistently exhibits the maximum amplitude spike at approximately 98 Hz; Frame 014 shows the largest spike with a magnitude of .00551 inch/second. The Aft Camera exhibits maximum amplitude spikes at different frequencies from frame-to-frame with the maximum amplitude spike occurring on Frame 011 at 95 Hz with a magnitude of .00274 inch/second.

MCRECON was run on each camera for the same frames used for Fourier analyses. Figure 7-6 shows the predicted smear for Frame 011 on both cameras. Table 7-10 is a tabulation of mean values and standard deviations for smear (ΔS) and FBS error. It should be noted the slit was commanded to the maximum width (0.91 inches) during these frames resulting in maximum predicted smear. The smear values would be reduced by a factor of three if operational slits (0.3 inches) were commanded.

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METERING CAPSTAN AND LINE SPECTRUM FROM FOURIER ANALYSIS

(Run 116, Seq 8-5, Forward Camera, Frame 011)

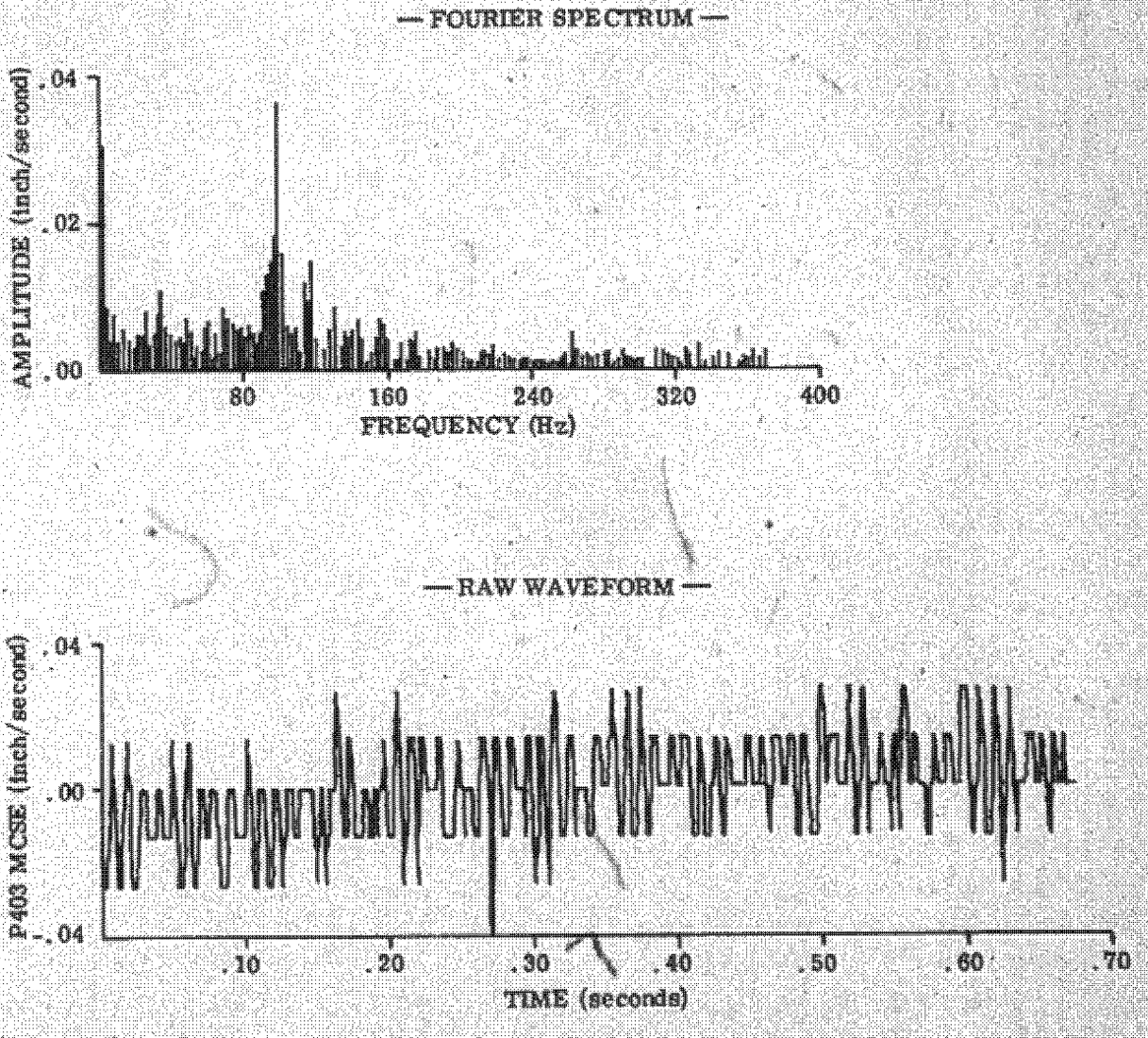


FIGURE 7-4

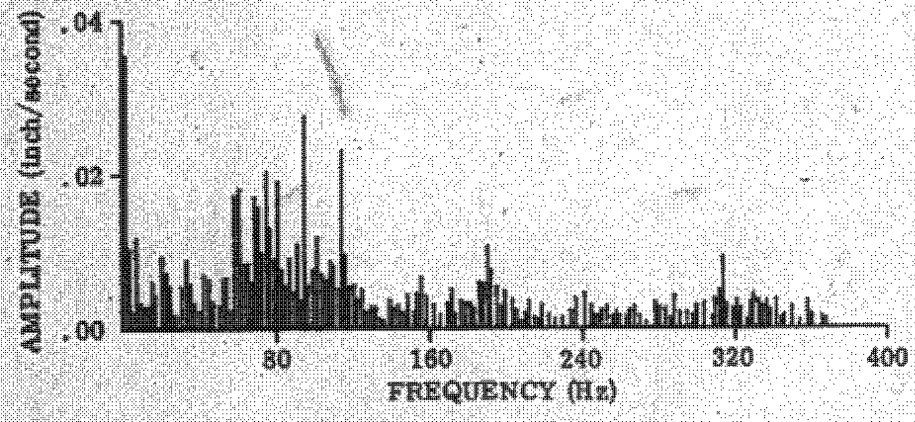
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METERING CAPSTAN AND LINE SPECTRUM FROM FOURIER ANALYSIS

