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Hexagon
Sensor Subsystem

C002723

FLIGHT MODEL (SN-013)
ACCEPTANCE TEAM REPORT

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PUBLICATION REVIEW

This Acceptance Team Report for S/N 013 Hexagon Sensor Subsystem has been reviewed and approved by:

P. Petty, Deputy General Manager — Date: 1/21/74

D. Berganini, Special Projects Office — Date: 1/18/74

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Summary

SECTION 1

SUMMARY

1.1 ACCEPTABILITY

Hexagon Sensor System SN013 was accepted for delivery on 19 October 1973, and is intended to be used as the payload in SV-10.

Resolving capability of both cameras at all collimators and temperatures exceeds the performance requirements. An on-orbit performance prediction using camera-measured values predicts resolution, at Nadir at 70°F, of 191 cy/mm for the forward-looking camera and 190 cy/mm for the aft-looking camera. This agrees with the peak mean resolution measurements, at Nadir in Chamber A, of 205 cy/mm for the forward-looking camera and 190 cy/mm for the aft-looking camera.

Color resolving capability of both cameras was measured to be better than 110 cy/mm for each camera. This color resolution performance is similar to the performance of the previous models that were tested using color film.

Film-to-image synchronization performance of Midsection SN013 is improved by the addition of the Servo-Inhibit Assembly (SIA). Prior to the introduction of the SIA, interaction of the film drive servos and the optics caused severe smear errors during off-camera scans. Addition of the SIA improves the camera system's smear performance to the point that operational scan modes were tested, and demonstrated that off-center scans perform the same as scans centered at Nadir.

Smear performance of both cameras was within specification for all collimator positions at all temperatures and speeds, with the following four exceptions:

V_x/h	CAM	VALUE	AMOUNT OVER SPEC
.036	FWD	CT/45° - Mean @ 70°F	.020 In/Sec
.052	FWD	CT/45° - Mean @ 47°F	.015 In/Sec
.052	FWD	CT/ 0° - 2σ @ 47°F	.011 In/Sec
.052	AFT	IT/55° - Mean @ 70°F	.002 In/Sec

1.2 ACCEPTANCE TEST HISTORY

The standard test flow used for acceptance testing a Sensor Subsystem is shown in Figure 1-1 including the MFN (manufacturing flow number) and the designation of each test. The chronological testing sequence, however, for Sensor Subsystem S/N013 is given in Table 1-1 including highlights of significant deviations from the standard test flow. The major deviations, in turn, are described in paragraphs 1.2.1 through 1.2.6.

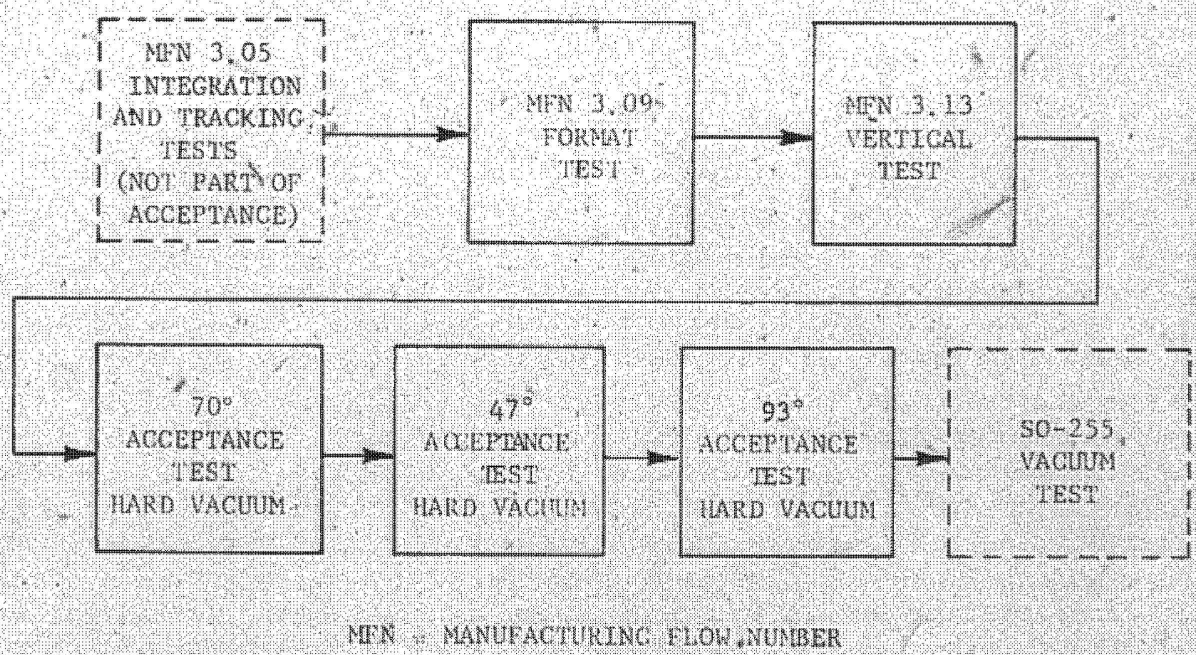


Figure 1-1. Simplified Acceptance Test Flow, Hx Sensor Subsystem

TABLE 1-1

S/N 013 MILESTONE HISTORY

ACTIVITY	COMPLETION DATE
1. MFN 3.05 Tracking Adjustment	6 March 1973
2. MFN 3.09 Format Test	7 March
3. MFN 3.13 Vertical Test	8 March
4. AFT Looper Carriage Flexure Replaced	13 March
5. Mini-Format Retest for (4) above	16 April
6. SIA Modification	27 April
7. SIA On-Floor (EM) Test	30 April
8. In-Air Photo Test (and Stop Film Test)	2 May
9. 70° Hard Vacuum Photo Baseline Test	3 May
10. 2nd Hard Vacuum Baseline Test	9 May
11. Field Curvature Investigation	
a. 2° Tilt Vacuum Test	12 May
b. -2 1/2 Tilt Vacuum Test	14 May
c. Thru- Focus Vacuum Test	19 May
d. Midsection Reversed Test	20 May
12. Replaced PDS Due to Relay Hang-Up	6 June
13. Replaced NCVU and SCC Boxes due to Current Surge Overstress	10 June
14. Installed Supply with Additional Test Film	10 June
15. Replaced AFT Film Drive (Loose Twister Causing Tracking Variability)	12 June
16. MFN 3.09 Format Test	14 June

NOTE: PDS = Power Distribution System
NCVU = Negative Constant Velocity Unit
SCC = System Command and Control

TABLE 1-1 (Cont'd)

ACTIVITY	COMPLETION DATE
17. In-Air Photo Test	16 June
18. 70° Hard Vacuum Photo Baseline	18 June
19. Removed AFT Platen, Pretilted 20μ Across 6", Reinstalled (Per Customer Direction)	29 June
20. Mini-Format Test, SO-255 and 1414	10 July
21. 70° Hard Vacuum Photo Baseline and Image Motion Error Test	13 July
22. In-Air Photo Test (After OOAA Fixed Board Change)	18 July
23. 70° Hard Vacuum Baseline Test	20 July
24. Removed AFT Platen to Investigate Skew Change	26 July
25. Mini-Format Test	31 July
26. 70° Hard Vacuum Baseline Test	1 August
27. 70° Acceptance Test	8 August
28. 93° Acceptance Test	11 August
29. 47° Acceptance Test	16 August
30. SO-255 Vacuum Photo Test	22 August
31. Pneumatics Module Replace and Retest	4 September
32. AFT 40Hz Flasher Replacement and Retest	7 September
33. Supply Caging Pin Retrofit	8 October
34. Mini-Format and Caging Pin Test	11 October
35. Presentation and Acceptance of Technical Certification	19 October

NOTE: OOAA = On Orbit Adjust Assembly

1.2.1 Modification and Retest, Servo Inhibit Assembly (SIA)

After the completion of MFN 3.05, 3.09, and 3.13, the SIA capability was added to the system; this consisted of installing two SIA boxes and modifying mid-section cables. The system retest consisted of on-the-floor tests with E/M data comparison with and without servo inhibiting, and photo testing with and without inhibiting. Test results verified improved performance. (The SIA design had previously been tested on both S/N 012 and S/N 011 Sensor Subsystems.)

1.2.2 Field Curvature Investigation

Photo tests showed field curvature on the FWD camera of about 25 microns (raw data). Corrections to the raw data for collimator focus, gravity, and film flatness reduces the unexplained curvature to 15 microns. To investigate the curvature, vacuum tests were first performed with the midsection tilted 2 degrees and -2 1/2 degrees, and then with the midsection installed in reverse. Variability of the test data masked any effect of tilting and reversing the camera; however, a single focus position has been selected that results in an in-specification resolution for all temperatures at all collimator positions.

1.2.3 Removal of AFT Platen

Based on photographic tests through June 18, the AFT camera Platen was removed and pre-tilted 20 microns across six inches in the advance direction. Then, the system was built-up; and miniformat, in-air, and vacuum photo tests were again performed.

1.2.4 Removal of AFT Platen to Investigate Skew Change

It was necessary to again remove the AFT camera Platen to investigate a change in skew that was detected after the previous installation. Platen position transducer and encoder alignment were checked; they had not changed. After reinstallation, the platen repeated the baseline tests performed prior to removal. It was concluded that the initial platen installation was incorrect. A miniformat test and hard vacuum baseline test were repeated and the sensor subsystem proceeded into the acceptance test phase of the test flow.

1.2.5 Acceptance Tests

Acceptance tests were conducted 8 - 16 August 1973; two significant anomalies occurred:

A. MR 4085, FWD Camera Photo Mode Error (PME) Out-of-Limits

During a portion of one frame at 70° acceptance test, the FWD camera PME and Platen tach were out of limits. This anomaly has not recurred during the remainder of acceptance testing nor during a special 7000 cycle test.

B. MR 4088, Shutter Open Error Out of Limits

On one occasion during the 70° acceptance test, and twice during the 47° acceptance test, the FWD camera shutter opened early. This anomaly also has not recurred during the remainder of acceptance testing nor during the special 7000 cycle test.

NOTE

Both of these anomalies are discussed in Section 2, Significant Anomalies.

1.2.6 Post Acceptance Test Activity

Several activities were accomplished after acceptance test.

A. Addition of Supply Caging

The supply was removed and the caging pin modification made. This modification adds caging pin mechanisms and interfacing caging rings so that the supply can be caged during launch. In addition, brake adjustment capability has been added. West Coast Receiving and Inspection stacks were loaded into the supply after modification, and system level caging verification has been completed. The supply will be shipped to the integrating contractor in a caged configuration.

B. Supply FWD Encoder Replacement

During manufacturing testing prior to the caging pin modification, the FWD encoder master track pulse level was intermittently below specification. This problem had not been observed at system level because the pulse was still large enough to trigger its interfacing circuit. The encoder was replaced and normal manufacturing build-up and tests were performed. The supply was revibrated to acceptance level in the X-Axis.

C. 40 Hz Flasher (AFT) Replaced

This box was replaced because of excessive spurious start of frame marks. The replacement box is a higher configuration than called for, the change to the box being better internal grounding and additional filtering to minimize spurious marks. A 150 frame in-air run was made as a retest with no spurious marks observed.

D. Pneumatics Module Replacement

The AFT high pressure transducer was erratic during acceptance test. When the midsection was removed from the Chamber, the anomaly was isolated to the pneumatics module. The module was replaced and retested with the applicable portion of MFN 3.05.

1.3 PERFORMANCE SUMMARY

1.3.1 Optical Bars

Both Optical Bars passed all Modulation Transfer Function (MTF) specifications including pre and post vibration at 70°F, and measurements at 93 and 47°F. The flange focal length and passive focus shifts for both Optical Bars did not meet specification. The Chamber A performance prediction based on Chamber D data and budgeted errors, however, indicates excellent performance (See Table 1-2).

TABLE 1-2

PREDICTED AVERAGE RESOLUTION (CYCLES/MM AT 47°F)

FIELD ANGLE (DEGREES)	FWD CAMERA SCAN ANGLE (DEGREES)		AFT CAMERA SCAN ANGLE (DEGREES)	
	0	±50	0	±50
-2.5	184	170	178	165
0	193	177	187	173
+2.5	183	170	163	154

These results at 47°F (worst case) indicated that both bars would exceed system level requirements; therefore, they were considered acceptable. Both Optical Bars met the longitudinal color performance requirements, at all measured wavelengths.

1.3.2 Resolution

Both cameras fully meet the tri-bar resolution performance requirements. Table 1-3 is a summary of the resolution values and acceptance criteria at all three temperatures. The actual focus position for each camera for all three temperatures, in Chamber "A" vacuum tests was:

FWD Camera	41 microns
AFT Camera	35 microns

1.3.3 Film Synchronization

The sync-flash analysis resulting from three temperature-vacuum acceptance tests is presented in tabular form in Section 3.6 with out-of-specification values noted. The following paragraphs (1.3.3.1 through 1.3.3.3) summarize the significant out-of-specification values.

TABLE 1-3

SUMMARY OF GEOMETRIC MEAN RESOLUTION AT Vx/h OF .052 (cy/mm)

Temperature (°F)	Camera	Collimator Position					
		45°		0°		55°	
		Spec	Actual	Spec	Actual	Spec	Actual
70	FWD	130	149	150	183	130	168
	AFT	130	164	150	187	130	170
47	FWD	110	150	150	154	110	158
	AFT	110	152	150	188	110	177
93	FWD	110	122	150	218	110	147
	AFT	110	142	150	172	110	142

1.3.3.1 CEI Run No. 112 (47°F, Vx/h = .052, FWD Camera)

The measured 2 σ crosstrack value at the nadir position was 0.111 in/sec vs. a specification of 0.100 in/sec. Even though this is only slightly over specification, a complete EM diagnostic analysis was performed since the 2 σ readings at this position are typically in the 0.06 and 0.07 in/sec range. Analysis of the metering capstan summed error and film-to-bar (FBS) diagnostics showed no correlation to the photographically measured 2 σ. The most probable conclusion that can be drawn is that gravity-induced dynamic image motion caused this measured 2 σ value.

1.3.3.2 CEI Run No. 105 (70°F, Vx/h = .052, AFT Camera)

The mean without gravity (WOG) in-track value at the 55° position was 0.052 in/sec vs. a specification of 0.050 in/sec. Again, since this is only slightly out of specification, this discussion is presented as a point of interest. Reviewing all AFT Camera data shows the 55° in-track position to be biased in the platen lag direction. The major portion of this smear is attributed to a fixed known error source, which is an error in the generation of ψ (in-track portion of the image motion compensation function). This error source will be eliminated by a ψ (PSI) design modification for SV13 and subsequent units.

1.3.3.3 FWD Camera Cross-Track On Orbit Adjust Assembly (OOAA) Settings

Review of the FWD Camera crosstrack mean WOG smear values shows the smear errors to be biased in the film-too-slow direction across the scan with a few values falling out of spec. Implementation of a two-bit knob correction in the OOAA variable board in the direction to increase film velocity will improve mean smear across all three collimator positions and at all temperatures. This correction is further enhanced by review of OOAA calibration data presented in Section 3.9. The results of applying this two-bit correction to Chamber A data are presented in Section 3.6.

1.3.4 Dynamic Focus

The dynamic focus results of the 70°F tests at Vx/h of 0.052 and 0.036 show both cameras to be well within the performance requirements. The results of the combined temperature tests are discussed in detail in Paragraph 3.4. The FWD Camera does not meet dynamic focus test requirements due to focus change at 93°F. A recommendation is being prepared to more realistically define the dynamic focus requirements.

1.3.5 Midsection, Film Markings

During acceptance testing the percentages of spurious SOF marks failed to meet the 5% maximum specification limits on the AFT Camera. The flasher box was replaced and subsequent testing indicated that the problem was corrected.

1.3.6 Electro-Mechanical Performance

The analysis of all acceptance EM data for this model indicates that all EM data requirements were met; this includes those runs that tested the SIA capability of the system. A detailed discussion of the EM performance is contained in Section 4 of this document.

Significant Anomalies

SECTION 2

SIGNIFICANT ANOMALIES

The anomalies discussed in this section are considered significant in terms of their potential impact on future performance. The complete tabulation of Malfunction Reports (MR's) against SN013 has been provided as an integral part of the Technical Certification package. Paragraphs 2.1 through 2.4 are reviews of these significant anomalies.

2.1 MR 4013 - FIELD CURVATURE - OPTICAL BAR, FWD

Results of the investigation to date show that the problem of field curvature is not isolated to S/N 013, but rather has occurred noticeably on S/N 012 and S/N 014 during Chamber A testing, and on all Chamber A2 pitch testing at WCFO.

Mission data from SV-5 and SV-6, however, indicates that the on-orbit field curvature is of a magnitude similar to what has been measured in Chamber D testing at SSC. An active test and analysis program exists that is attempting to resolve the curvature uncertainty.

2.2 MR 4085 - OUT-OF-LIMITS ON FWD PLATEN OF PME AND PL TACHOMETER SIGNALS

The FWD Camera Photo Mode Error (PME) and Platen Tachometer (PL Tach) diagnostic signals both exhibited an out-of-limit condition for a single frame of the fine thru-focus 70° acceptance test. Subsequent extensive testing failed to reproduce the anomaly.

At 90°F in vacuum, a special test of 1100 frames was performed with no repeat of the problem. After completion of acceptance testing the platen was exercised through about 7000 cycles. For about one third of these cycles local vibration was induced in the 2A1 box, 1A2 box, 1A7 box, 2A3 box, P-mode attenuator, and the tangential links and fixed OB support near the PL assembly. No repeat of the anomaly occurred either on the SSTC or the special instrumentation. This anomaly is an isolated occurrence and its cause is undetermined.

Analysis by simulation has failed to duplicate a failure mode that would result in diagnostic signatures observed.

2.3 POWER DISTRIBUTION SECTION (PDS) RELAY FAILURE (MR 4040, 4041, 4045 and 4047)

This group of MR's was caused by failure of the PDS 10-ampere relay to operate properly because of a misapplication of these relays. The relay contacts welded together due to high inrush currents from power supplied to high capacitive loads. Malfunction Reports 4041, 4040, 4045 and 4047 were caused by PDS S/N 5015 and S/N 5020 failing to turn off power to the sequencer. PDS S/N 5015 was removed and replaced with PDS S/N 5020. The box was returned to ASD and the failure was verified. Subsequent box investigation showed relays K15 and K16 to have welded contacts. A PDS hang-up log has been generated and all PDS hang-ups have been recorded. Corrective action is to modify the design of the PDS by eliminating the relays with the 10 ampere contact rating and replacing them with relays with 50-ampere contact ratings. Engineering change order 11093 has accomplished this modification by updating the PDS configuration. This change will be effective on SV 8, 9 and 10. Since PDS S/N 5015 (currently on SN 013) does not reflect the new configuration, it will be replaced at the WCFO with an updated unit. The PDS hang-up condition will be monitored in the field as noted in the S/N 013 Technical Certification package.

2.4 MR 4088 FWD SHUTTER OPEN ERROR

There were three occurrences of SH open early on S/N 013 FWD camera during acceptance testing. The first occurred during 70°F test for one frame only. The Open SH was 31 counts (approximately 86 arc-minutes) early. The second and third occurrences were during 47°F test. On one frame, the SH opened 96 counts (approximately 271 arc minutes) early. On the next frame the SH opened 31 counts early.

Analysis shows the SCC commanded the SH to open early, and the SH correctly responded to the command. Later operation for approximately 7000 frames failed to repeat the problem; thus, an intermittent failure of SCC FWD System logic is the suspected cause.

This suspect SCC logic is completely block redundant; therefore, SCC Block II should be designated as the primary operating mode. SCC Block I is still a reliable back-up block since the failures described above would cause slight elongation of frames with only failures greater than 2.5" resulting in double exposure. This use of SCC Blocks would still require two failures to result in loss of one camera photography, i.e., an on-orbit failure of SCC Block I with an ensuing complete failure of this suspect logic in Block II.

Photo-Optical Performance

SECTION 3

PHOTO-OPTICAL PERFORMANCE

3.1 OPTICAL BARS

3.1.1 Optical Set Identification

Table 3-1 identifies the operational cameras for SS S/N 013. It is intended for operational purposes and postflight analyses, etc., that these optical set nomenclatures will serve as identifiers for the individual cameras.

TABLE 3-1

CAMERA IDENTIFICATION

Optical Bar	Flight Direction	Optics Set
A	Forward	042
B	Aft	040

3.1.2 Physical Characteristics

Table 3-2 identifies the measured physical characteristics of both cameras.

TABLE 3-2

CAMERA PHYSICAL CHARACTERISTICS

Characteristic	Specification	Forward Camera	Aft Camera
Focal Length (inches)	60 $\pm$0.2 (2σ)	59.9724	59.9844
T Number	3.5 maximum	3.46	3.50

Note that both cameras are within acceptable design specification requirements.

