TOP SECRET

HANDLE VIA BYEMAN CONTROL SYSTEM ONLY—HEXAGON

C002722

Hexagon Sensor Subsystem

SV-10 (SN-013) FLIGHT READINESS REPORT

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

BYE 15240-75

Classified by BYE 1
Exempt from general declassification
Schedule of Executive Order 11652
Exemption category [5B(2)]
Automatically declassified on
IMPOSSIBLE TO DETERMINE

TOP SECRET

Warning

This document contains information affecting the national security of the United States within the meaning of the espionage laws U.S. Code Title 18, Sections 793 and 794. The law prohibits its transmission or the revelation of its contents in any manner to an unauthorized person, as well as its use in any manner prejudicial to the safety or interest of the United States or for the benefit of any foreign government to the detriment of the United States. It is to be seen only by U. S. personnel especially indoctrinated and authorized to receive information in the designated control channels. Its security must be maintained in accordance with regulations pertaining to the designated controls.

Published By

HQ AIR FORCE SPECIAL PROJECTS PRODUCTION FACILITY

HEXAGON SENSOR SUBSYSTEM

SV-10 (SN-013)

FLIGHT READINESS REPORT

APRIL 1975

This report consists of 105 pages. Cy 15 of 23 Cys

BYE 15240-75

Handle via Byeman
Controls Only

FLIGHT READINESS REPORT
SV-10 (SN-013)

PUBLICATION REVIEW

This report has been reviewed and is approved.

Guy F. Welch
GUY F. WELCH
Major, USAF
1210 Ass't Vehicle Manager

FOREWORD

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

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.

Contributors to this report included:

PRS STAFF	SSC	WCFO
[redacted]	J. Garrish	[redacted]
	[redacted]	
	A. Squillante	
	[redacted]	

FLIGHT READINESS REPORT
SV-10 (SN-013)

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

FLIGHT READINESS REPORT
SV-10 (SN-013)

DISTRIBUTION

Organization	For Attention of	Copy Number
SAFSP-7	- Maj D. Berganini	1,2
Aerospace Corporation	- I. Rzepnick	3
Central Intelligence Agency(CIA)/OD&E	- [redacted]	4,5
CIA/OJCS	- [redacted]	6
Northeast Project Office(NEPO)	- [redacted]	7,8
SAFSS	- H. Wheeler	9
West Coast Field Office(WCFO)	- [redacted]	10 - 13
National Photographic Interpretation Center(NPIC)/C-TSG	- [redacted]	14
NPIC/APSD	- [redacted]	15,16
Sensor Subsystem Contractor(SSC)/PFA	- J. Garrish	17
SSC/OTD	- P. Petty	18 - 21
Eastman Kodak/MAA	- A. Kubber	22
AFSPPF/EV	[redacted]	23

INTRODUCTION

SECTION I

INTRODUCTION

1.1 SUMMARY

Flight focus should be set at 30 microns on both the Forward and Aft Cameras for 1414 Film. In addition to 1414, the Aft Camera contains high resolution (SO-124), conventional color (SO-255), and infrared (SO-130) films. When using SO-255 and SO-130 Films, the Aft Camera PBF should be set at 60 microns. When using SO-124 Film, the Aft Camera PBF should be set at 30 microns. The vacuum test data is summarized in Table 1-1.

TABLE 1-1

VACUUM TEST EVENT SUMMARY

	Test Results	
Chamber A	Forward Camera	Aft Camera
1414 Film		
Cross-Track (inch/second)	-.018	.001
In-Track (inch/second)	-.005	.007
PBF (microns)	41	35
Peak Resolution (cycles/mm)	183	187
SO-255 Film		
Cross-Track (inch/second)	-.040	-.022
In-Track (inch/second)	.033	-.006
PBF (microns)	70	59
Peak Resolution (cycles/mm)	111	107
Inter Test Events		
Platens Removed and Replaced for Shutter Retrofit		
PDS Box Replaced		
Chamber A-2 (1414 Film)		
First A-2(1A-2) Test		
Cross-Track (inch/second)	-.011	.010
In-Track (inch/second)	.032	-.124
PBF (microns)	38	35
Peak Resolution (cycles/mm)	159	N/A
Inter Test Events		
OOAA Fixed Ladder Changed		

TABLE 1-1 (CONT'D)

	Test Results	
	Forward Camera	Aft Camera
Second A-2(2A-2) Test		
Cross-Track (inch/second)	-.021	-.011
In-Track (inch/second)	.001	-.008
PBF (microns)	38	35
Peak Resolution (cycles/mm)	N/A	N/A
Inter Test Events		
None		
Third A-2(3A-2) Test		
Cross-Track (inch/second)	.023	-.020
In-Track (inch/second)	.006	-.018
PBF (microns)	38	35
Peak Resolution (cycles/mm)	155	150

NOTES:
1. Mean smear values and peak resolution were taken from the 0° collimators at a Vx/h of .052 radians/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-124, SO-255, and SO-130 Film.
4. Chamber A PBF data is normalized for field angle.
5. All Chamber A-2 tests were run on 1414 material.

The OOAA adjustments recommended for flight are summarized in Table 1-2. These adjustments are derived by analysis of data from eight runs on SV-10 with the image motion compensation (IMC) enabled and from on-orbit operations of previous systems.

TABLE 1-2

RECOMMENDED OOAA ADJUSTMENTS

(counts)

Motion Component	Film Type	Forward Camera	Aft Camera
In-Track	1414/SO-124	-1	-4
Cross-Track	1414/SO-124	0	0
Cross-Track	SO-255/SO-130	N/A	Δ-15

1.2 SYSTEM IMPROVEMENTS

The following improvements have been made on this system:

A. Both cameras of SV-10 have the settling time fix in the MC Servo (2A-3), whereas on SV-9 only the Aft had it. The changes in the box involved increasing the phase lock loop gain by a factor of approximately 1.4, placing voltage limiter on the output of the Absolute Value Circuit (AVC), and rescaling the tachometer electronics to prevent resonance conditions.

B. In the Forward-section, RV-1 has a 0° wrap builder roller (B/R) while RVs 2, 3, and 4 have 180° wrap B/Rs. All builder rollers are of the "cage up" design so that operationally they will be caged and uncaged in a manner consistent with SV-9. Due to the fact that the 180° wrap B/Rs are an integral part of the film path during caging and uncaging, the coarse tensions will change slightly. Also, the 180° wrap B/Rs do not drive as rapidly as the 0° wrap B/Rs and as a consequence, the uncage times for RVs 2, 3, and 4 will be longer than that of RV-1. The new worst case time for uncaging RVs 2, 3, and 4 will be 76 seconds. Formerly the worse case time was 60 seconds.

In addition, the 180° wrap B/Rs in RVs 2, 3, and 4 do not rest on the Take-up core when they are uncaged, they rest on snubbers positioned not more than .010" from the core. Consequently, during the initial transfer and wrap (PREP 1), a minimum of five Take-up revolutions will be executed to assure sufficient layers of film to raise the B/R from the snubbers. Five revolutions will result in 10 layers of film on the Forward Camera Take-up and nine layers of film on the Aft Take-up. The 180° B/R design was initiated to solve an off-stacking problem experienced on SV-3. An extensive qualification test was performed to verify the 180° B/R design prior to its use in SV-10. This test program consisted of engineering model tests, qualification vibration tests, and SV-10 Forward-section buildup and vehicle level tests. The purpose was to obtain as many hours as possible of operational test time to observe the Take-up and system performance with the 180° B/R design. In many cases, the hardware was tested under conditions equal to or exceeding worst case alignment tolerances and film stack profiles. There were no rewind restrictions imposed during any of these tests. Special tests were performed during the Forward-section buildup at SVIC. In addition to the buildup performance, double wrap and stacking tests were performed with fixed bias and sinusoidal articular inputs. After Forward-section/Mid-section mate, the Take-ups went through the normal system level ambient, thermal-vacuum, and acoustic tests. Prior to launch of SV-10, approximately one million feet of film will have been run through the 180° B/R design on various Take-ups. All tests indicate the 180° B/R Take-up will perform better than the 0° wrap B/R design under all operational conditions.

C. The Power Distribution System (PDS) (15A-1) in SV-10 does not command BUFT-minus (ESD) coincident with the power-off command, whereas the PDS in SV-9 did. The Block II Subsystem Command and Control (SCC) units do not distinguish between commanded and system generated ESDs so that the

ESD telemetry monitor will indicate both. As a result, if BUFT-minus were executed after peak rewind but before film transport stop, as was done in Block I vehicles, the diagnostics would show an ESD condition. This is unacceptable; therefore, BUFT-minus will be issued after the execution of the camera power-off command.

D. The Fine Film Path Crossover Pneumatics Tube design has been changed to prevent an infligl catastrophic failure. During the factory assembly and test phase, SN-015 experienced an emergency shutdown as the result of a severe kink in the urethane tube which supplies gas to the input air bar in the crossover. A design change was initiated to place a light compression spring inside each crossover pneumatic tube to prevent the possibility of a kink causing loss of gas to the air bars.

1.3 AREAS OF CONCERN

The assembly and testing cycle of SV-10 (SN-013) at SVIC was accomplished without major incidents. However, there were some anomalies which should be noted. None of the following concerns are significa enough to preclude the launching of SV-10, nor should they impact the system's optical performance.

1.3.1 Delayed Brake Release (TU-020A/SV-10-1)

During R&I at WCFO, an out-of-specification brake release time was observed on the first actuation of the Forward Take-up. This same phenomenon was observed at the MWC on TU-028A during high temperature tests. This condition was reproduced when the Take-up has been inactive for more than 60 days and tested at worse case voltage levels. When brake sticking does occur, it is only during the first activation. Any sticking can be easily overcome by the application of torque and does not affect the operation of the Take-up. The Take-ups in RV Position 1 will be run at R-1, R-0 sub-orbital checks, and approximately every day thereafter. For these reasons, the Government will use as is.

1.3.2 Rubbing Brake (TU-020A/SV-10-1)

A brake rub against the Take-up core on a once-per-revolution of the Take-up shows up in the summed error signal when running without film. However, it has not been detected when pulling film during the Chamber A-1 and Chamber A-2 tests. A brake adjustment would involve risk to the Take-up operation because of the required removal and disassembly. For this reason, the Government will use as is.

1.3.3 Platen Diagnostic Out-of-Limit

The Forward platen photo mode error, recycle mode error, and platen tachometer diagnostic signals produced an out-of-limit value during SN-013 Acceptance testing. The diagnostic indicated a speed increase in the platen tachometer; thus if it occurred during image formation, it would result in smear. A detailed review of the test data showed the anomaly to be a one time occurrence. Extensive investigation, including computer model analysis, produced no definite results. During the malfunction analysis, various tests were performed which added approximately 4,000 cycles to the platen with no recurrence of the anomaly. In addition, tests performed at WCFO produced no recurrence. At present, there is not enough data available to worse case repair any AVE because the source cannot be isolated to a particular part of the camera system. For this reason, the Government will use as is.

1.3.4 Shutter A Open Error

The Shutter A diagnostic was out-of-limit for three frames during Acceptance testing. This was determined to be caused by the shutter opening too early. All diagnostics available verify that the slit and shutter assembly responded to the Sequencer commands. Malfunction analysis indicates the shutter anomaly is most probably related to the 210 counter circuitry or logic gates of the shutter logic in the Sequencer. This circuitry is susceptible to noise. The camera has been operated through approximately 7,000 cycles and tested without any recurrence. Furthermore, a full supply of film was run through the camera in the WCFO tests. Block II of the Sequencer will be used as the Primary Block for flight, leaving the side with the shutter anomaly as the Secondary Block. Since this anomaly, a shutter retrofit was performed which replaced the shutter springs. The shutter retrofit required rework and retest of the mechanical area of concern. This reduces the potential of this anomaly recurring if the Block I side of the Sequencer is required during flight. For this reason, the Government will use as is.

1.3.5 Measurement Filter Assembly (MFA) Diagnostics Zero

During one camera operation, the Measurement Filter Assembly diagnostics were zero. The MFA provides a large number of diagnostics for the camera system. This anomaly occurred once during Acceptance testing, and has not repeated since. The anomaly could not be duplicated in subsequent testing. The nature of the anomaly would require the MFA to go "OFF". Examination of the redundant relay design indicates that to reproduce this anomaly it would take the loss of MFA power which would require two relays to fail simultaneously. Since this is highly improbable, it is concluded that the MFA never reached an "ON" state, and the anomaly is most likely caused by AGE. These diagnostics are not essential for camera operation. For this reason, the Government will use as is.

1.3.6 Contamination

Occurrence of contaminants in the flight systems increase the risk of catastrophic failure. During factory assurance tests, SN-016 experienced an emergency shutdown. The anomaly was traced to contamination in the 4" FEV roller in the Supply. At the same time, SV-10's Supply was being prepared for the flight film load. The Supply was then thoroughly cleaned, during which time, two loose rivets were found. The Supply was inspected for missing rivets and none were found. The rivets were possibly left in the Supply structure by the Supply vendor. The Supply was recleaned, tumbled, and cleaned again. A special cleaning procedure was implemented to verify the cleanliness of the 4" roller. Due to the number of cleanings and special cleaning procedures used, SV-10's should have the cleanest Supply area to date.

A minor quantity of dimethyl terephthalate outgassing was again observed during the Chamber A-1 testing. It has been determined that this contaminant is not injurious to the optical coatings.

1.3.7 Tribar Image Quality (Chamber A-2)

Chamber A-2 Readiness data evaluation determined that the camera system's resolution performance is satisfactory. However, when the Chamber A-2 data was compared with the Chamber A data, a loss in performance was apparent. The Chamber A imagery was reread since the tribar reading criteria had been changed since the Chamber A data had been taken. Although the difference was reduced, a one tribar element disparity still existed. A detailed examination of the Chamber A-2 test data revealed that tribar target images lacked the sharpness and image contrast of earlier tests and that the targets were very difficult to read. A thorough investigation was undertaken to identify the cause of the image quality degradation. A detailed description of the areas of investigation is located in Section III. The results indicate that a complex combination of processing chemistry, film characteristics, and exposure conditions may be the cause of the degraded SV-10 imagery. A special test plan has been written for the SV-11 Chamber A-2 test to further evaluate this problem. Since the camera system meets resolution requirements, the Government will use as is.

1.3.8 Platen Tilt

The evaluation of the Chamber A-2 Forward Camera data indicated a need for 13 to 25 microns of tilt across the slit. The concern is that Chamber A-2 testing of the past six satellite vehicles has indicated a need for additional tilt on the Forward Camera. The post flight analysis of the imagery from these six vehicles has not supported this indication for additional tilt. This apparent field tilt was also detected in the Chamber A tests. The Government is concerned about any tilt indications, especially on the Forward Camera, arising from chamber testing. Special tests have been implemented to isolate the cause of field tilt. To date, these tests have exonerated the optical design, longitudinal color, optical bars, and collimators, and have indicated that lack of film flatness contributes to only about 6 microns. Further tests are planned to investigate the anomaly. Chamber tests show that the camera system meets resolution requirements; therefore, the Government will use as is.

1.3.9 V-Funnel Swag Terminals

This anomaly originated during manufacturing buildup of the Supply Assembly as an intermittent output of the Supply encoder. This intermittent output was determined to be associated with the use of the V-Funnel Swag Terminals on printed circuit boards with thru-board soldered connections. This type of connection has latent fractures due to induced mechanical stresses during the soldering process. If this stress is combined with poor workmanship, a resultant intermittent is possible. A hardware review determined that all Block II Mid-section encoders, except Type IV, and all Block II Mid-section ASD electronic boxes have this type of solder terminal. This results in approximately 2,800 terminals on all satellite vehicles which could produce this type of intermittent. Only two failures have occurred from all the potentials and both were in the SV-10's Supply encoder. Both these failures were identified very early in the buildup cycle. The most critical effect of any terminal failure in the Supply encoder would be the loss of one side of the camera system. However, it was decided due to: (1) the magnitude and cost of reworking the circuit boards, (2) the intensive test cycle each vehicle undergoes, (3) the successful flights of SV-7, SV-8, and SV-9, and (4) the lack of this anomalous condition during the test cycles of SV-11 and SV-12, that the Government will use as is on all Block II Mid-sections. A new design has been implemented on Block III Mid-sections and on any Block II electronic boxes which have to be reworked.

1.3.10 180° Wrap Angle Take-up Builder Roller

There is a high probability that there will be some corona marking due to the Aluminum builder roller (B/R) in the 180° wrap B/R design on SV-10. Subsequent vehicles will have Tamol B/Rs which should correct this situation. Tamol was not available for SV-10. For this reason, the Government will use as is.

1.3.11 Black Dots

Black dots on the operational film have been reported by the PFA Team for SV-7, SV-8, and SV-9. These dots will most likely be observed on SV-10's operational imagery. The source of these dots has been identified. Tests performed by BRIDGEHEAD have shown that the frequency of occurrence of these marks is directly related to the high B/R forces used during Supply stack makeup. Relatively high builder roller forces, e.g., 100 psi, are required to attain the core pressures specified to insure Supply stack integrity during launch. This requirement was effective on Block II with the elimination of the caging arms. BRIDGEHEAD has the problem under investigation. Since there is no alternate method for spooling film stacks at this time, the Government will use as is.

1.4 WCFO FACTORY TEST FLOW

The overall test flow for SV-10 at WCFO is shown in Figure 1-1. The following paragraphs provide brief descriptions of the activities during each of the major tests.

1.4.1 Forward-section Buildup

Buildup and testing were completed on 1 March 1974. The following retrofits were completed as follows:

A. Builder roller full switch disabled in TUA-8, TUA-19, TUA-20, and TUA-31.

B. Install alignment markers in TUA-10 and TUA-31.

C. Replace and reset microswitches (A9S6) in TUA-19 and TUA-31.

D. Replace PI connectors on TUA-19.

Functional testing of the Forward-section was completed without any incidents.

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

The Mid-section was received at the West Coast Facility on 1 December 1973 and R&I testing completed on 27 February 1974.

Testing resulted in one anomaly; a P408 OB/MC phase lock error signal appeared to be noisy. Troubleshooting isolated the problem to SBAC equipment.

1.4.3 SV Mate

The mechanical mating of the Mid-section and Forward-section was completed on 19 March 1974.

1.4.4 Vertical Baseline Test

The test was completed on 9 April 1974, no problems were encountered.

1.4.5 Acoustic Test

Prior to this test, eight torsion rod support brackets were replaced. The vehicle was installed in the Acoustic Chamber and the test was completed on 5 June 1974.

1.4.6 Horizontal Baseline Test

Prior to the Horizontal Baseline Test, the PDS was replaced. The test was completed on 14 June 1974. Prior to entering Chamber A-1, the following tasks were performed:

A. Platens removed for slit and shutter spring retrofit.

B. Starfield Simulator Test was run and completed 26 July 1974.

C. TU S/N-024 removed and TU S/N-040 installed.

D. TU S/N-040 removed and TU S/N-020 installed. Both S/N-024 and S/N-040 were removed for use on SV-9.

1.4.7 Thermal Vacuum Test

The vehicle was installed in Chamber A-1 on 6 September 1974 and all chamber testing completed on 18 September 1974. No problems were encountered.

1.4.8 First Chamber A-2 Photographic Tests (1A-2)

The SV was installed in the chamber and testing completed on 7 October 1974. An analysis of the sync-flash data showed that both the Forward and Aft in-track biases were offset and needed to be adjusted. The adjustments were made to the OOAA fixed ladder resistors.

1.4.9 Second Chamber A-2 Photographic Tests (2A-2)

A decision was made to perform a short vacuum test to verify the OOAA settings. Analysis of the data verified all settings were correct.

1.4.10 Third Chamber A-2 Photographic Tests (3A-2)

The in-air and vacuum portions of this test were completed on 13 November 1974.

Analysis of the data indicated image motion was correct; however, image quality was not as sharp when compared to Acceptance data. Resolution values decreased approximately 15 cycles/mm on the

Forward and approximately 10 cycles/mm on the Aft Camera.

An identical test sequence was dual gamma processed by BRIDGEHEAD and compared to the sequence processed by MX-641 at WCFO. The portion processed dual gamma differed subjectively in quality to the portion processed MX-641. At the present time, there is an unknown relationship between the processing film (Batch 38) and exposure settings. These relationships are presently under evaluation.

Table 1-3 summarizes the milestone events for the factory flow, shipment, and launch of SV-10.

TABLE 1-3

SV-10 MILESTONE SCHEDULE

Activity	Date Completed
1. Forward-section Buildup	1 March 1974
2. Mid-section R & I	27 February 1974
3. SV Mate	19 March 1974
4. Vertical Baseline Test	9 April 1974
5. Acoustic Test	5 June 1974
6. Horizontal Baseline Test	14 June 1974
7. Starfield Simulator Test	26 July 1974
8. Chamber A-1 Test	18 September 1974
9. 1st Chamber A-2 Test (1A-2)	7 October 1974
10. 2nd Chamber A-2 Test (2A-2)	8 November 1974
11. 3rd Chamber A-2 Test (3A-2)	13 November 1974
12. Preliminary Shipping Preparation	11 February 1975
13. Final Shipping Preparation	18 April 1975
14. Ship	14 May 1975
15. AVE Mate	19 May 1975
16. AVE Systems Test	21 May 1975
17. Countdown	28 May 1975

NOTE: Items 14-17 show projected dates for completion of those activities.

ASSEMBLY AND TEST FLOW AT SVIC

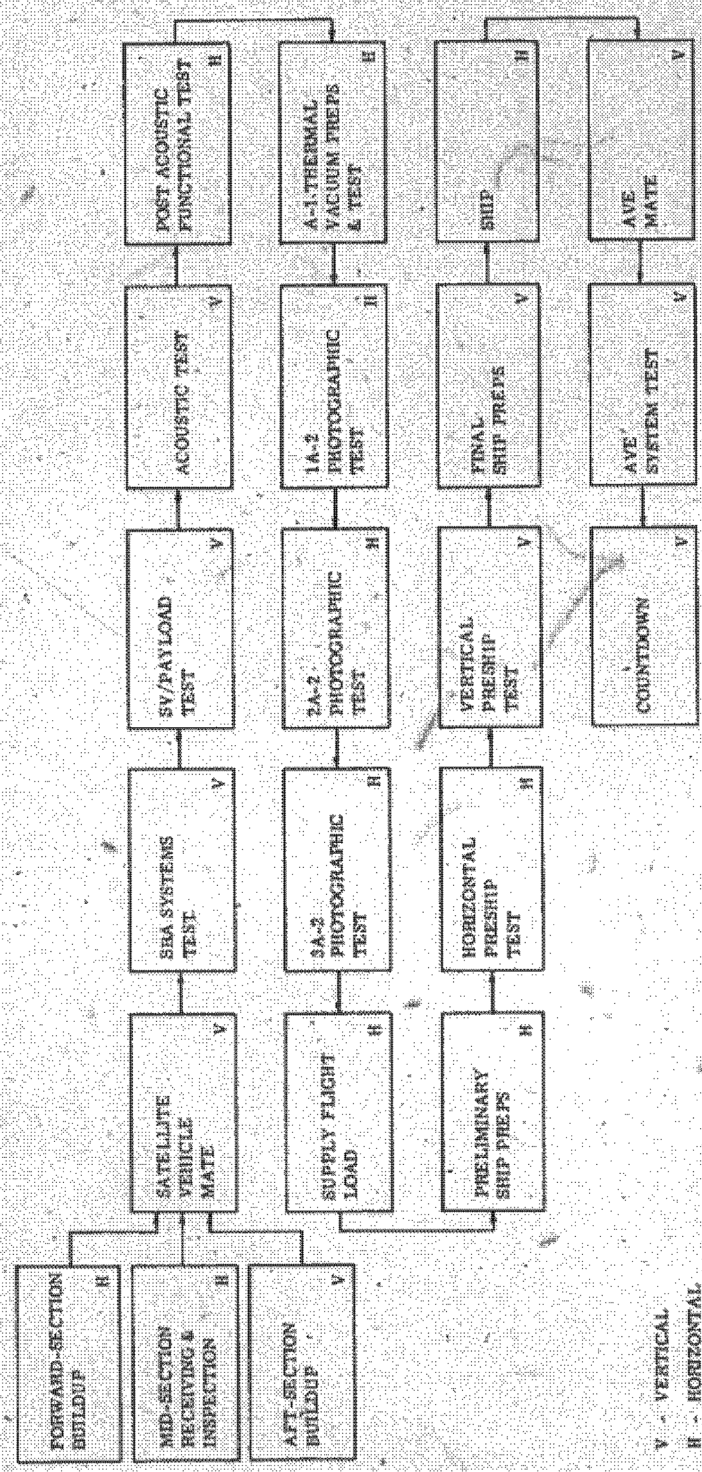


FIGURE 1-1

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

TABLE 1-4

HARDWARE CHANGES AT SVIC FACILITY

CHANGE	DATE	REASON	REVERIFICATION
1. T19/31 A9S6 MICRO SWITCH RETROFIT TUA-29/30 OLD 6402/6450/7008/6472 NEW 6570/7744/6909/7058	1/20/74	RETROFIT TUA-29/30.	FEWO T19-05/T31-05.
2. T08A B/R DR ASSY (MR 64570) OLD 038 NEW 044	1/22/74	DRIVE MOTOR FAILED.	FEWO T008A-04.
3. DLF FUSE MODULES MODEL DIRECTIVE 635 OLD 940239/9400224 NEW 940396/940408	1/22/74	NON-QUALIFIED CONNECTOR.	FEWO 10-4 MS R & I.
4. T19A A-2 ELECT (B) (MR 64562) OLD 054A NEW 020A	2/18/74	FDC A/C RIPPLE OUT-OF-SPEC.	FEWO T019A-14.
5. T19A A-1 ELECT (B) (MR 64573) OLD 019A NEW 023A	2/18/74	SUMMING AMP OUT-OF-SPEC.	FEWO T019A-14.
6. TUA-19 P-1 CONN. RETROFIT TUA-34	3/5/74	RETROFIT TUA-34.	FEWO T19-16.
7. STR'R PRESS. TRANS. (MR 64584) OLD 5953 NEW 5047	3/8/74	OUTPUT OUT-OF-SPEC.	FEWO 10-33.
8. TORSION ROD BRKTS (MR 6447) OLD LOT 107/110 NEW LOT 112	5/5/74	RETROFIT SV10-1/2.	HBL PER FTI 30004.
9. PDS (MR 64579) OLD 5016 NEW 5014	5/8/74	MODEL DIRECTIVE 644.	HBL PER FTI 30004.
10. TUA FEWO 10-28/46 OLD 024/040 NEW 020	9/3/74	FOR USE ON SV-9.	FEWO 10-46.