(Run 116, Seq 8-5, Aft Camera, Frame 011)

— FOURIER SPECTRUM —



— RAW WAVEFORM —

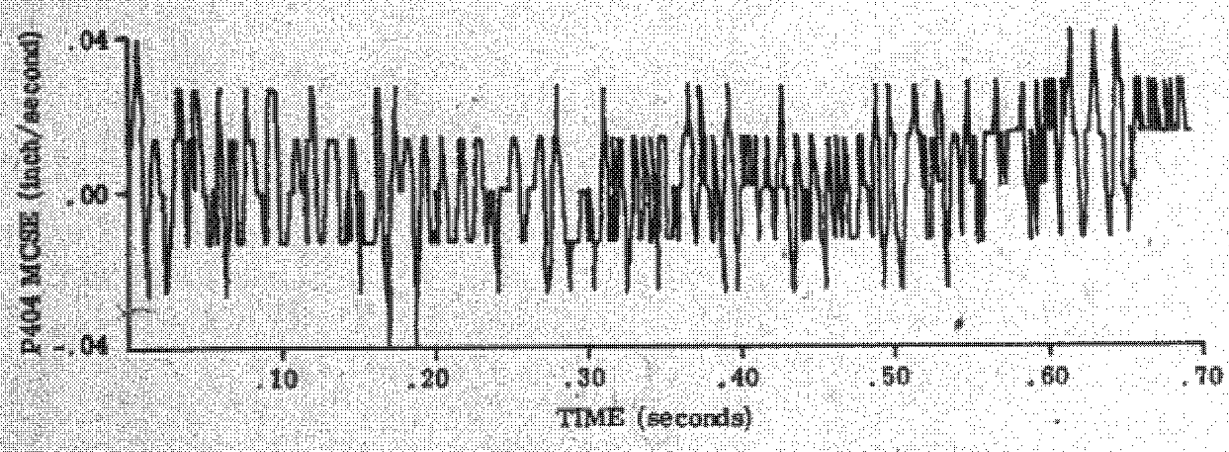


FIGURE 7-5

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TABLE 7-9

SPECTRUM CHARACTERISTICS

— Forward Camera —

Frame 011		Frame 012		Frame 013		Frame 014	
Frequency (Hz)	Amplitude (inch/second)	Frequency (Hz)	Amplitude (inch/second)	Frequency (Hz)	Amplitude (inch/second)	Frequency (Hz)	Amplitude (inch/second)
33	.00110	29	.00125				
68	.000849	70	.00148	61	.00145	61	.00106
99	.00366	97	.00260	99	.00355	97	.00351
117	.00148	117	.00189	117	.00266	116	.00182
130	.000847	130	.000737	137	.000898	141	.000751

— Aft Camera —

61	.00178	68	.00169	61	.00244	69	.00241
75	.00200	78	.00179		.00187		
95	.00274	96	.00222	95			
114	.00230					116	.00217
191	.00105	191	.00142	191	.000990	192	.00121
314	.000898	313	.000652	314	.000539	314	.00109

NOTE: * Blanks appear because spikes do not occur at the same frequency on every frame.

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PREDICTED SMEAR FROM MCRECON PROGRAM
(Run 116, Seq 8-5, Frame 011)