3.1.3 Longitudinal Color

Figure 3-1 plots the on-axis longitudinal color response for both optical bar sets. The focus position was measured at six wavelengths, 4720Å, 5175Å, 5500Å, 6050Å, 6630Å, and 6975Å.

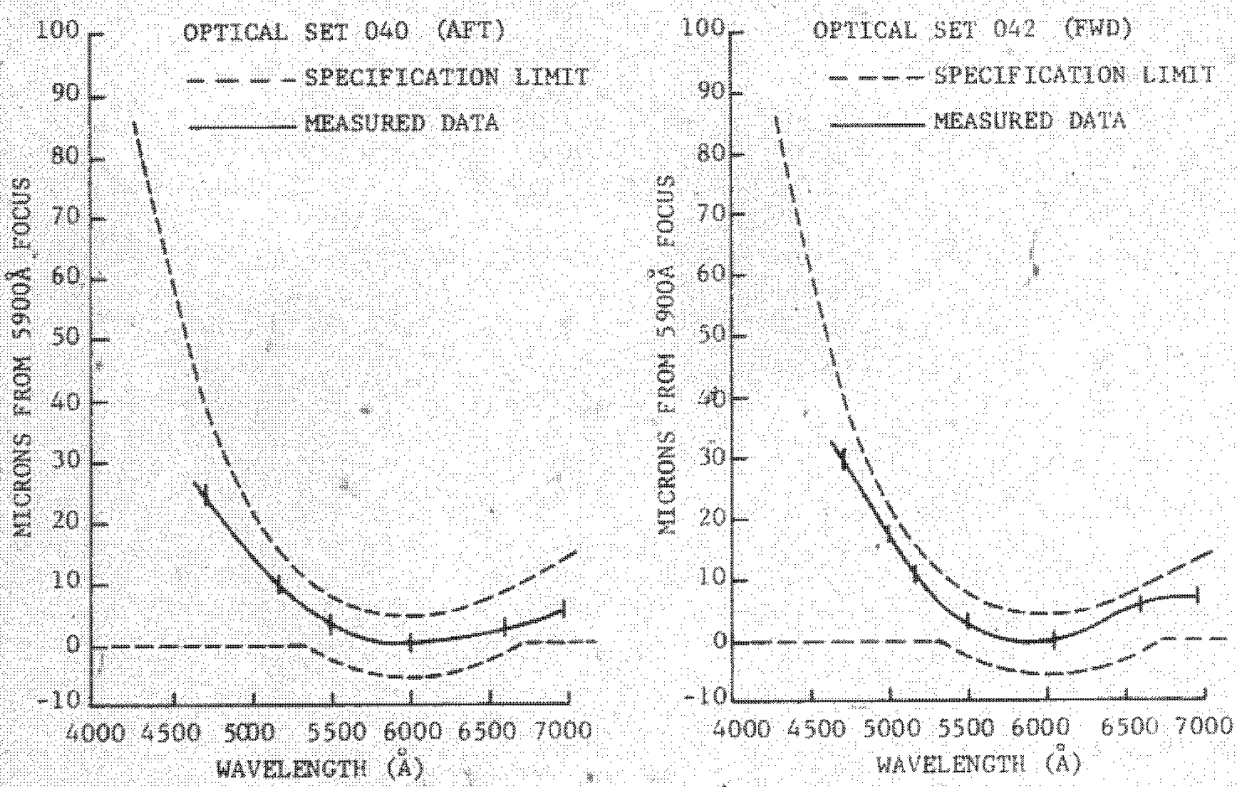


Figure 3-1. On-Axis Longitudinal Color Response

3.1.4 Focal Plane Tilt

Figure 3-2 plots the field curvature for both optical bar sets. Each graph in the figure indicates the curvature as determined from monochromatic data taken in Chamber D.

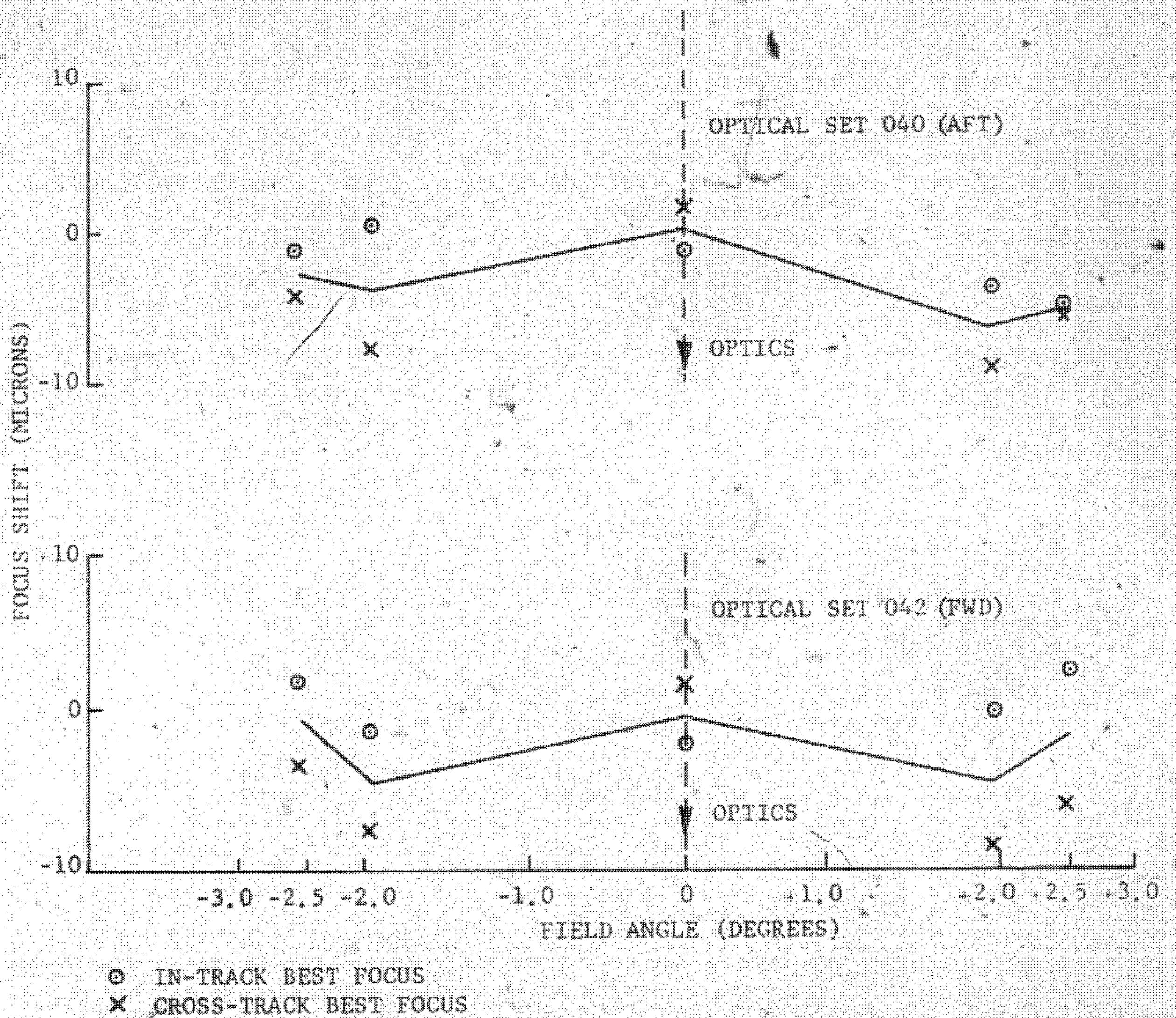


Figure 3-2. Field Curvature, Optical Bar, Glass Sets 040 and 042, FWD and AFT Cameras

Figure 3-2 is plotted with Chamber A and Chamber A-2 sign conventions to facilitate additional plotting of the film plane profile across the slit based upon the resolution data. The in-track and cross-track best focus are also shown.

Chamber D data showed that the FWD Optical Bar has a 0 micron tilt (0.2 micron per 1/2 slit) in the retreat direction, and that the AFT Optical Bar has a 3 micron tilt (1.7 microns per 1/2 slit) in the advance direction.

3.1.5 MTF Comparison

Modulation Transfer Functions (MTF's) are obtained at 70, 93 and 47°F. The measured transfer functions and their respective specification curves for each optical bar are illustrated in Figures 3-3 through 3-8.

All measured transfer functions exceed the specification transfer functions over the spatial frequencies measured. The 70°F MTF ratios of the post vibration values to the previbration values at a frequency of 140 C/MM indicate that the optical performance was essentially unchanged by exposure to acceptance vibration (See Table 3-3).

TABLE 3-3

MTF RATIOS, POST VIBRATION TO PREVIBRATION AT 140 C/MM

Field Angle	OB Set			
	042 (FWD)		040 (AFT)	
	Flight	Scan	Flight	Scan
+2.5°	1.03	1.01	1.07	1.04
0.00°	1.01	1.02	1.04	1.04
-2.5°	1.01	1.02	1.02	1.03

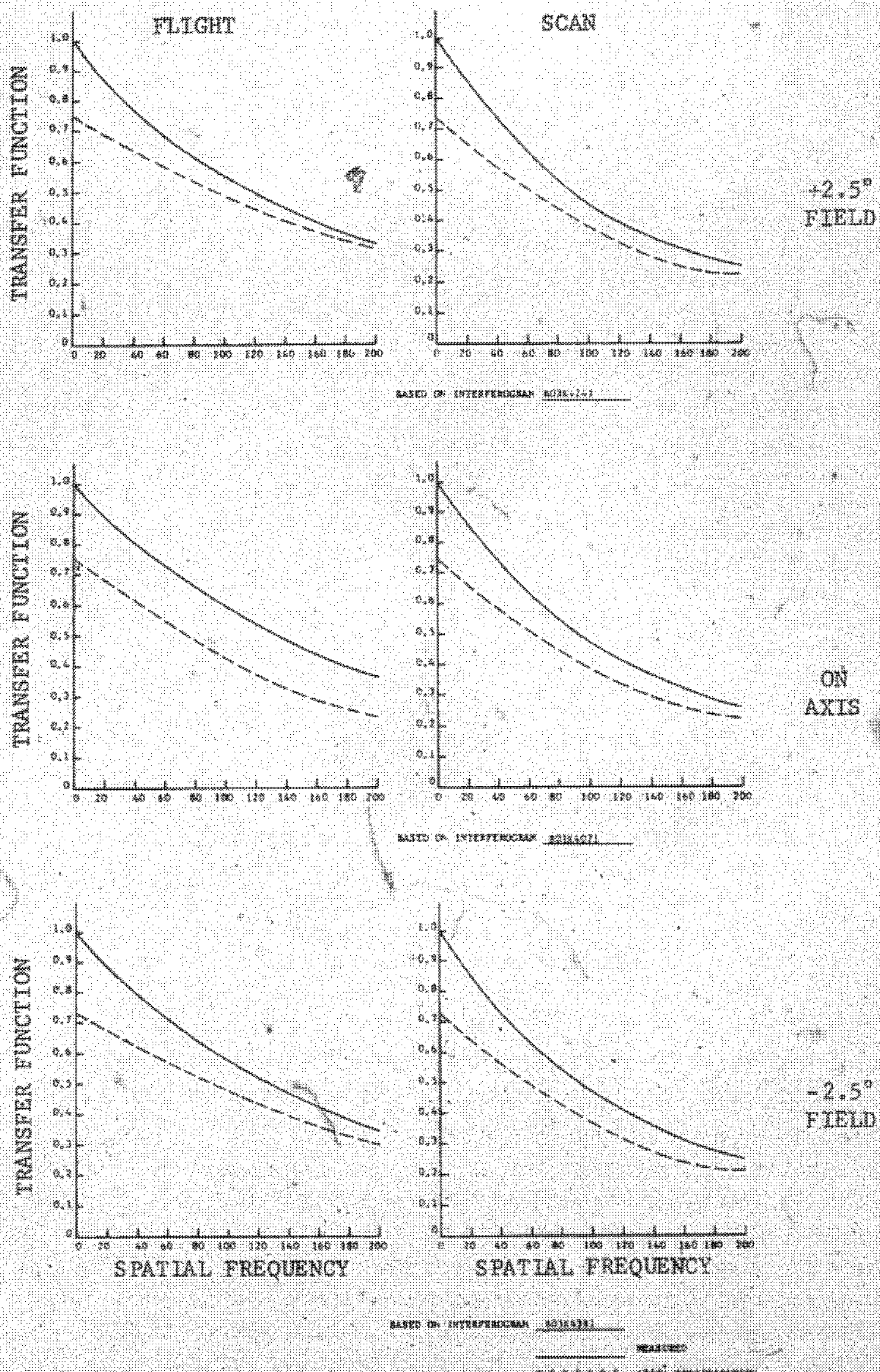


Figure 3-3. Monochromatic Post Vibration MTF at 70°F, Glass Set 040, On-Axis and ± 2.5° Field, AFT Camera.

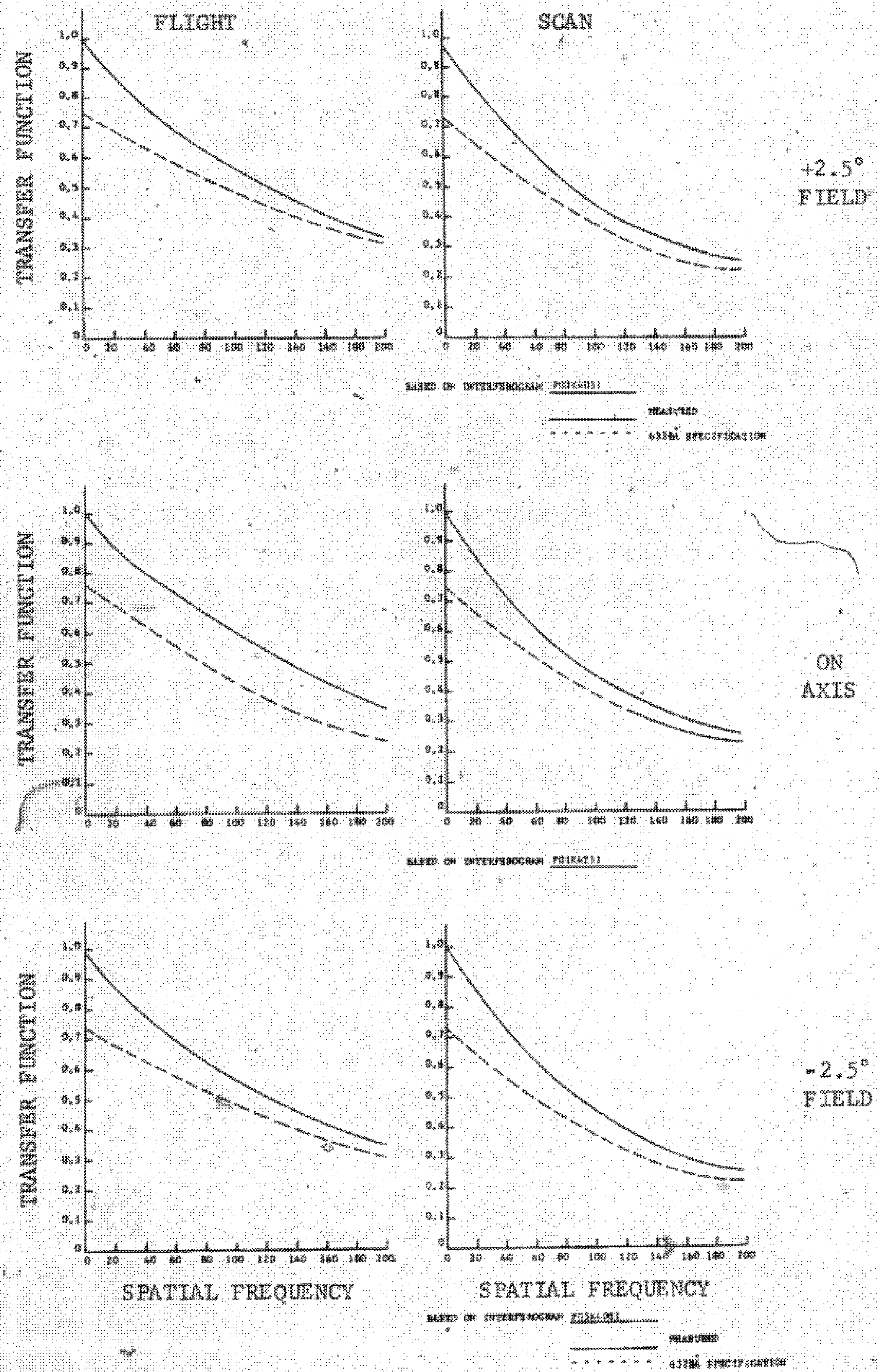


Figure 3-4. Monochromatic Post Vibration MTF at 93°F, Glass Set 040, On-Axis and ± 2.5° Field, AFT Camera.

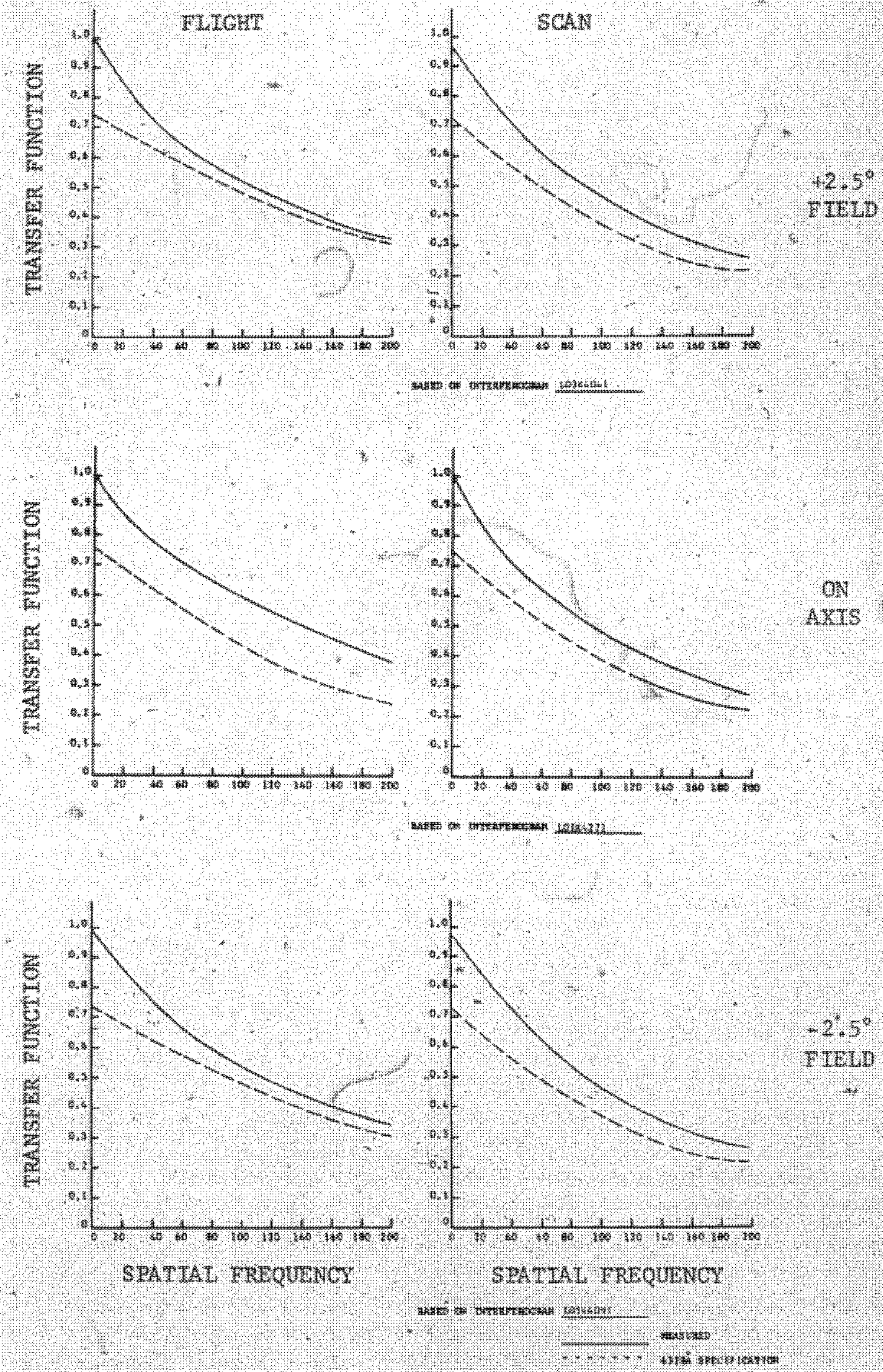


Figure 3-5. Monochromatic Post Vibration MTF at 47°F, Glass Set 040, On-Axis and ± 2.5° Field, AFT Camera.