[illegible]

CHAMBER A-2 TEST PLAN

Handle via Byeman
Controls Only

[illegible]

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-10 was subjected to three Chamber A-2 tests. The details of these tests are discussed in Sections IV and V of this report. The Chamber A-2 test sequences are listed in Table 2-1.

The purpose of the second (2A-2) and third (3A-2) tests was to evaluate the changes made to the skew setting on both cameras and to the F-knob setting on the Forward Camera. These skew changes were necessitated by removal of the platens for shutter retrofit prior to the first (1A-2) test.

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 and 3A-2 tests were standard test sequences, while 2A-2 was an abbreviated test. Tables 2-1 and 2-2 present a listing of the first and third A-2 test sequences.

TABLE 2-1

1A-2 TEST SEQUENCES

Run	Seq	Vx h (rad/sec)	Slit Width (inches)	Pitch Angle (degrees)	Scan Angle (degrees)	Scan Center (degrees)	Frames	IMC	Illumination
357	K	.052	.303	-1.0	30	0	144	Dis	Continuous
360	K	.052	.303	-2.0	30	0	144	Dis	Continuous
363	K	.052	.303	-2.5	30	0	144	Dis	Continuous
368	K	.052	.303	1.0	30	0	144	Dis	Continuous
369	K	.052	.303	2.0	30	0	144	Dis	Continuous
370	K	.052	.303	2.5	30	0	144	Dis	Continuous
373	K	.052	.303	0	30	0	144	Dis	Continuous
376	H	.052	.303	0	90	0	144	Dis	Continuous
378	L	.044	.259	0	90	0	53	Dis	Continuous
379	G	.044	.525	0	90	0	144	Dis	Continuous
380	C	.036	.910	0	90	0	10	Dis	Flash
381	U	.044	.910	0	30	0	144	Ena	Flash
382	V	.052	.910	0	30	0	144	Ena	Flash
383	M	.044	.910	0	90	0	77	Ena	Flash
384	R	.052	.910	0	90	0	33	Ena	Flash
385	R	.052	.910	0	90	0	33	Ena	Flash
387	K	.052	.303	0	30	0	144	Dis	Continuous
391	N	.044	.910	0	30	0	33	Ena	Flash
392	P	.052	.910	0	30	0	33	Ena	Flash
393	N	.044	.910	0	30	0	33	Ena	Flash
394	P	.052	.910	0	30	0	33	Ena	Flash

TOP SECRET - HEXAGON
Approved for Release: 2025/07/25 C05127144

TABLE 2-2

3A-2 TEST SEQUENCES

Run	Seq	Vx/h (rad/sec)	Slit Width (inches)	Pitch Angle (degrees)	Scan Angle (degrees)	Scan Center (degrees)	Frames	IMC	Illumination
468	K	.052	.303	-1.0	30	0	144	Dis	Continuous
470	K	.052	.303	-2.0	30	0	144	Dis	Continuous
472	K	.052	.303	-2.5	30	0	144	Dis	Continuous
474	K	.052	.303	1.0	30	0	144	Dis	Continuous
476	K	.052	.303	2.0	30	0	144	Dis	Continuous
477	K	.052	.303	2.5	30	0	144	Dis	Continuous
480	K	.052	.303	0	30	0	144	Dis	Continuous
482	C	.036	.910	0	90	0	10	Dis	Flash
483	U	.044	.910	0	30	0	144	Ena	Flash
484	V	.052	.910	0	30	0	144	Ena	Flash
485	M	.044	.910	0	90	0	77	Ena	Flash
486	R	.052	.910	0	90	0	33	Ena	Flash
487	P	.052	.910	0	30	0	33	Dis	Continuous
488	K	.052	.303	0	30	0	144	Dis	Continuous
489	J	.052	.615	0	30	0	144	Ena	Flash
491	K	.052	.303	0	30	0	144	Dis	Continuous
493	K	.052	.303	0	30	0	144	Dis	Continuous
494	H	.052	.303	0	90	0	144	Dis	Continuous
498	N	.044	.910	0	30	0	33	Ena	Flash
499	P	.052	.910	0	30	0	33	Ena	Flash
500	N	.044	.910	0	30	0	33	Ena	Flash
501	P	.052	.910	0	30	0	33	Ena	Flash

CHAMBER A-2 TARGET RETICLE

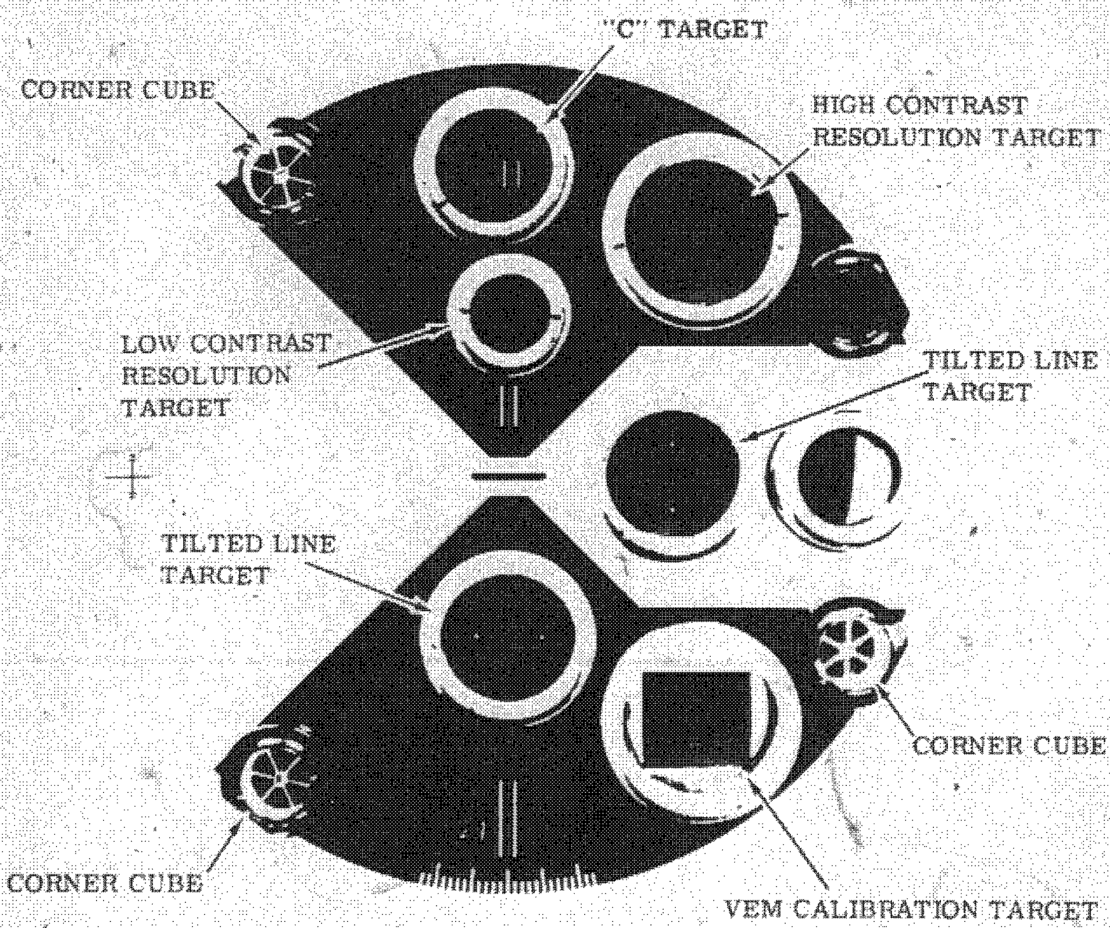


FIGURE 2-1

SYSTEM RESOLUTION PERFORMANCE

Handle via Byeman
Controls Only

SECTION III

SYSTEM RESOLUTION PERFORMANCE

3.1 INTRODUCTION

The Chamber A-2 Readiness test data evaluation has determined that the SV-10 Camera System's resolution performance is satisfactory for this mission. The two cameras have essentially equivalent predicted performance of 163 cycles/mm in-track and 134 cycles/mm cross-track for 2:1 contrast tribar resolution. The resolution data presented in this section is from the third Chamber A-2 test. The resolution tests reviewed in this section are as follows:

A. Resolution as a function of field angle.

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

C. Resolution variability.

Also included is a description of the image quality degradation observed in SV-10's Chamber A-2 test runs, along with a discussion of the possible causes.

3.2 TEST PARAMETERS

The optical bar sets in SV-10 are 042 and 040 on the Forward and Aft Cameras respectively. Each camera incorporates an In-flight Changeable Filter Assembly (ICF) having equivalent W-12 and W-2E3 Filters. All the test sequences run in Chamber A-2 with the exception of Seq L used the W-12 Filter. Seq L was a test to determine if a focus shift results with the use of the W-2E3; this test is analyzed in Section V. Resolution tests analyzed in this section are summarized in Table 3-1. Sign conventions used for the pitch sequences are given in Table 3-2.

TABLE 3-1

3A-2 CAMERA RESOLUTION TEST SUMMARY

Run	Seq	Scan Length (degrees)	Pitch (degrees)	Platen Position (no./increment)
468	K	30	-1.0	9/6
470	K	30	-2.0	9/6
472	K	30	-2.5	9/6
474	K	30	1.0	9/6
476	K	30	2.0	9/6
477	K	30	2.5	9/6
480	K	30	0.0	9/6
491	K	30	0.0	9/6
493	K	30	0.0	9/6
494	H	90	0.0	9/6

NOTE: All of these test runs had 144 frames, were at a Vx/h value of .052 radians/second, and a slit width of .303 inch.

TABLE 3-2

PITCH/FIELD SIGN CONVENTIONS

(degrees)

Vehicle Pitch (degrees)	Forward Camera 0° Scan	Forward Camera 37° Scan	Aft Camera 0° Scan	Aft Camera 37° Scan
-2.5	2.5	N/A	-2.5	N/A
-2.0	2.0	N/A	-2.0	N/A
-1.0	1.0	N/A	-1.0	N/A
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. N/A means not acquired.

3.3 TEST RESULTS

3.3.1 Resolution as a Function of Field Angle

In-track and cross-track thru focus resolution data at five field positions are given in Figures 3-1 and 3-2, for the Forward and Aft Cameras respectively. The test conditions used during the thru focus/thru pitch sequences, which comprise this data base, were at a Vx/h of .052 and a slit width of .303 inch. Based on the 2:1 contrast tribar readings at each of the test field locations, a single position representing peak resolution from each test was selected. These frames were then microdensitometrically analyzed using the FOCMO Program to determine the position of best focus from the line arrays. Line determined PBFs are indicated by arrows in each of the plots in the two figures. Collimator defocus has been accounted for in these determinations. As in past A-2 tests, only the 0° collimators were used to generate the above data since the field collimators do not encompass the entire sweep across the web.

3.3.2 Comparison Between Chambers A and A-2

Three A-2 tests were required to complete the SV-10 Readiness testing. The first A-2 test provided data on the Forward Camera performance only, as the Aft Camera results were degraded by a large error in the platen skew setting which produced in-track smear. The 2A-2 test was a mini test intended primarily to verify the corrections made in IMC for both cameras. As such, it did not include the pitch sequences normally associated with Readiness testing.

FORWARD CAMERA RESOLUTION THRU FOCUS CURVES
AT 3A-2 CONDITION

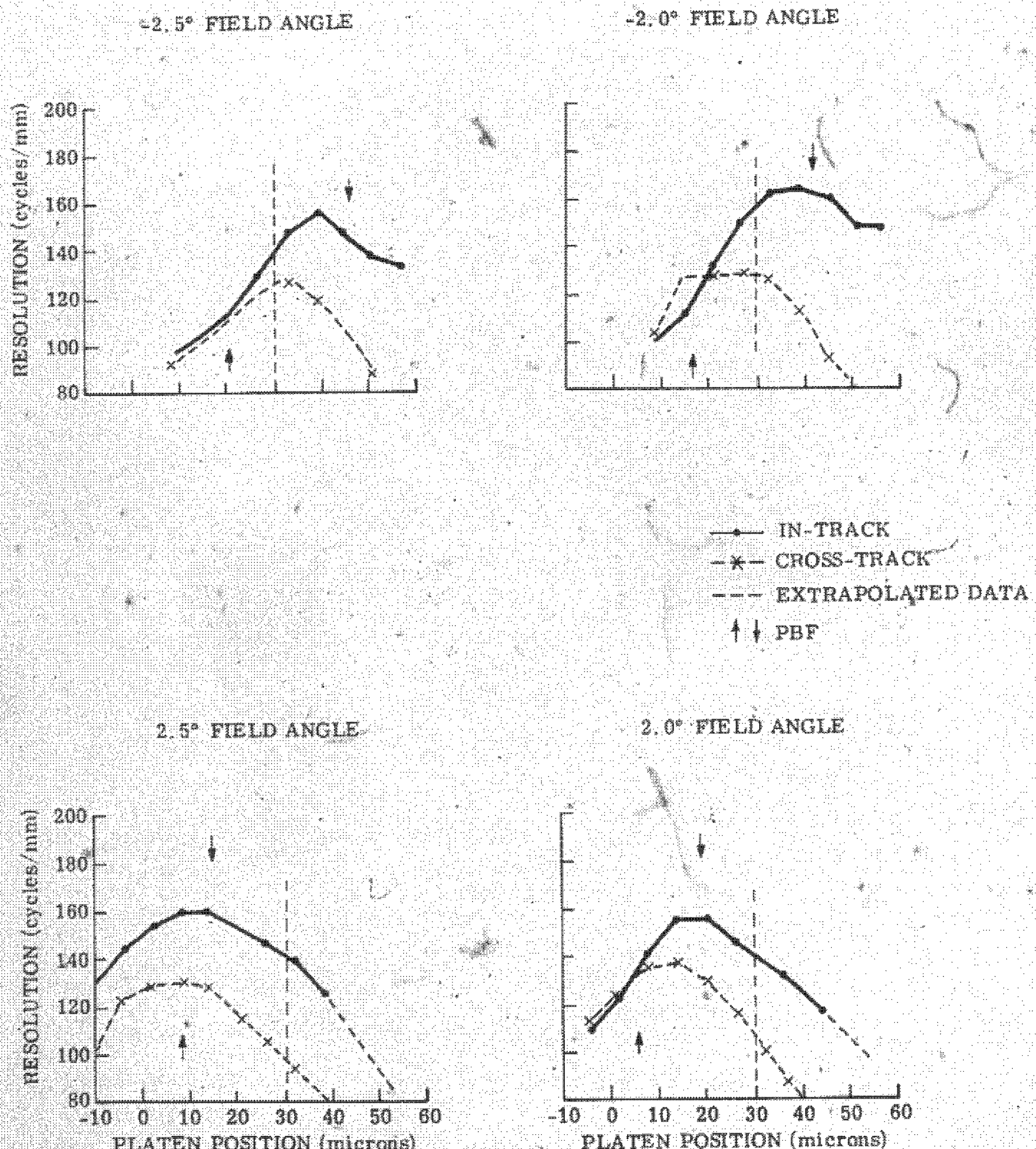
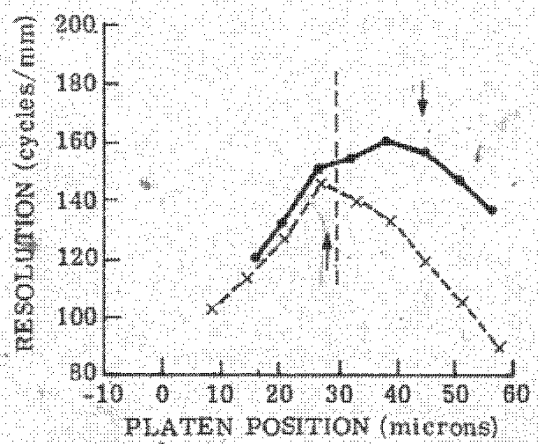


FIGURE 3-1

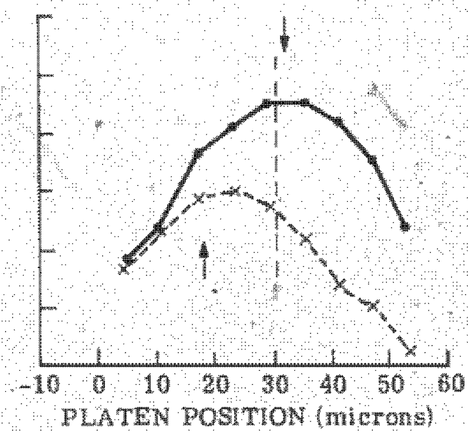
FORWARD CAMERA RESOLUTION THRU FOCUS CURVES

AT 3A-2 CONDITION (CONT'D)

-1.0° FIELD ANGLE

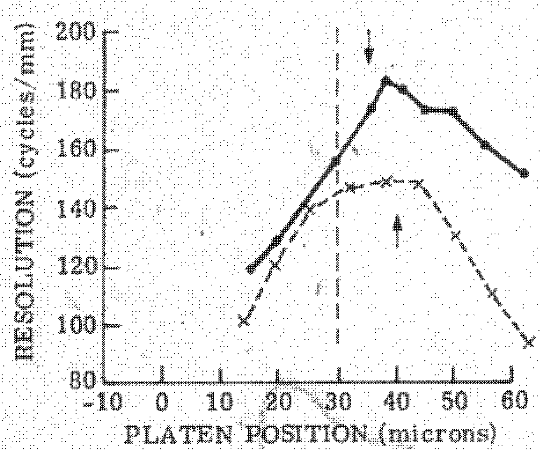


1.0° FIELD ANGLE



—•— IN-TRACK
—✕— CROSS-TRACK
↑ ↓ PBF

0° FIELD ANGLE



AFT CAMERA RESOLUTION THRU FOCUS CURVES

AT 3A-2 CONDITION

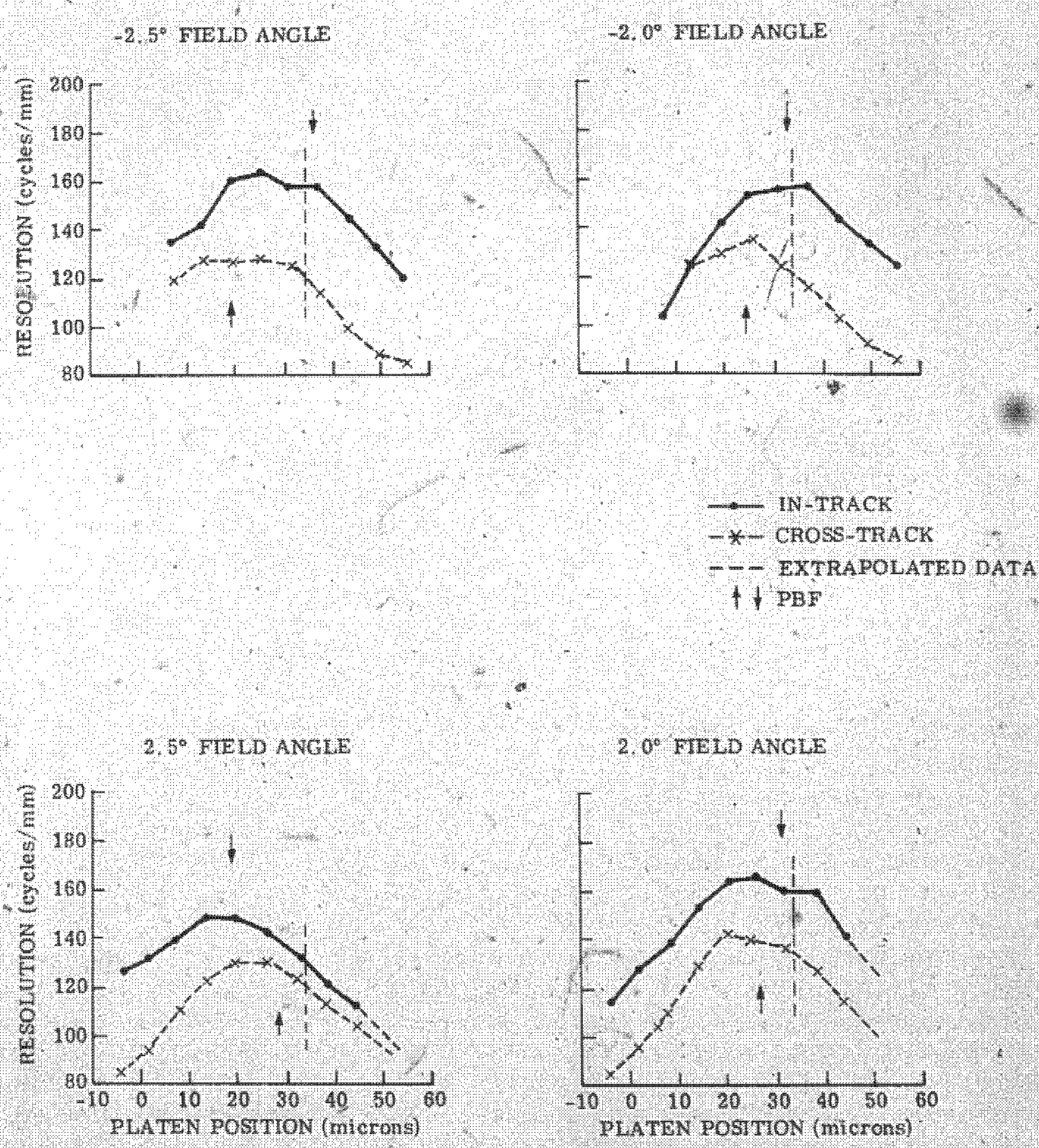
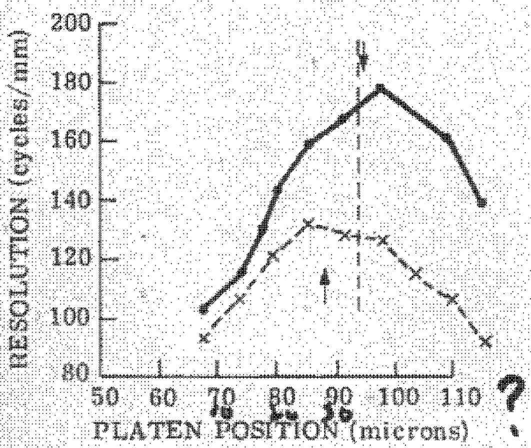


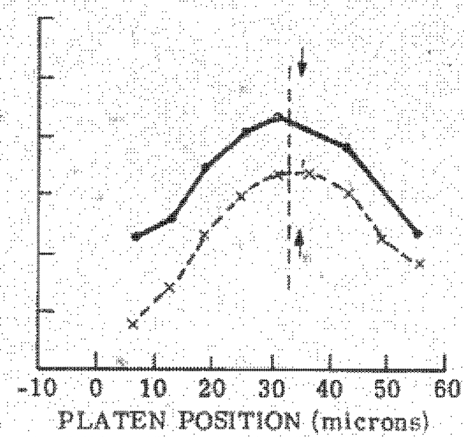
FIGURE 3-2

AFT CAMERA RESOLUTION THRU FOCUS CURVES AT 3A-2 CONDITION (CONT'D)

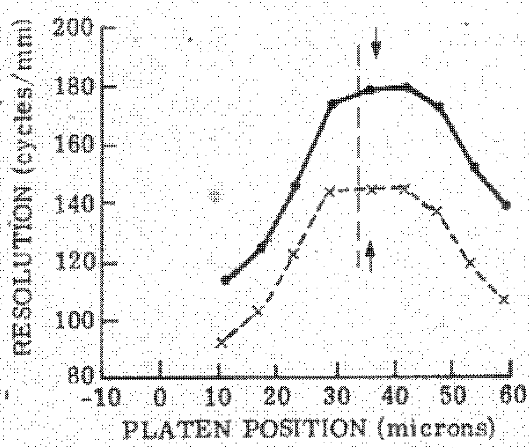
-1.0° FIELD ANGLE



1.0° FIELD ANGLE



0° FIELD ANGLE



The 3A-2 test was a typical Readiness test with the addition of several runs that were used to evaluate the effect of different processing conditions on image quality.