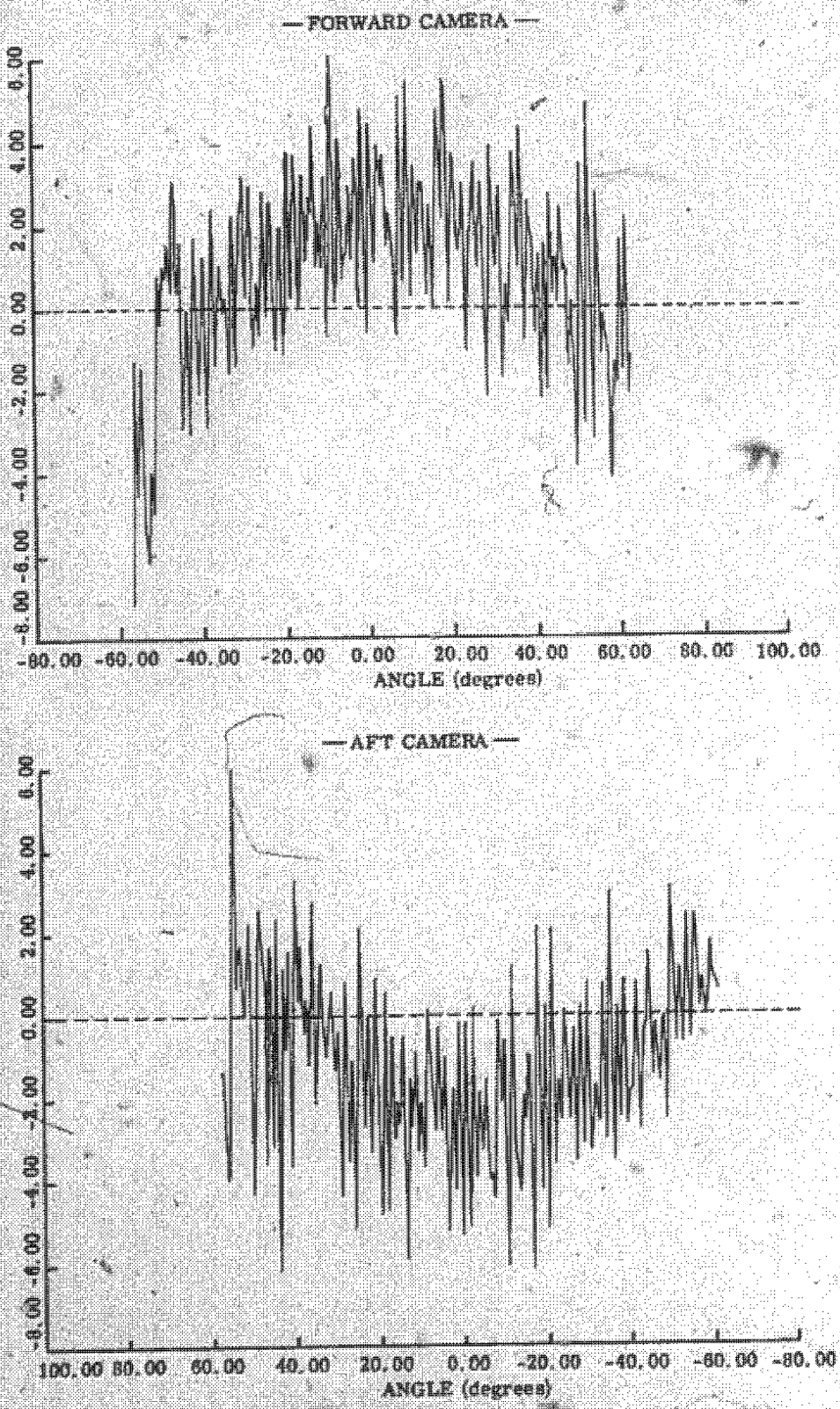


FIGURE 7-6

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TABLE 7-10

MCRECON OUTPUT FOR SMEAR AND FBS ERROR

— Forward Camera —

Frame	ΔS (microns) Mean	ΔS (microns) Standard Deviation	FBS Error (inch/second) Mean	FBS Error (inch/second) Standard Deviation
011	0.9201	2.176	.00825	.0162
012	1.021	2.135	.00583	.0190
013	0.9027	2.271	.00651	.0210
014	0.9581	2.329	.00762	.0192
Average	0.9505	2.228	.00705	.0183

— Aft Camera —

011	-1.152	2.030	.00266	.0160
012	-1.157	2.011	.00283	.0167
013	-1.109	1.945	-.00006	.0175
014	-1.156	2.020	.00242	.0165
Average	-1.144	2.002	.00196	.0167

MCRECON and Fourier analyses were run on Seq R (.052/90/0) of the 2A-2 test. The results showed no changes when compared to similar sequences performed during the Chambers A-1 and the 1A-2 tests.

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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 .015 inch/second. This results in a three sigma equivalent to .045 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 fourteen PCM counts (2.26 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 .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 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. Optical Bar Summed Error (P501, P502)

As a result of the experience gained from Missions 1206 and 1207 the OB summed error signals will be processed from camera power-on to camera power-off using a 12 PCM count rate algorithm. The tolerance of 12 PCM counts is approximately 1 pound-foot.

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TABLE 7-11

AUGIE ON-ORBIT SYSTEM CALIBRATION LOG

Parameter	Camera	Data Nominal		Tolerance		Nomenclature
		Volts	Eng Units	Volts	Eng Units	
Metering Capstan Summed Error	Fwd	2.22	0.0 ips	.120	.0800 ips	P403
	Aft	2.26	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	N/A	N/A	.240	1.0 lb.-ft.	P501
	Aft	N/A	N/A	.240	1.0	P502

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7.15 ON-ORBIT ADJUSTMENT ASSEMBLY (OOAA)

The OOAA calibration tests consisted of Chamber A-2 Sequences V and W, in which skew commands of 0, $\pm$5, $\pm$10, and $\pm$15 steps and V_t commands of 0, $\pm$5, $\pm$10, and +15 and -21 steps were executed. The results of these modulation commands are summarized in Figures 7-7 thru 7-10 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.