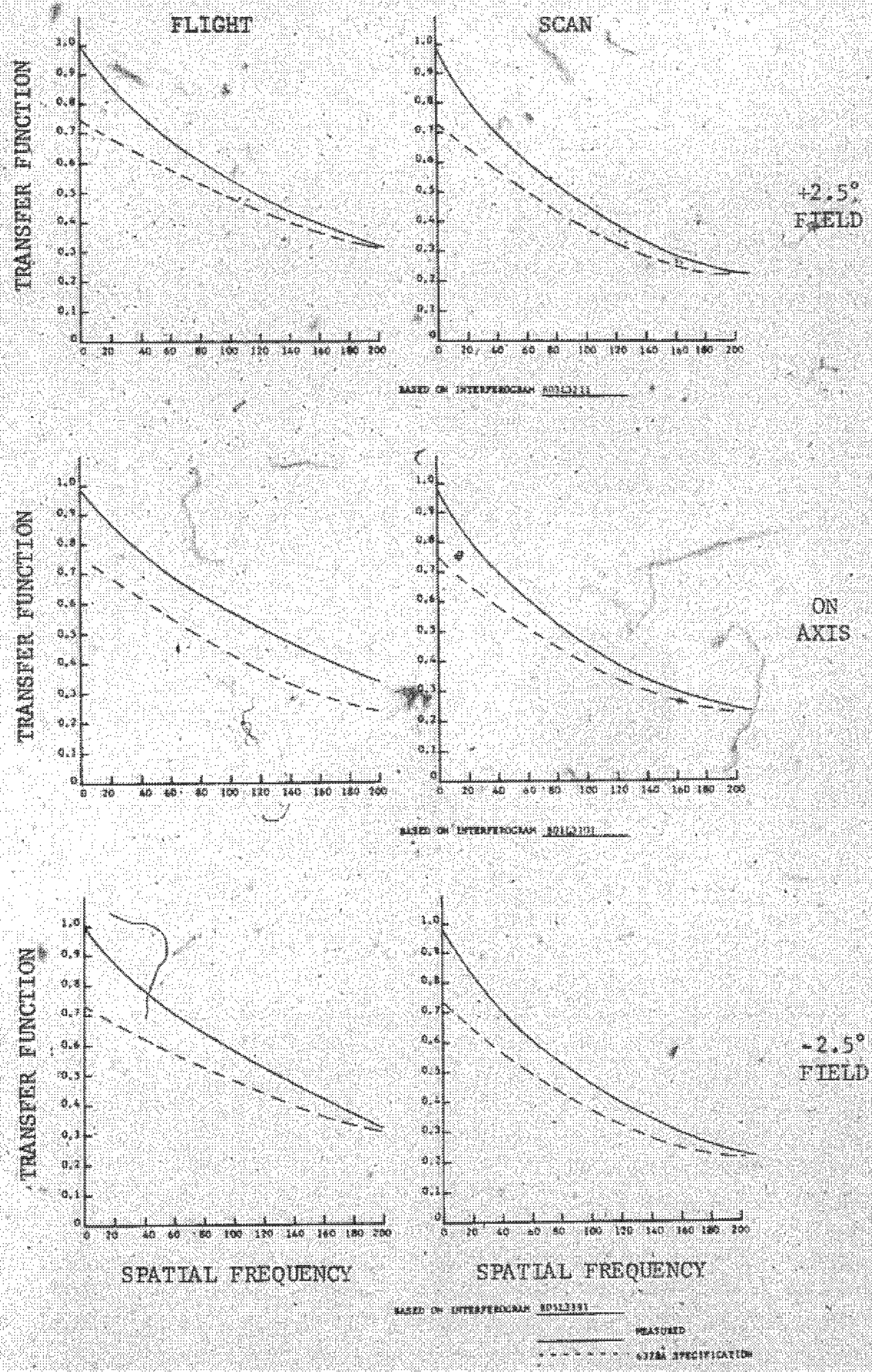


Figure 3-6. Monochromatic Post Vibration MTF at 70°F, Glass Set 042, On-Axis and ± 2.5° Field, FWD Camera.

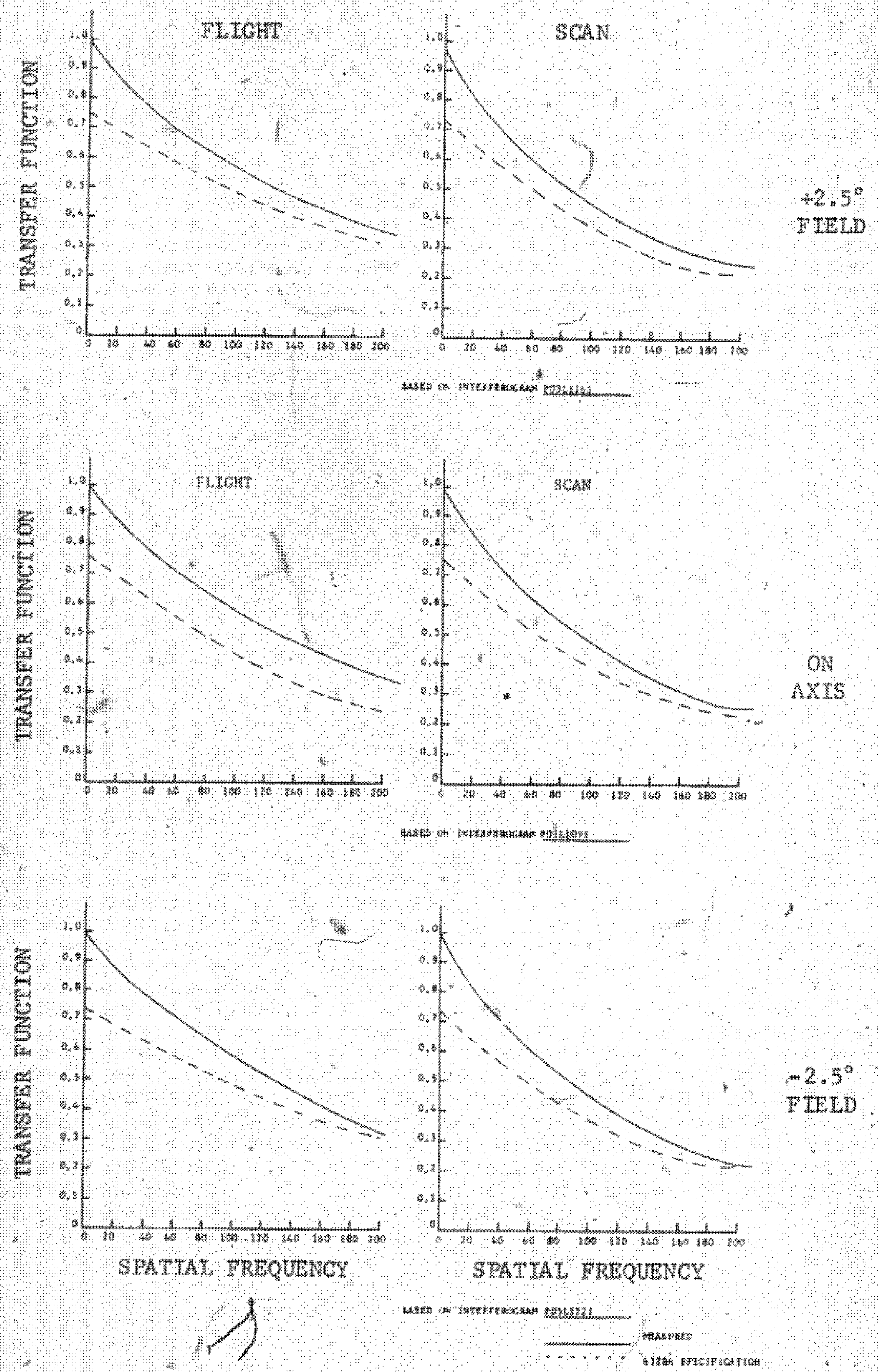


Figure 3-7. Monochromatic Post Vibration MTF at 93°F, Glass Set 042, On-Axis and ± 2.5° Field, FWD Camera.

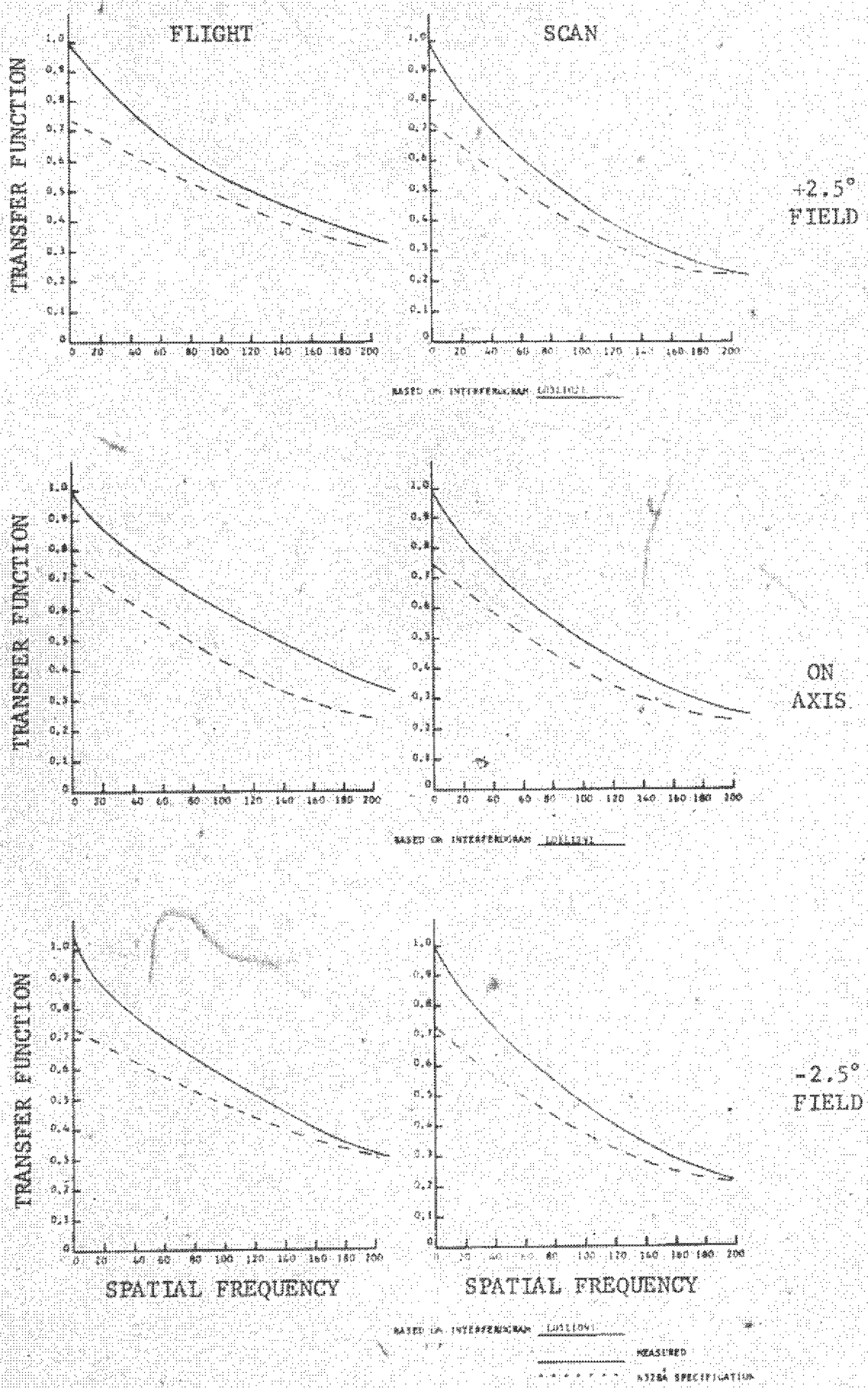


Figure 3-8. Monochromatic Post Vibration MTF at 47°F, Glass Set 042, On-Axis and ± 2.5° Field, FWD Camera.

3.1.6 Passive Focus Shift

Both cameras were tested in a Chamber D test environment and, following thermal stabilization at each of the 47°F and 93°F environments, the amount of focus change was measured. Table 3-4 identifies the amount of defocus at the 0° and ±2.5° field positions as related to the focus position established at 70°F. Essentially, the data contained in this table is a measure of the optics' ability to passively maintain the best focus position over the operating thermal range. The signs reflect the Chamber A sign convention, which is the normal optical sign convention, i.e., plus is away from the last optical surface.

TABLE 3-4

PASSIVE FOCUS

Optical Bar		042 (FWD)	040 (AFT)
Temperature (°F)	Field Position (degrees)	Defocus (microns)	Defocus (microns)
93	2.5	0.1	3.1
	0	-3.9	0.4
	-2.5	-3.9	-1.3
47	2.5	6.2	1.5
	0	8.9	6.2
	-2.5	10.3	9.0

The data shows that the FWD OB does meet the ±4.5 microns performance requirement at 93°F in all field positions, but does not at 47°F in all field positions. The AFT OB meets the requirement at 93°F in all field positions but does not at 47°F in the 0° and -2.5° field position. Figure 3-9 illustrates the effect of the passive focus errors on field curvature and tilt. Both optical bars show significant shift in focus with temperature, and also significant changes in tilt.

These out-of-specification conditions did not degrade the predicted resolution performance below its specification value and the OBs were moved ahead in assembly.

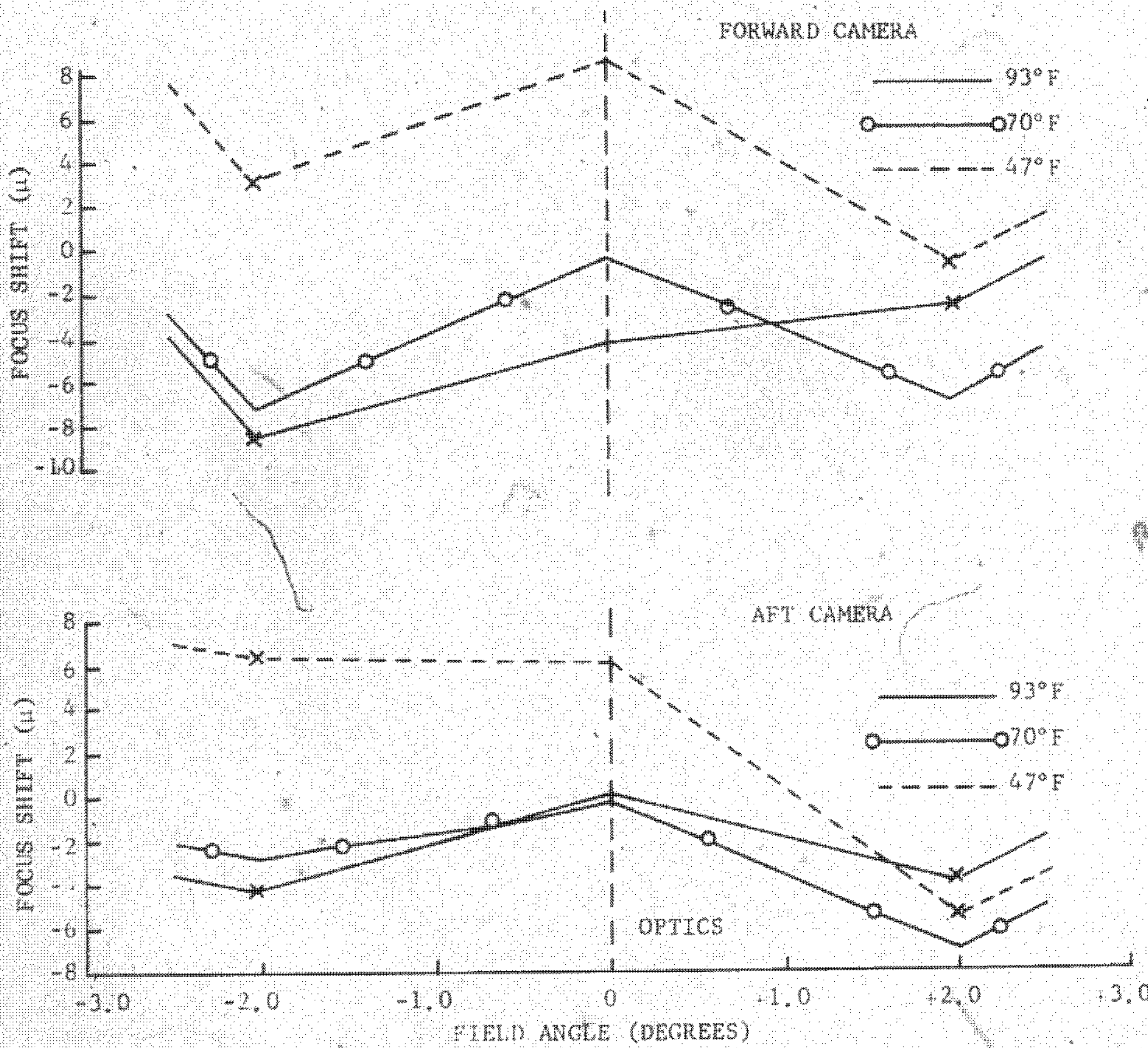


Figure 3-9. Effect of Temperature on Field Curvature and Tilt, FWD and AFT Cameras.

3.1.7 Gravity Induced Defocus and Aberration

Testing in a gravity field causes errors in focus and wavefront aberration that should be accounted for. The measured gravity induced defocus and astigmatism for this system are as follows:

At Nadir	FWD Camera	AFT Camera
Gravity induced defocus	9.1μ	6.1μ
Gravity induced 0° - astigmatism	-0.11λ	-0.12λ
Chamber D Correction		
Gravity induced 45° - astigmatism	0.09λ	0.09λ

Plus defocus is away from the optics.

3.1.8 Dynamic Gravity Corrections

The dynamic gravity corrections, for both optical bars for Chambers A and A-2 are shown in Table 3-5. These values are used to adjust the measured image motion values for both chambers.

TABLE 3-5

GRAVITY CORRECTIONS - CHAMBERS A AND A2

	FWD OB #5042						AFT OB #5040					
	IN-TRACK			CROSS-TRACK			IN-TRACK			CROSS-TRACK		
	45°	0°	55°	45°	0°	55°	45°	0°	55°	45°	0°	55°
31.2rpm Vx/h = 0.052	0.045	- 0.003	-0.051	-0.023	-0.034	-0.025	0.040	-0.009	-0.046	-0.028	-0.035	-0.023
26.4rpm Vx/h = 0.044	0.038	- 0.002	-0.043	-0.020	-0.028	-0.021	0.035	-0.008	-0.038	-0.023	-0.032	-0.020
21.6rpm Vx/h = 0.036	0.030	0.000	-0.035	-0.017	-0.024	-0.019	0.031	-0.008	-0.032	-0.018	-0.025	-0.015

	FWD				AFT			
	IN-TRACK		CROSS-TRACK		IN-TRACK		CROSS-TRACK	
	0°	37°	0°	37°	0°	37°	0°	37°
31.2rpm Vx/h = 0.052	-0.003	-0.038	-0.034	-0.031	-0.009	-0.028	-0.035	-0.031
26.4rpm Vx/h = 0.044	-0.002	-0.032	-0.028	-0.027	-0.008	-0.024	-0.032	-0.028
21.6rpm	0.000	-0.027	-0.024	-0.023	-0.008	-0.020	-0.025	-0.022

1. All values given in inches/sec.
2. All values in OB coordinate system.
3. Flash interval 7 counts.

3.2 MIDSECTION ASSEMBLY, DYNAMIC RESOLUTION

3.2.1 Geometric Means

A summary of the tri-bar resolution for the vacuum acceptance tests, in Table 3-6, shows two sets of data listed for each camera at each of three test temperatures (70°, 47°, 93°F). The first set is raw resolution data read directly from the film at a selected platen diagnostic focus position 41 microns for the FWD Camera and 35 microns for the AFT Camera. The 70° test values are the average of three readers while a single reader was used for the other test data. Both cameras, at all three temperatures, fully meet the CEI specification requirements (referenced at the top of the tables).

The second set of data is the result of each in-track and cross-track raw focus position being corrected for measured collimator focus errors, gravity effects on the optics and measured film profile effects. On the FWD Camera, this results in a significant decrease in apparent field curvature, such that the resolution peaks for the nadir and off-axis positions are closer allowing the selection of a focus position effecting higher resolution across the field. For the AFT Camera apparent field curvature is a good deal less and correcting the data for collimator, gravity, and film profile effects results in the selection of a new focus position but does not significantly change the field curvature characteristics or resolution performance. The magnitude of the individual Focus Correction Factors for each camera are listed in Tables 3-7 and 3-8.

To determine film profile effects, samples of 100 feet to 200 feet of film are set aside just prior to and just following each acceptance thru-focus run; film splices are accounted for, so that these samples will encompass all splice segments on which the thru-focus run is made.

These film samples are cut out prior to processing and measured for film flatness on the Abbreviated Film Path; this duplicates the film tension and roller locations at the platen position, but the platen is in a horizontal rather than a vertical position. Traces are made across the Film Web (in the flight direction) with a photonic sensor having a measurement repeatability of one micron.