The results of the 3A-2 test were compared with the Chamber A test data. This evaluation indicated a severe loss in performance. The Chamber A imagery was reread to determine if the change in the tribar reading criterion, which occurred between the Chamber A and A-2 tests, may have been the cause of the lower performance. The reread data diminished the difference to some extent but still indicated a problem, see Figures 3-3 and 3-4. Examination of the test material revealed an image quality characteristic which can best be described as a lack of sharpness, and lowering of contrast to the 2:1 tribar target image. These qualities made reading the targets extremely difficult.

As a result of the 3A-2 test, a detailed examination of potential causes of this image quality degradation was undertaken. This investigation covered the following areas:

A. Electromechanical signatures.

B. Image motion.

C. Collimator quality.

D. Material quality.

E. Target reticle contamination (SV-9 oil spill).

F. Historical performance in Chambers A and A-2 for SV-8, SV-9, and SV-12.

3.3.3 Areas of Investigation

Investigations of each of the above areas are summarized below:

A. Electromechanical Signatures

Comparison of electromechanical data recorded during both the Chambers A and A-2 test cycles showed no significant difference.

B. Image Motion

The sync-flash mean velocity errors from the 3A-2 test (Vx/h of .052 radians/second, IMC disabled runs) are listed in Table 3-3.

TABLE 3-3

MEAN VELOCITY ERRORS FROM 3A-2 TEST

(inch/second)

Camera	In-Track	Cross-Track
Forward	.009	.014
Aft	.000	.000

Velocity errors of this magnitude could not cause the image quality degradation exhibited by SN-013 in Chamber A-2.

SPPF RESOLUTION READER COMPARISON BETWEEN
CHAMBER A AND 3A-2 TESTS FOR AFT CAMERA

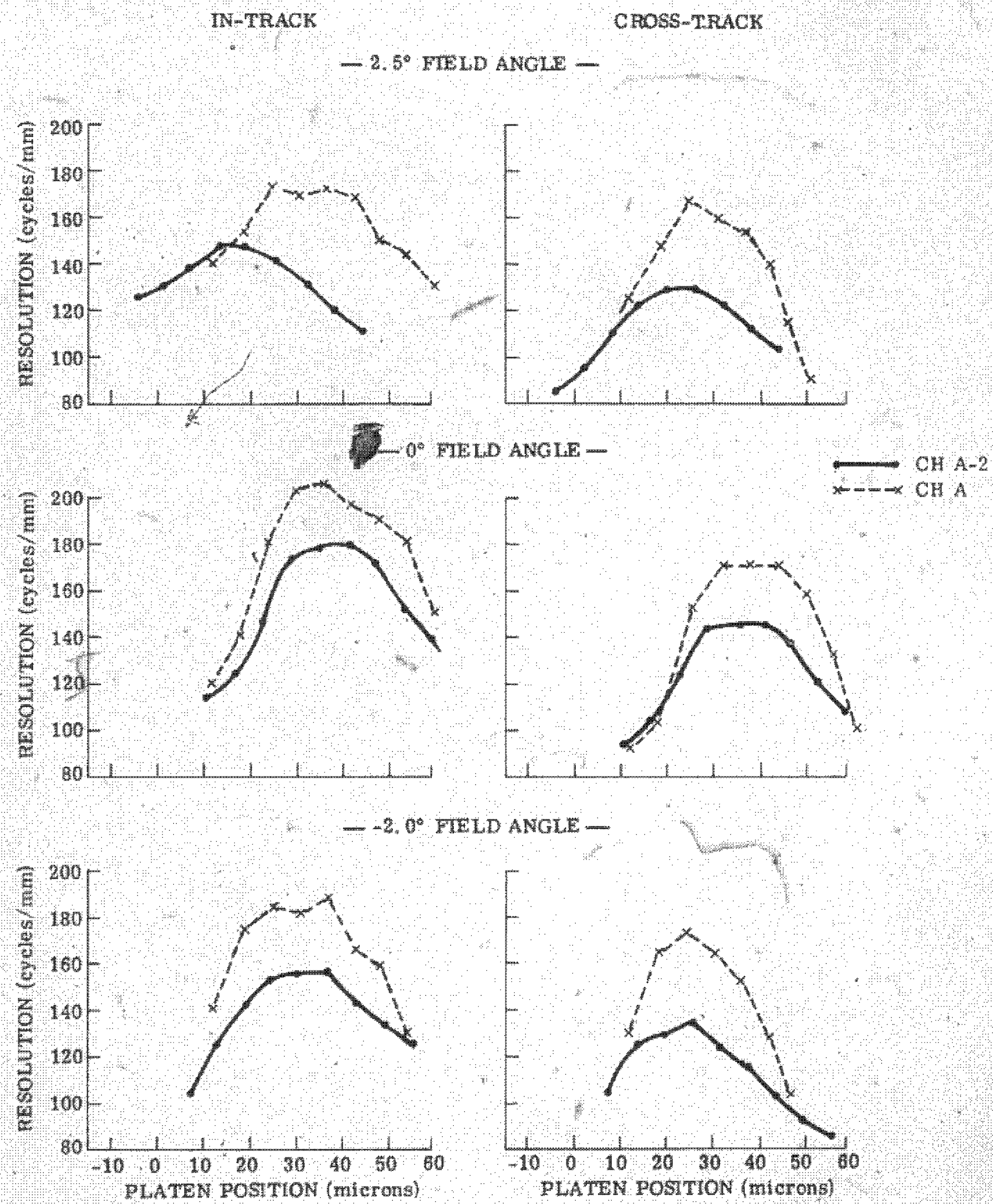


FIGURE 3-3

SPPF RESOLUTION READER COMPARISON BETWEEN CHAMBER A AND 3A-2 TESTS FOR FORWARD CAMERA

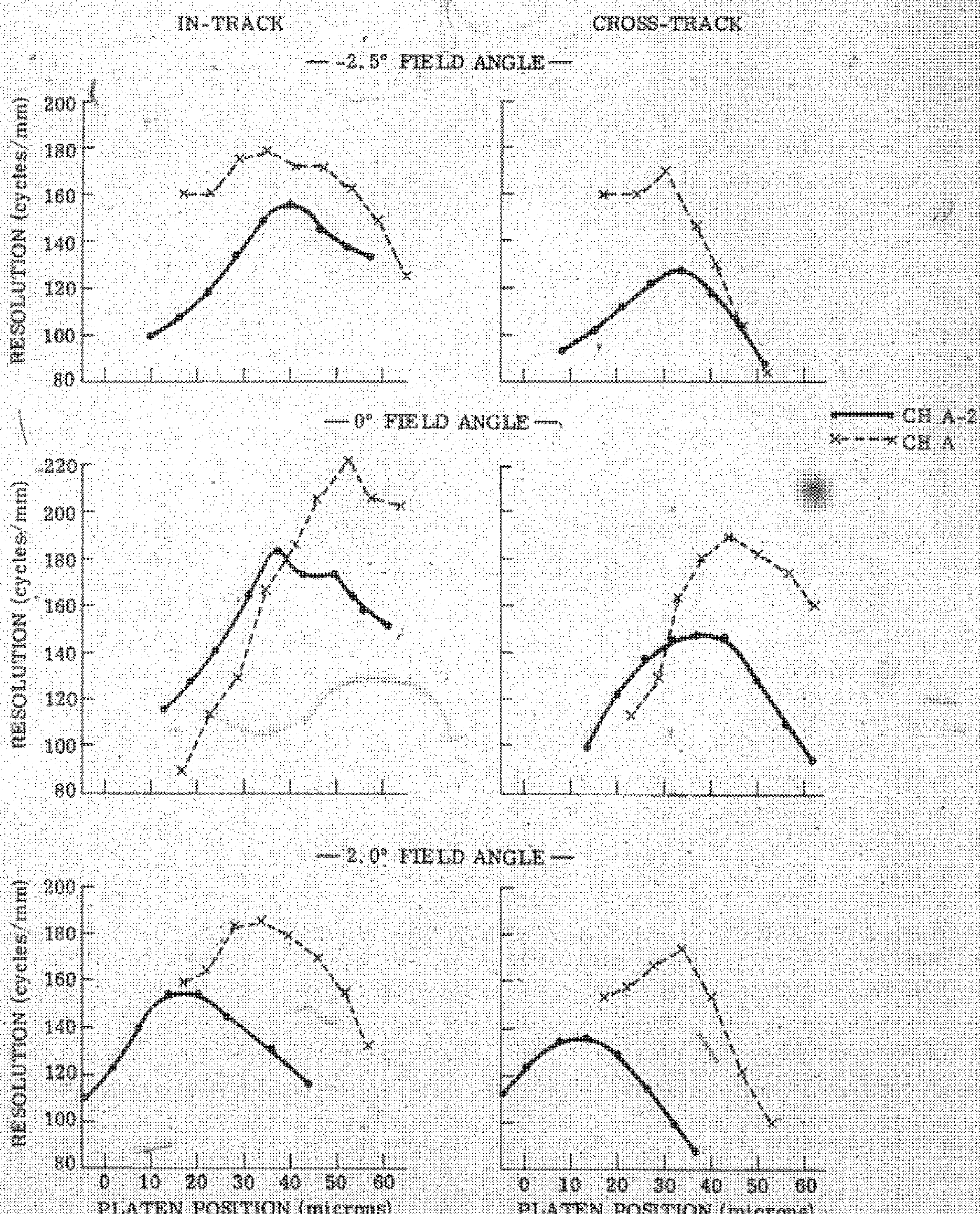


FIGURE 3-4

C. Collimator Quality

Interferograms taken during the 3A-2 tests were typical of past test cycles.

D. Target Reticle Contamination

During the A-2 testing of SV-9, an oil spill occurred from one of the hydraulic jacks used to pitch the vehicle causing some oil to be sprayed into the A0° Collimator and possibly deposited on the 2:1 tribar reticle. Oil was found and removed from the collimator primary, but some oil may have reached the reticle. Examination of imagery acquired before and after the oil spill, revealed no apparent loss in quality or change in the subjective appearance of the 2:1 target; therefore, possible oil contamination is ruled out as a source of the image degradation.

E. Material Quality

Samples of film from the test stacks used for the Chamber A-2 test were sent to BRIDGEHEAD for evaluation to determine if the test material could cause the poor image quality observed in the Readiness test. These samples were compared to a control batch of 1414 material for resolving power and granularity. The results of these tests are given in Table 3-4. No apparent difference could be found between the control and test film samples.

TABLE 3-4

FILM RESOLVING POWER (cycles/mm) AND GRANULARITY

			Film from	
Contrast Ratio	Published Data	Control Batch	Forward Camera	Aft Camera
1000:1	732 ± 160	783 ± 213	758 ± 157	790 ± 127
1.70:1	231 ± 45	247 ± 38	221 ± 48	234 ± 47

—RMS Granularity at 1.0 Density*—

Published Data	Forward Camera	Aft Camera
103.1	115	117

NOTE: The asterisk (*) denotes that the scanning aperture was 2 microns.

F. Historical Performance

A comparison of the imagery from SV-8 and SV-9 chamber tests showed no significant change in performance between Chambers A and A-2, see Table 3-5 on page 3-12. The subjective impression of the image quality between the two chambers was similar; the only visually discernible difference was between the Chamber A CEI-101 runs processed Versamat B-modified, and those processed dual gamma (CEI-109 and the Chamber A-2 test runs). This difference was exhibited as a slightly higher contrast image for the Versamat B-modified processed material; however, this is consistent with the characteristic of this process. When this same comparison was performed for the SV-10 test materials, a difference in image quality (i.e., lack of sharpness and image contrast) became apparent between the Chamber A runs (both CEI-101 and CEI-109) and the Chamber A-2 dual gamma runs. A comparison was made between SV-10 Chamber A-2 dual gamma runs and tests processed in a similar fashion to SV-8 and SV-9 Chamber A-2 tests. The subjective results of this comparison showed that SV-10 quality was consistently judged poorer.

It is felt, therefore, that the dual gamma processing itself is not the cause of the poor image quality. Further investigation revealed that a similar image quality degradation was observed in the Acceptance test imagery for SV-12. The same change in image quality between Versamat B-modified and dual gamma processed runs was also observed. The only commonality between SV-12 and SV-10 tests were that both Supply stacks consisted of Film Batch No. 38. It is possible that some complex combination of processing chemistry, film characteristics, and exposure conditions may be the cause of the degraded appearance of the SV-10 imagery. Special tests are planned as part of the SN-014 (SV-11) Readiness test cycle to thoroughly evaluate this problem.

The Chamber A to Chamber A-2 comparison shown in Figures 3-3 and 3-4 represents SPPF readings. SSC reread the on-axis targets at best focus, see Table 3-6. This data indicates that the difference between chamber tests is not as large as originally conceived. However, it does show that a difference on the order of one tribar element lower for Chamber A-2 versus Chamber A still exists.

TABLE 3-6

SSC READ ON-AXIS PEAK RESOLUTION

(cycles/mm)

Direction	CEI-101	CEI-109	1A-2	3A-2				3A-2 Avg
— Forward Camera —								
In-Track	192	*	180	168	168	158	184	170
Cross-Track	157	157	138	142	139	137	141	140
— Aft Camera —								
In-Track	170	165		155	157	160	160	158
Cross-Track	141	144		143	139	140	140	141

NOTE: The asterisk (*) means that peak focus was not reached.

TABLE 3-5

COMPARISON OF ON-AXIS PEAK RESOLUTION BETWEEN SV-8 THRU SV-10

(cycles/mm)

— Forward Camera —

In-Track

Mission	CEI-101	CEI-109	1A-2	2A-2	3A-2
SV-10	192	*	180	N/A	170
SV-9	186	187	194	182	-
SV-8	198	N/A	191	-	-

Cross-Track

Mission	CEI-101	CEI-109	1A-2	2A-2	3A-2
SV-10	157	157	138	-	140
SV-9	152	148	155	140	-
SV-8	161	N/A	147	-	-

— Aft Camera —

In-Track

Mission	CEI-101	CEI-109	1A-2	2A-2	3A-2
SV-10	170	165	N/A	N/A	158
SV-9	173	177	179	177	-
SV-8	194	N/A	186	-	-

Cross-Track

Mission	CEI-101	CEI-109	1A-2	2A-2	3A-2
SV-10	141	144	N/A	N/A	141
SV-9	144	140	156	146	-
SV-8	162	N/A	153	-	-

NOTES:
1. The following are the major test parameters/factors for CEI-101 and CEI-109:
   a. CEI-101: Versamat B-modified, 120° Scans, .303" slit, and a Vx/h of .052 radians/second.
   b. CEI-109: Dual gamma processed.
2. All Chamber A-2 tests were dual gamma processed.
3. All readings were made by SSC.
4. The asterisk (*) means that peak focus was not reached.

3.4 SELECTION OF PLATEN POSITION FOR FIELD OPTIMIZED PERFORMANCE

Field profiles at a particular platen position, in terms of 2:1 contrast tribar data from the Chamber A-2 test, are given in Figures 3-5 and 3-6. The positions were chosen to encompass that platen setting that yields the best overall performance. The data is summarized in Table 3-7 on pages 3-16 and 3-17. For each platen position, the resolution performance was derived directly from Figures 3-1 and 3-2 using interpolation between data points where necessary. Based on this analysis, the Forward Camera platen setting for optimum performance is 30 microns, and the Aft is 33 microns. These two best focus positions are indicated by vertical dashed lines in Figures 3-1 and 3-2 to show the trade-offs from peak performance that have been made to optimize performance across the field. The choice of 30 microns on the Forward Camera results in the best overall performance across the field. This results in lower performance near the center of format but is compensated for by the improved field performance. The Aft Camera platen position of 33 microns shows a significant departure from peak only at the +2.5° field position; however, the resolution is not significantly different from other field positions.

Average resolution across the field is 151 cycles/mm in-track, 125 cross-track for the Forward Camera, and 159 cycles/mm in-track, 130 cross-track for the Aft Camera, see Table 3-7.

3.5 RESOLUTION VARIABILITY

A measure of image quality variability in terms of 2:1 tribar readings is the ratio of the standard deviation-to-mean resolution for a series of replicated tribar images. This analysis was performed at each of the field positions obtained in the pitch sequence for both the in-track and cross-track resolution data. The results are given in Table 3-8. Both cameras have an average 7% variability for in-track and cross-track.

TABLE 3-8

RESOLUTION VARIABILITY

— Vx/h of .052, Slit Width of .303 Inch —

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

FORWARD CAMERA RESOLUTION THRU FOCUS PROFILES

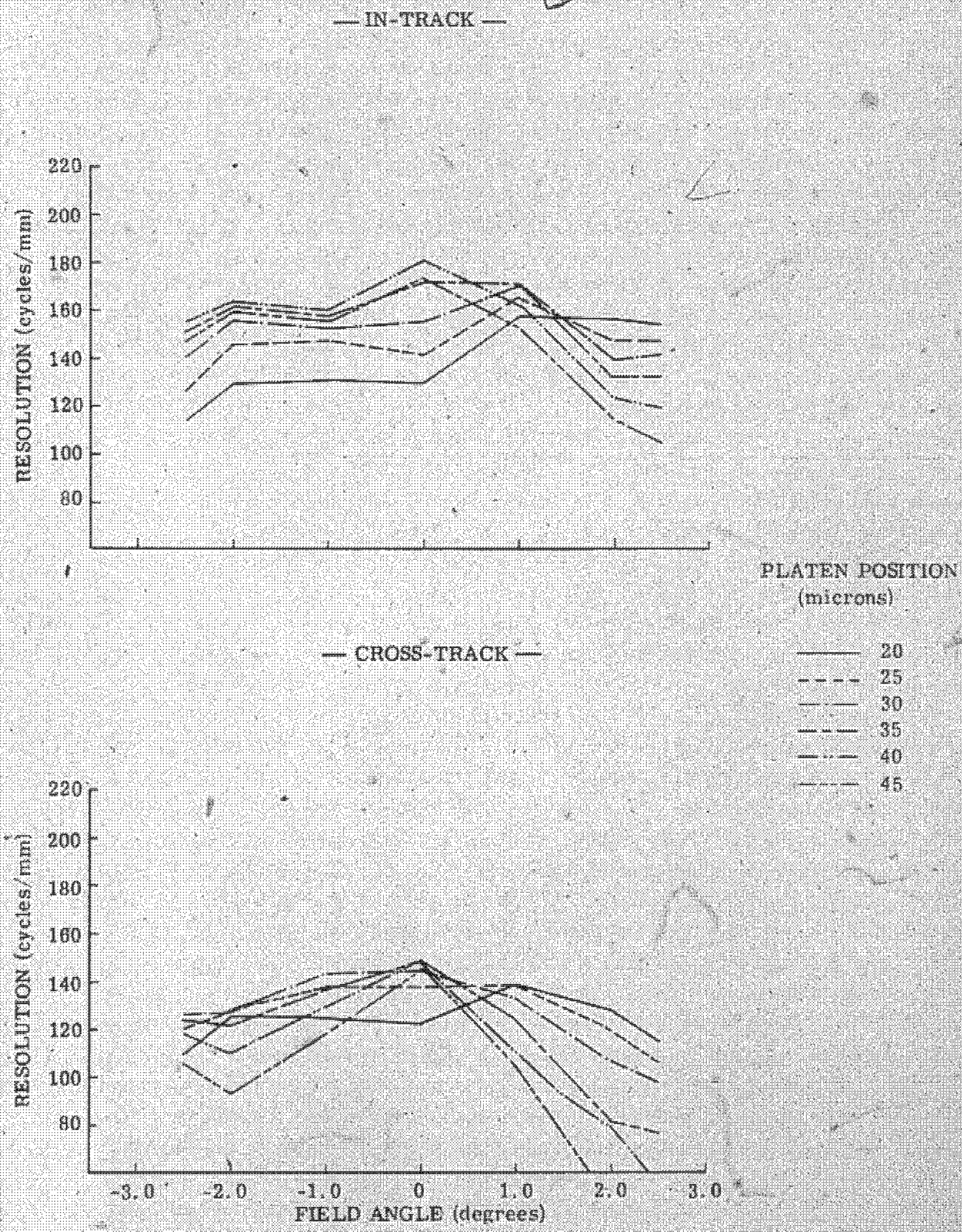


FIGURE 3-5

AFT CAMERA RESOLUTION THRU FOCUS PROFILES

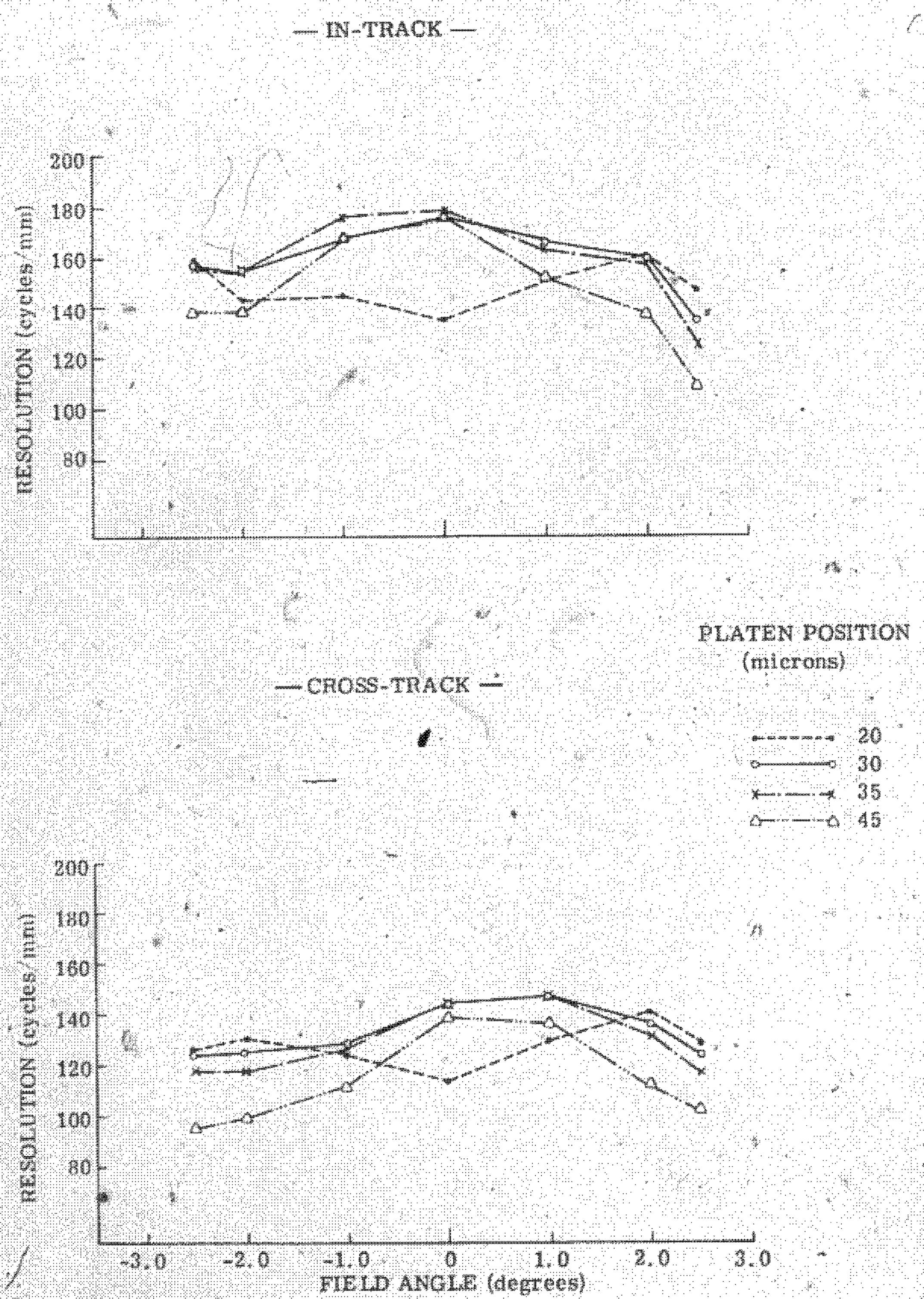


FIGURE 3-6

TABLE 3-7

SN-013 (SV-10) FIELD RESOLUTION PERFORMANCE (3A-2)

(cycles/mm)

Forward Camera

— In-Track —

Platen Position (microns)	Field Angle (degrees) -2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average ± 1σ
20	114	129	131	130	158	157	155	139 ± 17
25	126	145	147	142	165	148	148	146 ± 11
30	140	156	153	156	170	140	142	151 ± 11
35	151	162	158	172	170	133	133	154 ± 16
40	155	163	160	181	163	124	120	152 ± 22
45	147	160	157	173	154	115	106	145 ± 25

— Cross-Track —

Platen Position (microns)	-2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average ± 1σ
20	110	125	125	123	140	129	116	124 ± 10
25	120	128	138	138	139	120	107	127 ± 12
30	126	127	143	144	133	107	98	125 ± 17
35	124	122	138	148	124	92	87	119 ± 22
40	118	110	130	148	110	80	76	110 ± 26
45	106	94	119	146	103	67	65	100 ± 29

TABLE 3-7 (CONT'D)

Aft Camera

— In-Track —

Platen Position (microns)	Field Angle (degrees) -2.5	-2.0	-1.0	0	1.0	2.0	2.5	Average ± 1σ
20	160	143	145	135	151	161	147	149 ± 9
25	163	152	160	157	161	164	141	157 ± 8
30	157	155	167	175	166	160	135	159 ± 13
35	156	155	176	178	163	158	126	159 ± 17
40	147	148	174	180	159	151	118	154 ± 20
45	138	139	167	176	151	137	109	145 ± 22
— Cross-Track —								
20	126	130	124	113	129	141	129	127 ± 8
25	126	134	133	129	139	138	129	132 ± 5
30	124	126	129	144	147	137	125	133 ± 10
35	118	118	127	144	147	131	117	129 ± 13
40	107	100	120	145	144	122	108	122 ± 17
45	95	99	112	139	136	111	101	113 ± 17

3.6 EXPECTED ON-ORBIT RESOLUTION

The expected on-orbit performance for SV-10 (Table 3-9) is based on the 3A-2 test results combined with the Chamber D field curvature and the predicted on-orbit absence of astigmatism. The predicted on-orbit absence of astigmatism historically matches the measured on-orbit field curvature performance better than the field curvature derived from the pitch test in Chamber A-2.