Sequence V was rerun in the second Chamber A-2 test and the results are shown in Figures 7-11 and 7-12.

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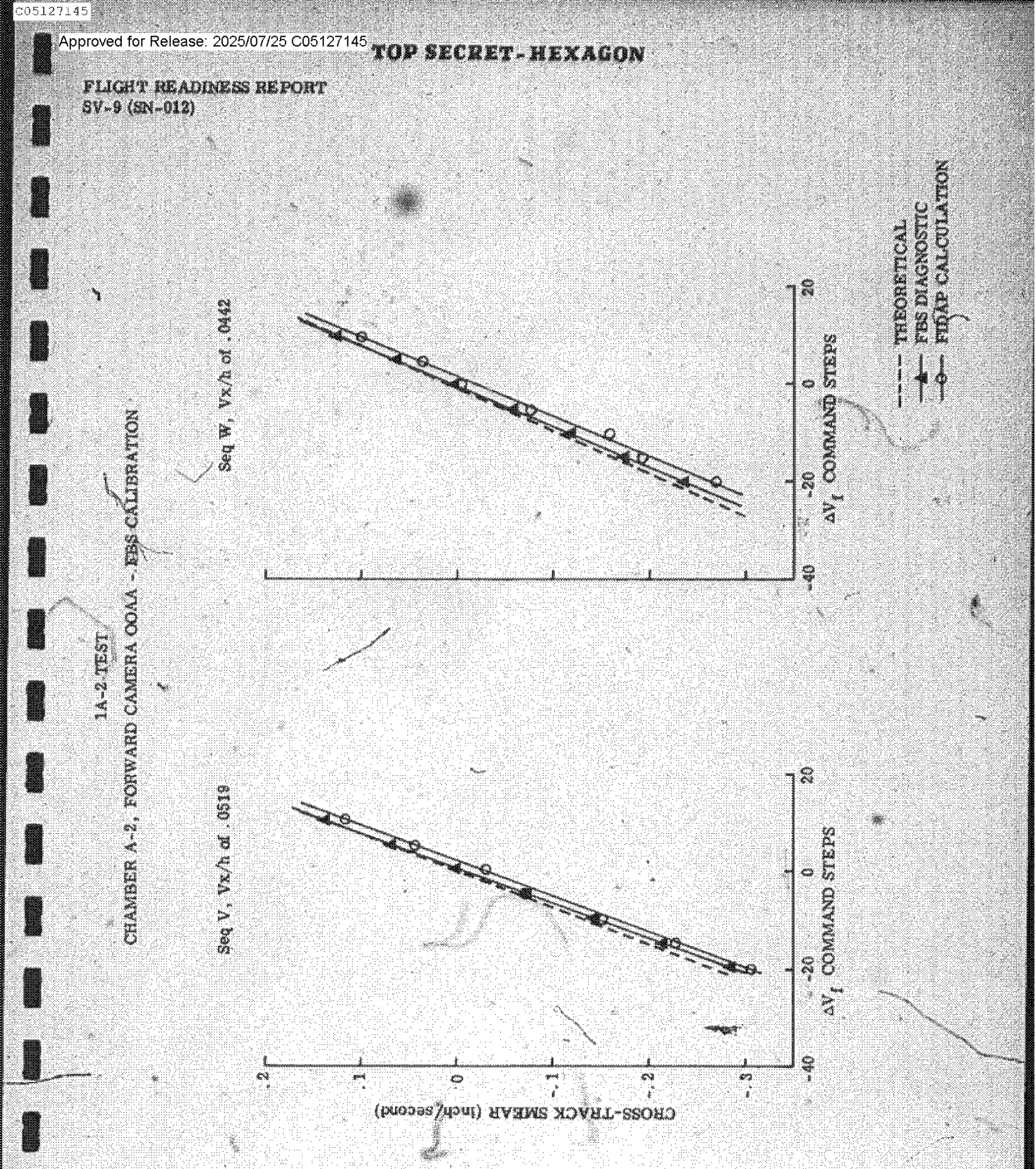