TABLE 3-6

VACUUM ACCEPTANCE TESTS, FWD AND AFT CAMERAS, S/N 013

FWD CAMERA

SUMMARY OF TRIBAR RESOLUTION — WESTOVER READINGS

* TEST DESCRIPTION		45° IN TRACK	45° CROSS TRACK	45° GEOM. MEAN	0° IN TRACK	0° CROSS TRACK	0° GEOM. MEAN	55° IN TRACK	55° CROSS TRACK	55° GEOM. MEAN
CEI SPEC. REQUIREMENTS	70°			130			150			130
	47° & 93°			110			150			110
*Avg of three readers										
70° CEI-101 SEQ 424 8-08-73	* FP 41μ	169	132	149	186	181	183	184	154	163
	** FP 28μ	177	166	171	222	181	200	169	154	161
47° CEI-111 SEQ 424 8-16-73	FP 41μ	166	135	150	143	167	154	160	156	158
	** FP 31μ	166	140	152	213	167	189	160	156	158
93° CEI-115 SEQ 424 8-13-73	FP 42μ	160	93	122	245	194	218	181	120	147
	** FP 28μ	171	130	149	231	185	207	181	149	164
**Focus Positions corrected for Collimator, gravity & material effects.										

AFT CAMERA

TEST DESCRIPTION		45° IN TRACK	45° CROSS TRACK	45° GEOM. MEAN	0° IN TRACK	0° CROSS TRACK	0° GEOM. MEAN	55° IN TRACK	55° CROSS TRACK	55° GEOM. MEAN
CEI SPEC. REQUIREMENTS	70°			130			150			130
	47° & 93°			110			150			110
*Avg of three readers										
70° CEI-101 SEQ 424 8-08-73	* FP 35μ	172	156	164	204	171	187	186	155	170
	** FP 28μ	170	156	163	197	170	183	168	155	161
47° CEI-111 SEQ 424 8-16-73	FP 35μ	154	150	152	204	172	188	188	167	177
	** FP 28μ	158	150	154	209	156	180	187	167	177
93° CEI-115 SEQ 424 8-13-73	FP 35μ	153	131	142	189	157	172	160	126	142
	** FP 28μ	153	132	142	185	145	164	154	126	139
**Focus Positions corrected for Collimator, gravity & material effects.										

NOTE: COLLIMATORS SET FOR INFINITY.

TABLE 3-7

FOCUS CORRECTION FACTORS (MICRONS) AFT CAMERA

CEI TEST	COLL. POS.	RAW FOCUS FROM LINE TGTS.			COLLIM. C/C CORR.		GRAVITY CORRECT		MAT'L FLATNESS	FINAL FOCUS		
		IN-TRK	CR-TRK	AVE.	IN-TRK	CR-TRK	IN-TRK	CR-TRK		IN-TRK	CR-TRK	AVE.
101 (70°F)	45°	26	28	27	-2	-2	-11	-3	-3 -3 -3	10	20	15
	0°	40	36	38	0	+1	-16	-4	-2 0 -1	25	34	30
	-55°	38	26	32	-4	-4	-10	-2	-1 +3 +2	22	18	20
111 (47°F)	45°	23	29	26	-1	-1	-11	-3	-2	9	23	16
	0°	37	36	37	0	0	-16	-4	+1	22	33	28
	-55°	42	33	37	-6	-6	-10	-2	-2	24	23	24
115 (93°F)	45°	38	30	34	-2	-2	-11	-3	+3	22	22	22
	0°	39	30	35	0	+1	-16	-4	+3	26	30	28
	-55°	38	21	30	-4	-4	-10	-2	0	24	15	20

TABLE 3-8

FOCUS CORRECTION FACTORS (MICRONS) FWD CAMERA

CEI TEST	COLL. POS.	RAW FOCUS FROM LINE TGTS.			COLLIM. C/C CORR.		GRAVITY CORRECT.		MAT'L FLATNESS	FINAL FOCUS		
		IN-TRK	CR-TRK	AVE.	IN-TRK	CR-TRK	IN-TRK	CR-TRK		IN-TRK	CR-TRK	AVE.
101 (70°F)	-45°	40	19	29	+2	+2	-11	-3	0	31	18	24
	0°	62	50	56	-5	-4	-16	-4	-2	39	40	40
	55°	36	28	32	-3	-3	-10	-2	-3	20	20	20
111 (47°F)	-45°	47	26	36	-1	+1	-11	-3	0	37	24	30
	0°	68	53	61	-4	-2	-16	-4	-3	45	44	44
	55°	43	30	36	-2	-2	-10	-2	-7	24	19	22
115 (93°F)	-45°	31	11	21	-2	-2	-11	-3	-2	24	12	18
	0°	51	42	46	-5	-4	-16	-4	-1	51	35	33
	55°	31	22	27	-3	-3	-10	-2	-3	15	14	14

3.2.2 Thru-Focus Resolution

Thru-focus performance plots (shown in Figures 3-10 through 3-12), of geometric mean resolution values are shown for each camera at each of the three temperatures. The location of the arrows that depict predicted point-of-best-focus in each plot was selected by the LINE program.

The plots of the raw resolution data indicate that a focus position of 41μ is a good compromise for the FWD Camera performance taking into account apparent field curvature and shifts of focus with temperature. The AFT Camera, however, is not as sensitive; it has much less field curvature and minimal change in focus with temperature - a focus position of 35μ is about optimum for all field positions and all temperatures. The FWD Camera would be optimized at 41μ at 70°, 47μ to 50μ at 47° and 36μ at 93°F.

Figures 3-13 through 3-15 illustrate the resolution performance plots with the focus positions corrected for collimator, gravity and material effects described in the previous section. As shown in Table 3-6, optimum performance across the field at all three temperatures is obtained at 28 to 31 microns for the FWD Camera and 28μ for the AFT Camera.

3.2.3 Performance at 0.6" Slit

Performance at the 0.6" slit was determined by comparing the actual delta change in resolution between the 0.3" and 0.6" slit width runs and the delta change as predicted using 0.3" slit width data as a baseline and applying Chamber A image motion error and 2σ values. The 0.3" and 0.6" slit width data is given in Table 3-9 along with the disabled mean image error measured for each test and the tribar resolution at the same platen diagnostic focus position for the CEI resolution run. Note, in the table, the two 0.3" slit width runs are essentially equivalent in resolution values. The actual change and predicted change in resolution are in good agreement.

3.2.4 Color Performance

The S/N 013 tri-bar resolution with SO-255 color film, summarized in Table 3-10, is typical of what has been experienced on previous systems; the values

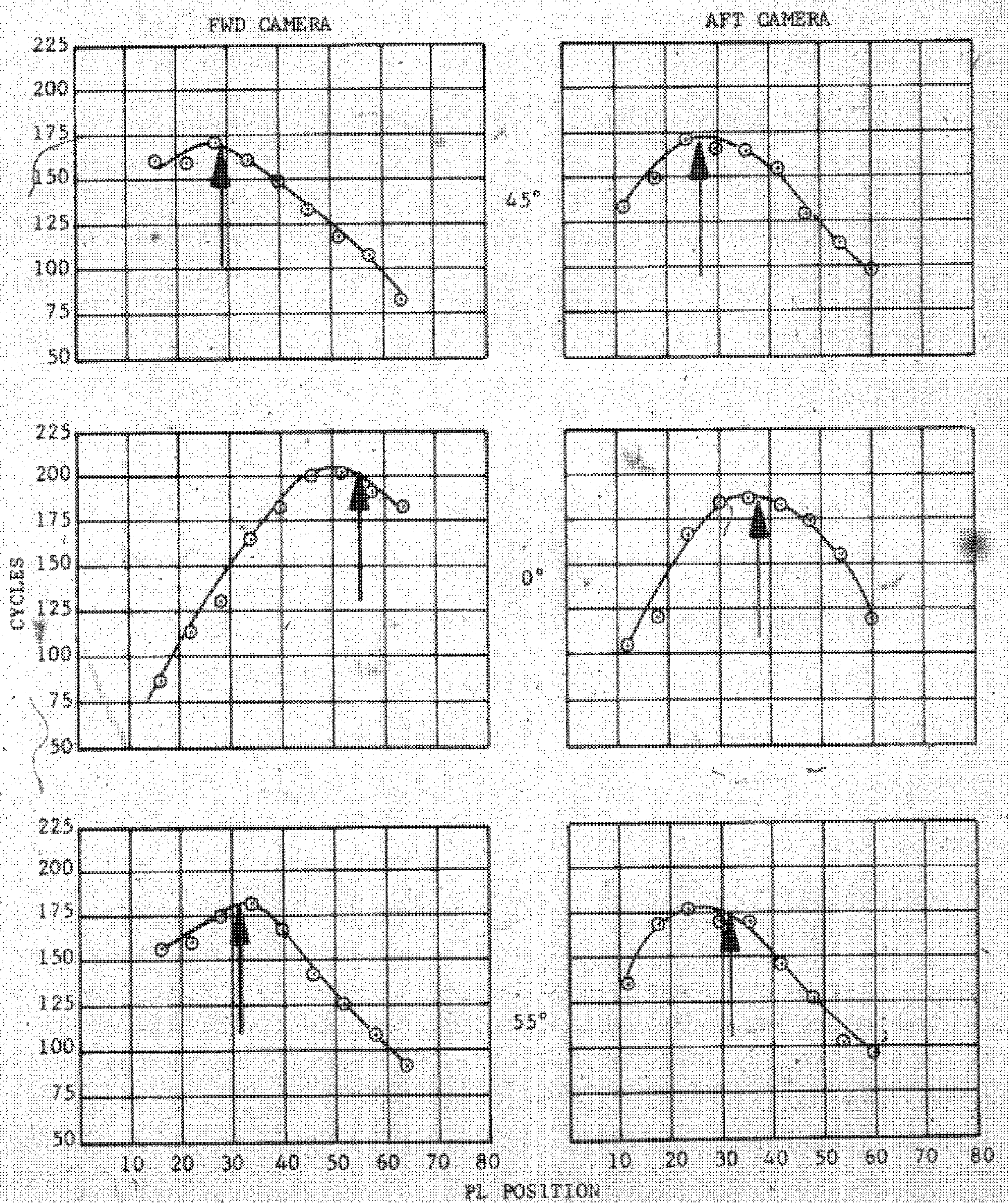


Figure 3-10. Performance Plot, Geometric Mean, Rad X = 0.052, 70°F, CEI 101, FWD and AFT Camera

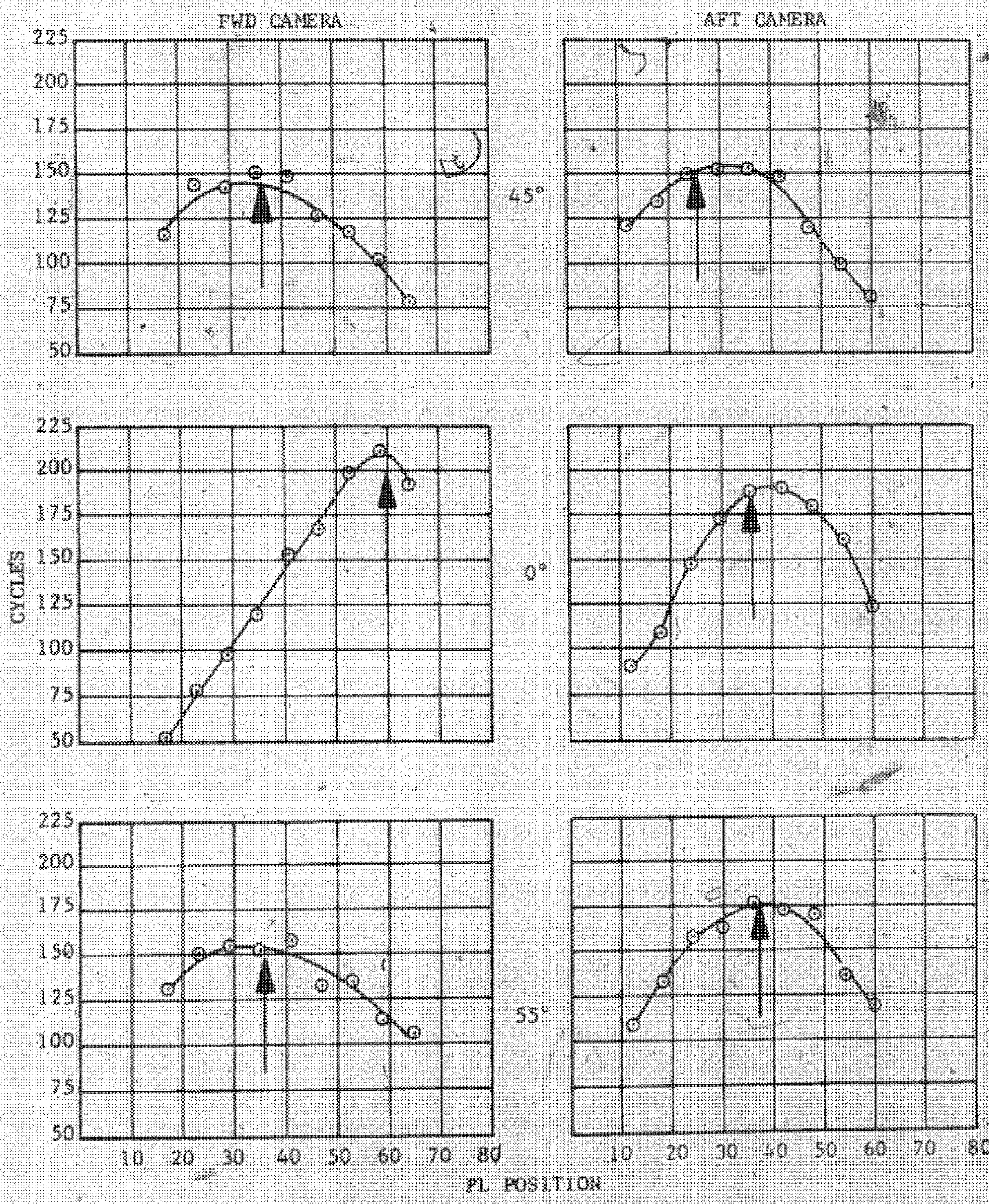


Figure 3-11. Performance Plot, Geometric Mean, Rad X = 0.052, 47°F, CEI 111, FWD and AFT Camera

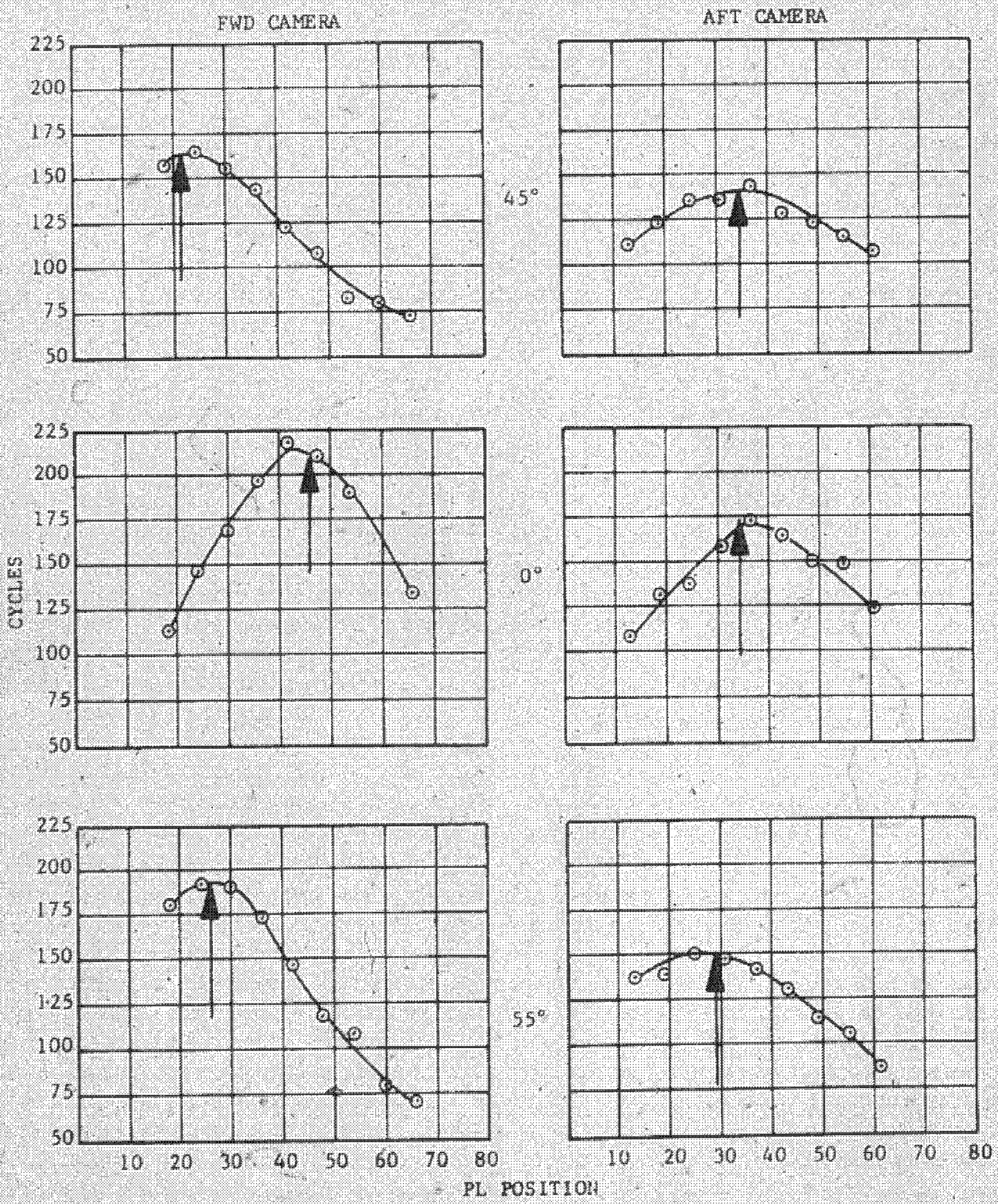


Figure 3-12. Performance Plot, Geometric Mean, Rad X = 0.052, 93°F, CEI 115, FWD and AFT Camera

NOTE: FOCUS POSITIONS CORRECTED FOR COLLIMATOR, GRAVITY AND MATERIAL EFFECTS.

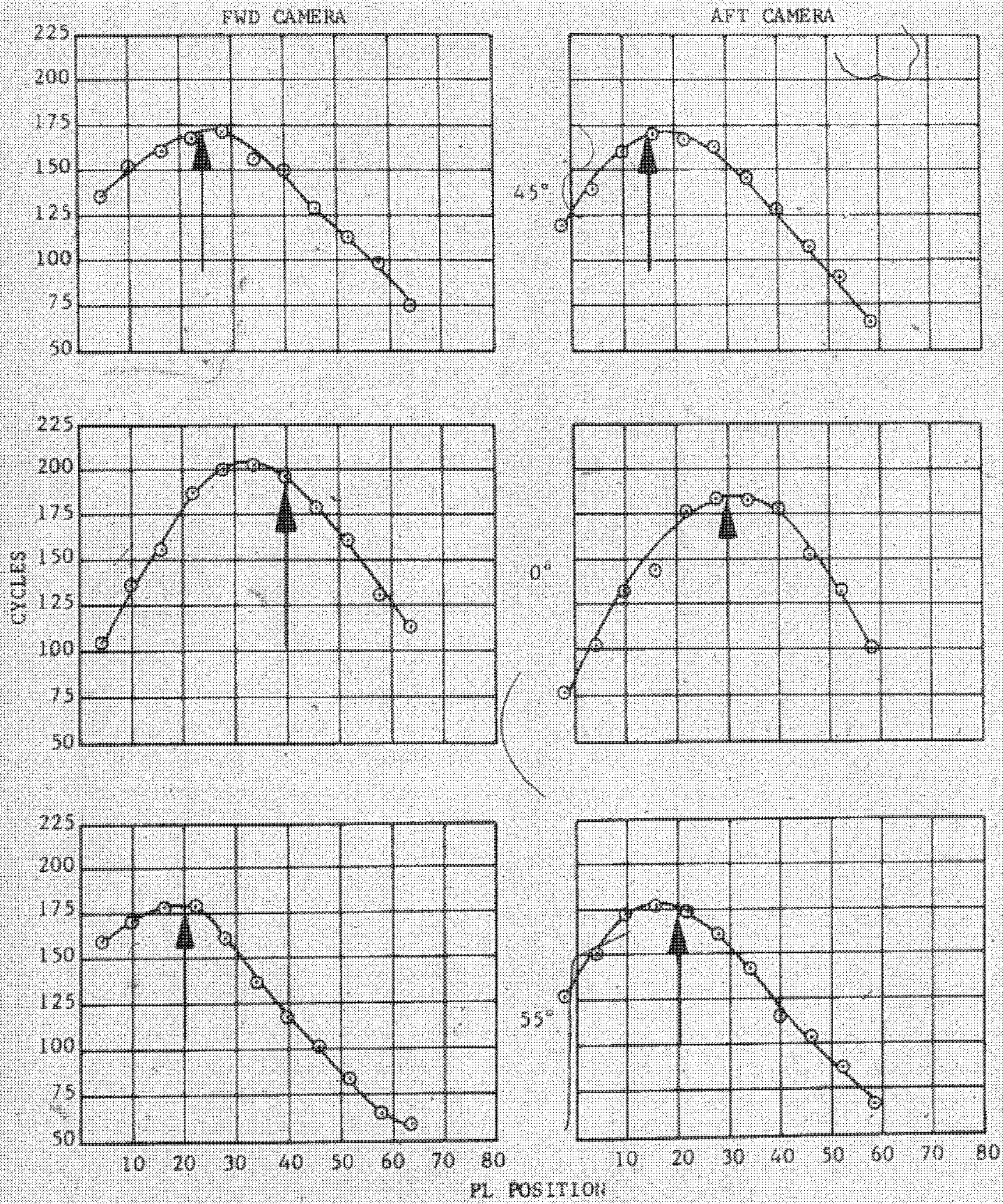


Figure 3-13. Performance Plot, Geometric Mean, Rad X = 0.052, 70°F, FWD and AFT Camera, Test No. 5

NOTE: FOCUS POSITIONS CORRECTED FOR COLLIMATOR, GRAVITY AND MATERIAL EFFECTS.