TABLE 3-9

SV-10 EXPECTED ON-ORBIT PERFORMANCE

— Forward Camera —

Field Angle (degrees)	In-Track (cycles/mm)	Cross-Track (cycles/mm)	Geometric Mean (cycles/mm)
-2.5	150	125	137
-2.0	163	127	144
-1.0	160	140	150
0	178	148	162
1.0	170	140	154
2.0	155	132	143
2.5	158	128	142

— Aft Camera —

Field Angle (degrees)	In-Track (cycles/mm)	Cross-Track (cycles/mm)	Geometric Mean (cycles/mm)
-2.5	162	126	143
-2.0	155	128	141
-1.0	178	127	150
0	180	145	162
1.0	164	147	155
2.0	162	134	147
2.5	144	126	135

FILM SYNCHRONIZATION
TESTS

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 any of the Chamber A-2 tests.

4.2 GRAVITY EFFECTS ON IMAGE MOTION

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

TABLE 4-1

GRAVITY CORRECTION DATA FOR A VX/H OF .052

(inch/second)

Direction	Collimator Position (degrees) -45	0	37	55
— Forward Camera —				
In-Track	.045	-.003	-.038	-.051
Cross-Track	-.023	-.034	-.031	-.025
— Aft Camera —				
In-Track	.040	-.009	-.028	-.046
Cross-Track	.028	-.035	-.031	-.031

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-10 film. All sync-flash data in this report has been corrected for these measured rotations.

4.4 OOAA CALIBRATION EVALUATION

The results of the OOAA calibration sequences performed during the Chamber A-2 vacuum 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° scan position from the 1A-2 and 3A-2 tests, and at a Vx/h value of .052 at the 0° scan position from the 2A-2 test.

Figures 4-1 thru 4-6 are plots of the 0° scan position data from all three A-2 tests. Straight lines have been fitted to the points using the least squares technique. The equations of these best fit straight lines are listed in Table 4-3, together with the correlation that indicates the accuracy of fit. A comparison of the OOAA calibration curves shows that uniformity exists between the Chamber A-2 tests. With the exception of the Aft Camera in-track slope, the data from the A-2 tests show good correlation between the OOAA calibration curves and the theoretical curves.

4.5 SYNC ERROR MEASUREMENT SUMMARY

Tables 4-4 thru 4-7 present the summary of the SV-10 film synchronization performance from the Chamber A and the three Chamber A-2 tests. The following are significant observations and analyses relating to the film synchronization.

4.5.1 Chamber A Versus Chamber A-2 Comparison

Both the Forward and Aft Camera platens were removed between the Chamber A and Chamber A-2 testing. A comparison of the sync-flash data from both of these tests showed that skew angle errors, as a result of platen removal, were introduced into both cameras. The magnitude of these errors were 30 arc-seconds for the Forward and 120 arc-seconds for the Aft Camera. The cross-track smear errors did not change from Chamber A.

The following OOAA hardware changes were made to the system as a result of the Chamber A-2 data analyses.

A. An in-track skew adjustment of -3 command counts was made on the Forward Camera.

B. A cross-track velocity adjustment of +2 command counts was made on the Forward Camera. This velocity adjustment was also indicated as a result of the Chamber A data analysis.

C. An in-track skew adjustment of -12 command counts was made on the Aft Camera.

4.5.2 First Chamber A-2 Versus Second and Third Chamber A-2 Comparison

The sync-flash data results from the 2A-2 and 3A-2 tests showed that the OOAA hardware changes made to the system to reduce both the in-track and cross-track mean smear errors were correct both in magnitude and direction.

4.5.3 Flight Configuration Test

No change in the mean motion errors of either camera was noted when comparing data from post

TABLE 4-4

FILM SYNCHRONIZATION ERROR SUMMARY

(inch/second)

Temperature 70° F — FORWARD CAMERA — IMC Enabled

Nominal Vx/h	Direction	0° COLLIMATOR										
		Spec	Chamber A Vac Accept		Chamber A-2							
			SSC	SPPF	1A-2 Vac Box In	Post 1A-2 Box In	Post 1A-2 Box Out	2A-2 Vac Box In	3A-2 Vac Box In	Post 3A-2 Box In	Post 3A-2 Box Out
.052	IN-TRACK MEAN	±.050	-.005		.032	.035	.033	.001	.006	.011	.009
	IN-TRACK TWO SIGMA	.050	.033		.031	.029	.022	.029	.039	.025	.030
	CROSS-TRACK MEAN	±.050	-.018		-.011	-.024	-.015	-.021	.023	-.012	-.009
	CROSS-TRACK TWO SIGMA	.100	.075		.076	.044	.050	.051	.063	.054	.051
.044	IN-TRACK MEAN	±.050	-.001		.016	.014	.015	-.006	-.012	-.005	.001
	IN-TRACK TWO SIGMA	.050	.026		.034	.022	.025	.035	.028	.023	.031
	CROSS-TRACK MEAN	±.050	-.020		-.002	-.028	-.026	.010	.019	.017	.019
	CROSS-TRACK TWO SIGMA	.100	.075		.045	.034	.045	.060	.058	.049	.047
.036	IN-TRACK MEAN	±.035	-.010								
	IN-TRACK TWO SIGMA	.037	.030								
	CROSS-TRACK MEAN	±.045	-.018								
	CROSS-TRACK TWO SIGMA	.098	.049								

NOTES: 1. Table Information.
- a. All data is plus (+) unless otherwise noted.
- b. Plus (+) in-track error indicates the platen leads optical bar.
- c. Plus (+) cross-track error means film speed is too fast.
- d. The FIDAP sign convention is used.

2. SPPF did not measure any sync-flash during the Acceptance testing of SN-013 (SV-10).
3. There was no testing at the Vx/h value of .036 during the three Chamber A-2 tests.

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	3A-2 Vac Box In
.052	IN-TRACK MEAN	±.050	.023		.064			.030
	IN-TRACK TWO SIGMA	.050	.030		.045			.038
	CROSS-TRACK MEAN	±.050	-.022		-.021			.019
	CROSS-TRACK TWO SIGMA	.100	.049		.055			.041
.044	IN-TRACK MEAN	±.050	.025		.052			.027
	IN-TRACK TWO SIGMA	.050	.027		.033			.028
	CROSS-TRACK MEAN	±.050	-.009		-.013			.019
	CROSS-TRACK TWO SIGMA	.100	.045		.050			.058
.036	IN-TRACK MEAN	±.035	.013					
	IN-TRACK TWO SIGMA	.037	.020					
	CROSS-TRACK MEAN	±.045	-.010					
	CROSS-TRACK TWO SIGMA	.098	.035					

NOTES: 1. Table Information.

a. All data is plus (+) unless otherwise noted.

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

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

d. The FIDAP sign convention is used.

2. SPPF did not measure any sync-flash during the Acceptance testing of SN-013 (SV-10).

3. There was no testing at the Vx/h value of .036 during the three Chamber A-2 tests.

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		Chamber A-2						
			Vac Accept		1A-2 Vac Box In	Post 1A-2 Box In	Post 1A-2 Box Out	2A-2 Vac Box In	3A-2 Vac Box In	Post 3A-2 Box In	Post 3A-2 Box Out
			SSC	SPPF							
.052	IN-TRACK MEAN	±.050	.007		-.124	-.148	-.139	-.008	-.016	-.013	-.012
	IN-TRACK TWO SIGMA	.050	.031		.042	.022	.025	.027	.032	.024	.027
	CROSS-TRACK MEAN	±.050	.001		.010	-.025	-.018	-.011	-.020	-.005	.009
	CROSS-TRACK TWO SIGMA	.100	.041		.034	.034	.029	.044	.034	.031	.042
.044	IN-TRACK MEAN	±.050	.000		-.108	-.098	-.109	.003	-.014	-.018	-.015
	IN-TRACK TWO SIGMA	.050	.021		.035	.019	.019	.023	.028	.019	.020
	CROSS-TRACK MEAN	±.050	.006		-.012	.006	.003	-.009	-.004	-.008	-.006
	CROSS-TRACK TWO SIGMA	.100	.039		.034	.030	.030	.032	.032	.034	.027
.036	IN-TRACK MEAN	±.035	.011								
	IN-TRACK TWO SIGMA	.037	.024								
	CROSS-TRACK MEAN	±.045	-.005								
	CROSS-TRACK TWO SIGMA	.098	.034								

NOTES: 1. Table Information.

a. All data is plus (+) unless otherwise noted.

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

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

d. The FIDAP sign convention is used.

2. SPPF did not measure any sync-flash during the Acceptance testing of SN-013 (SV-10).

3. There was no testing at the Vx/h value of .036 during the three Chamber A-2 tests.

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		Chamber A-2			
			Vac Accept		1A-2 Vac Box In	Post 1A-2 Box Out	Post 1A-2 Box In	3A-2 Vac Box In
			SSC	SPPF				
.052	IN-TRACK MEAN	±.050	-.052		-.197			-.075*
	IN-TRACK TWO SIGMA	.050	.031		.033			.031
	CROSS-TRACK MEAN	±.050	.011		-.020			.015
	CROSS-TRACK TWO SIGMA	.100	.051		.044			.039
.044	IN-TRACK MEAN	±.050	-.049		-.162			-.070*
	IN-TRACK TWO SIGMA	.050	.026		.023			.029
	CROSS-TRACK MEAN	±.050	-.013		.012			-.001
	CROSS-TRACK TWO SIGMA	.100	.045		.060			.043
.036	IN-TRACK MEAN	±.035	-.030					
	IN-TRACK TWO SIGMA	.037	.022					
	CROSS-TRACK MEAN	±.045	-.011					
	CROSS-TRACK TWO SIGMA	.098	.030					

* Out-of-specification.

NOTES: 1. Table Information.
   a. All data is plus (+) unless otherwise noted.
   b. Plus (+) in-track error indicates the platen leads optical bar.
   c. Plus (+) cross-track error means film speed is too fast.
   d. The FIDAP sign convention is used.
2. SPPF did not measure any sync-flash during the Acceptance testing of SN-013 (SV-10).
3. There was no testing at the Vx/h value of .036 during the three Chamber A-2 tests.

Chamber 3A-2 vacuum tests with the IMC disable box removed (box out) to the box in test data.

4.6 ON-ORBIT IMAGE MOTION ERROR PREDICTIONS

The predictions of SV-10 on-orbit image motions errors at a Vx/h of .052 are depicted on an original negative frame format for the Forward and Aft Cameras, see Figures 4-7 and 4-8. These predicted errors were developed by the algebraic combination of the most recent synchronous flash data with the orbital image motion errors. This data is corrected for both gravity and "C" target rotation. These errors are listed in Table 4-8.

4.7 CONCLUSIONS AND RECOMMENDATIONS

A. With nominal OOAA setting, the Forward Camera mean errors are all within specification. The Aft Camera meets specification at the 0° scan position; however, the in-track mean error at the 37° scan position is out-of-specification. This 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 skew adjustment of -1 command count from nominal is recommended for in-track compensation of the Forward Camera.

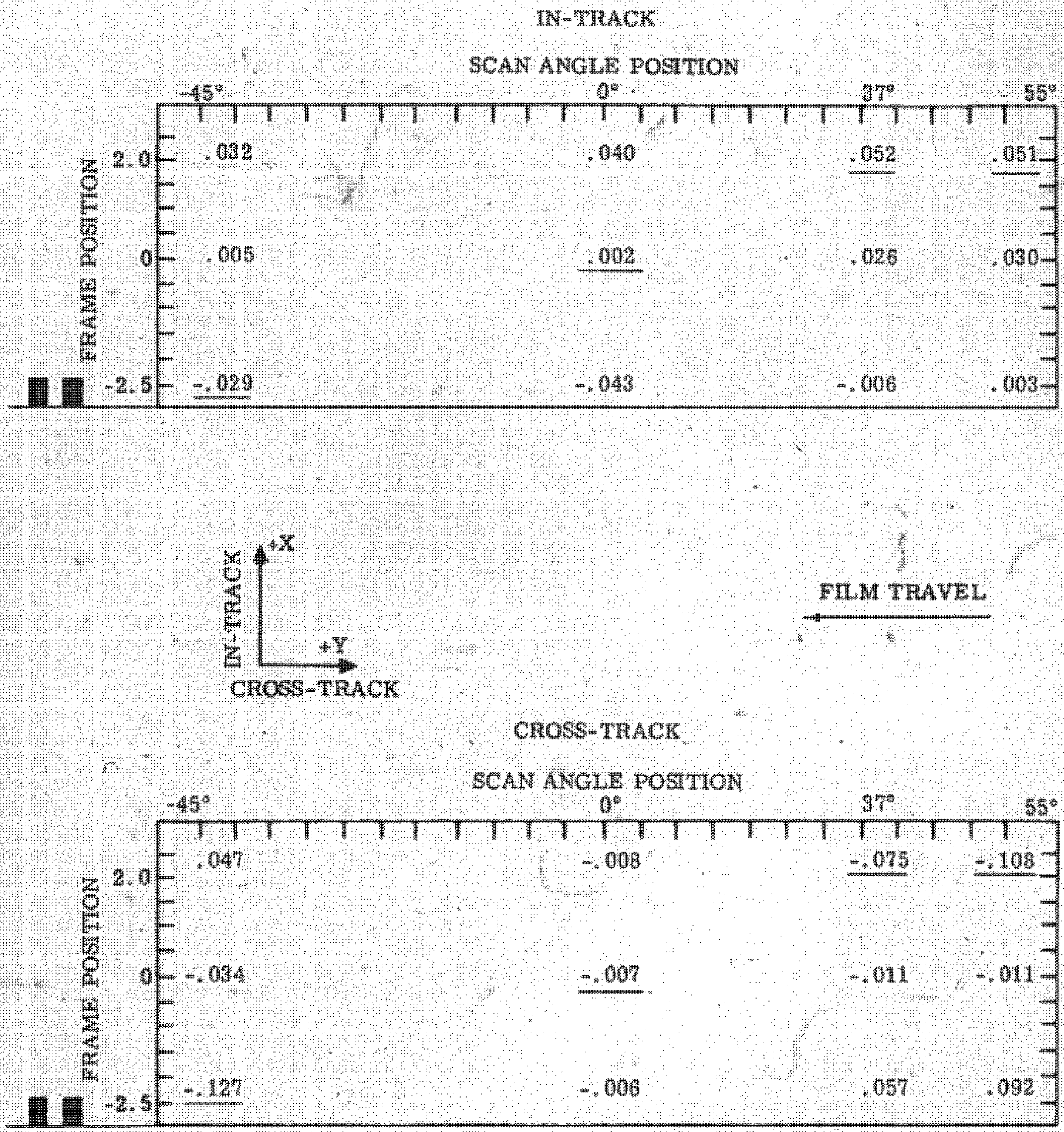
(2) An OOAA skew adjustment of -4 command counts from nominal is recommended for in-track compensation of the Aft Camera. The mean smear data for the Aft Camera indicated that skew adjustment of a -1 command count be made. However, based on the flight adjustments made as a result of on-orbit smear slit tests on SV-6 thru SV-9, an additional -3 command counts are being recommended. To date, the possible sources of this residual error in setting the Aft in-track OOAA flight nominal from the ground test sync-flash data have not been determined but are under investigation.

C. A velocity adjustment derived from the Acceptance test of -15 command counts from flight nominal is recommended for both the SO-255 and SO-130 materials. This cross-track velocity adjustment assumes the mechanical characteristics of SO-130 material are similar to that of SO-255.

D. The OOAA adjustments for the SO-124 material shall be assumed to be the same as for the 1414 material.

FORWARD CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION

(Vx/h of .052)



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

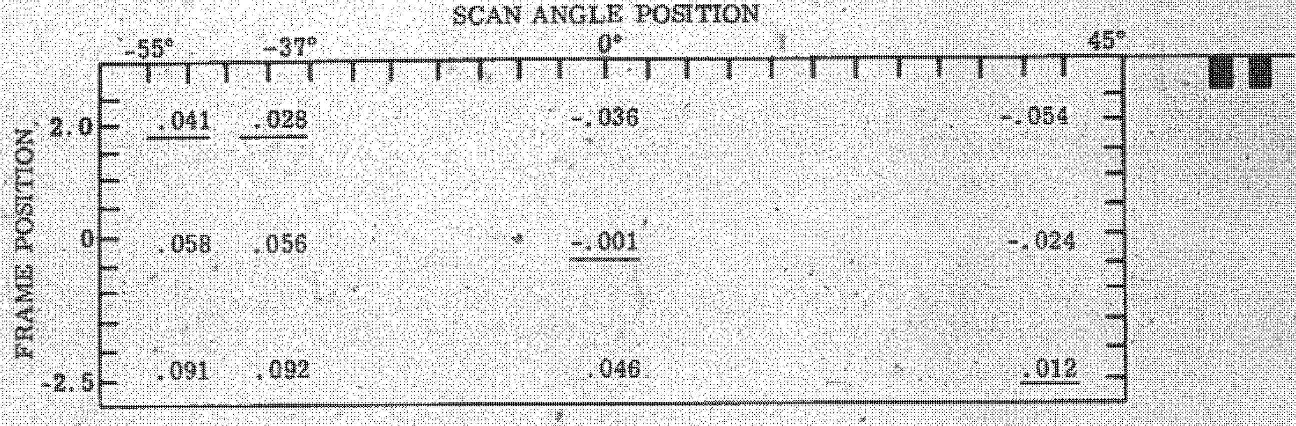
FIGURE 4-7

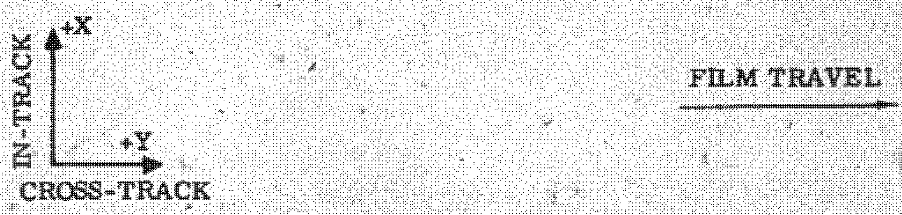
TOP SECRET-HEXAGON

AFT CAMERA ON-ORBIT IMAGE MOTION ERROR PREDICTION

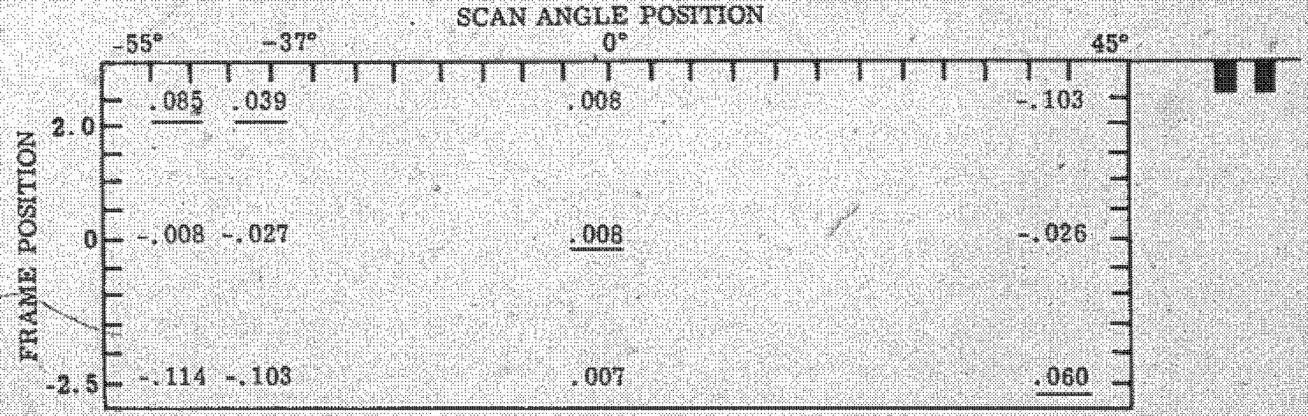
(Vx/h of .052)

IN-TRACK





CROSS-TRACK



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

FIGURE 4-8

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	37	55
FRAME POSITION (DEGREES)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SMEAR ERROR	.010	.011	.035	.039	-.035	-.007	-.011	-.011
ORBITAL FIXED KNOWN	.033	.038	.026	.023	.082	-.001	-.064	-.097
ORBITAL RESULTANT	.043	.049	.061	.062	.047	-.008	-.075	-.108
RECOMMENDED ODAA BIAS	-.009	-.009	-.009	-.009	0	0	0	0
RESULTANT	.032	.040	.052	.051	.047	-.008	-.075	-.108

	IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	-45	0	37	55	-45	0	37	55
FRAME POSITION (DEGREES)	0	0	0	0	0	0	0	0
SMEAR ERROR	.010	.011	.035	.039	-.035	-.007	-.011	-.011
ORBITAL FIXED KNOWN	.004	0	0	0	.001	0	0	-.006
ORBITAL RESULTANT	.014	.011	.035	.039	-.034	-.007	-.011	-.011
RECOMMENDED ODAA BIAS	-.009	-.009	-.009	-.009	0	0	0	0
RESULTANT	.005	.002	.026	.030	-.034	-.007	-.011	.011

	IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	-45	0	37	55	-45	0	37	55
FRAME POSITION (DEGREES)	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
SMEAR ERROR	.010	.011	.035	.039	-.035	-.007	-.011	-.011
ORBITAL FIXED KNOWN	-.030	-.045	-.032	-.027	-.092	.001	.058	.103
ORBITAL RESULTANT	-.020	-.034	.003	.012	-.127	-.006	.057	.092
RECOMMENDED ODAA BIAS	-.009	-.009	-.009	-.009	0	0	0	0
RESULTANT	-.027	-.043	-.006	.003	-.127	-.006	.057	.092

AFT CAMERA

	IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	45	0	-37	-55	45	0	-37	-55
FRAME POSITION (DEGREES)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SMEAR ERROR	-.012	.011	.068	.070	-.027	.008	-.027	-.002
ORBITAL FIXED KNOWN	-.030	-.035	-.028	-.017	-.076	0	.066	.097
ORBITAL RESULTANT	-.042	-.024	.040	.053	-.103	.008	.039	.095
RECOMMENDED ODAA BIAS	-.012	-.012	-.012	-.012	0	0	0	0
RESULTANT	-.054	-.036	.028	.041	-.103	.008	.039	.095

	IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	45	0	-37	-55	45	0	-37	-55
FRAME POSITION (DEGREES)	0	0	0	0	0	0	0	0
SMEAR ERROR	-.012	.011	.068	.070	-.027	.008	-.027	-.002
ORBITAL FIXED KNOWN	0	0	0	.006	.001	0	0	-.006
ORBITAL RESULTANT	-.012	.011	.068	.070	-.026	.008	-.027	-.008
RECOMMENDED ODAA BIAS	-.012	-.012	-.012	-.012	0	0	0	0
RESULTANT	-.024	-.001	.056	.058	-.026	.008	-.027	-.008

	IN-TRACK				CROSS-TRACK			
SCAN ANGLE (DEGREES)	45	0	-37	-55	45	0	-37	-55
FRAME POSITION (DEGREES)	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
SMEAR ERROR	-.012	.011	.068	.070	-.027	.008	-.027	-.002
ORBITAL FIXED KNOWN	.036	.047	.036	.033	.087	-.001	-.106	-.112
ORBITAL RESULTANT	.024	.058	.104	.103	.060	.007	-.133	-.114
RECOMMENDED ODAA BIAS	-.012	-.012	-.012	-.012	0	0	0	0
RESULTANT	.012	.046	.092	.091	.060	.007	-.133	-.114

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

FLIGHT FOCUS

Handle via Byeman
Controls Only

SECTION V

FLIGHT FOCUS

5.1 INTRODUCTION

The recommended flight focus settings for the black and white portion of SV-10 are 30 microns for the Forward Camera (1414) and 30 microns for the Aft Camera (both 1414 and SO-124). Conventional color film (SO-255) and infrared film (SO-130) will be on the Aft Camera and will require a platen offset of +30 microns resulting in a focus setting of 60 microns. This section presents the rationale for these decisions as well as the analysis of platen tilt adequacy and the effect of filter change on focus.