FIGURE 7-7

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FIGURE 7-8

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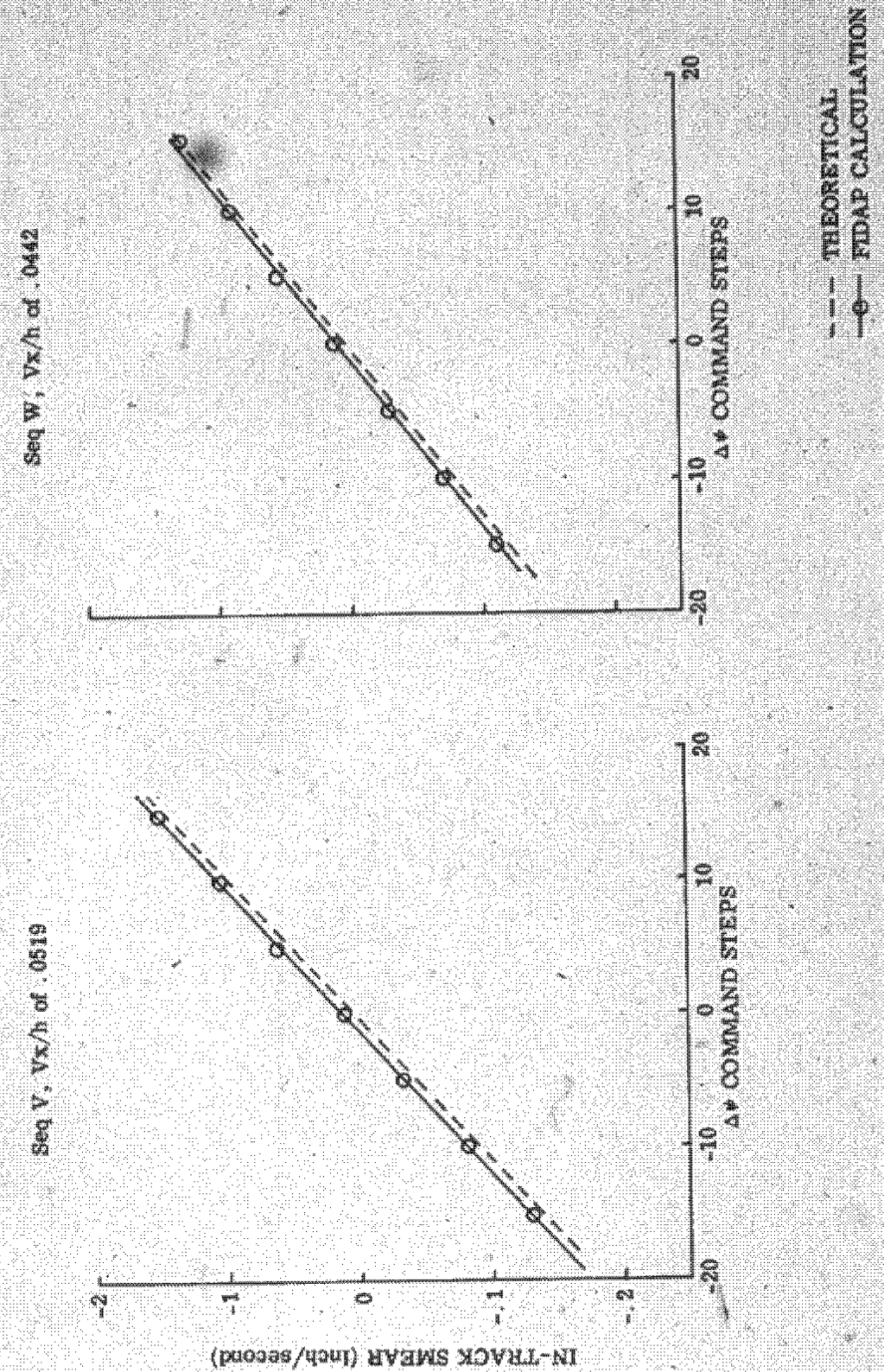