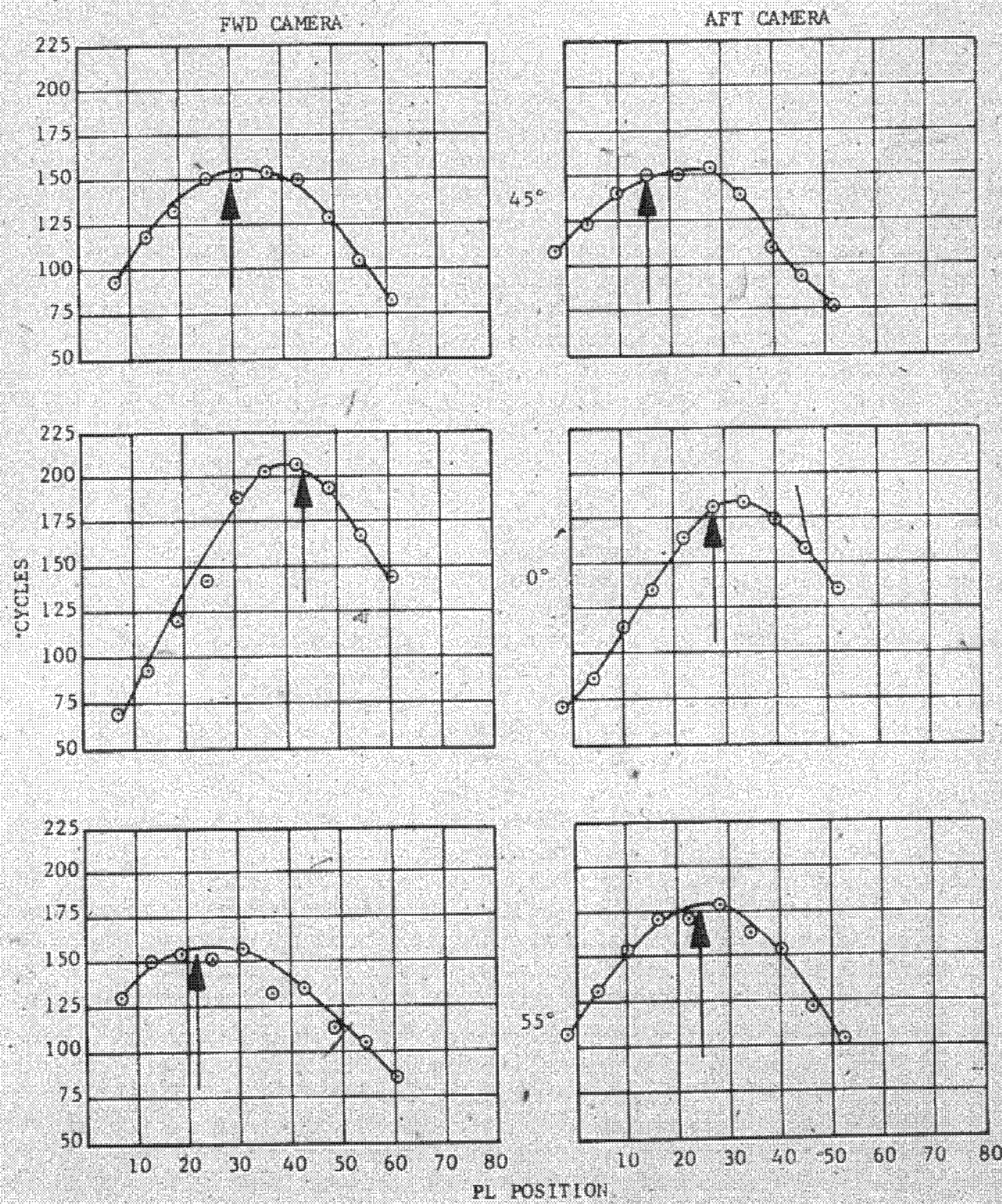


Figure 3-14. Performance Plot, Geometric Mean, Rad X = 0.052, 47°F, FWD and AFT Camera, Test No. 6

NOTE: FOCUS POSITIONS CORRECTED FOR COLLIMATOR, GRAVITY AND MATERIAL EFFECTS.

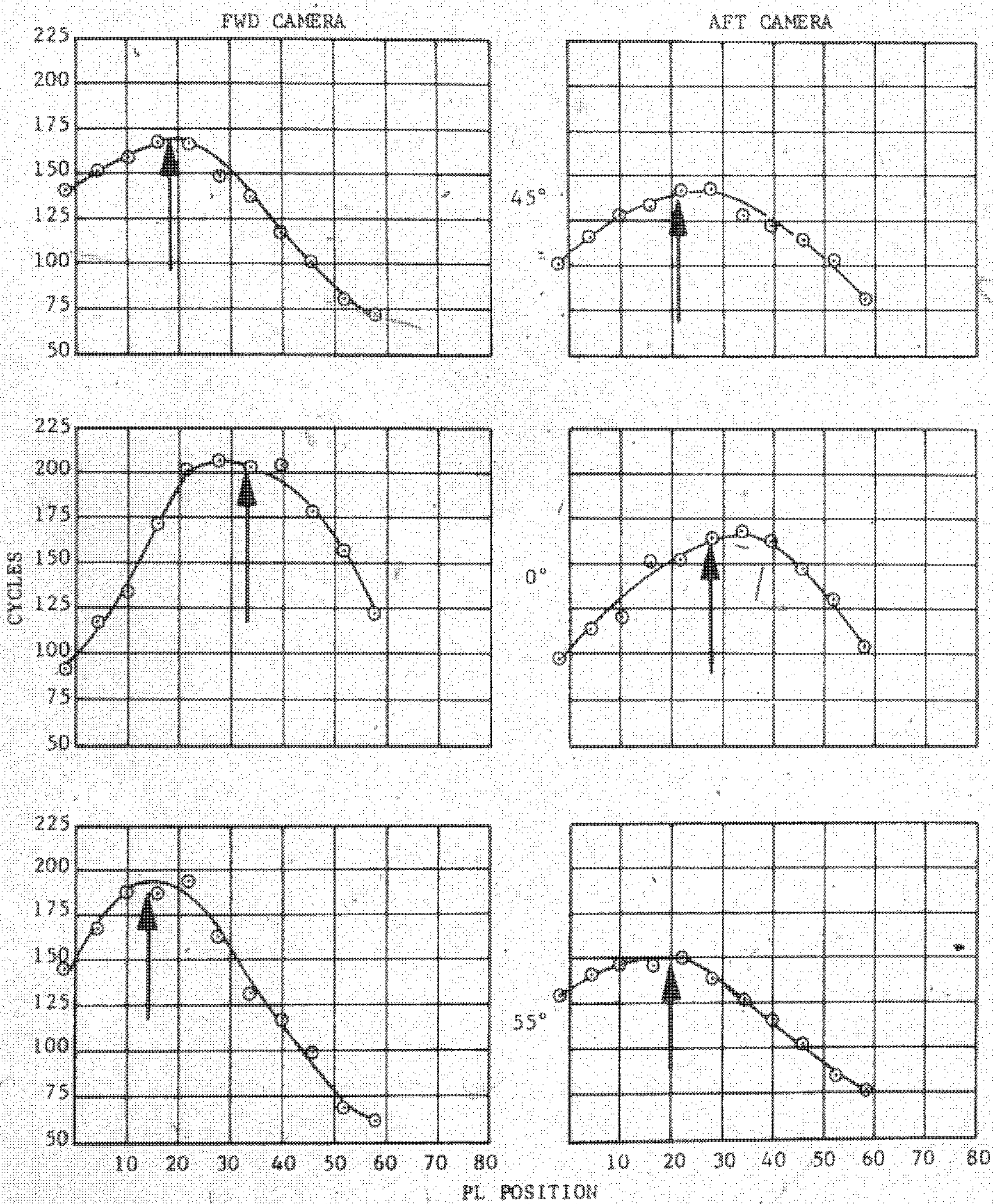


Figure 3-15. Performance Plot, Geometric Mean, Rad X = 0.052, 90°F, FWD and AFT Camera, Test No. 7

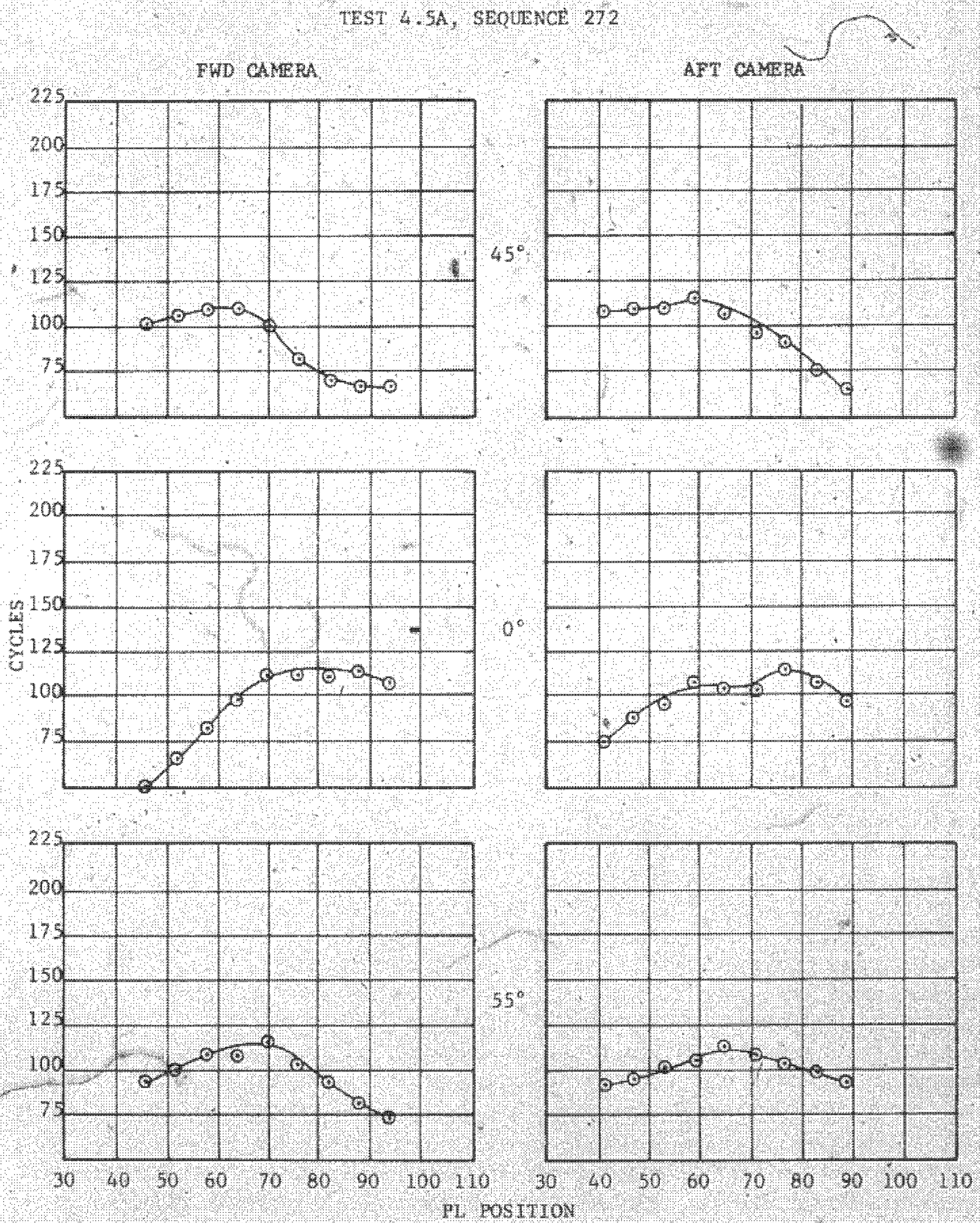


Figure 3-16. Geometric Mean Resolution as a Function of Temperature at Rad X = 0.052, 70°F, SO-255 Testing, FWD and AFT Cameras.

TABLE 3-9

SCAN ANGLE LENGTH CONTROL TESTS, DUAL GAMMA, FWD AND AFT CAMERAS

FWD CAMERA

TEST DESCRIPTION		45°			0°			55°		
		IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN
CEI-109 SEQ-427 052 DISABLED 6 PULSE COUNT	MEAN	X	X		.036	.039		.050	.019	
	2σ	X	X		(.049)	(.070)		(.066)	(.063)	
CEI-110 SEQ-428 052 DISABLED 7 PULSE COUNT	MEAN	.055	.005		.016	-.011		-.076	.011	
	2σ	(.036)	(.041)		(.024)	(.058)		(.032)	(.057)	
CEI-101 FP 40μ	0.3	169	132	149	186	181	183	184	154	168
CEI-109 FP 40μ CEI-110	0.3	177	131	152	180	179	180	188	162	174
	0.6	130	122	126	207	182	193	156	160	158
	Δ	47	9		-27	[illegible]		32	2	
PREDICTED 0.6 IN. SLW RESOLUTION USING 0.3 IN. SLW DATA AS A BASELINE AND APPLYING CHAMBER "A" IMAGE MOTION ERROR AND 2σ VALUES	0.3	177	131		180	179		188	162	
	0.6	139	129		176	175		154	157	
	Δ	35	2		4	4		34	5	

AFT CAMERA

TEST DESCRIPTION		45°			0°			55°		
		IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN
CEI-109 SEQ-427 052 DISABLED 6 PULSE COUNT	MEAN	.051	.029		-.007	.039		-.080	.016	
	2σ	(.049)	(.063)		(.051)	(.067)		(.053)	(.070)	
CEI-110 SEQ-428 052 DISABLED 7 PULSE COUNT	MEAN	.059	.015		.004	.019		-.071	.050	
	2σ	(.029)	(.042)		(.034)	(.049)		(.034)	(.034)	
CEI-101 FP 35μ	0.3	172	156	164	204	171	187	186	155	170
CEI-109 FP 35μ CEI-110	0.3	179	139	156	191	159	174	182	145	162
	0.6	141	140	140	136	154	169	138	126	131
	Δ	38	-1		5	5		44	19	
PREDICTED 0.6 IN. SLW RESOLUTION USING 0.3 IN. SLW DATA AS A BASELINE AND APPLYING CHAMBER "A" IMAGE MOTION ERROR AND 2σ VALUES	0.3	179	139		191	159		162	145	
	0.6	140	136		163	155		129	126	
	Δ	39	3		3	4		53	19	

SLIT WIDTHS 0.3/0.6, MEAN IMAGE MOTION ERROR IN IPS, TRIBAR RESOLUTION IN CY/MM

TABLE 3-10

SO-255 TESTING, FWD AND AFT CAMERAS

SUMMARY OF TRIBAR RESOLUTION

TEST DESCRIPTION		45°			0°			55°		
		IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN
TEST NO. 4-5A SEQ 272 8-22-73 FWD CAMERA	FP 70µ	122	82	100	121	102	111	127	104	115
AFT CAMERA	FP 59µ	115	114	115	113	102	107	103	108	105

indicate an approximate shift of +30 microns from the black and white film (1414) focus position (see through-focus plots, Figure 3-16).

3.3 MIDSECTION, FOCAL PLANE TILT AND APPARENT FIELD CURVATURE

3.3.1 Focal Plane Tilt

The calculated corrections for focal plane tilt required over a six-inch baseline from corrected line target data for every vacuum test conducted on S/N 013 are summarized in Table 3-11. Focal plane tilt plots are shown in Figure 3-17 from Chamber D data and Chamber A corrected line target data for the three temperature tests.

The FWD Camera tilt history includes a 9.0 micron tilt correction in the retreat direction made prior to vacuum acceptance testing, leaving a correction capability of 11 microns in the retreat direction and 29 microns in the advance direction.

In the final adjustment of the AFT Camera, the platen was tilted 3.0 microns in the retreat direction leaving a correction capability of 17 microns in the retreat direction and 23 microns in the advance direction.

3.3.2 Apparent Field Curvature

Referring again to the tilt plots (Figure 3-17) the FWD Camera has an apparent field curvature that significantly exceeds the field curvature measured in Chamber D. This phenomenon is being thoroughly investigated and will be reported separately at a later date.

3.4 MIDSECTION, DYNAMIC FOCUS

A summary of the nadir collimator focus positions and 2 sigma values from raw line target data for all three temperatures is presented in Tables 3-12 and 3-13. In particular, the measured 2 sigma values are all well controlled, the greatest value being 3.6 microns. From this data the center position shift with temperature has been calculated and listed in Table 3-14.