5.2 PLATEN TILT ASPECTS

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

In all cases but three (Forward/cross-track at both -2.5° and -2.0°, and the Aft/in-track at -2.5°) the two diagnostics yield good agreement. The results for each diagnostic are averaged to determine the PBF for any condition. Of the three cases where there is a discrepancy, two are explained by a flat thru focus response (Forward/cross-track at -2.0°, and Aft/in-track at -2.5°); the third is unexplainable at this time. The effect of not weighting the results to either extreme in any of the three instances is minimal because the mean approaches the resolution peak. Therefore, the best estimate in-track and cross-track PBFs are averaged to yield a final assessment for PBF. Figure 5-1 is a plot of these results in comparison with Chamber D interferometric measurements made on the individual optical bars. As has been noticed in the past, the field curvature as measured in Chamber A-2 is greater than that measured in Chamber D. This is especially true in the case of the Forward Camera. In addition to the increased field curvature, the platen appears grossly tilted. The historic relationship between these two chambers is characteristic, see Figure 5-2. This figure presents a comparison of the SV-10 field curvature with those of the previous four systems similarly tested via the vehicle pitch configuration. As can be seen in Figure 5-2, there is a striking similarity in the five sets of data, including the asymmetry between the plus and minus field of the Forward Camera.

Based on this historical comparison, the apparent tilt of the Forward Camera platen is judged to be non-existent. This conclusion is also supported by the fact that VEM analysis of image quality across the minor axis from Missions 1206 thru 1209 reveals no evidence of a mistilted platen on either the Forward or Aft Cameras. In summary, the Readiness Team feels that the SV-10 platens are adequately tilted for launch.

TABLE 5-1

TRIBAR AND LINE DETERMINATIONS OF PBF

(microns)

Position (degrees)	Raw Data: Forward Camera Tribar IT	Raw Data: Forward Camera Tribar XT	Raw Data: Forward Camera Lines IT	Raw Data: Forward Camera Lines XT	Raw Data: Aft Camera Tribars IT	Raw Data: Aft Camera Tribars XT	Raw Data: Aft Camera Lines IT	Raw Data: Aft Camera Lines XT	Best Estimates: Forward Camera IT	Best Estimates: Forward Camera XT	Best Estimates: Aft Camera IT	Best Estimates: Aft Camera XT	Final Assessment: Forward Camera	Final Assessment: Aft Camera
-2.5	39	32	46	21	27	23	36	19	42	27	32	21	35	27
-2.0	39	27	42	17	32	23	33	24	40	22	33	24	31	29
-1.0	38	30	44	28	38	30	34	28	41	29	36	29	35	33
0	42	38	35	40	37	36	37	36	39	39	37	36	39	37
1.0	31	23	32	18	31	34	35	35	32	21	33	35	27	34
2.0	17	13	19	6	27	25	31	27	18	10	29	26	14	28
2.5	14	8	15	9	17	23	19	28	15	9	18	26	12	22

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

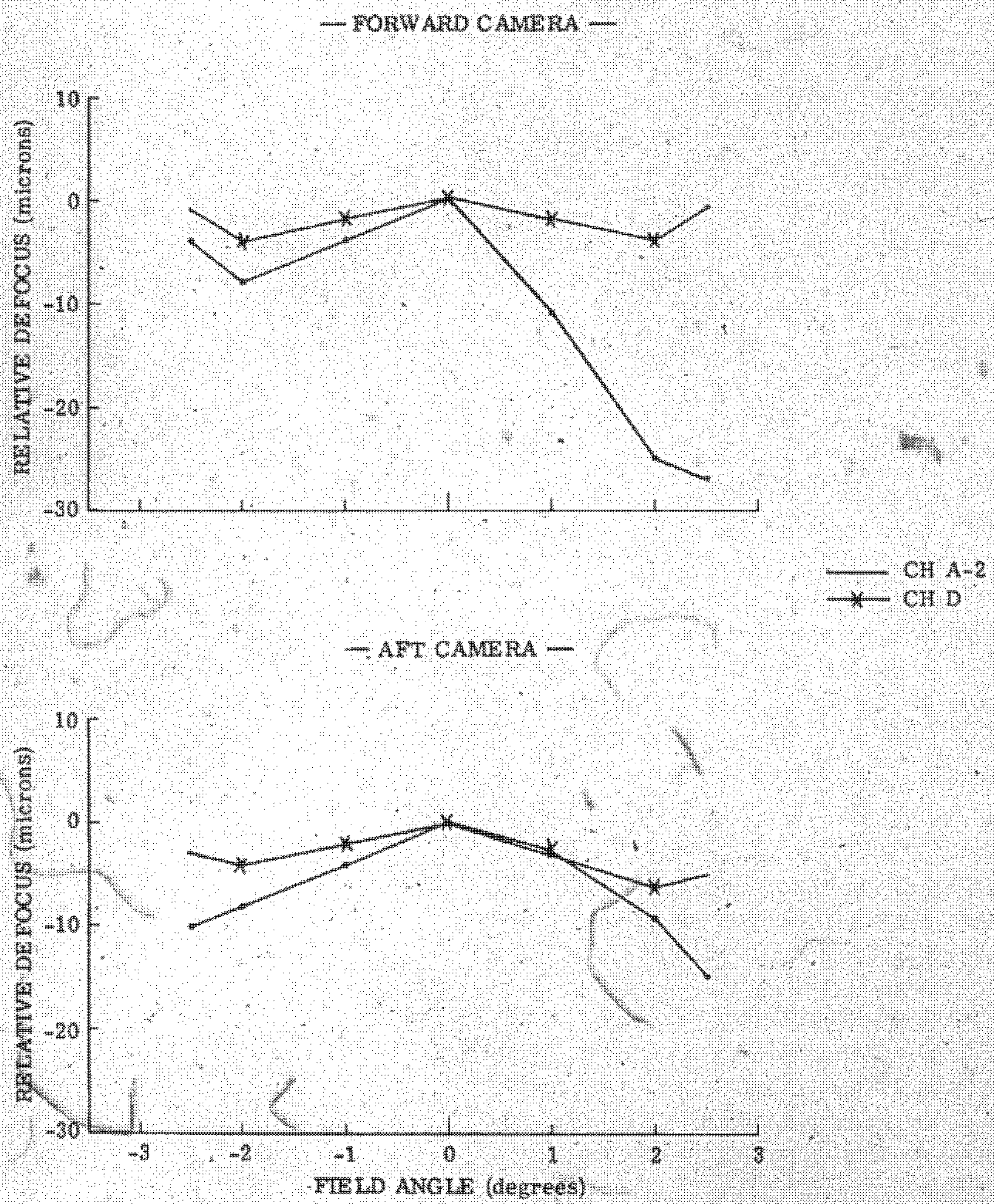


FIGURE 5-1

HISTORICAL COMPARISON OF CHAMBER A-2 MEASURED FIELD CURVATURE

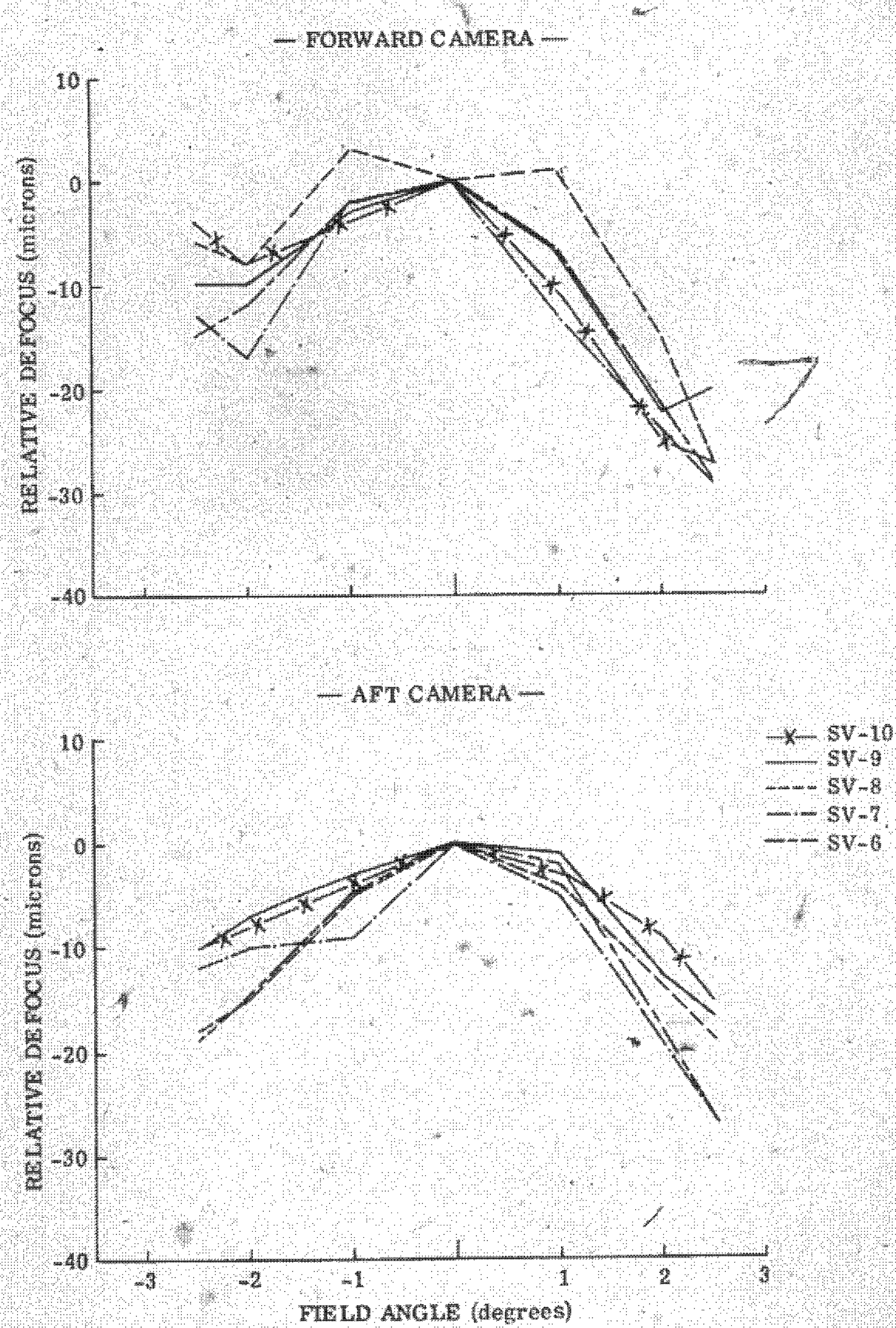


FIGURE 5-2

5.3 EFFECT OF FILTER CHANGE ON FOCUS

Both cameras of SV-10 are equipped with ICFs allowing choice between two filters, a Wratten 12 or a Wratten 2E3. During Readiness testing (1A-2), Seq L was run to determine if changes in either resolution performance or focus occur when a change in filter type is made. Test parameters for this sequence were a Vx/h of .044 and a slit width of .259", with IMC disabled. The results of this analysis show that there is no detectable difference in PBF on either camera as a result of changing filters.

Replicate frames were acquired with each filter in place at platen positions of 44 and 36 microns for the Forward and Aft Cameras respectively. No change in the 2:1 contrast geometric mean resolution performance was found for either camera with the use of the different filters, see Table 5-2. It should be noted that the resolution values obtained from this test are somewhat suppressed for both cameras, especially the Aft in-track. These lower resolution values are due to film synchronization errors present in the Chamber 1A-2 test. These errors were not substantial on the Forward Camera and do not preclude a meaningful comparison; however, this was not the case on the Aft Camera where there was an in-track error of approximately .1 inch/second. This situation does not allow a meaningful comparison of the in-track resolution. The Readiness Team does feel that the cross-track resolution analysis provides meaningful results.

TABLE 5-2

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
001-013	W-12	161	121	13	001-010	W-12	136	131	10
016-023	W-2E3	157	125	8	012-020	W-2E3	130	128	9
026-033	W-12	156	120	8	023-030	W-12	126	129	8
036-043	W-2E3	156	121	8	033-040	W-2E3	134	127	8
046-053	W-12	154	115	8	043-050	W-12	134	124	8
Average	W-12	157	119		Average	W-12	132	128	
Average	W-2E3	157	123		Average	W-2E3	132	128	

Microdensitometric analysis of the line target under the same conditions was done using the FOCMO Program for the Forward Camera and the SSC XLINE Program for the Aft Camera to determine the PBFs for each filter.

Table 5-3 summarizes the data and shows that there is no difference in focus between filters on the

Forward or Aft Cameras.

TABLE 5-3

COMPARISON OF LINE DETERMINED FOCUS BETWEEN THE TWO FILTERS

(microns)

		In-Track			Cross-Track		
Camera	Filter*	PBF	Sigma	Sample Size	PBF	Sigma	Sample Size
Forward	W-12	37.8	3.7	14	29.3	2.2	14
	W-2E3	39.0	3.1	14	31.0	0.9	14
Aft	W-12	35.9	0.8	26	34.1	0.8	26
	W-2E3	36.5	0.8	17	34.8	1.0	17

5.4 SELECTION OF LAUNCH PLATEN POSITION

Based on the resolution performance analysis in Section III, the platen positions resulting in balanced field performance are 30 microns for the Forward Camera and 33 microns for the Aft Camera. These platen positions must be corrected for vehicle altitude, gravity effects, and collimator focus errors as follows:

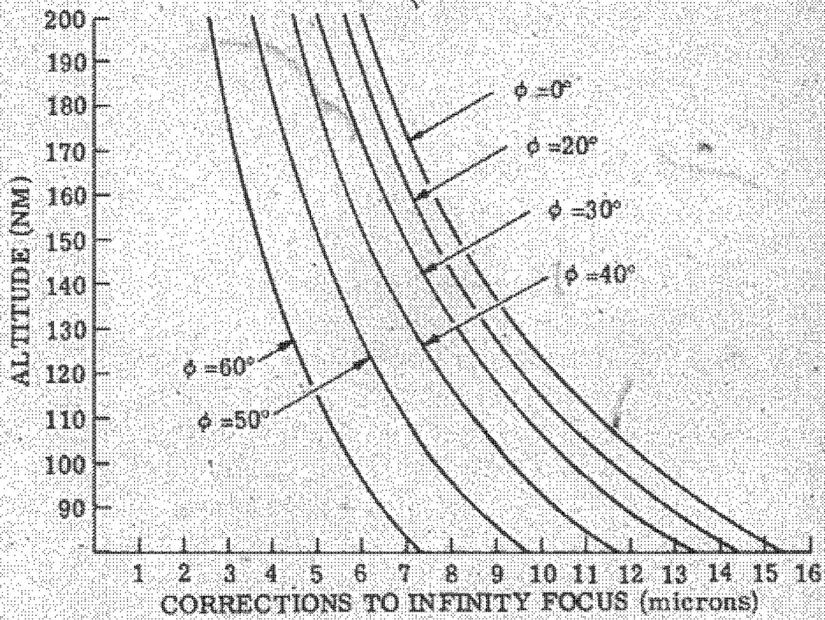
A. The collimators in Chamber A-2 are set for infinity focus. Since the reference orbit for Mission 1210 is approximately 85 NM, a correction of 14 microns is required to focus the camera for a finite object distance. This adjustment is made so that 0° scan will be in focus, see Figure 5-3.

B. The following consideration is given for the on-orbit effect on focus of gravity release as compared to the chamber test. The Chamber C measured residual 0° astigmatism on-axis is $-.12\lambda$ for both OB Sets 042 (Forward Camera) and 040 (Aft Camera). As with previous Readiness tests, the deformation of the folding flat is assumed to be fully spherical. With this assumption, focus shift (in microns) obeys a linear relationship with residual 0° astigmatism ($\delta\lambda$), i.e., $\Delta f = \delta\lambda\,(137)$. The resultant corrections in focus are therefore -16 microns for both the Forward and Aft Cameras.

C. Chamber A-2 collimator focus settings are monitored interferometrically and departures from specification can be measured. During Readiness test operations, the Forward 0° collimator focus deviation was measured to be +2 microns while the Aft 0° collimator deviation was measured at -1 micron.

These three correction factors are applied to the optimum platen positions as determined in Section III to establish the recommended launch settings. Table 5-4 presents these factors for SV-10.

FOCUS CORRECTIONS AS A FUNCTION OF ALTITUDE AND SCAN ANGLE



ϕ = SCAN ANGLE

FIGURE 5-3

TABLE 5-4

LAUNCH FOCUS SETTINGS

(microns)

Factor	Forward Camera	Aft Camera
Platen Position for Best Resolution Across the Field	30	33
Adjustment for 85 NM Altitude	14	14
Adjustment for Gravity Release on Fold Flat Assuming Spherical Deformation	-16	-16
Collimator Defocus Adjustment	2	-1
Launch Platen Position	30	30

ON-ORBIT PERFORMANCE

ESTIMATES

VI

SECTION VI

ON-ORBIT PERFORMANCE ESTIMATES

6.1 INTRODUCTION

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

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

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

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

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

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

(3) It is for only one focus position.

6.2 CRYSPER CONCEPTS

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

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

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

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

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

A third type of performance prediction entitled CRYSPER VEM resolution has been included in this section of the readiness report, see Table 6-3. These predictions are designed to relate to the VEM resolution data acquired during the PFA time period and the subsequent in-depth analyses of the mission. VEM provides an estimate of the 2:1 contrast resolution in cycles/mm, the basic performance measure of the camera system. The VEM matrix is calibrated to 2:1 contrast resolution irrespective of the contrast of the edge itself, so the atmospheric subroutines of CRYSPER, which ultimately adjust the AIM curve for exposure and contrast, are bypassed.

6.3 PREDICTIONS FOR MISSION 1210

A series of CRYSPER runs have been made to estimate the performance from Mission 1210. The CRYSPER output discussed in this section consists of the format/solar altitude table and one page of the target access data for the conditions used. The orbital elements for a June 1975 launch were used along with the performance estimates from the Chamber A acceptance test and the latest Chamber A-2 test. Chamber A-2 provides data at only two collimator locations, whereas Chamber A has three. In order to have as much data as possible for determining the synchronization errors as a function of scan angle, both sets of data are used. There are, however, some inconsistencies in the data between these two tests. This causes slight inconsistencies in the resolution predictions as a function of scan angle. All runs are for descending passes.

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

6.4 UNCERTAINTIES IN PERFORMANCE ESTIMATES

The predictions made in this test have been based primarily on laboratory data. Since there are uncertainties in some of the data, a CRYSPER run was made using a worse case estimate for some of these parameters.