FIGURE 7-9

BYE 15303-74

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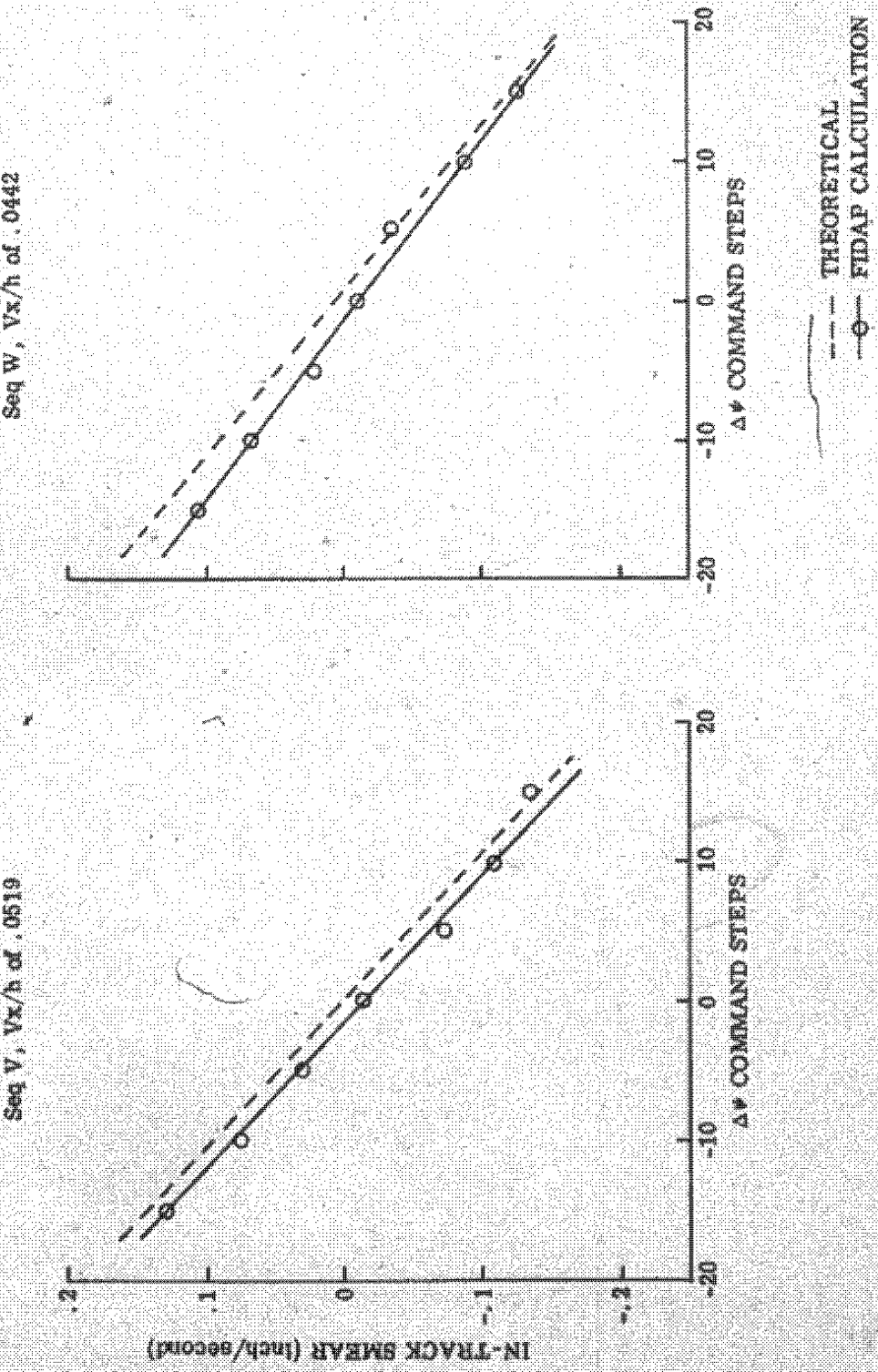
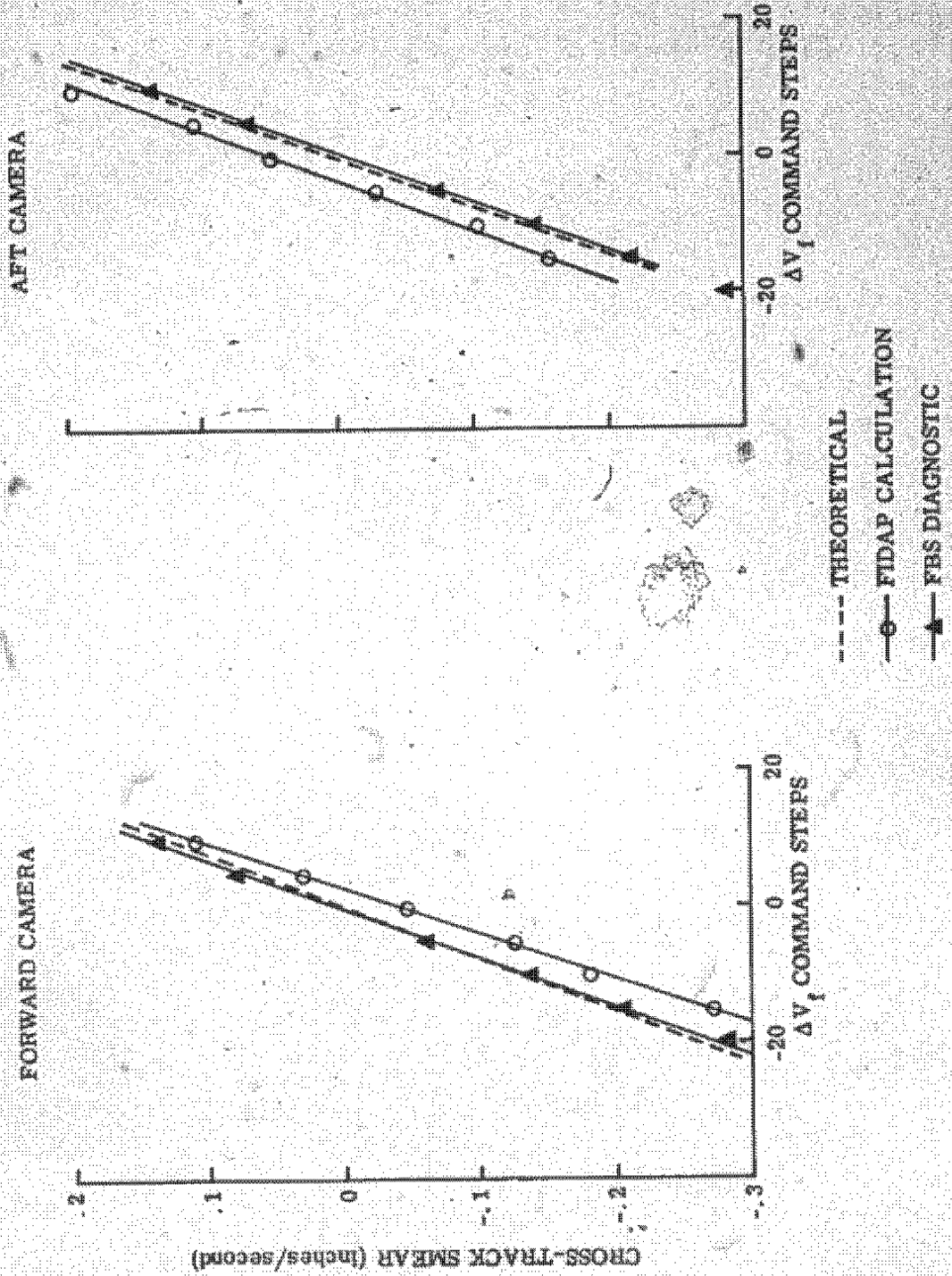