The most significant focal shift with temperature, as measured in Chamber A, occurs at 93°F on the FWD Camera. On this instance the shift exceeds the

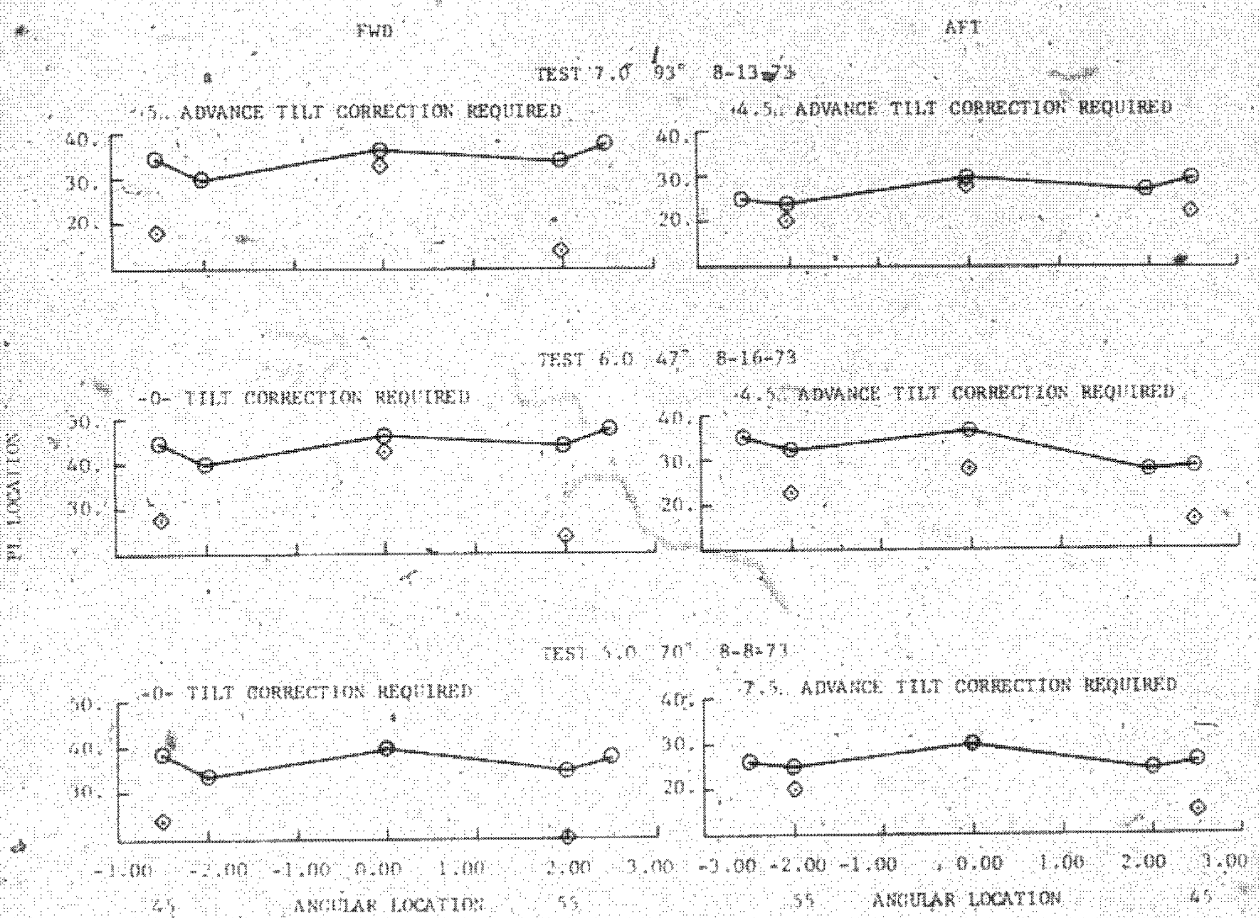
TABLE 3-11

PLATEN TILT SUMMARY

− RETREAT
+ ADVANCE

SN	OB SN	CHAMBER A TESTS	DATE	CHAMBER D TILT	CALC. TILT CORRECTION REQ'D FROM LINE TGTS.		TILT CHANGES	TO MATCH CHAMBER D Δ TILT
						CORRECTED DATA		
013	042	FWD CAMERA		-0-				
		#4 BASELINE	5-04-73			-6.0		
		#4-1 BASELINE	5-07-73			+1.5		
		#9 SIA BOX	5-09-73			-6.0		
		#9-1&2 PITCH	5-14-73			-0-		
		#9-3 BASELINE	5-18-73			-4.5		
		#9-4 M/S REVERSED	5-22-73			+6.0		
		#4-2 BASELINE	6-18-73			-1.5		
		*#4-3 BASELINE	7-13-73			-4.5	-9.0	
		#4-4 BASELINE	7-20-73			-3.0		
		#4-5 BASELINE	8-02-73			-0-		
		#5 70° ACCEPT.	8-08-73			-0-		
		#6 47° ACCEPT.	8-16-73			-0-		
		#7 93° ACCEPT.	8-13-73			+5.0		
013	040	AFT CAMERA		+4.0				
		#4 BASELINE	5-04-73			+15.0	+15.0	
		#4-1 BASELINE	5-07-73			+4.5		
		#9 SIA BOX	5-09-73			+10.5		
		#9-1&2 PITCH	5-14-73			+13.5		
		#9-3 BASELINE	5-18-73			+7.5		
		#9-4 M/S REVERSED	5-22-73			-10.5		
		#4-2 BASELINE	6-18-73			-6.0	+20.0 MECHANICAL	
		*#4-3 BASELINE (BEFORE SPLICE NO. 61) (AFTER SPLICE NO. 61)	7-13-73			+1.5 +3.0	-3.0	
		#4-4 BASELINE	7-20-73			-0-		
		#4-5 BASELINE	8-02-73			-4.5		
		#5 70° ACCEPT.	8-08-73			+7.5		
		#6 47° ACCEPT.	8-16-73			+4.5		
		#7 93° ACCEPT.	8-13-73			+4.5		

*Collimator Data Not Available
Assumed Values of Previous Test



NOTE: CORRECTED FOR COLLIMATOR, GRAVITY, AND MATERIAL EFFECTS.

○ - Chamber "D" Data. ◇ - Line Data

Figure 3-17. Tilt Determination, FWD and AFT Cameras

TABLE 3-12

SUMMARY OF BEST POSITION FROM LINE DATA, FWD CAMERA, 54 MICRONS POSITION

TEMP.	RADX		IN (MICRONS)	CR (MICRONS)
47	.052	MEAN	68.	53.
		TWO SIGMA	2.7	2.5
70	.036	MEAN	61.	50.
		TWO SIGMA	2.3	2.0
	.052	MEAN	62.	50.
		TWO SIGMA	3.6	2.8
93	.052	MEAN	51.	41.
		TWO SIGMA	3.2	3.6

TABLE 3-13

SUMMARY OF BEST POSITION FROM LINE DATA, AFT CAMERA, 35 MICRONS POSITION

TEMP.	RADX		IN (MICRONS)	CR (MICRONS)
47	.052	MEAN	37.	36.
		TWO SIGMA	2.4	2.4
70	.036	MEAN	40.	36.
		TWO SIGMA	3.4	3.0
	.052	MEAN	40.	36.
		TWO SIGMA	2.3	2.3
93	.052	MEAN	39.	30.
		TWO SIGMA	3.6	3.6

TABLE 3-14

CENTER POSITION SHIFT WITH TEMPERATURE, RADX = .052

TEMPERATURE	DEVICE	CHAMBER D	CHAMBER A
93	FWD	-3.8	-9.5 (-7)
	AFT	-0.4	-3.2 (-2)
47	FWD	+9.0	4.9 (4)
	AFT	+6.1	-1.4 (-2)

(AVERAGE POSITION AT TEMPERATURE - AVERAGE POSITION AT 70°F.) ALL VALUES GIVEN IN MICRONS. (DATA CORRECTED FOR COLLIMATOR, GRAVITY AND MAT'L EFFECTS)

Chamber D measurement by over 5 microns. At 47°F, however, both cameras shifted considerably less than Chamber D measurements.

As a direct result of the focal shift at 93°F, the FWD Camera does not meet the dynamic focus requirement as listed in Table 3-15. The AFT Camera on the other hand, is well within the specified limit.

The dynamic focus test results at 70°F and for the two operational speeds of RADX = 0.052 and 0.036 (listed in Table 3-16) show that both cameras fully meet the CEI specification requirements.

While the focal shifts summarized in these tables cause some degradation of optical performance, the tri-bar resolution values cited in Paragraph 3.2.1 fully meet CEI specifications at recommended focal positions common for all three temperatures.

3.5 MIDSECTION, IN FLIGHT CHANGEABLE FILTER (ICF) PERFORMANCE (FILTER FLIP/FLOP TEST)

The filter flip/flop test was conducted to corroborate tri-bar resolution and focus performance as the Wratten 12 and 2E3 filters are interchanged in the optical path. The interchange was conducted three times at the best focus position for each camera (see Table 3-17, summary of tri-bar resolution). The focus variations, found by evaluating the line focus targets for this test series, are tabulated in Table 3-18. The resolution performance is equivalent for both cameras within the reader variability and/or test-to-test variations in focus. A review of the data shows excellent focus repeatability, with the greatest focus difference occurring on the AFT Camera between the first and last 2E3 filter run. As these two runs occur in different splice sections, this may very well account for the difference in focus although film profile measurements for these runs were not made.

3.6 MIDSECTION, FILM SYNCHRONIZATION

The synch-flash analysis for SO-255 and 1414 material is presented in tabular form with the out-of specification values noted in Tables 3-19 and 3-20.

Prior to Chamber A-2 testing an OOAA correction of 2 bits will be made to increase the film speed on the FWD Camera; this will bring the cross-track values

TABLE 3-15

DYNAMIC FOCUS TEST RESULTS
(47°F, 70°F, 93°F)
RADX = .052

FWD CAMERA		AFT CAMERA	
IN (2 SIGMA)	CR (2 SIGMA)	IN (2 SIGMA)	CR (2 SIGMA)
14.6	10.4	3.9	6.2
IN AND CR AVERAGE		IN AND CR AVERAGE	
12.51		5.03	
ALL VALUES GIVEN IN MICRONS. CEI SPEC. 6.5 MICRONS			

TABLE 3-16

DYNAMIC FOCUS TEST RESULTS
(70°F)
RADX = .052, .036

FWD CAMERA		AFT CAMERA	
IN (2 SIGMA)	CR (2 SIGMA)	IN (2 SIGMA)	CR (2 SIGMA)
3.3	2.4	2.9	2.6
IN AND CR AVERAGE		IN AND CR AVERAGE	
2.83		2.75	
ALL VALUES GIVEN IN MICRONS. CEI SPEC. 4.9 MICRONS			

TABLE 3-17

WRATTEN 12/2E3 FILTER FLIP/FLOP TEST
FWD AND AFT CAMERAS

SUMMARY OF TRIBAR RESOLUTION — WESTOVER READINGS

TEST DESCRIPTION		45°			0°			55°		
		IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN	IN TRACK	CROSS TRACK	GEOM. MEAN
CEI-102 SEQ 425 FWD CAMERA FP 39μ	W-12	174	139	155	180	170	175	181	158	169
	2 E 3	161	129	144	173	173	173	177	157	166
	W-12	172	142	156	184	172	177	174	153	163
	2 E 3	157	130	143	167	160	164	163	150	156
	W-12	163	133	147	173	165	169	177	153	164
	2 E 3	167	141	153	162	156	159	173	148	160
AFT CAMERA FP 35μ	W-12	177	140	158	173	136	153	164	136	149
	2 E 3	163	134	148	182	150	165	159	141	150
	W-12	153	128	139	185	144	163	161	140	150
	2 E 3	154	134	144	176	146	161	154	136	146
	W-12	149	123	135	177	151	163	169	127	146
	2 E 3	149	123	135	182	148	164	163	125	142

TABLE 3-18

FOCUS (μ) FROM LINE TARGET DATA, FILTER FLIP/FLOP TEST, FWD AND AFT CAMERAS, RAW DATA

FWD CAMERA

TEST DESCRIPTION		45° IN TRACK	45° CROSS TRACK	45° GEOM. MEAN	0° IN TRACK	0° CROSS TRACK	0° GEOM. MEAN	55° IN TRACK	55° CROSS TRACK	55° GEOM. MEAN
#5 CEI-102 FILTER FLIP/FLOP TEST	W-12	NOTE 1			57	46	52	33	24	28
	2 E 3	38	17	28	59	49	54	32	20	26
	W-12	39	14	26	59	49	54	31	21	26
	2 E 3	38	11	24	59	49	54	32	22	27
	W-12	38	12	25	60	49	54	32	22	27
	2 E 3	39	11	25	60	49	54	33	22	28

NOTE 1: DATA NOT REDUCIBLE BY LINE TARGET COMPUTER PROGRAM.

AFT CAMERA

TEST DESCRIPTION		45° IN TRACK	45° CROSS TRACK	45° GEOM. MEAN	0° IN TRACK	0° CROSS TRACK	0° GEOM. MEAN	55° IN TRACK	55° CROSS TRACK	55° GEOM. MEAN
#5 CEI-102 FILTER FLIP/FLOP TEST	W-12	28	29	29	39	36	37	39	27	33
	2 E 3	27	29	28	35	33	34	44	32	38
	W-12	27	28	28	37	35	36	42	31	36
	2 E 3	26	29	28	37	35	36	42	30	36
	W-12	28	30	29	37	35	36	41	30	36
	2 E 3	27	30	28	37	35	36	36	25	30

TABLE 3-19

UNCOMPENSATED IMAGE MOTION

TEST 4.5A, 8-22-73

7 PULSE COUNTS

(+) IN-TRACK ERROR MEANS PLATEN LEAD OB

(+) CROSS-TRACK ERROR MEANS FILM TOO FAST

RUN NO. V_x/h		IN-TRACK			CROSS-TRACK		
		45°	0°	55°	45°	0°	55°
FWD CAMERA							
273T	MEAS. MEAN	.066	.030	.022	-.092	-.040	-.053
	MEAN W/O GRAV.	.021	.033	.073	-.092	-.040	-.028
V_x/h = .052	MEAS. 2σ	.042	.041	.038	.063	.074	.051
274T	MEAS. MEAN	.035	.020	.029	-.077	-.056	-.046
	MEAN W/O GRAV.	.005	.020	.064	-.060	-.032	-.020
V_x/h = .036	MEAS. 2σ	.029	.027	.027	.040	.061	
AFT CAMERA							
273T	MEAS. MEAN	.049	-.015		-.004	-.057	
	MEAN W/O GRAV.	.009	-.006		.024	-.022	
V_x/h = .052	MEAS. 2σ	.031	.037		.064	.051	
274T	MEAS. MEAN	.039	-.007		-.	-.049	
	MEAN W/O GRAV.	.008	.001		-.619	-.024	
V_x/h = .036	MEAS. 2σ	.022	.031			.026	

SO-255 MATERIAL   IMC ENABLED

ALL VALUES IN INCHES/SECOND

TABLE 3-20

SUMMARY OF SYNCH FLASH ANALYSIS

V_x/h .052

V_y/h .00174

7 PULSE COUNTS

(+) IN-TRACK ERROR MEANS PLATEN LEAD OB

(+) CROSS-TRACK ERROR MEANS FILM TOO FAST

SEQ CEI RUN NO.		IN-TRACK 45°	IN-TRACK 0°	IN-TRACK 55°	CROSS-TRACK 45°	CROSS-TRACK 0°	CROSS-TRACK 55°
C E I SPEC	MEAN W/O GRAV.	.050	.050	.050	.050	.050	.050
	MEAS. 2σ	.050	.050	.050	.100	.100	.100
FWD CAMERA							
70° 105 SEQ 411	MEAS. MEAN	.049	-.008	-.028	-.069	-.052	-.047
	MEAN W/O GRAV.	.004	-.005	.023	-.046	-.018	-.022
	MEAS. 2σ	.023	.033	.030	.070	.075	.049
47° 112 SEQ 412	MEAS. MEAN	.038	-.010	-.039	-.088	-.043	-.026
	MEAN W/O GRAV.	-.007	-.007	.012	-.065	-.009	-.001
	MEAS. 2σ	.036	.025	.031	.048	.111	.062
93° 116 SEQ 412	MEAS. MEAN	.048	-.017	-.035	-.033	-.030	-0-
	MEAN W/O GRAV.	.003	-.014	.016	-.010	.004	.025
	MEAS. 2σ	.037	.030	.031	.055	.062	.070
AFT CAMERA							
70° 105 SEQ 411	MEAS. MEAN	.070	-.002	-.098	.008	-.034	-.012
	MEAN W/O GRAV.	.030	.007	-.052	.036	.001	.011
	MEAS. 2σ	.026	.031	.031	.045	.041	.051
47° 112 SEQ 412	MEAS. MEAN	.075	.013	-.085	-.005	-.023	-.038
	MEAN W/O GRAV.	.035	.022	-.039	.023	.012	-.015
	MEAS. 2σ	.034	.019	.026	.060	.045	.030
93° 116 SEQ 412	MEAS. MEAN	.056	.003	-.091	.005	-.037	-.023
	MEAN W/O GRAV.	.016	.012	-.045	.033	-.002	-0-
	MEAS. 2σ	.025	.020	.028	.043	.038	.049

TABLE 3-20 (Cont'd)

V_x/h .044

V_y/h .00232 7 PULSE COUNTS

(+) IN-TRACK ERROR MEANS PLATEN LEAD OB

(+) CROSS-TRACK ERROR MEANS FILM TOO FAST

SEQ CEI RUN NO.		IN-TRACK 45°	IN-TRACK 0°	IN-TRACK 55°	CROSS-TRACK 45°	CROSS-TRACK 0°	CROSS-TRACK 55°
70° CEI SPEC	MEAN W/O GRAV.	.050	.050	.050	.050	.050	.050
	MEAS. 2σ	.050	.050	.050	.100	.100	.100
FWD CAMERA							
70° 106 SEQ 334	MEAS. MEAN	.022	-.003	-.018	-.059	-.048	-.030
	MEAN W/O GRAV.	-.016	-.001	.025	-.039	-.020	-.009
	MEAS. 2σ	.023	.026	.027	.056	.075	.045
47° 113 SEQ 346	MEAS. MEAN	.020	-.008	-.028	-.066	-.025	-.018
	MEAN W/O GRAV.	-.018	-.006	.015	-.046	.003	.003
	MEAS. 2σ	.034	.035	.029	.055	.074	.057
93° 117 SEQ 346	MEAS. MEAN	.044	-.013	-.027	-.038	-.033	-.011
	MEAN W/O GRAV.	.006	-.011	.016	-.018	-.005	.010
	MEAS. 2σ	.027	.034	.033	.058	.068	.059
AFT CAMERA							
70° 106 SEQ 334	MEAS. MEAN	.054	-.008	-.087	-.014	-.026	-.033
	MEAN W/O GRAV.	.019	-0-	-.049	.009	.006	-.013
	MEAS. 2σ	.032	.021	.026	.037	.039	.045
47° 113 SEQ 346	MEAS. MEAN	.064	-0-	-.064	-.042	-.043	-.021
	MEAN W/O GRAV.	.029	.008	-.026	-.019	-.011	-.001
	MEAS. 2σ	.027	.026	.019	.049	.039	.053
93° 117 SEQ 346	MEAS. MEAN	.056	-.004	-.077	-.005	-.009	.006
	MEAN W/O GRAV.	.021	.004	-.039	.018	.023	.026
	MEAS. 2σ	.029	.031	.024	.042	.040	.055

TABLE 3-20 (Cont'd)

V_x/h 036

V_y/h -.00209   7 PULSE COUNTS

(+) IN-TRACK ERROR MEANS PLATEN LEAD OB

(+) CROSS-TRACK ERROR MEANS FILM TOO FAST

SEQ CEI RUN NO.		IN-TRACK			CROSS-TRACK		
		45°	0°	55°	45°	0°	55°
70° CEI SPEC	MEAN W/O GRAV.	.045	.035	.045	.045	.045	.045
	MEAS. 2σ	.037	.037	.037	.098	.098	.098

FWD CAMERA

SEQ CEI RUN NO.		IN-TRACK 45°	IN-TRACK 0°	IN-TRACK 55°	CROSS-TRACK 45°	CROSS-TRACK 0°	CROSS-TRACK 55°
70° 107 SEQ 416	MEAS. MEAN	.025	-.010	-.022	-.082	-.042	-.023
	MEAN W/O GRAV.	-.005	-.010	.013	-.065	-.018	-.010
	MEAS. 2σ	.032	.030	.020	.041	.049	.035
47° 114 SEQ 347	MEAS. MEAN	.022	-.010	-.013	-.085	-.055	-.023
	MEAN W/O GRAV.	-.008	-.010	.022	-.068	-.031	-.004
	MEAS. 2σ	.025	.030	.041	.051	.066	.043
93° 118 SEQ 347	MEAS. MEAN	.019	-.005	-.021	-.052	-.021	-.025
	MEAN W/O GRAV.	-.011	-.005	.014	-.035	.003	-.006
	MEAS. 2σ	.018	.032	.032	.061	.044	.049

AFT CAMERA

SEQ CEI RUN NO.		IN-TRACK 45°	IN-TRACK 0°	IN-TRACK 55°	CROSS-TRACK 45°	CROSS-TRACK 0°	CROSS-TRACK 55°
70° 107 SEQ 416	MEAS. MEAN	.045	.003	-.062	-.022	-.030	-.026
	MEAN W/O GRAV.	.014	.011	-.030	-.004	-.005	-.011
	MEAS. 2σ	.022	.024	.022	.033	.034	.030
47° 114 SEQ 347	MEAS. MEAN	.055	.013	-.063	-.039	-.032	-.033
	MEAN W/O GRAV.	.024	.021	-.031	-.021	-.007	-.018
	MEAS. 2σ	.031	.028	.022	.034	.037	.047
93° 118 SEQ 347	MEAS. MEAN	.050	.001	-.076	-.006	-.035	-.022
	MEAN W/O GRAV.	.019	.009	-.044	.012	-.010	-.007
	MEAS. 2σ	.025	.023	.020	.044	.022	.037

more in line with CEI specifications. The results of applying this correction to the acceptance data are tabulated in Table 3-21.

3.7 MIDSECTION, FILM MARKINGS

Both cameras fully comply with the photographic format measurements specifications. Film markings such as static discharge marks and fog marks are either light, are infrequent in occurrence or are confined to areas outside of the photographic format and are listed as waivers in the technical certification document. Overall light intermittent emulsion scratches are found throughout all testing; this has always been a normal situation.

During format tests, the FWD Camera experienced no misplaced or spurious start of operations marks and only 1% of the start of frame marks were misplaced or spurious. The AFT Camera also experienced no misplaced or spurious start-of-operations marks and 3% of the start-of-frame marks were spurious while none were misplaced.

During vacuum acceptance tests at 70°F, the AFT Camera failed to meet the required performance (5%) for start of frame marks. This condition was corrected by replacing the 40Hz flasher box (Ref. paragraph 1.1.6c).

3.8 MIDSECTION, FORMAT TESTING

All photographic format measurements comply with the format drawing tolerances and CEI specification requirements.

3.9 MIDSECTION, ON-ORBIT ADJUST ASSEMBLY (OOAA)

The On-Orbit Adjust Assembly (OOAA) calibration data is presented in Figures 3-18 and 3-19. The data includes means determined by analysis of both photographic and electromechanical data.

The raw data for these calibrations was obtained from CEI runs 105, 106 and 107, which are run at V_x/h values of .0519, .044 and .0359 respectively, with IMC enabled. Each run consists of 90 frames encompassing three OOAA command combinations of thirty frames each.