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

TABLE 6-1

MISSION 1210 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)

Camera	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	118	145	156	167	176	181	183	182	178	172	163	149	130
	75	37	132	151	161	173	182	186	189	188	185	179	173	156	136
	65	47	141	158	169	180	187	191	194	195	193	189	180	169	148
	55	56	147	168	174	185	191	194	197	196	198	196	187	177	153
AFT CAMERA	45	65	151	171	178	188	192	196	198	199	199	197	189	163	156
	35	72	152	173	179	188	192	196	198	198	198	196	189	179	155
SSN 013 USN 40R	25	75	152	173	179	188	192	195	198	198	197	195	188	174	156
	15	71	152	173	180	189	193	196	199	199	199	197	189	179	156
	80	32	132	149	150	154	157	159	155	155	155	153	151	140	137
	75	37	145	153	159	162	164	164	159	159	159	156	156	152	144
	65	47	156	165	170	172	173	165	164	164	164	163	162	164	153
	55	56	163	175	175	176	176	172	168	169	169	170	167	172	162
FORWARD CAMERA	45	65	165	176	176	177	177	174	171	172	173	174	174	177	167
	35	72	167	178	176	177	176	174	173	172	174	176	176	175	167
SSN 013 USN 42A	25	75	167	173	176	176	176	173	170	172	174	176	175	173	167
	15	71	168	180	178	178	177	174	171	172	175	176	176	174	169

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

Camera	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	11.06	5.75	4.00	3.05	2.54	2.30	2.22	2.29	2.52	2.97	3.83	5.62	10.13
	75	37	9.61	5.42	3.79	2.89	2.41	2.19	2.10	2.17	2.36	2.78	3.59	5.23	7.37
	65	47	8.66	4.95	3.46	2.67	2.25	2.05	1.97	2.01	2.18	2.54	3.25	4.64	8.38
	55	56	7.98	4.50	3.24	2.50	2.13	1.94	1.97	1.90	2.05	2.36	3.02	4.27	7.70
AFT CAMERA	45	65	7.55	4.28	3.09	2.40	2.06	1.88	1.83	1.85	1.98	2.29	2.91	4.09	7.32
	35	72	7.36	4.18	3.01	2.36	2.03	1.85	1.79	1.83	1.97	2.26	2.87	4.04	7.22
SSN 013 USN 40R	25	75	7.35	4.18	3.01	2.36	2.03	1.86	1.79	1.83	1.98	2.27	2.88	4.15	7.25
	15	71	7.45	4.23	3.03	2.38	2.05	1.87	1.80	1.84	1.99	2.28	2.89	4.07	7.28
	80	32	9.69	5.70	4.14	3.31	2.55	2.61	2.61	2.68	2.90	3.34	4.15	5.72	9.58
	75	37	8.81	5.31	3.83	3.28	2.67	2.47	2.49	2.55	2.75	3.16	3.91	5.36	8.86
	65	47	7.79	4.75	3.44	2.78	2.44	2.32	2.32	2.39	2.57	2.94	3.61	4.76	8.00
	55	56	7.19	4.31	3.23	2.63	2.30	2.19	2.19	2.24	2.40	2.73	3.32	4.39	7.28
FORWARD CAMERA	45	65	6.85	4.13	3.12	2.55	2.24	2.11	2.10	2.14	2.29	2.59	3.16	4.15	6.85
	35	72	6.68	4.05	3.07	2.51	2.22	2.08	2.07	2.10	2.24	2.53	3.08	4.05	6.70
SSN 013 USN 42A	25	75	6.67	4.16	3.07	2.51	2.22	2.09	2.08	2.11	2.24	2.53	3.08	4.17	6.72
	15	71	6.72	4.07	3.08	2.52	2.23	2.11	2.10	2.14	2.26	2.56	3.10	4.19	6.75

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 AZIMUTH	DATE D M Y	HOUR	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER(NM)	VXTH	VYTH
16 46 45	33	7	1	4	56.58	16 6 75	0.00322	25704.73	15.1412	28.356	87.9	3443.1	3531.1	9.0465	0.03274

TABLE 6-2

MISSION 1210 CRYSPER PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR 10-20% REFLECTANCE TARGETS (NOMINAL INTELLIGENCE TARGETS)

(lines/mm and feet)

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

	LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	80	104	114	123	126	131	132	131	129	126	118	106	85
	75	37	91	109	118	127	132	135	136	136	134	133	127	113	93
	65	47	98	116	126	135	139	142	143	144	143	141	132	120	101
	55	56	103	121	130	138	142	144	146	146	146	145	137	124	106
AFT CAMERA	45	65	106	123	133	140	143	145	147	147	147	145	139	127	108
	35	72	106	124	134	140	143	145	146	148	148	145	139	127	108
SSN 013 CSN 408	25	75	106	124	133	140	142	143	143	143	145	144	139	126	107
	15	71	106	124	134	141	143	145	147	147	147	145	139	127	108
	80	32	89	105	112	116	118	120	118	118	118	116	112	106	90
	75	37	95	111	119	121	123	123	121	121	121	119	119	113	98
	65	47	107	121	127	130	130	128	127	127	127	126	124	119	106
	55	56	112	125	131	132	132	131	129	130	130	130	129	125	112
FORWARD CAMERA	45	65	115	127	132	133	133	132	130	131	132	132	131	127	115
	35	72	115	127	131	132	132	131	130	131	132	132	131	127	115
SSN 013 CSN 428	25	75	115	127	131	132	129	128	127	128	129	132	131	127	114
	15	71	116	128	132	133	132	131	130	131	132	133	132	126	115

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

	LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	85	32	16.31	8.26	5.67	4.15	3.69	3.17	3.07	3.17	3.48	4.04	5.30	7.92	15.33
	75	37	14.91	7.56	5.16	3.93	3.42	3.32	2.91	2.99	3.26	3.75	4.57	7.26	13.72
	65	47	12.62	6.39	4.85	3.55	3.32	2.76	2.65	2.71	2.94	3.43	4.42	6.53	12.08
	55	56	11.37	6.25	4.33	3.15	2.96	2.62	2.53	2.55	2.78	3.20	4.11	6.03	11.06
AFT CAMERA	45	65	10.76	5.95	4.13	3.22	2.77	2.53	2.45	2.50	2.73	3.10	3.96	5.77	10.51
	35	72	10.90	5.93	4.04	3.17	2.84	2.51	2.42	2.48	2.67	3.07	3.88	5.68	10.34
SSN 013 CSN 408	25	75	10.68	5.42	4.04	3.18	2.74	2.56	2.48	2.53	2.68	3.08	3.89	5.70	10.42
	15	71	10.61	5.69	4.09	3.19	2.75	2.53	2.44	2.49	2.69	3.09	3.92	5.73	10.44
	85	32	14.62	7.45	5.56	4.40	3.78	3.67	3.63	3.51	3.81	4.42	5.56	7.91	14.60
	75	37	13.32	7.35	5.17	4.12	3.56	3.29	3.28	3.34	3.62	4.16	5.13	7.21	12.58
	65	47	11.39	6.45	4.93	3.70	3.23	3.04	3.00	3.07	3.31	3.81	4.71	6.55	11.50
	55	56	10.44	6.31	4.32	3.50	3.07	2.88	2.84	2.91	3.12	3.56	4.39	6.06	10.48
FORWARD CAMERA	45	65	9.91	5.76	4.17	3.39	2.95	2.79	2.75	2.81	3.01	3.42	4.19	5.77	9.68
	35	72	9.68	5.66	4.11	3.38	2.96	2.77	2.72	2.77	2.96	3.38	4.11	5.66	9.72
SSN 013 CSN 428	25	75	9.68	5.64	4.12	3.38	3.32	2.83	2.78	2.83	3.02	3.36	4.13	5.68	9.78
	15	71	9.75	5.70	4.14	3.38	2.98	2.80	2.75	2.90	2.98	3.38	4.14	5.70	9.80

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

TARGET LATITUDE (D M S)	REFLECTANCE HIGH	REFLECTANCE LOW	TARGET SIG TYPE	HAZE COND	SOLAR AZIMUTH	DATE (D M Y)	RCOM	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER(NM)	PATH	[illegible]
14 40 48	25	10	3	A	56.58	6 6 78	0.00022	25704.70	15.1412	28.056	87.9	3443.1	3531.3	0.0460	[illegible]

TABLE 6-3

MISSION 1210 CRYSPER VEM PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR 2:1 APPARENT CONTRAST OBJECTS

(lines/mm and feet)

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

	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	138	153	159	165	170	173	175	174	172	170	166	158	152
	75	37	151	160	161	167	173	175	177	176	176	173	170	166	156
	65	47	158	162	164	170	174	176	177	178	179	178	174	170	164
	55	56	161	165	167	173	175	176	178	179	180	181	178	173	167
AFT CAMERA	45	65	164	168	169	174	175	176	178	179	180	181	178	174	168
	35	72	165	169	171	175	175	176	177	178	179	181	178	174	168
SSN 013 USN 40[illegible]	25	75	165	169	171	175	175	176	177	178	179	180	178	174	168
	15	71	164	168	171	175	176	176	178	178	180	181	178	174	168
	80	32	148	150	153	152	151	152	148	149	149	150	152	151	154
	75	37	159	161	159	157	156	156	150	150	151	152	155	159	157
	65	47	172	168	165	162	159	156	150	151	152	156	157	162	166
	55	56	175	170	166	162	159	155	152	153	155	158	162	167	172
FORWARD CAMERA	45	65	176	171	166	162	159	155	153	154	156	160	164	17[illegible]	175
	35	72	177	172	167	162	158	155	153	154	157	161	166	17[illegible]	177
SSN 013 USN 424	25	75	177	172	167	162	158	155	153	154	157	161	166	172	178
	15	71	178	173	169	163	159	155	153	154	158	162	166	172	177

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

	LAT	SUN \ SCAN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	9.50	5.45	3.92	3.10	2.63	2.40	2.32	2.39	2.60	3.01	3.75	5.31	8.62
	75	37	8.42	5.11	3.74	2.98	2.53	2.32	2.25	2.30	2.48	2.86	3.50	4.93	8.22
	65	47	7.64	4.82	3.57	2.82	2.42	2.22	2.15	2.19	2.35	2.70	3.36	4.62	7.46
	55	56	7.26	4.58	3.38	2.67	2.32	2.14	2.07	2.11	2.26	2.56	3.18	4.36	7.03
AFT CAMERA	45	65	6.95	4.38	3.25	2.59	2.26	2.09	2.02	2.06	2.20	2.49	3.08	4.23	6.78
	35	72	6.83	4.28	3.17	2.54	2.23	2.06	1.99	2.04	2.18	2.46	3.03	4.18	6.66
SSN 013 USN 40[illegible]	25	75	6.78	4.27	3.16	2.54	2.22	2.06	1.99	2.04	2.16	2.44	3.03	4.15	6.6[illegible]
	15	71	6.90	4.34	3.20	2.57	2.25	2.08	2.02	2.06	2.20	2.48	3.07	4.20	6.72
	80	32	8.85	5.57	4.09	3.37	2.96	2.74	2.74	2.83	3.00	3.40	4.10	5.56	9.42
	75	37	8.01	5.06	3.65	3.18	2.81	2.64	2.65	2.71	2.90	3.27	3.93	5.13	8.12
	65	47	7.09	4.65	3.55	2.96	2.65	2.53	2.53	2.59	2.76	3.11	3.72	4.84	7.38
	55	56	6.71	4.43	3.39	2.85	2.55	2.43	2.42	2.47	2.63	2.94	3.49	4.53	6.85
FORWARD CAMERA	45	65	6.46	4.28	3.30	2.78	2.49	2.37	2.35	2.39	2.54	2.87	3.35	4.32	6.51
	35	72	6.31	4.20	3.24	2.74	2.46	2.33	2.31	2.35	2.49	2.76	3.26	4.21	6.33
SSN 013 USN 424	25	75	6.29	4.18	3.23	2.73	2.46	2.33	2.31	2.35	2.48	2.75	3.26	4.19	6.30
	15	71	6.36	4.22	3.26	2.75	2.48	2.38	2.34	2.37	2.50	2.78	3.29	4.23	6.38

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 AZIMUTH	DATE D M Y	ROUH	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER(NM)	WXOX	VYOH
14 40 45	20	10	1	4	56.58	8 6 75	0.00022	23204.70	15.1432	28.056	87.9 *	3443.1 *	3531.1	0.0465	0.00274

TABLE 6-4

MISSION 1210 CRYSPER PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR WORSE CASE PHOTOGRAPHY OF 7-33% REFLECTANCE TARGETS

(8 Microns Defocus, .05 IPS Film Synchronization Error)

(lines/mm and feet)

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

	LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	134	145	149	156	157	159	159	159	158	157	155	148	135
	75	37	138	149	153	157	160	162	153	163	163	163	161	155	143
	65	47	146	155	157	162	164	165	157	158	169	164	168	166	152
	55	56	152	163	162	165	166	167	168	170	172	173	173	172	155
AFT CAMERA	45	65	156	166	164	156	157	167	168	173	172	173	173	174	161
	35	72	156	167	164	166	155	166	167	168	170	171	172	172	160
SSN 013 OSN 408	25	75	156	166	164	165	156	166	166	167	169	171	171	167	159
	15	71	157	167	166	167	167	167	169	169	171	173	173	173	161
	80	37	125	126	128	128	128	128	127	127	128	126	128	127	120
	75	37	126	133	133	132	131	130	128	129	125	130	131	131	126
	65	47	135	134	139	137	134	131	129	130	131	133	135	139	132
	55	56	139	145	141	138	135	131	130	131	133	136	139	144	139
FORWARD CAMERA	45	65	141	146	141	137	134	131	130	131	133	136	140	146	142
	35	72	142	146	140	137	133	130	129	130	132	136	140	147	142
SSN 013 OSN 428	25	75	142	142	140	136	132	130	129	129	132	136	140	142	141
	15	71	143	148	141	137	134	130	129	130	133	137	141	143	142

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

	LAT	SUN	SCAN -60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	4.77	5.77	4.23	3.33	2.66	2.62	2.54	2.62	2.83	3.25	4.34	5.65	9.72
	75	37	9.22	5.46	3.99	3.17	2.73	2.51	2.43	2.49	2.69	3.07	3.80	5.28	8.87
	65	47	8.33	5.04	3.71	2.97	2.57	2.36	2.29	2.33	2.44	2.83	3.45	4.71	8.02
	55	56	7.60	4.81	3.69	2.91	2.44	2.26	2.19	2.22	2.37	2.68	3.27	4.38	7.35
AFT CAMERA	45	65	7.31	4.62	3.55	2.72	2.37	2.20	2.13	2.17	2.31	2.61	3.17	4.24	7.07
	35	72	7.15	4.34	3.30	2.68	2.35	2.18	2.12	2.16	2.30	2.59	3.15	4.20	7.00
SSN 013 OSN 408	25	75	7.14	4.33	3.29	2.68	2.35	2.15	2.12	2.16	2.30	2.60	3.16	4.31	7.04
	15	71	7.22	4.37	3.30	2.69	2.36	2.19	2.12	2.16	2.30	2.60	3.17	4.22	7.04
	80	36	10.44	6.64	4.87	3.98	3.49	3.25	3.21	3.27	[illegible]	[illegible]	4.87	6.51	10.89
	75	37	10.12	6.21	4.58	3.77	3.33	3.13	3.09	3.16	3.3[illegible]	3.83	4.64	6.25	10.18
	65	47	9.05	5.66	4.20	3.50	3.13	2.98	2.94	3.00	3.21	3.61	4.33	5.63	9.22
	55	56	8.41	5.17	4.03	3.36	3.01	2.87	2.83	2.88	3.06	3.42	4.07	5.27	8.47
FORWARD CAMERA	45	65	8.05	4.91	3.84	3.28	2.95	2.81	2.77	2.81	2.98	3.30	3.92	5.02	8.06
	35	72	7.88	4.93	3.85	3.25	2.94	2.79	2.74	2.79	2.94	3.26	3.85	4.92	7.86
SSN 013 OSN 428	25	75	7.87	5.06	3.85	3.25	2.94	2.79	2.74	2.79	2.95	3.26	3.86	5.08	7.92
	15	71	7.92	4.99	3.87	3.27	2.95	2.81	2.77	2.81	2.96	3.27	3.87	5.09	7.95

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 AZIMUTH	DATE D M Y	ROCH	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER (NM)	VROH	VY
14.40.45	33	7	1 3	6	56.58	8 A 75	0.00022	25704.70	15.1412	26.056	87.9 *	3443.1 *	3531.1	0.0465	0.13274

TABLE 6-5

MISSION 1210 CRYSPER VEM PREDICTIONS OF TWO SIGMA LOW RESOLUTION FOR WORSE CASE PHOTOGRAPHY FOR 2:1 APPARENT CONTRAST OBJECTS

(8 Microns Defocus, .05 IPS Film Synchronization Error)

(lines/mm and feet)

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

	LAT	SCAN / SUN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	156	153	152	152	151	151	151	151	152	155	158	157	160
	75	37	158	159	153	152	152	153	152	152	156	157	161	165	163
	65	47	165	160	153	152	151	150	151	152	154	158	162	167	171
	55	56	167	162	155	152	151	149	149	151	154	158	163	169	174
AFT CAMERA	45	65	169	162	155	152	150	148	149	150	153	157	162	168	174
	35	72	169	163	155	152	149	147	147	148	151	156	161	167	174
(SSN 013 CSN 408)	25	75	169	163	155	152	149	147	147	148	151	156	161	167	173
	15	71	169	163	156	153	150	148	148	149	152	157	162	168	174
	80	32	141	136	129	127	125	123	122	122	124	126	129	131	136
	75	37	139	138	132	128	126	124	122	123	124	127	130	137	138
	65	47	149	141	135	129	126	123	121	122	124	126	131	136	144
	55	56	150	142	135	128	125	122	121	122	124	127	132	140	148
FORWARD CAMERA	45	65	150	142	134	127	124	121	120	121	123	127	133	141	150
	35	72	151	142	133	127	123	121	120	121	123	127	133	142	151
(SSN 013 CSN 422)	25	75	151	142	133	127	123	121	120	121	123	127	133	142	151
	15	71	152	143	134	128	124	121	120	121	124	127	134	142	152

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

	LAT	SCAN / SUN	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60
	80	32	8.40	5.95	4.13	3.37	2.96	2.75	2.59	2.75	2.94	3.25	3.94	5.32	8.18
	75	37	8.04	5.14	3.98	3.28	2.89	2.63	2.61	2.67	2.85	3.19	3.79	4.96	7.82
	65	47	7.38	4.90	3.81	3.15	2.78	2.60	2.53	2.57	2.73	3.03	3.50	4.68	7.13
	55	56	7.00	4.67	3.65	3.04	2.70	2.53	2.46	2.50	2.64	2.93	3.46	4.47	6.75
AFT CAMERA	45	65	6.73	4.52	3.56	2.96	2.64	2.49	2.42	2.46	2.60	2.87	3.39	4.37	6.55
	35	72	6.60	4.44	3.48	2.92	2.62	2.46	2.40	2.44	2.58	2.85	3.35	4.32	6.45
(SSN 013 CSN 408)	25	75	6.53	4.43	3.47	2.92	2.61	2.46	2.40	2.44	2.57	2.85	3.35	4.31	6.45
	15	71	6.68	4.49	3.50	2.96	2.64	2.48	2.42	2.46	2.59	2.87	3.37	4.35	6.50
	80	32	9.25	6.41	4.81	4.03	3.59	3.36	3.31	3.39	3.61	4.05	4.83	6.38	9.62
	75	37	9.13	5.91	4.60	3.89	3.48	3.28	3.25	3.31	3.52	3.94	4.67	5.97	9.23
	65	47	8.19	5.53	4.33	3.71	3.35	3.18	3.14	3.20	3.40	3.79	4.47	5.59	8.44
	55	56	7.81	5.31	4.19	3.61	3.25	3.09	3.05	3.10	3.28	3.65	4.27	5.39	7.94
FORWARD CAMERA	45	65	7.57	5.17	4.10	3.53	3.19	3.02	2.98	3.03	3.21	3.56	4.14	5.21	7.60
	35	72	7.42	5.04	4.05	3.49	3.16	2.99	2.95	3.00	3.17	3.50	4.07	5.10	7.41
(SSN 013 CSN 422)	25	75	7.43	5.08	4.04	3.49	3.16	2.99	2.95	3.00	3.16	3.50	4.06	5.08	7.34
	15	71	7.46	5.12	4.07	3.52	3.18	3.02	2.98	3.02	3.19	3.53	4.09	5.13	7.47

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	ROOH	INERTIAL VELOCITY (FT/SEC)	SATELLITE LAT (DEGREES)	SATELLITE LONG (DEGREES)	SAT ALT (NM)	OBLATE EARTH RADIUS	SATELLITE TO EARTH CENTER(NM)	VROH	VYTH
14 40 48	20	10	1	4	56.58	8 6 75	0.03022	25704.70	15.1412	28.058	87.9	3443.1	3531.1	0.0468	0.03274

ELECTROMECHANICAL SYSTEM EVALUATION

Handle via Byeman
Controls Only

SECTION VII

ELECTROMECHANICAL SYSTEM EVALUATION

7.1 INTRODUCTION

The electromechanical evaluation reported in this section was derived from telemetry data from the tests run at the West Coast Facility using MACFACT, Strip Chart, 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 commanded 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° F (Optical Bar A) 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° F, delaying generation of the PSW-Not signal. Table 7-1 lists the scan modes affected.

TABLE 7-1

SCAN MODES AFFECTED BY LATE PSW-NOT SIGNAL

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

NOTE: Dashes denote scan modes not affected.

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

7.3 'TUNITY/OPERATIONAL SOFTWARE DATA BASE INPUTS

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

TABLE 7-2

'TUNITY/OPERATIONAL SOFTWARE DATA BASE INPUTS

Input	Forward	Aft
1. OB Stow Angle (degrees)	179	179
2. OB Start Uncertainty (seconds)	0.3	0.3
3. FT Start Uncertainty (seconds)		
VI Enable	1.4	1.4
VI Disable	0.7	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)	59.972	59.984
7. Optical Lens Number	042	040
8. Plane of Best Focus (microns)	30	30
9. PBF Altitude (NM)	85	85
10. Lift-off Filter Configuration	W-12	W-12
11. OOAA Orbital Nominals		
Cross-Track (Command Counts)	0	0
In-Track (Command Counts)	-1	-4
12. On-axis On-orbit Image Motion Error Predictions		
Cross-Track (inch/second)	37° -.011	-.027
	0° -.007	.008
	45° -.034	-.026
In-Track (inch/second)	37° .026	.056
	0° .002	-.001
	45° .005	-.024
13. Frame Lengths	See Table 7-7	
14. Interframe Spacing	See Table 7-7	
15. PN Use Rate	A-2 = .0249 (pounds/min)	
16. First Frame Early Shutter Open From 5° Mark to Start of Image (inches)	5.8	5.6

NOTE: Values include the effect of the recommended OOAA adjustments.

7.4 SLIT WIDTH

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

TABLE 7-3

SLIT WIDTH DATA

(inches)

	Forward Camera		Aft Camera	
Command	Telemetry Reading	Film Measurement	Telemetry Reading	Film Measurement
.080	.079	.080	.079	.075
.150	.152	.155	.152	.150
.281	.280	.285	.283	.280
.525	.522	.525	.517	.517
.910	.892	.900	.901	.900
.525	.527	.530	.527	.525
.281	.280	.285	.280	.280
.150	.149	.150	.148	.148
.080	.079	.079	.079	.075

7.5 LATERAL SEPARATION FOCUS SENSOR (LSFS)

The LSFS calibration curves for Mission 1210 are shown in Figures 7-1 and 7-2. For reference, the ground test curves, which are the basis for the flight calibration, are also shown. This data was obtained from Seq K of the Chamber A-2 test (Vx/h of .052, IMC disabled, 72°F).

The orbital calibration curves reflect a predicted gravity release of -16 microns for both the Forward and Aft Cameras.

The slopes of the calibration curves at the plane of best focus (PBF) are approximately 1.43 microns/count for the Forward and 1.38 microns/count for the Aft Camera.

7.6 OPTICAL BAR ANGULAR VELOCITY SCALING TO Vx/h

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

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

FORWARD CAMERA FOCAL PLANE POSITION

VERSUS LSFS COUNTS AT 72° F

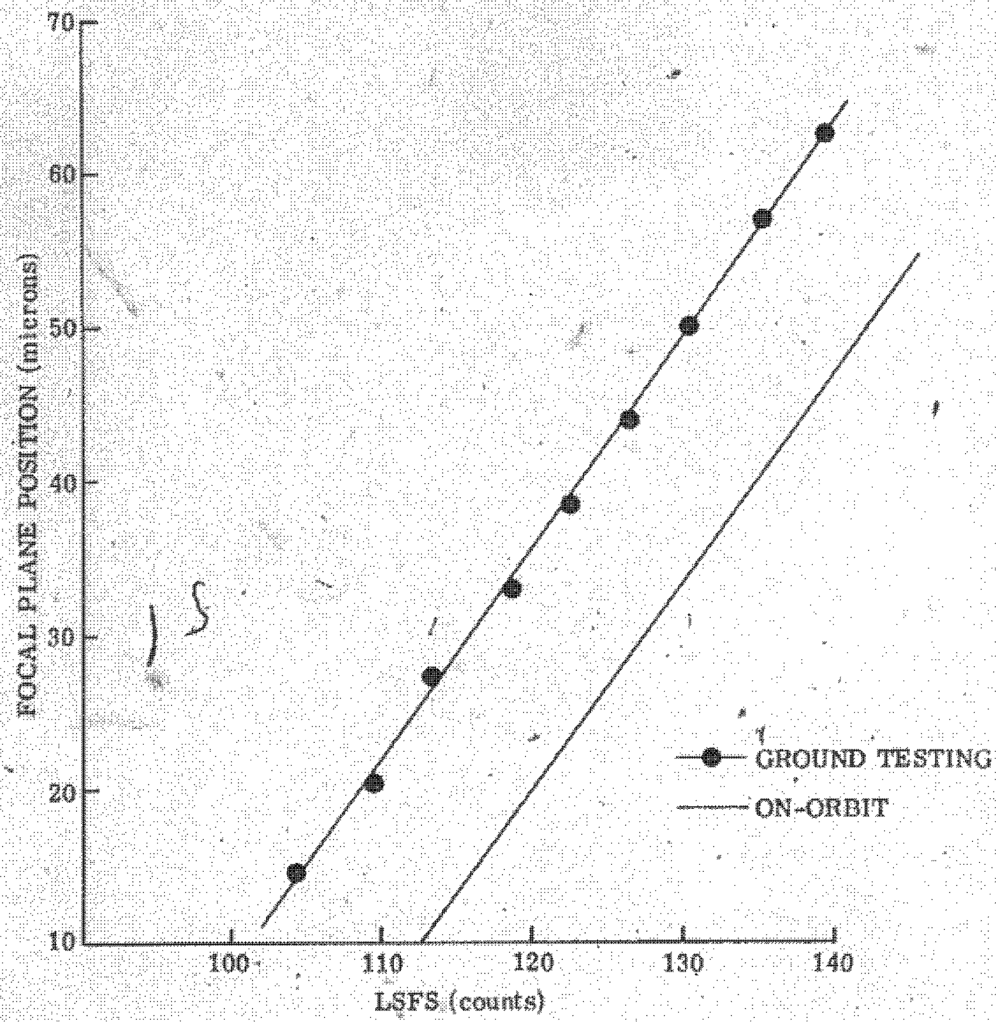


FIGURE 7-1

AFT CAMERA FOCAL PLANE POSITION
VERSUS LSFS COUNTS AT 72°F

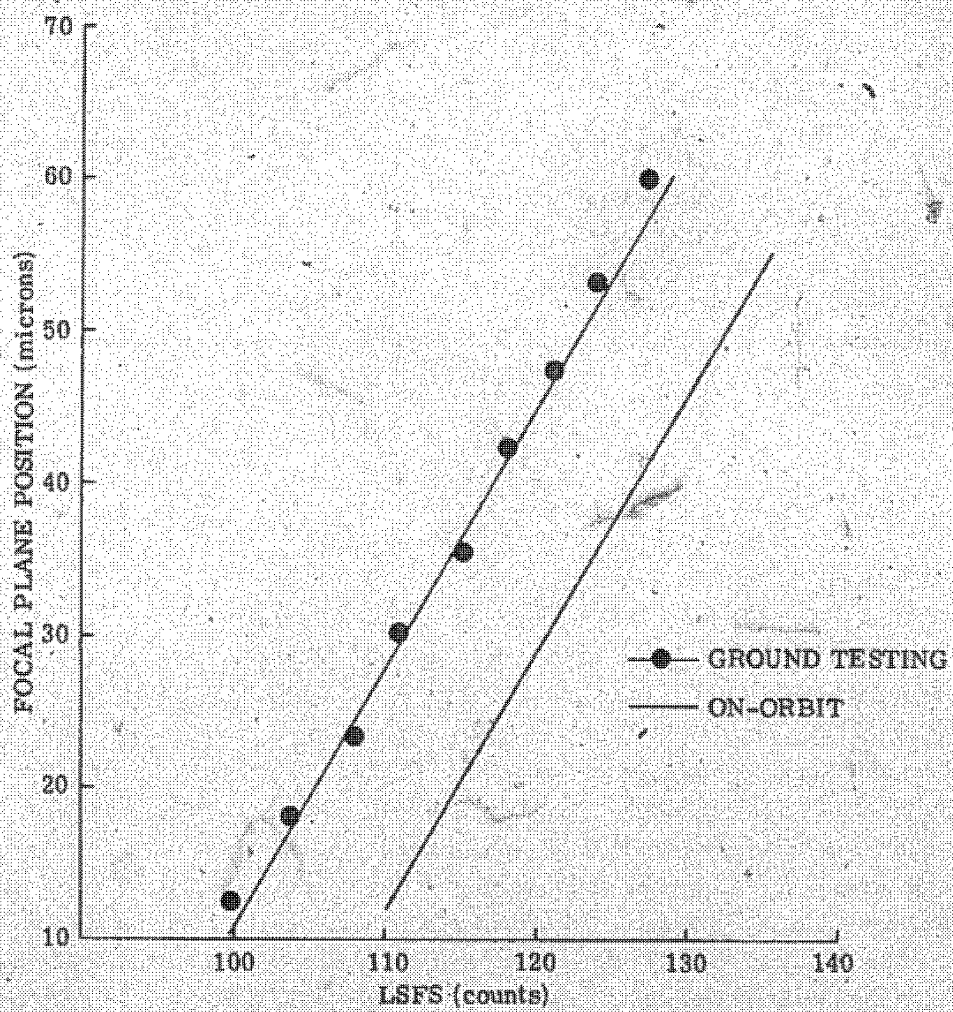


FIGURE 7-2

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 Maximum	Forward Optical Bar Minimum	Aft Optical Bar Maximum	Aft Optical Bar Minimum
282-3	.044	.369	.297	.369	.297
282-4	.048	.413	.328	.413	.328
282-5	.052	.444	.344	.444	.344

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 7-8 is a tabulation of the mean value and standard deviation of both signals obtained from 3A-2 tests at two Vx/h values. The FBS signals (P451 and P452) follow the nominal expected profiles.