FIGURE 7-10

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2A-2 TEST
CHAMBER A-2 OOAA - FBS CALIBRATION
(Seq V, Vx/h of .0519)

FIGURE 7-11

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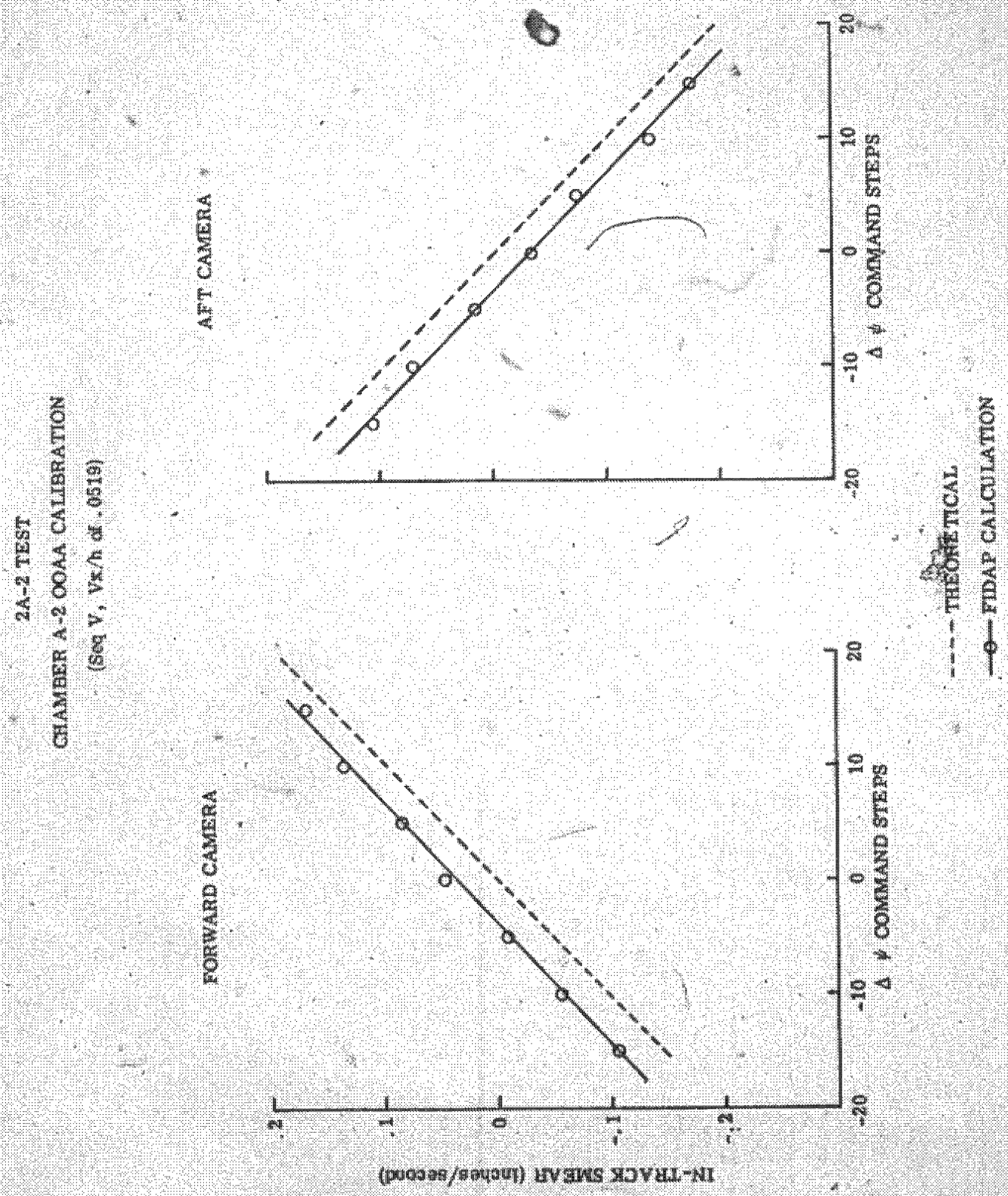


FIGURE 7-12

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PHYSICAL CHARACTERISTICS

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SECTION VIII

PHYSICAL CHARACTERISTICS

8.1 EVALUATION RESULTS

8.1.1 Film Markings

Material from both cameras on the 1A-2 test was generally free of scratches and abrasions. However, material from both A-2 tests was slightly affected by the characteristic static discharge markings, and exhibited signatures of film path components.