TABLE 3-21

SUMMARY OF SYNCH FLASH ANALYSIS
V_x/h = .052, .044 and .036

V_x/h .052

V_y/h .00174   7 PULSE COUNTS

(+) IN-TRACK ERROR MEANS PLATEN LEAD OB

(+) CROSS-TRACK ERROR MEANS FILM TOO FAST

SEQ CEI RUN NO.		IN-TRACK			CROSS-TRACK		
		45°	0°	55°	45°	0°	55°
CEI SPEC	MEAN W/O GRAV.				.050	.050	.050
	MEAS. 2σ						
FWD CAMERA							
70°	MEAS. MEAN						
	MEAN W/O GRAV.				-.018	.010	.006
	MEAS. 2σ						
47°	MEAS. MEAN						
	MEAN W/O GRAV.				-.037	.019	.027
	MEAS. 2σ						
93°	MEAS. MEAN						
	MEAN W/O GRAV.				.018	.032	.053
	MEAS. 2σ						

NOTE: KNOB CORRECTION BY 2 BITS, .024 INCHES/SECOND, SPEED INCREASED.

TABLE 3-21 (Cont'd)

V_x/h .044

V_y/h .00232

7 PULSE COUNTS

(+) IN-TRACK ERROR MEANS PLATEN LEAD OB

(+) CROSS-TRACK ERROR MEANS FILM TOO FAST

SEQ CEI RUN NO.		IN-TRACK			CROSS-TRACK		
		45°	0°	55°	45°	0°	55°
CEI SPEC	MEAN W/O GRAV.				.050	.050	.050
	MEAS. 2σ	( )	( )	( )	( )	( )	( )
FWD CAMERA							
70°	MEAS. MEAN						
	MEAN W/O GRAV.				-.015	.004	.015
	MEAS. 2σ	( )	( )	( )	( )	( )	( )
47°	MEAS. MEAN						
	MEAN W/O GRAV.				-.022	.027	.027
	MEAS. 2σ	( )	( )	( )	( )	( )	( )
93°	MEAS. MEAN						
	MEAN W/O GRAV.				.006	.019	.034
	MEAS. 2σ	( )	( )	( )	( )	( )	( )

NOTE: KNOB CORRECTION BY 2 BITS, .024 INCHES/SECOND, SPEED INCREASED.

TABLE 3-21 (Cont'd)

V_x/h .036

V_y/h -.00209

7 PULSE COUNTS

(+) IN-TRACK ERROR MEANS PLATEN LEAD OB

(+) CROSS-TRACK ERROR MEANS FILM TOO FAST

SEQ CEI RUN NO.		IN-TRACK 45°	IN-TRACK 0°	IN-TRACK 55°	CROSS-TRACK 45°	CROSS-TRACK 0°	CROSS-TRACK 55°
CEI SPEC	MEAN W/O GRAV.				.045	.045	.045
	MEAS. 2σ						
FWD CAMERA							
70°	MEAS. MEAN						
	MEAN W/O GRAV.				-.046	.001	.009
	MEAS. 2σ						
47°	MEAS. MEAN						
	MEAN W/O GRAV.				-.049	-.012	.015
	MEAS. 2σ						
93°	MEAS. MEAN						
	MEAN W/O GRAV.				-.016	.027	.013
	MEAS. 2σ						

NOTE: KNOB CORRECTION BY 2 BITS, .024 INCHES/SECOND, SPEED INCREASED.

~~Hx TOP SECRET~~

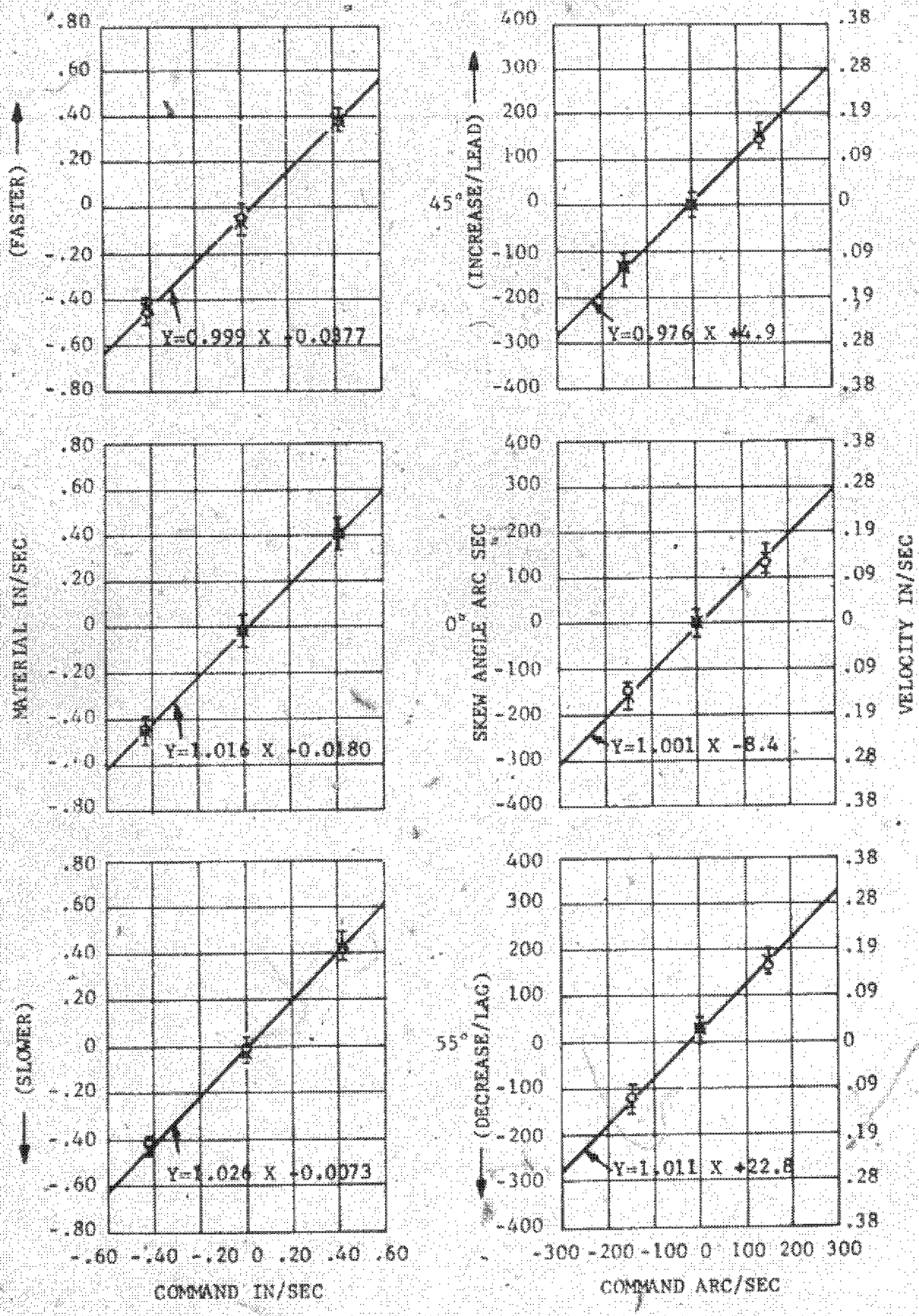


Figure 3-18. Synch Flash Tests WOG Mean Cross-Track Vs OOAA Velocity Command and In-Track Vs OOAA Skew Command, FWD Camera.

~~Hx TOP SECRET~~

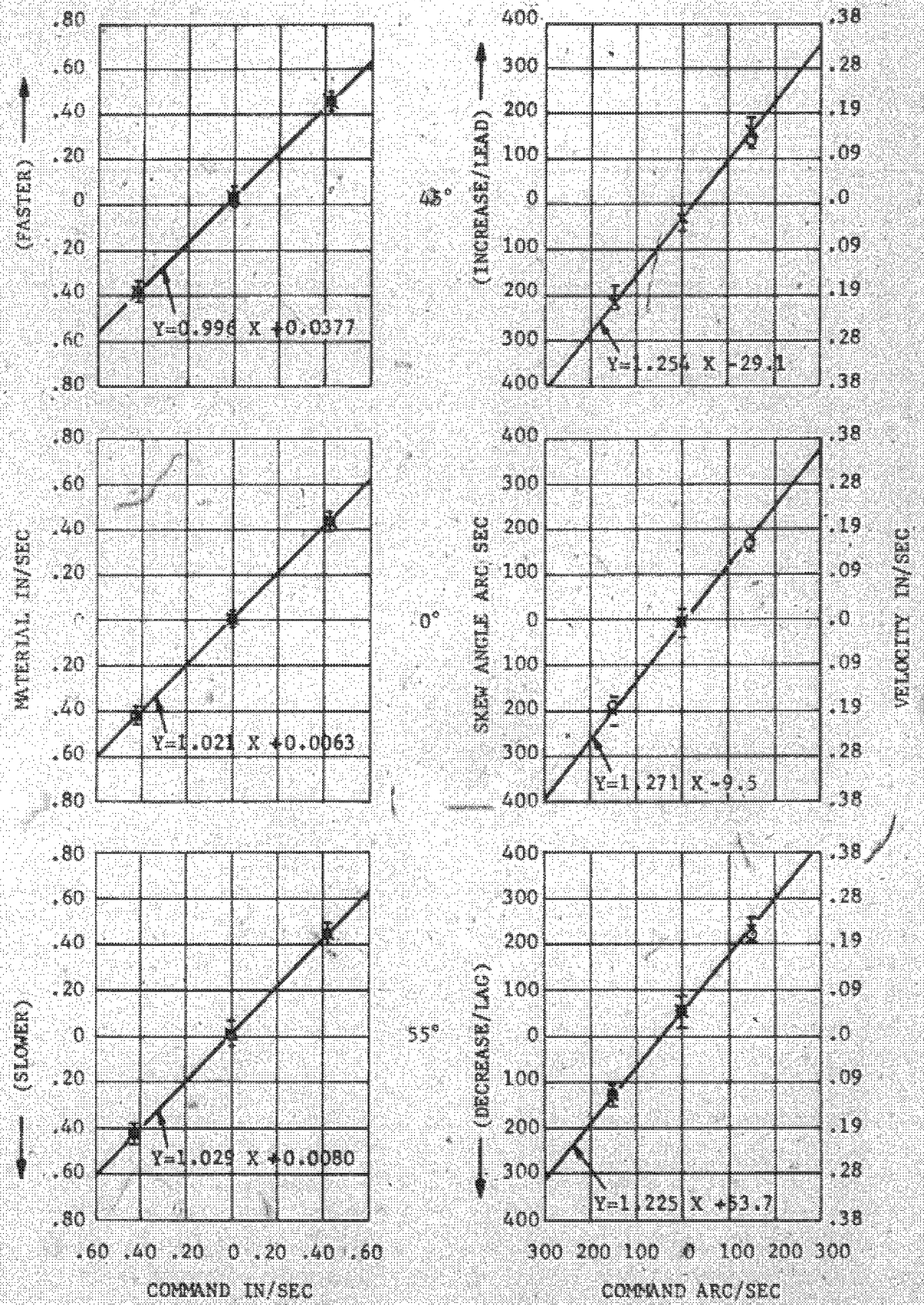


Figure 3-19. Synch Flash Tests WOG Mean Cross-Track Vs OOAA Velocity Command and In-Track Vs OOAA Skew Command, AFT Camera.

The OOAA commands are:

COMMANDS

FRAMES	SKEW	VELOCITY
30	+15	+30
30	0	0
30	-15	-30

The developed film is examined and the C targets are measured at each command position to determine the resultant in-track and cross-track image motions. The electromechanical data for the same runs is examined to determine changes in skew angle and film velocity by use of E/M signals only. The E/M and photo averages of the thirty frames are calculated and plotted individually in Figures 3-18 and 3-19.

3.10 SERVO INHIBIT ASSEMBLY

The tests of S/N 013 with and without the Servo Inhibit Assembly (SIA) have demonstrated that the elimination of servo dither improves camera performance.

Examination of the 16 available scan angle/scan center command combinations shows that the dither/vibration phenomena would have its greatest effect during the 30°/-45° and 30°/+45° command combinations. With the 30°/-45° combination, the time period for the FWD Camera P-mode is within the AFT Camera pause interval. With a 30°/+45° command combination the AFT Camera is in P-mode while the FWD Camera is in its pause period. The scan angle/scan center combination of (30°/±30°) and (60°/±30°) are also such that some degraded optical performance can be expected. Data form these combinations with and without this utilization of the SIA as shown in Table 3-22 has demonstrated the effectiveness of the SIA.

TABLE 3-22

SYNCH FLASH ERRORS, SIA TESTS

						FWD					AFT				
SEQ	O C P	RUN	SCAN)	SCAN CNTR.	S I A MODE	COLL. POS.	IN MEAN	IN 2σ	CROSS MEAN	CROSS 2σ	COLL. POS.	IN MEAN	IN 2σ	CROSS MEAN	CROSS 2σ
9065	12	1	30°	-45°	OVRDE	-45°		.157		.122					
9065	13	1	30°	-45°	RESET	-45°		.034		.057					
9065	12	7	30°	+45°	OVRDE						45°		.140		.224
9065	13	7	30°	+45°	RESET						45°		.020		.039
9065	12	8	60°	-30°	OVRDE	-45°		.116		.116					
9065	13	8	60°	-30°	RESET	-45°		.034		.058					
9065	12	6	30°	+30°	OVRDE						45°		.128		.236
9065	13	6	30°	+30°	RESET						45°		.030		.058
9065	12	12	60°	+30°	OVRDE						45°		.082		.085
9065	13	12	60°	+30°	RESET						45°		.031		.042

V_x = .052, V_y = .0017, 7-COUNT FLASH, IMC ENABLED, STEREO CHAMBER A AT 70° VACUUM, 5-9-73

ERROR IN INCHES-PER-SECOND

Electro-Mechanical Performance

SECTION 4

ELECTROMECHANICAL PERFORMANCE

Review of electromechanical data and its correlation to photo data confirms that the system has demonstrated compliance with all performance requirements.

4.1 EMERGENCY SHUTDOWN

Verification of controlled system response to both internally and externally commanded ESDs was performed during assurance and acceptance testing.

In addition to the ESDs that were commanded per procedure, the SSTC had initiated several "unexpected" ESDs as a result of SSTC parameters exceeding SSTC limit checking. In all cases the test was terminated by a controlled shutdown, and subsequently documented and dispositioned in malfunction reports.

4.2 RV TRANSFER

Functional tests verified normal operation with a take-up cabled to each of the four RV locations.

4.3 CAGING

Looper Cage/Uncage testing was performed during Assurance and Vertical Baseline testing. Caging was successful and all performance requirements were met.

In addition, the loopers were caged during miniformat testing on 31 July 1973 to reverify that the function was not lost or degraded during the interim since Vertical Baseline tests. After completion of acceptance testing the supply core and loopers were caged and verified in preparation for shipment to the Integrating Contractor.

4.4 NEGATIVE CONSTANT VELOCITY TESTS (NCVU)

The NCVU operation in TU ONLY and SU ONLY was verified during assurance and acceptance testing. In all cases, tracking and electromechanical performance were proper and no anomalies observed. NCVU box S/N 5002 was replaced by S/N 5008 and SCC S/N 1013 by S/N 1003 on 7 June 1973, due to a current surge caused by a short in the Power Interrupt Box (PIB) connector (MR 4045 and 4044). Analysis and subsequent tests verified no other components were overstressed or damaged.

4.5 SCAN MODE

All scan centers and scan angle length combinations were tested several times since SCC S/N 1003 was installed on 7 June 1973 during assurance and acceptance testing. Evaluation of electromechanical and photo data verified that phasing, shutter open/close time and associated system performance were proper, with the exception of the occurrence of FWD-side early shutter open error signal (MR 4088, see Section 2 for detailed discussion).

4.6 START/STOP TIMES

All measured start/stop times as required by the CEI specification were within specification. The longest start/stop time was 67.6 seconds complying with the performance requirement of 71 seconds maximum.

4.7 SLIT WIDTH

All slit width calibrations performed per MFN 3.09 and reverified several times since are repeatable and in limits (see Table 4-1).

TABLE 4-1

S/N 013

SLIT WIDTH CALIBRATION

(MFN 3.09 8/3/73)

	FWD		AFT		
CMD (Binary)	Diag (PCM Counts)	Width (Inch)	Diag (PCM Counts)	Width (Inch)	Nominal (Inch)
0	2	0.080	-	-	0.080
1	9	0.086	10	0.086	0.086
2	17	0.094	17	0.094	0.093
4	32	0.110	35	0.110	0.109
8	66	0.152	65	0.151	0.150
16	129	0.283	130	0.285	0.280
24	193	0.526	193	0.526	0.525
31	249	0.897	249	0.903	0.910
28	227	0.729	227	0.727	0.719
20	162	0.392	163	0.388	0.384
16	129	0.284	131	0.281	0.280
12	97	0.207	97	0.206	0.205
0	1	0.081	1	0.080	0.080

SPEC = ± 0.015 IN. OR 5%

4.8 OPTICAL BAR SCALING

Optical bar velocity calibration was performed in both Blocks I and II of the SCC and is within 0.4 percent of full scale (0.054 RADX, see Table 4-2). At no time did the system exceed the 1 percent limit during SSTC limit checking.

TABLE 4-2

OB SERVO CALIBRATION

FWD CAMERA

CMD IN COUNT	CMD VX/H CE101XS (RAD/SEC)	*ACTUAL VX/H (RAD/SEC) (OB ENCODER)	ERROR FROM THEORETICAL
39	.01799	.01811	+.00011
49	.02208	.02220	+.00011
59	.02617	.02630	+.00012
69	.03026	.03039	+.00011
79	.03435	.03449	+.00013
89	.03844	.03861	+.00016
99	.04253	.04271	+.00017
109	.04662	.04680	+.00017
119	.05071	.05089	+.00016
127	.05398	.05418	+.00018

*ACTUAL VX/H = .0004099505 (CMD CTS) + .002114

AFT CAMERA

CMD IN COUNT	CMD VX/H CE101XS (RAD/SEC)	*ACTUAL VX/H (RAD/SEC) (OB ENCODER)	ERROR FROM THEORETICAL
39	.01799	.01811	+.00011
49	.02208	.02220	+.00011
59	.02617	.02630	+.00012
69	.03026	.03039	+.00011
79	.03435	.03447	+.00011
89	.03844	.03857	+.00011
99	.04253	.04266	+.00011
109	.04662	.04677	+.00013
119	.05071	.05085	+.00012
127	.05398	.05413	+.00013

*ACTUAL VX/H = .0004093069 (CMD CTS) + .002145

4.9 FINE PATH PERFORMANCE

The following parameters, evaluated to monitor the performance of the fine film path, were within specification during the acceptance runs delineated by the CEI specification:

- Metering Capstan Summed Error
- Phase Lock + ΔP_f (Theoretical)
- Platen Photo Summed Error
- Skew Angle Error

The limit checks and the percentage of samples within the limits for the metering capstan summed error and the film-to-bar synchronization signals are shown on Table 4-3. The CEI requirement is that at least 96 percent of the measurements between shutter open and shutter close lie within the limits. All runs exceeded 99.4 percent.

4.10 FOCUS ADJUSTMENT

The focus adjustment range has been verified and the system has responded to all platen advance/retreat commands except for one occasion (MR 4081) where the AFT camera focus did not respond to consecutive advance commands. As a result, a new F&E box was installed and verified prior to start of chamber acceptance testing. Since replacement, no anomalies have been detected.

4.11 POWER CONSUMPTION

The peak and average wattages during startup, photo and shutdown were all within the specified ICD limits. Table 4-4 indicates both the actual values and the ICD limits.