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	Run 282-3	Run 282-4	Run 282-5
Forward	Maximum	10.1	10.1	10.1
	Minimum	-7.6	-7.6	-7.6
	Mean	-.5	-.7	-1.0
	STDV	3.7	3.8	3.8
Aft	Maximum	20.1	18.2	20.1
	Minimum	-9.4	-7.5	-9.4
	Mean	6.2	6.6	6.7
	STDV	7.2	7.6	7.8

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	.006	.006	.003	-.006
			STDV	.019	.022	.014	.016
R	90/0	.052	Mean	-.004	.001	-.004	.000
			STDV	.018	.024	.014	.018

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-10. The Forward and Aft Camera differential tension was always within tolerance.

7.10 FRAME LENGTH AND INTERFRAME SPACING

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

7.11 STEERER PERFORMANCE

SV-10 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.

7.12 METERING CAPSTAN SETTLING TIME

The settling time for SV-10 was determined by examining the FBS signal for both cameras, 10 frames each, during Chamber A-1 test sequences RX-1A Runs 282-3 and 282-4. The results are summarized as follows:

A. <u>Run 282-3 (Vx/h of .044)</u>

(1) Forward Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on three frames: Frame 006, .057 inch/second at 2.88°; Frame 010, .057 inch/second at 2.88°; and Frame 015, .051 inch/second at 1.1°.

(2) Aft Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on four frames: Frame 002, .060 inch/second at .6°; Frame 007, .057 inch/second at .32°; Frame 019, .058 inch/second at 1.64°; Frame 015, -.053 inch/second at 2.31°.

B. <u>Run 282-4 (Vx/h of .048)</u>

(1) Forward Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on one frame: Frame 002, -.053 inch/second at 2.31°.

(2) Aft Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on five frames: Frame 003, .060 inch/second at 1.90°; Frame 004, .051 inch/second at 3.7°; Frame 006, .059 inch/second at 1.62°; Frame 014, .051 inch/second at 3.7°; Frame 017, .059 inch/second at 1.56°.

TABLE 7-7

SUMMARY OF FRAME LENGTH AND INTERFRAME SPACING

(inches)

— Forward Camera —

Subsystem Command & Control	Seq	Scan Angle (degrees)	Frame Length	Interframe
No. 1	12-1	30	31.32	2.83
	11-1	60	62.75	3.06
	15	90	94.18	2.72
	11-2	120	125.65	2.98
No. 2	22-1	30	31.34	3.08
	21-1	60	62.76	3.11
	25	90	94.18	2.93
	21-2	120	125.68	3.06

— Aft Camera —

Subsystem Command & Control	Seq	Scan Angle (degrees)	Frame Length	Interframe
No. 1	12-1	30	31.32	2.77
	11-1	60	62.74	2.84
	15	90	94.29	2.52
	11-2	120	125.61	2.80
No. 2	22-1	30	31.34	2.96
	21-1	60	62.76	2.92
	25	90	94.29	2.66
	21-2	120	125.62	2.86

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-10. The Forward and Aft Camera differential tension was always within tolerance.

7.10 FRAME LENGTH AND INTERFRAME SPACING

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

7.11 STEERER PERFORMANCE

SV-10 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.

7.12 METERING CAPSTAN SETTLING TIME

The settling time for SV-10 was determined by examining the FBS signal for both cameras, 10 frames each, during Chamber A-1 test sequences RX-1A Runs 282-3 and 282-4. The results are summarized as follows:

A. Run 282-3 (Vx/h of .044)

(1) Forward Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on three frames: Frame 006, .057 inch/second at 2.88°; Frame 010, .057 inch/second at 2.88°; and Frame 015, .051 inch/second at 1.1°.

(2) Aft Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on four frames: Frame 002, .060 inch/second at .6°; Frame 007, .057 inch/second at .32°; Frame 019, .058 inch/second at 1.64°; Frame 015, -.053 inch/second at 2.31°.

B. Run 282-4 (Vx/h of .048)

(1) Forward Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on one frame: Frame 002, -.053 inch/second at 2.31°.

(2) Aft Camera

The film-to-bar sync error exceeded .05 inch/second after shutter open on five frames: Frame 003, .060 inch/second at 1.90°; Frame 004, .051 inch/second at 3.7°; Frame 006, .059 inch/second at 1.62°; Frame 014, .051 inch/second at 3.7°; Frame 017, .059 inch/second at 1.56°.

TABLE 7-7

SUMMARY OF FRAME LENGTH AND INTERFRAME SPACING

(inches)

— Forward Camera —

Subsystem Command & Control	Seq	Scan Angle (degrees)	Frame Length	Interframe
No. 1	12-1	30	31.32	2.83
	11-1	60	62.75	3.06
	15	90	94.18	2.72
	11-2	120	125.65	2.98
No. 2	22-1	30	31.34	3.08
	21-1	60	62.76	3.11
	25	90	94.18	2.93
	21-2	120	125.68	3.06

— Aft Camera —

Subsystem Command & Control	Seq	Scan Angle (degrees)	Frame Length	Interframe
No. 1	12-1	30	31.32	2.77
	11-1	60	62.74	2.84
	15	90	94.29	2.52
	11-2	120	125.61	2.80
No. 2	22-1	30	31.34	2.96
	21-1	60	62.76	2.92
	25	90	94.29	2.66
	21-2	120	125.62	2.86

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 .044 to .054 radians/second. On the Forward Camera, slight resonances were observed at Vx/h values of .05067 and .05108. The standard deviation for these Vx/h values was .031 inch/second. The nominal standard deviation for the run was .019 inch/second. It is felt that these resonances will not significantly affect photography, and therefore, there are no Vx/h restrictions imposed on this flight. Fourier analyses were performed on four frames for each camera at a single anticipated flight Vx/h value of .0479 radians/second. Frames 060 thru 063 were taken from Chamber A-1 Test Run 297, Seq RX-3B, scan angle of 120 degrees. Figures 7-3 and 7-4 show the MCSE signal and corresponding line spectrums for typical frames.

MCRECON was run for each camera over the same frames used for Fourier analysis. Figure 7-5 shows a typical FBS error plot for the Forward and Aft Cameras. These plots are comparable to those on SV-9.

7.14 AUGIE PERFORMANCE EVALUATION CRITERIA

The metering capstan summed errors, input and output fine tensions, 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. <u>Forward Camera Metering Capstan Summed Error (P403)</u>

The mean for P403 was derived from several Chamber 3A-2 test sequences. One hundred and fifteen PCM counts (2.28 volts) was selected as the most representative mean value. The mean shift as the result of changing variables in the test sequence (i.e., scan length, Vx/h, Vy/h, OOAA bias, etc.) was determined to be 2 PCM counts. The mean standard deviation for the representative test sequences was .016 inch/second. This results in a three sigma equivalent to .048 inch/second which converts into 4 PCM counts. Therefore, to set the limits for P403 in the AUGIE the mean shift was added to the three sigma to obtain a 6 PCM count tolerance (.120 volts), see Table 7-8.

B. <u>Aft Camera Metering Capstan Summed Error (P404)</u>

The mean for P404 was determined from the same test sequences used to compute the mean for P403. One hundred and eleven PCM counts (2.20 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 .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 P404 in

METERING CAPSTAN AND LINE SPECTRUM FROM FOURIER ANALYSIS

(Run 297, Forward Camera, Frame 061)

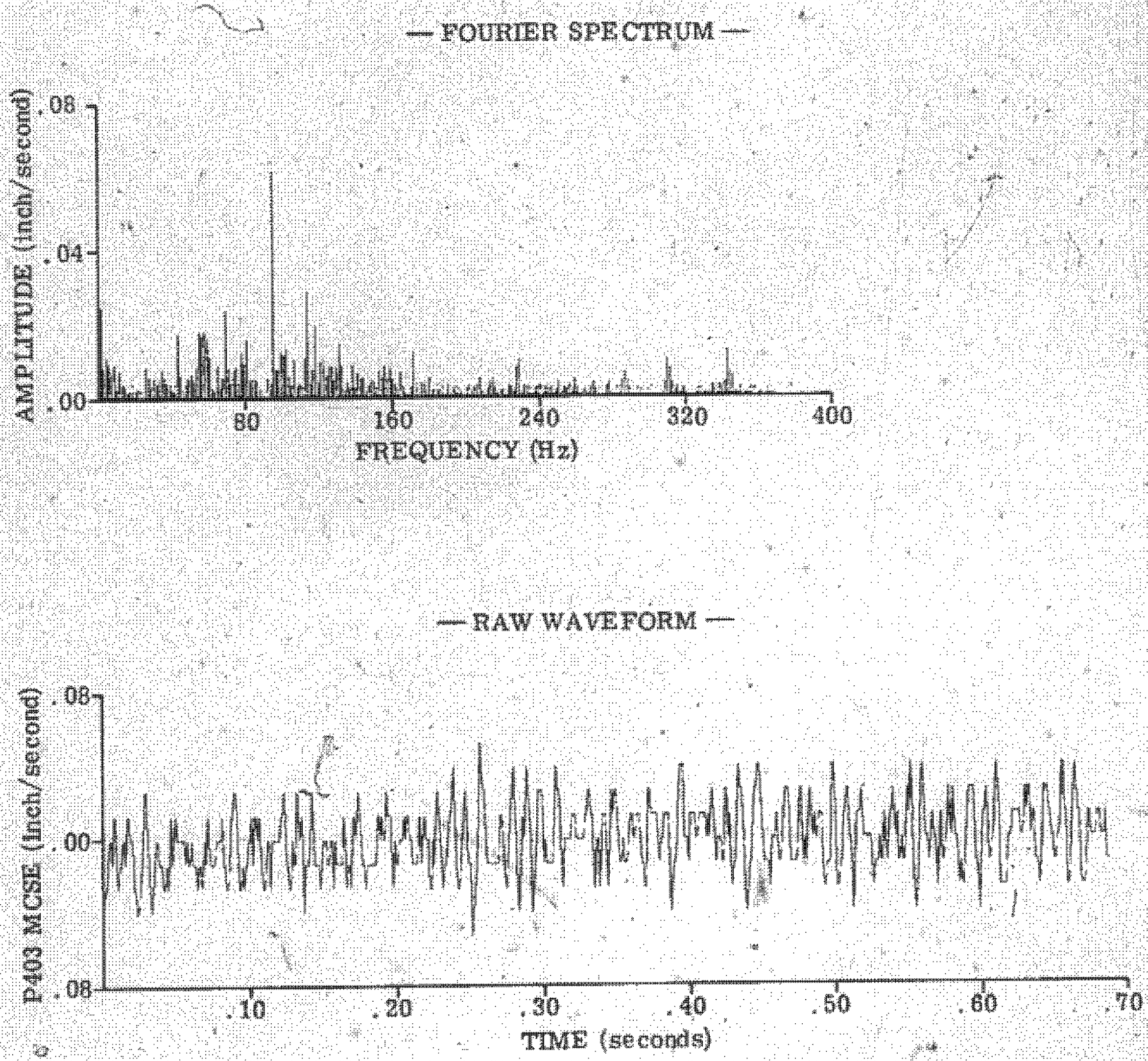


FIGURE 7-3

METERING CAPSTAN AND LINE SPECTRUM FROM FOURIER ANALYSIS

(Run 297, Aft Camera, Frame 062)

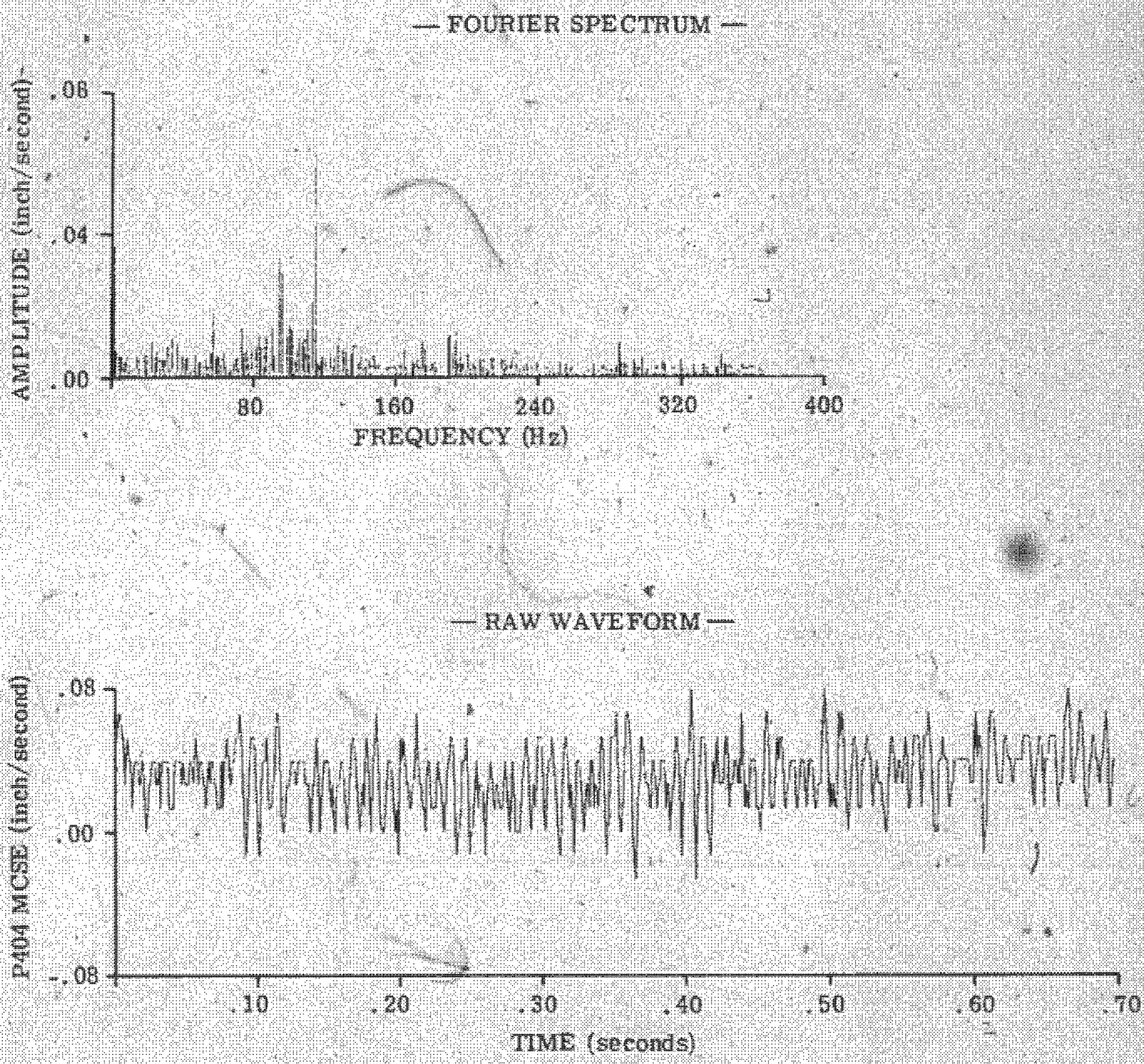
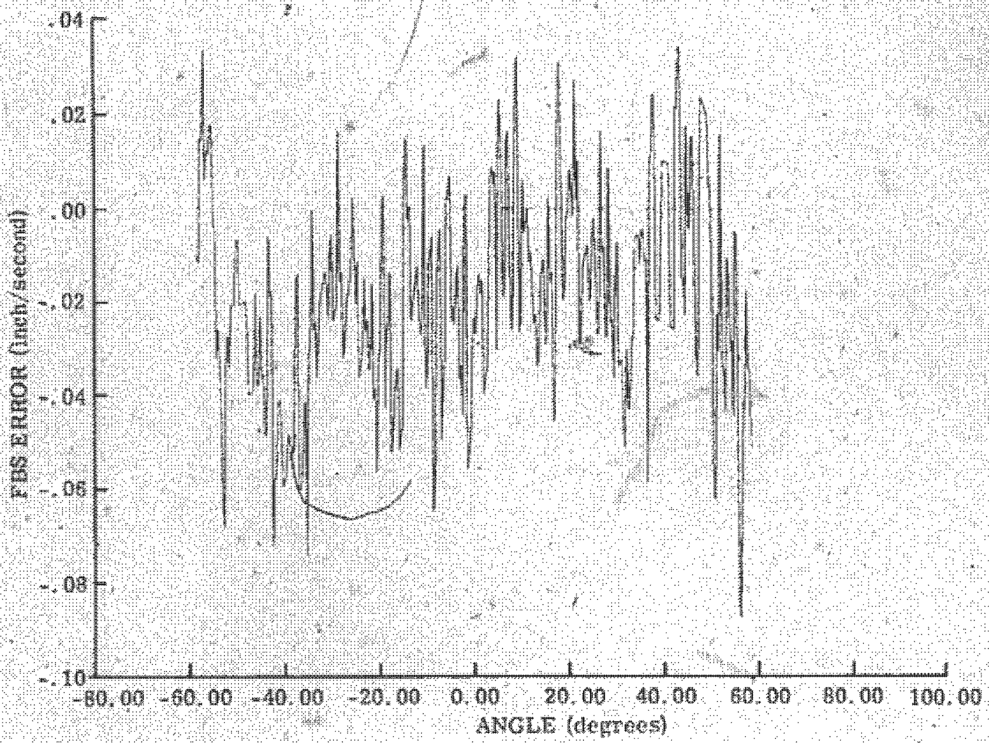


FIGURE 7-4

FBS SERVO VERSUS ANGLE FROM MCRECON PROGRAM

(Run 297)

— FORWARD CAMERA —



— AFT CAMERA —

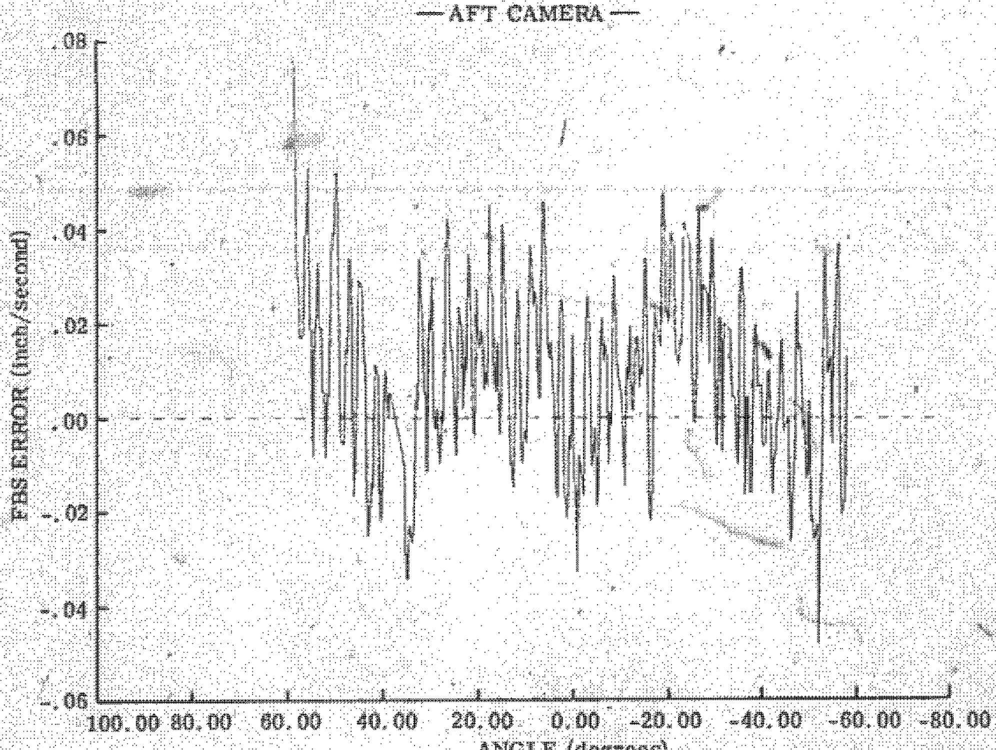


FIGURE 7-5

the AUGIE the mean shift was added to the three sigma to obtain a 6 PCM count tolerance (.120 volts), see Table 7-8.

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

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

D. Platen Photo Summed Error (P411, P412)

The mean for the Forward Camera was determined to be 126 PCM counts (2.51 volts). The mean for the Aft Camera was 130 PCM counts (2.58 volts). 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 within the budgeted tolerance 100% of the time, see Table 7-8.

E. Optical Bar Summed Error (P501, P502)

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, see Table 7-8.

7.15 ON-ORBIT ADJUSTMENT ASSEMBLY (OOAA)

The OOAA calibration tests consisted of Chamber 3A-2 Seqs U and V, in which skew commands of 0, ±5, ±10, and ±15 steps and V_f commands of 0, ±5, ±10, -15 and -20 steps were executed. The results of these modulation commands are summarized in Figures 7-6 thru 7-9 showing both nominal smear calculated from photographic measurements (FIDAP) and the FBS telemetry indications. This data has been used to adjust the FBS nominals in the computer programs which are used to evaluate flight FBS performance to bring them into agreement with FIDAP.