During retrieval of the 2A-2 material, a small piece of tape was attached to each side to indicate the point where a cut was to be made. Subsequently, it was decided not to cut the material at this point, and it was shipped to AFSPPF with the tape still in place. Since the presence of this tape was undesirable, an attempt was made by the operator to manually locate it. The operator wore nylon gloves while trying to feel for the tape. This search ultimately resulted in a band of plus-density lines due to static discharge. This band was approximately 1/2" wide and was located near the center of format for several hundred feet. Although these density lines occasionally passed through a tribar target, they had no discernible effect on the imagery or the evaluation.

One section of the Aft material from the 2A-2 test had small minus-density marks occurring on the SVT edge. While the shape of these marks varied, the pattern repeated with a period corresponding to the diameter of the shipped roll. At this time the cause is unknown.

8.1.2 Ancillary Data

Data from the 1A-2 test indicated that the format markings (scan angle, time track, SVT word, and start-of-frame/start-of-operations marks) were bright and within size and location specifications. There were no extra start-of-frame or start-of-operations marks.

In the time between the first and second A-2 tests, three of the four fiber optics light pipes, which image most of the ancillary data, were damaged and subsequently repaired. The 2A-2 test confirmed that no discernible degradation was present after this repair.

8.1.3 Fine Film Path Tracking

The index dot-to-film edge tracking measurements from Chamber A-1 material were made on nearly all scan mode/scan center combinations using various Vx/h values and rewind constants. This data showed a variation from 1.5 mm to 3.2 mm on the Forward Camera and from 2.2 mm to 3.5 mm on the Aft, with mean values of 2.2 mm and 2.8 mm respectively.

Tracking measurements made on test runs from the 1A-2 material did not show a significant difference from the Chamber A-1 test results. Three sequences from the Chamber A-2 test were measured, representing limited samples of scan mode/scan center, Vx/h combinations, and rewinds. Frames 001-010 and 101-110 were selected to check start-of-operation tracking disturbances.

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Both cameras indicated consistent tracking during the entire operation, deviating from average tracking by only .3 mm. The measured distance on both cameras was greater than centerline tracking with a mean of 2.5 mm on the Forward and 2.8 mm on the Aft. Following the reinstallation of the platens, tracking tests were conducted and the film was found to be tracking lower (SVT dots closer to the edge). Adjustments were made to the Aft Camera crossover assembly; thus tracking data for the 2A-2 test had a higher mean value.

During the pre-vacuum portion of the 2A-2 test, some runs on the Aft Camera had significantly high tracking values (approximately 3.6 mm). Analysis indicated that the high tracking was confined between two manufacturing splices. On both of these splices, the adjoining pieces of material appeared to be parallel but off-set in a direction corresponding to the high tracking. Tracking was checked on all subsequent manufacturing splices, but this condition was not seen again.

As in the first A-2 test, three sequences with different combinations of scan mode and Vx/h were measured. Because of the abbreviated nature of the 2A-2 test, Frames 101-110 were measured on only one sequence. The results are presented in Table 8-1.

A more complete set of scan mode/scan center tracking measurements is made in the Horizontal Preship Test. Ordinarily, the Horizontal Preship Test is run on flight film, but because of the problems experienced with the flight up-load, a different Supply unit with test film was used for testing. After the flight up-load was completed, a short test was run on flight film. The tracking data from this test agreed well with that of the Horizontal Preship Test.

Table 8-2 compares the average tracking data from the Horizontal Preship Test with that of previous systems. As can be seen, the Aft Camera has larger tracking values than any previous system. It should be noted however, that these values are well within specification and no corresponding edge damage has been caused by it. Also, comparisons have been made between ground and flight tracking data from previous systems which indicate that when tracking data has changed in flight, the values have become lower.

8.2 CONCLUSIONS

A. All 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 problem associated with start-of-operations.

D. The Forward Camera tracking was stable and constant throughout all the runs that were tested.

E. The tracking values for the Aft Camera, while higher than previous systems, are considered acceptable.

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TABLE 8-1

FILM TRACKING MEASUREMENTS

(millimeters)

	Scan Angle/Scan Center (degrees)					
	Forward Camera			Aft Camera		
Frame	30/0	90/0	90/0	30/0	90/0	90/0
001	1.9	1.9	2.1	2.9	3.3	3.4
002	2.1	2.2	2.0	2.8	3.6	3.2
003	2.0	1.9	2.2	2.7	3.2	3.4
004	1.8	2.1	2.0	2.9	3.2	3.4
005	1.9	2.0	2.1	3.1	3.4	3.2
006	2.0	2.1	2.0	3.1	3.2	3.4
007	2.0	2.1	2.0	3.0	3.4	3.3
008	2.0	2.0	2.0	3.2	3.4	3.2
009	2.1	2.1	2.1	3.0	3.2	3.4
010	2.1	2.2	2.1	2.9	3.3	3.2
101	2.1			2.8		
102	2.0			3.0		
103	2.1			3.1		
104	2.2			3.4		
105	2.1			3.0		
106	2.1			3.1		
107	2.2			3.0		
108	2.2			3.0		
109	2.1			3.1		
110	2.1			3.0		
Averages	2.1	2.1	2.1	3.0	3.3	3.3

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TABLE 8-2

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

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

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.

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