TABLE 7-8

AUGIE ON-ORBIT SYSTEM CALIBRATION LOG

Parameter	Camera	Data Nominal Volts	Data Nominal Eng Units	Tolerance Volts	Tolerance Eng Units	Nomenclature
Metering Capstan Summed Error	Fwd	2.28	0.0 ips	.120	.0800 ips	P403
	Aft	2.20	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	2.51	0.0 arc-sec	.260	25.7 arc-sec	P411
	Aft	2.58	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

3A-2 TEST

CHAMBER A-2, FORWARD CAMERA OOAA - FBS CALIBRATION

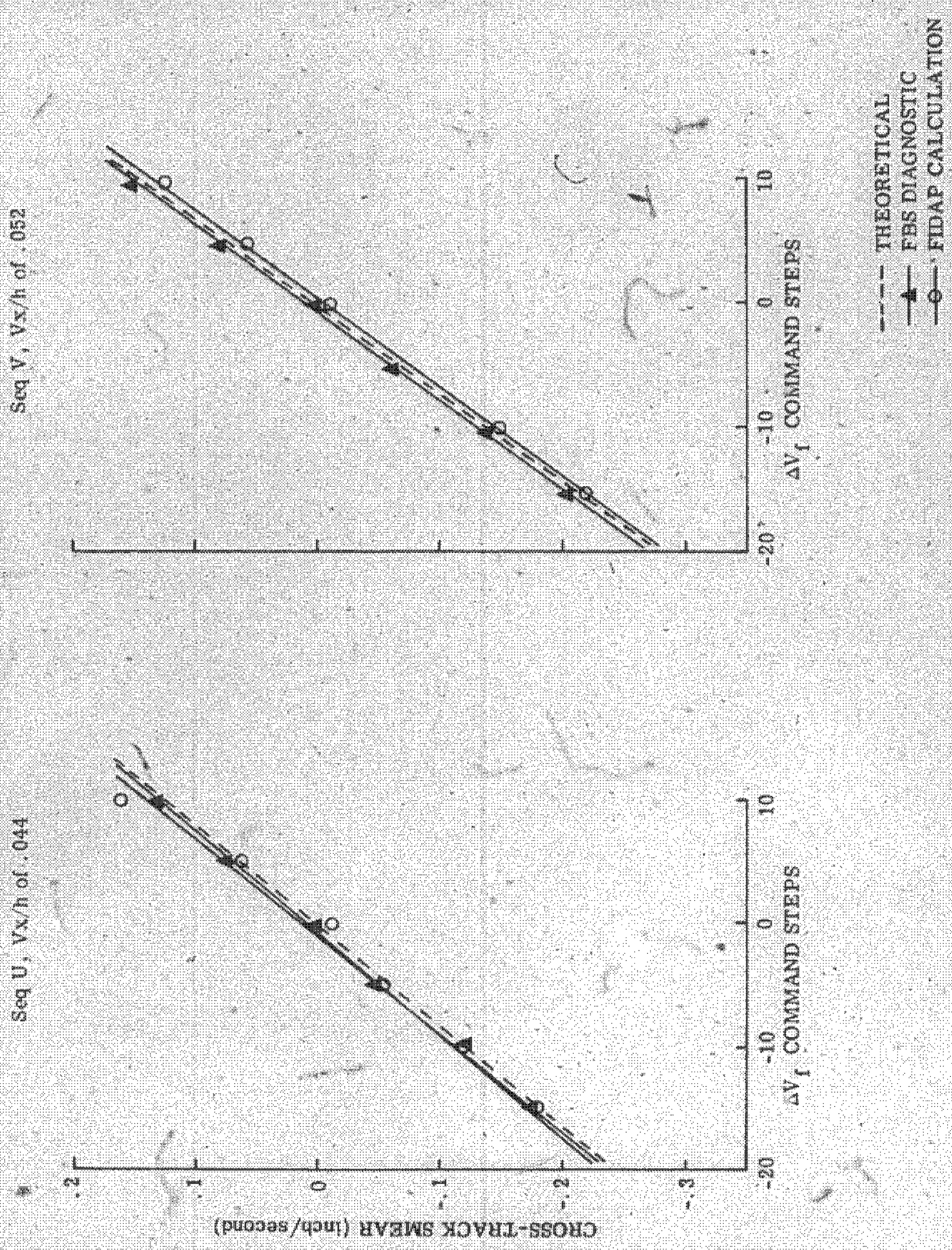


FIGURE 7-6

3A-2 TEST

CHAMBER A-2, FORWARD CAMERA OOAA - FBS CALIBRATION

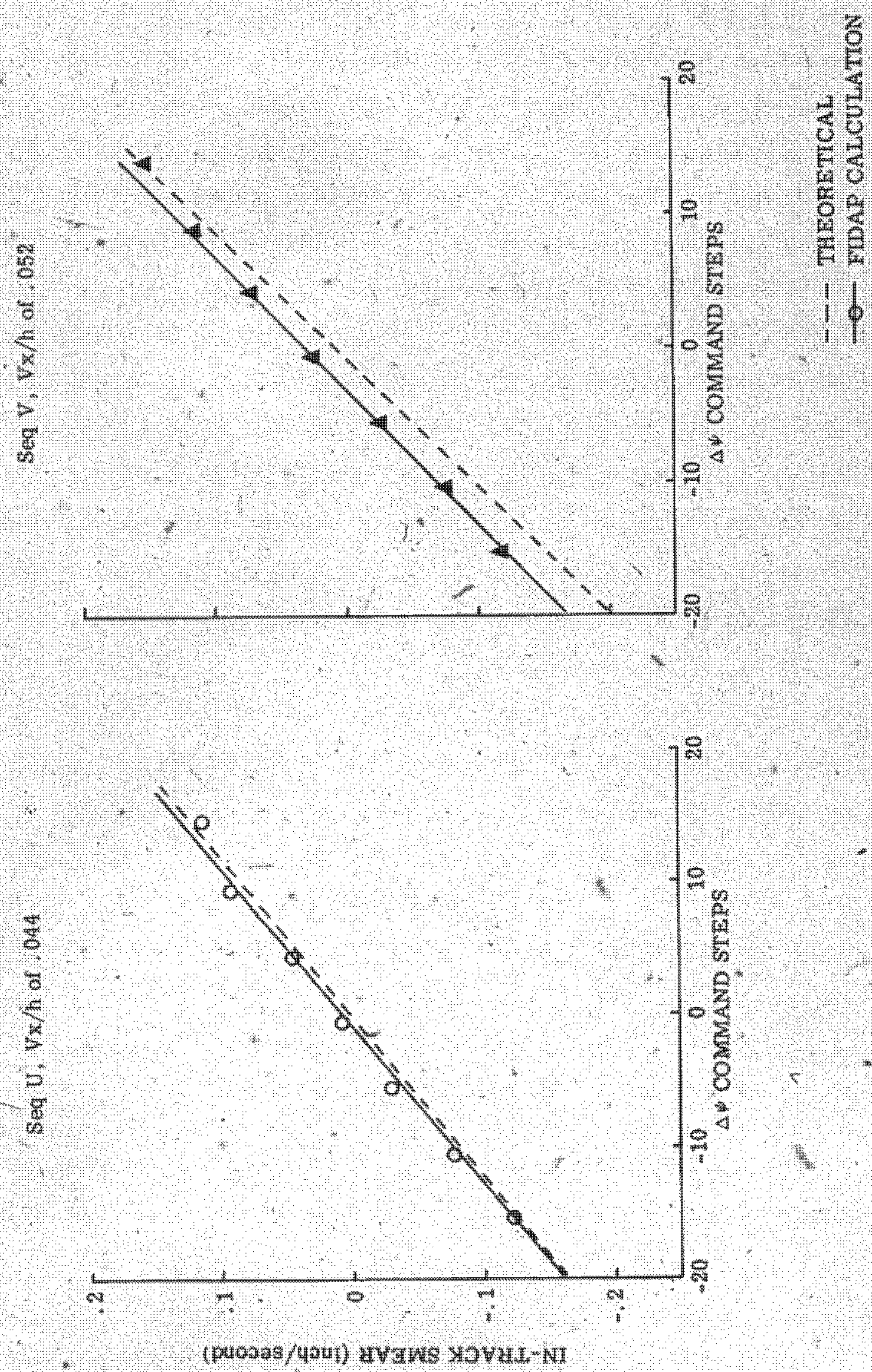


FIGURE 7-7

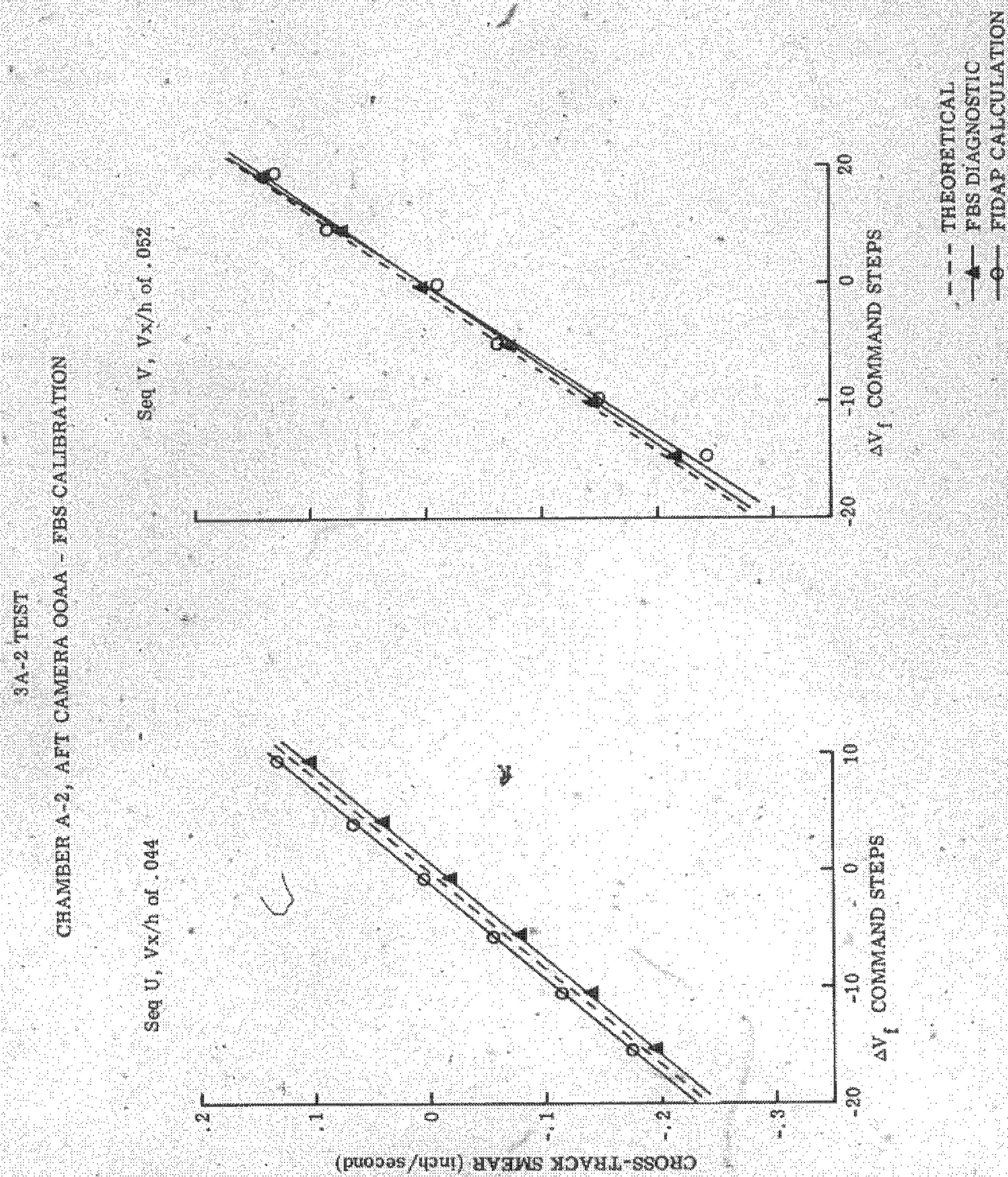

3A-2 TEST
CHAMBER A-2, AFT CAMERA OOAA - FBS CALIBRATION
Seq V, Vx/h of .052
Seq U, Vx/h of .044
CROSS-TRACK SMEAR (inch/second)
.2
.1
0
-.1
-.2
-.3
-20
-10
0
10
20
ΔVf COMMAND STEPS
THEORETICAL
FBS DIAGNOSTIC
FIDAP CALCULATION

FIGURE 7-8

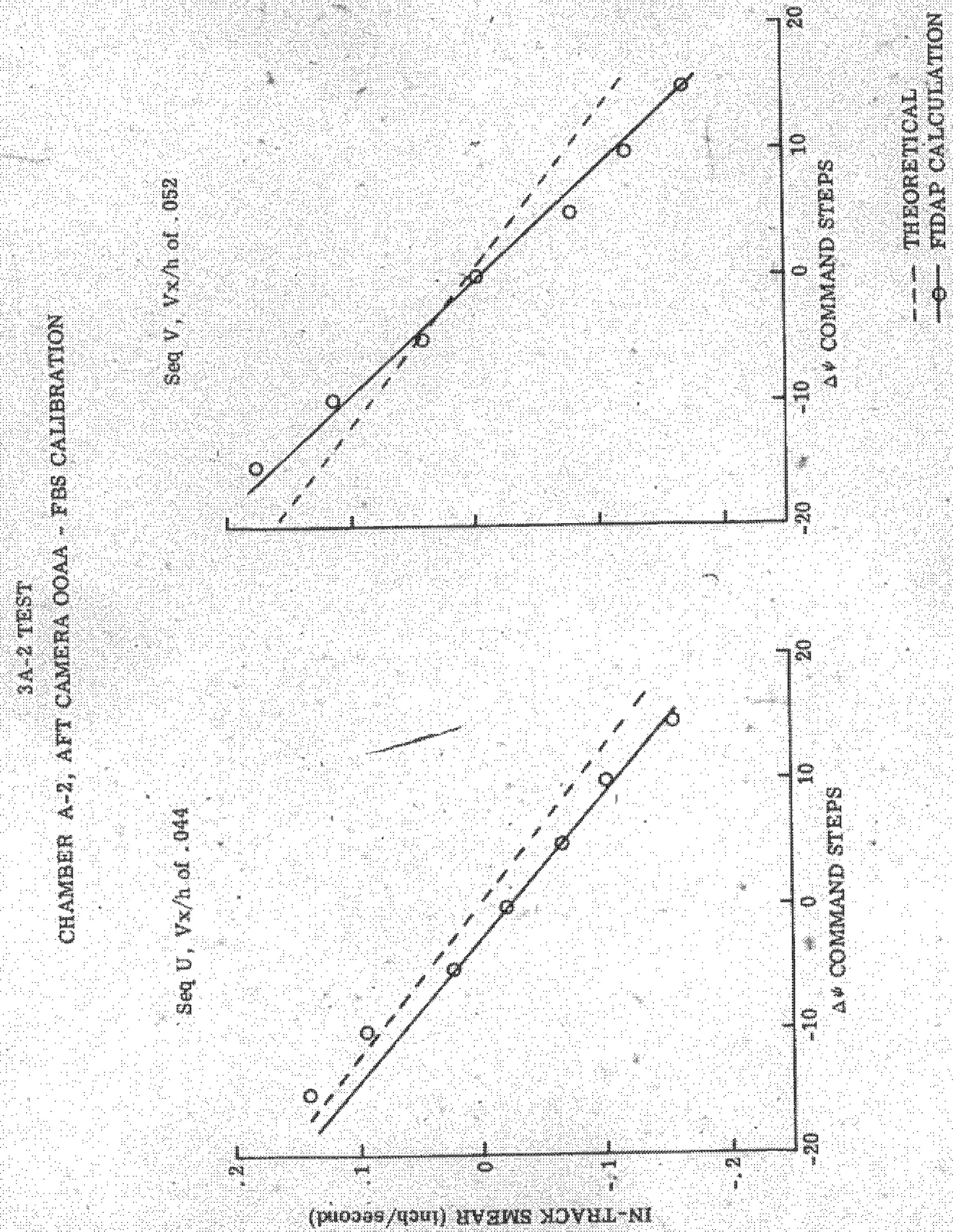

3A-2 TEST
CHAMBER A-2, AFT CAMERA OOAA - FBS CALIBRATION
Seq V, Vx/h of .052
Seq U, Vx/h of .044
Δψ COMMAND STEPS
Δψ COMMAND STEPS
IN-TRACK SMEAR (inch/second)
.2
.1
0
-.1
-.2
-20
-10
0
10
20
THEORETICAL
FIDAP CALCULATION

FIGURE 7-9

PHYSICAL

CHARACTERISTICS

SECTION VIII

PHYSICAL CHARACTERISTICS

8.1 EVALUATION RESULTS

8.1.1 Film Markings

While all the material from the A-2 tests was clear of scratches and abrasions, it was slightly affected by the characteristic static discharge markings and exhibited signatures of film path components. The new 180° wrap builder rollers in the Take-ups were found to cause some low density static discharge marks. These marks were at a density of 0.1 above base plus fog when viewed with a densitometer aperture of 1 millimeter. Also, plus-density marks have been found throughout the film stack which have been attributed to a high pressure builder roller used in the manufacture of the stacks.

8.1.2 Ancillary Data

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

8.1.3 Fine Film Path Tracking

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

The test runs showed tracking variations on the Forward Camera from 1.2 mm to 2.6 mm from the film edge and had an average value of 1.8 mm. The Aft Camera dots showed a tracking variation from 1.9 mm to 3.1 mm with an average value of 2.6 mm.

Measurements were made on several test runs from the Chamber A-2 test material on Frames 001-010 and 101-110. The purpose of these measurements are to verify whether there were any beginning-of-operation tracking disturbances caused by film start-up, see Table 8-1. The results did not show a significant difference from the Chamber A-1 tracking data. Unfortunately, the Chamber A-2 test does not have the option to measure many scan mode/scan center/Vx/h combinations and all rewind constants are the same. The Horizontal Preship Test has a more complete set of these combinations. The tracking data from the Horizontal Preship Test is displayed in Table 8-2. A comparison of the Horizontal Preship tracking data with that of past systems is shown in Table 8-3.

8.2 CONCLUSIONS

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

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

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

PHYSICAL CHARACTERISTICS

Handle via Byeman
Controls Only

SECTION VIII

PHYSICAL CHARACTERISTICS

8.1 EVALUATION RESULTS

8.1.1 Film Markings

While all the material from the A-2 tests was clear of scratches and abrasions, it was slightly affected by the characteristic static discharge markings and exhibited signatures of film path components. The new 180° wrap builder rollers in the Take-ups were found to cause some low density static discharge marks. These marks were at a density of 0.1 above base plus fog when viewed with a densitometer aperture of 1 millimeter. Also, plus-density marks have been found throughout the film stack which have been attributed to a high pressure builder roller used in the manufacture of the stacks.

8.1.2 Ancillary Data

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

8.1.3 Fine Film Path Tracking

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

The test runs showed tracking variations on the Forward Camera from 1.2 mm to 2.6 mm from the film edge and had an average value of 1.8 mm. The Aft Camera dots showed a tracking variation from 1.9 mm to 3.1 mm with an average value of 2.6 mm.

Measurements were made on several test runs from the Chamber A-2 test material on Frames 001-010 and 101-110. The purpose of these measurements are to verify whether there were any beginning-of-operation tracking disturbances caused by film start-up, see Table 8-1. The results did not show a significant difference from the Chamber A-1 tracking data. Unfortunately, the Chamber A-2 test does not have the option to measure many scan mode/scan center/Vx/h combinations and all rewind constants are the same. The Horizontal Preship Test has a more complete set of these combinations. The tracking data from the Horizontal Preship Test is displayed in Table 8-2. A comparison of the Horizontal Preship tracking data with that of past systems is shown in Table 8-3.

8.2 CONCLUSIONS

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

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

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

TABLE 8-1

FILM TRACKING MEASUREMENTS

(millimeters)

	Scan Angle/Scan Center (degrees)					
	Forward Camera			Aft Camera		
Frame	30/0 (Vx/h = .052)	30/0 (Vx/h = .044)	90/0 (Vx/h = .052)	30/0 (Vx/h = .052)	30/0 (Vx/h = .044)	90/0 (Vx/h = .052)
001	(no data)	1.6	1.9	2.4	2.1	2.5
002	2.1	1.5	1.7	2.2	2.2	2.6
003	2.2	1.7	1.8	2.3	2.3	2.6
004	2.0	1.5	1.8	2.4	2.3	2.4
005	1.8	1.3	1.8	2.6	2.3	2.6
006	2.0	1.5	1.9	2.6	2.2	2.7
007	2.2	1.8	1.9	2.6	2.3	2.5
008	2.2	1.7	1.9	2.5	2.5	2.5
009	2.0	1.6	1.7	2.4	2.6	2.4
010	2.0	1.6	1.7	2.5	2.3	2.5
101	1.5	1.6	1.8	2.8	2.5	2.5
102	1.7	1.6	1.9	2.8	2.4	2.6
103	1.6	1.5	1.9	3.0	2.4	2.5
104	1.8	1.5	1.8	2.9	2.3	2.6
105	1.5	1.5	1.8	2.8	2.4	2.3
106	1.4	1.7	1.9	2.8	2.3	2.4
107	1.5	1.8	1.7	2.7	2.6	2.6
108	1.6	1.6	1.8	2.8	2.5	2.7
109	1.8	1.7	1.7	3.0	2.5	2.6
110	1.6	1.8	1.7	2.8	2.6	2.7
Average	1.8	1.6	1.8	2.6	2.4	2.5

TABLE 8-2

TRACKING DATA FROM HORIZONTAL PRESHIP TEST

— Forward Camera —

SSC	Seq	SA/SC (degrees)	Vx/h	No. of Frames	Rewind Constant (inches/second)	Tracking (mm) Maximum	Minimum	Average
1	12-1	30/30	.044	6	-22	2.0	1.8	1.9
1	12-2	60/15	.028	7	0	1.9	1.7	1.8
1	13	120/0	.052	8	-44	2.0	1.7	1.9
1	15	90/-15	.052	5	-66	2.1	1.7	1.9
2	25	90/-15	.052	5	-66	2.2	1.9	2.0
2	23	120/0	.052	8	-44	2.3	1.7	1.9
2	22-1	30/30	.044	6	-22	2.1	1.2	1.6
2	22-2	60/15	.028	7	0	2.0	1.6	1.9
2	24	60/0	.044	6	-5	2.0	1.7	1.8

— Aft Camera —

SSC	Seq	SA/SC (degrees)	Vx/h	No. of Frames	Rewind Constant (inches/second)	Tracking (mm) Maximum	Minimum	Average
1	12-1	30/30	.044	6	-22	3.1	2.5	2.8
1	12-2	60/15	.028	4	0	2.6	2.3	2.5
1	13	120/0	.052	8	-44	2.4	2.2	2.3
1	15	90/-15	.052	5	-66	2.4	2.1	2.3
2	25	90/-15	.052	5	-66	2.5	1.9	2.2
2	23	120/0	.052	8	-44	2.5	2.0	2.3
2	22-1	30/30	.044	6	-22	3.3	2.8	3.0
2	22-2	60/15	.028	4	0	2.3	2.2	2.3
2	24	60/0	.044	6	-5	2.6	2.5	2.6

TABLE 8-3

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

— Forward Camera —

System	Scan Angle/Scan Center (degrees) 30/30	60/15	90/-15	30/30	60/15	90/-15	120/0	120/0	Average
SV-3	2.2	1.9	2.0	2.6	2.0	1.9	1.8	1.9	2.0
SV-4	3.0	3.1	2.0	2.6	2.8	2.0	2.8	2.0	2.5
SV-5	2.3	2.3	2.5	2.4	2.4	2.4	2.6	2.5	2.4
SV-6	1.9	1.7	2.6	2.1	1.7	2.5	2.8	2.8	2.2
SV-7	2.4	2.4	N/A	1.9	2.3	N/A	1.8	1.8	2.1
SV-8	N/A	2.3	2.1	2.0	2.1	2.0	2.1	2.1	2.1
SV-9	1.8	2.0	2.0	2.4	2.1	2.2	1.9	1.8	2.0
SV-10	1.9	1.8	1.9	1.6	1.9	2.0	1.9	1.9	1.9

— Aft Camera —

System	30/30	60/15	90/-15	30/30	60/15	90/-15	120/0	120/0	Average
SV-3	3.4	2.0	2.8	3.0	2.8	2.4	2.2	2.4	2.6
SV-4	3.3	3.1	2.6	3.0	3.1	2.6	2.8	2.8	2.9
SV-5	1.7	3.0	1.2	1.7	2.7	0.9	1.6	2.0	1.9
SV-6	2.2	2.1	2.1	1.9	2.0	1.9	1.5	1.5	1.9
SV-7	2.4	2.4	N/A	2.5	2.3	N/A	2.3	2.3	2.4
SV-8	N/A	2.5	2.0	2.0	2.6	2.0	2.1	2.0	2.1
SV-9	3.3	3.4	3.4	3.2	3.5	3.5	3.3	3.4	3.4
SV-10	2.8	2.5	2.3	3.0	2.3	2.2	2.3	2.3	2.5

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.