TABLE 4-3

LIMIT CHECKS AND SAMPLE PERCENTAGES, METERING CAPSTAN SUMMED ERROR AND FILM-TO-BAR SYNCHRONIZATION SIGNALS

CEI SPECIFICATION			TESTS											
			70° VAC				47° VAC				93° VAC			
PARA.	NAME	REQUIREMENT	OCP	SIDE	2σ + δ IN./SEC	% IN SPEC	OCP	SIDE	2σ + δ IN./SEC	% IN SPEC	OCP	SIDE	2σ + δ IN./SEC	% IN SPEC
2.11	MC SUMMED ERROR	WITHIN ±2σ + δ TOLERANCE 96% OF THE TIME	7	FWD AFT	0.086 0.078	99.9 99.9	11	FWD AFT	0.083 0.088	99.9 100	102	FWD AFT	0.083 0.075	99.9 99.9
		REF. RUNS AT 70° 105, OCP <u>16</u> 107, OCP <u>33</u>	16	FWD AFT	0.086 0.079	99.9 100	13	FWD AFT	0.083 0.088	99.9 100	104	FWD AFT	0.083 0.075	99.9 100
			25	FWD AFT	0.086 0.078	99.9 100	14	FWD AFT	0.083 0.088	99.8 99.9	105	FWD AFT	0.083 0.075	99.9 99.9
		REF. RUNS AT 47° 112, OCP <u>13</u>	33	FWD AFT	0.079 0.063	99.9 100	15	FWD AFT	0.083 0.088	99.4 99.9	106	FWD AFT	0.083 0.075	99.9 100
			37	FWD AFT	0.086 0.078	99.9 100								
		REF. RUN AT 93° 116, OCP <u>104</u>	41	FWD AFT	0.086 0.078	99.9 99.9								
			42	FWD AFT	0.086 0.078	99.9 99.9								
	FILM TO BAR SYNC	WITHIN ±0.08 IN./SEC 96% OF THE TIME	7	FWD AFT	0.08	99.9 99.9	11	FWD AFT	0.08	99.9 99.9	102	FWD AFT	0.08	99.9 99.9
			16	FWD AFT	0.08	99.8 99.9	13	FWD AFT	0.08	99.8 99.9	[illegible]	FWD AFT	[illegible]	99.9 99.9
			25	FWD AFT	0.08	99.9 100	14	FWD AFT	0.08	99.9 99.9	105	FWD AFT	0.08	99.9 99.9
			33	FWD AFT	0.08	100 100	15	FWD AFT	0.08	99.9 100	106	FWD AFT	0.08	99.9 100
			37	FWD AFT	0.08	100 100								
			41		0.08	100 100								
			42		0.08	99.9 100								

TABLE 4-4

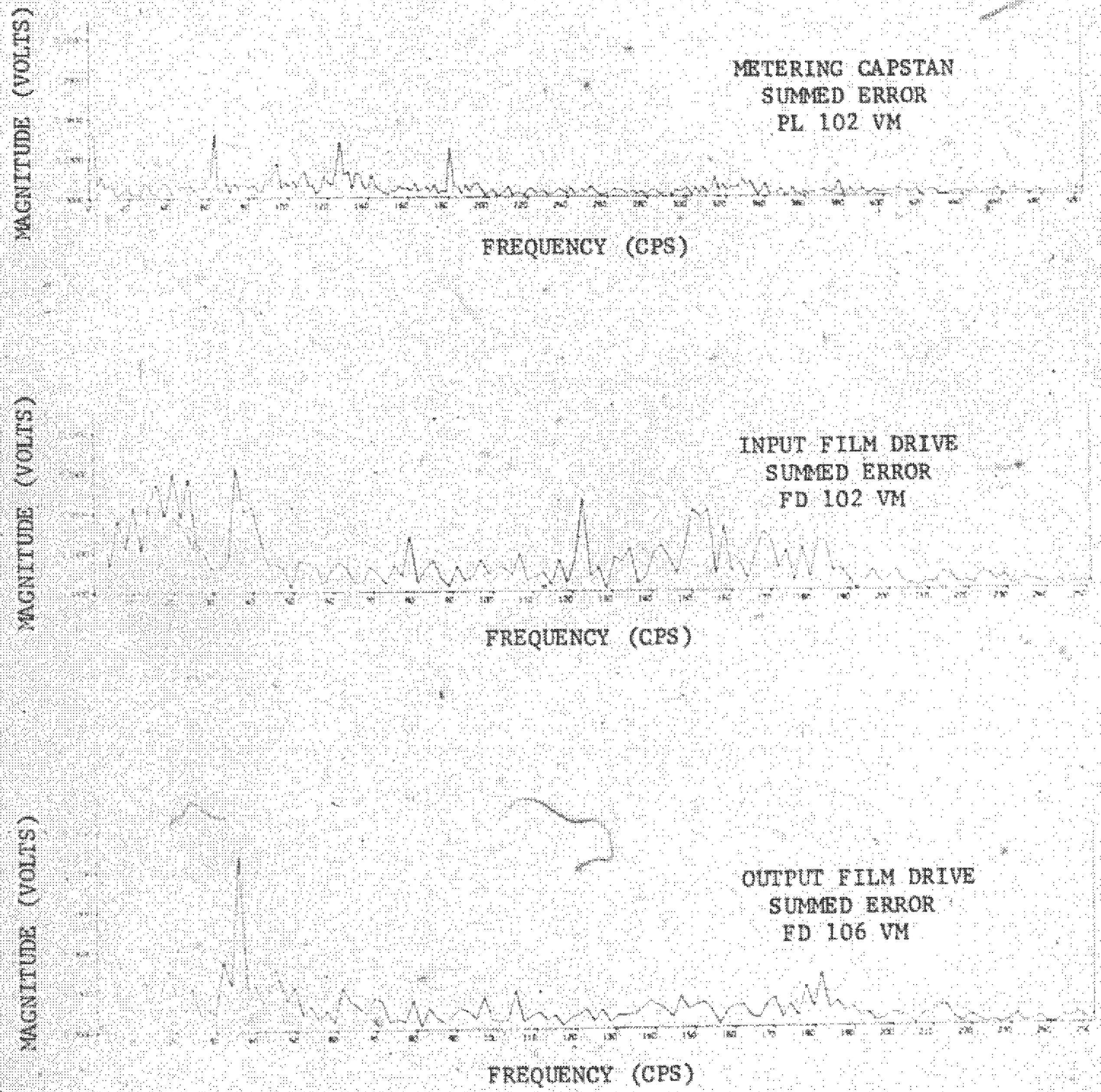
ICD LIMITS - START UP, PHOTO, SHUTDOWN

DATE	M'S/PARA /RUN GMT (START)	POWER (WATTS) ICD REQUIREMENTS AV/PEAK			EM DATA AV/PEAK			SAL	VOLTAGE	REMARKS
		STARTUP	OPERATE	SHUTDOWN	STARTUP	OPERATE	SHUTDOWN			
6/14/73 GMT 165	309/ocp 024 Seq 12 165:15:16:32	1390 / 1660	1420 / 1660	1450 / 1780	1010 / 1092	1080 / 1172	1198 / 1490	120	33V	Vx/h .036
6/14/73	309/ocp 024 Seq 12 165:15:16:32	1390 / 1660	1420 / 1660	1450 / 1780	1010 / 1092	880 / 972	998 / 1290	120		(Revised values to reflect 6 amp diagnostic bias)
8/7/73 Day 220	3.10/ocp 37/108 220:04:16:42	1390 / 1660	1420 / 1660	1450 / 1780	689 / 962	714 / 862	659 / 790	120	23.94	70°F VAC Vx/h .0519
8/10/73 Day 222	3.10/ocp 104/116 222:21:23:52	1390 / 1660	1420 / 1660	1450 / 1780	762 / 1330	767 / 938	738 / 1108	120	28.42	93°F VAC Vx/h .0519
8/16/73 Day 228	3:10/ocp 13/112 228:22:34:17	1390 / 1660	1420 / 1660	1450 / 1780	673 / 890	792 / 941	748 / 991	120	28.00	47°F VAC Vx/h .0519

4.12 DRIVE AND METERING CAPSTAN FREQUENCY SPECTRA

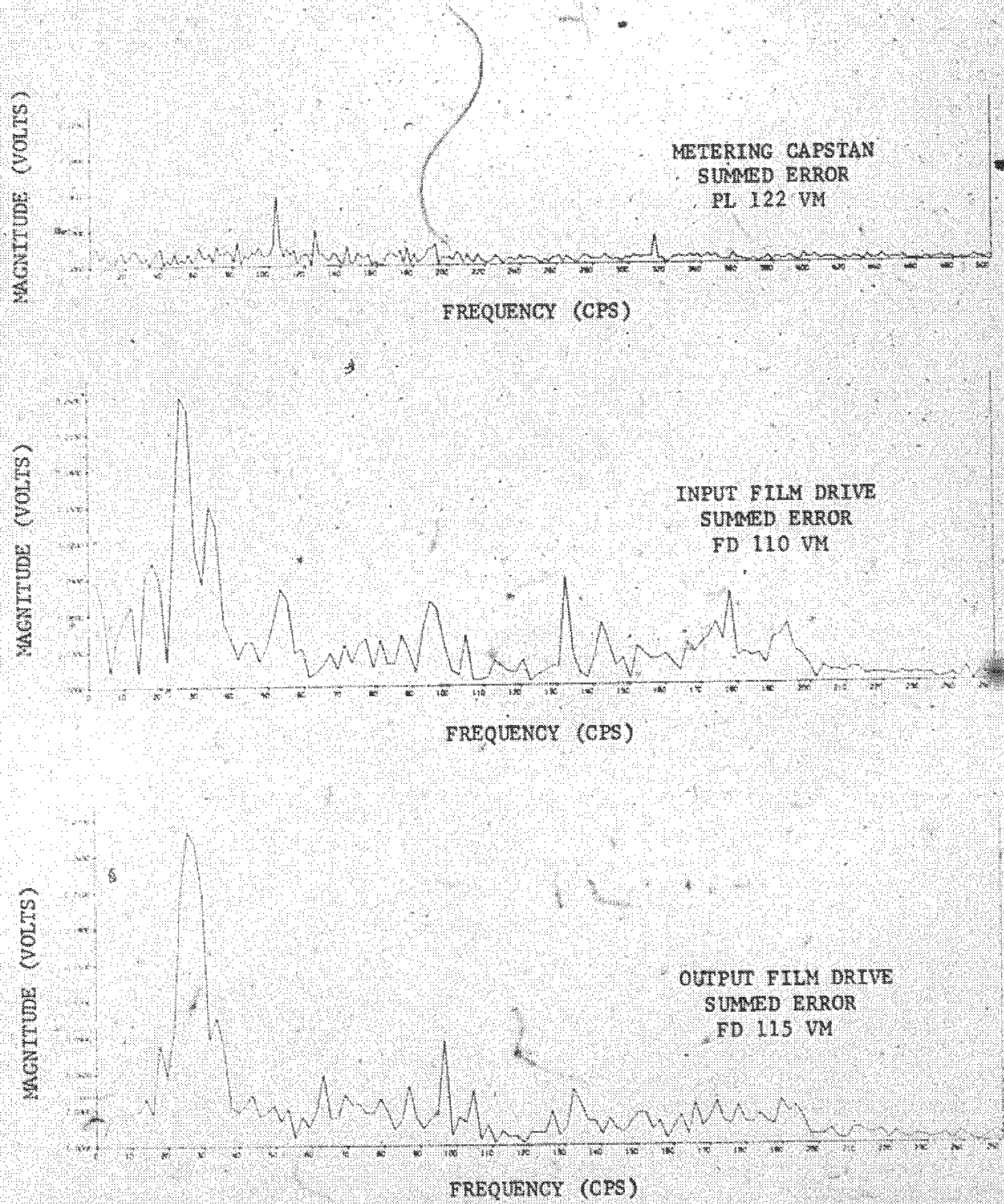
The Fourier spectra for all three capstan summed errors of both cameras are shown in Figures 4-1 and 4-2. The time-based correlations of each of these signals with the Film-to-Bar synchronization are shown in Figures 4-3 and 4-4. These plots are derived from data obtained during a single frame of CEI run 105 which is an OOAA calibration run. The sample frame was taken with both the skew and velocity variable commands set at zero. CEI run 105 is run at a RADX of 0.052 with IMC enabled.

All frequency components are well within the specification limits (FWD = 0.086, AFT = 0.078 in/sec) for their metering capstan summed errors. The three peaks shown on the FWD MC Fourier plot are at frequencies of once, twice and three times per revolution of the metering capstan. The peaks at 20 to 40 cycles shown on the drive servo plots are typical and are isolated from the metering capstan.



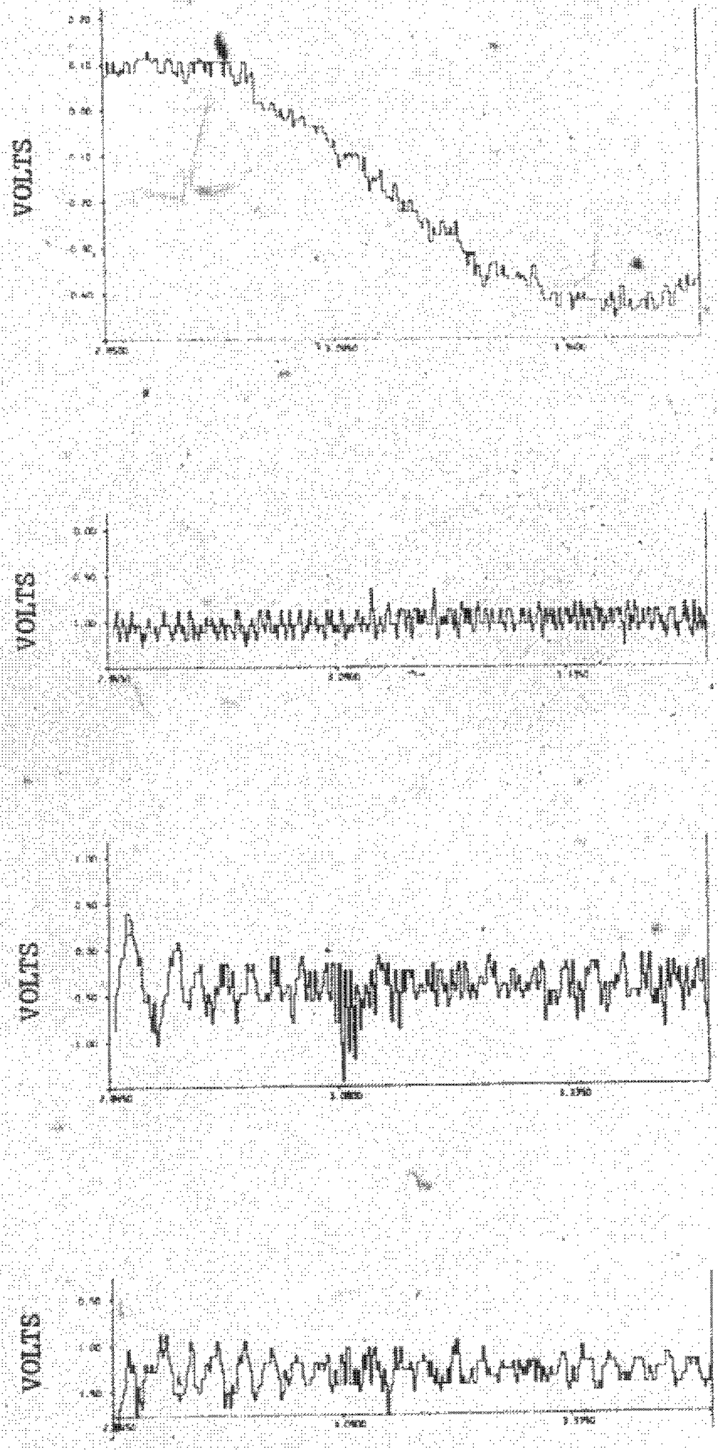
MUX3 START TIME 0 219 19 16 2.8490 'OCP 016 70' FR-18,A

Figure 4-1. Metering Capstan, Input Film Drive and Output Film Drive Summed Errors, Frequency Spectra FWD Camera.



MUX3 START TIME 0 219 19 16 2.8490 'SN13 OCP 016 70' FR-15,B

Figure 4-2. Metering Capstan, Input Film Drive and Output Film Drive Summed Errors, Frequency Spectra AFT Camera.



FILM TO BAR SYNCHRONIZATION CE 227 LM

METERING CAPSTAN SUMMED ERROR PL 102 VM

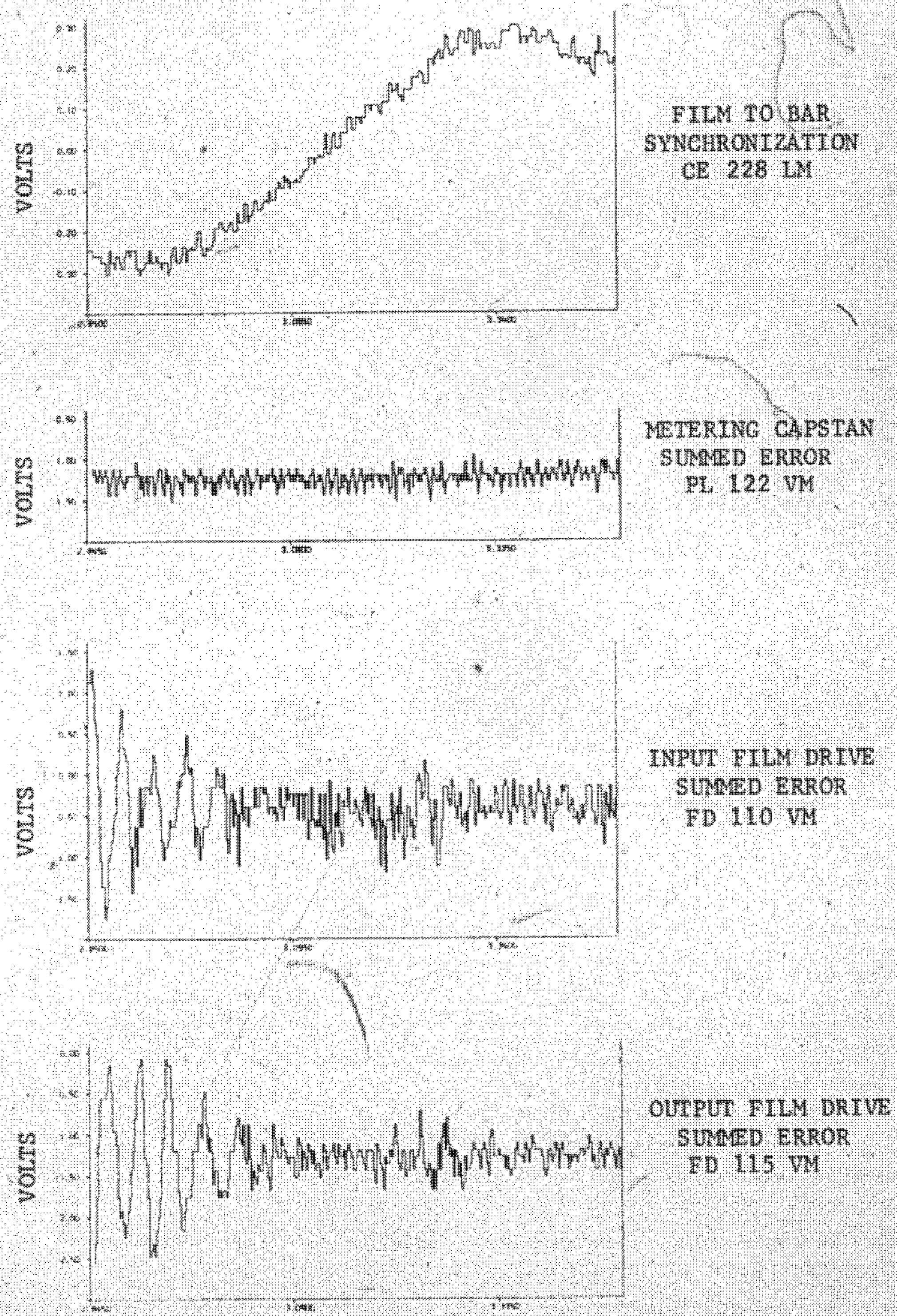
INPUT FILM DRIVE SUMMED ERROR FD 102 VM

OUTPUT FILM DRIVE SUMMED ERROR FD 106 VM

TIME (SEC)

START TIME 0 219 19 16 2.8490 'SN13 OCP 016 70' FR-18,A

Figure 4-3. Film-to-Bar Synchronization and Metering Capstan, Input Film Drive, Output Film Drive Summed Errors, FWD Camera.



START TIME 0 219 19 16 2.8490 'SN13 OCP 016 70' FR-15,B

Figure 4-4. Film-to-Bar Synchronization and Metering Capstan, Input Film Drive, Output Film Drive Summed Errors, AFT Camera.

Operational Data

SECTION 5

OPERATIONAL DATA

5.1 TEST/SOFTWARE PARAMETERS

The parametric values unique to S/N 013 are provided (Table 5-1) as information for use in future testing and software preparation.

TABLE 5-1

S/N 013 PARAMETRIC VALUES

Parameter	FWD Camera	AFT Camera	Units
1. Design Stereo Angle	10°±1'	10°±1'	Degrees
2. Field of View	5.749°	5.732°	Degrees
3. Theoretical Focal Length Shift (Vac to Air)	30	30	Microns
4. Flange Focal Length	4.7818*	4.7823*	Inches
5. Back Focal Length	0.9987	1.0015	Inches
6. Metering Capstan Diam.	0.99827	0.99823	Inches
7. OB Stow Angle	178	178	Degrees
8. Commandable Focal Step	2.0	1.9	Microns
9. ψ Offset CAB	-33 Lag	40 Lead	Arc-Sec
10. OOAA Skew Fixed Board Value	-130 001101	+220 110110	Arc-Sec Bit Pattern
11. OOAA Skew Variable Board Value	0 000000	0 000000	Arc-Sec Bit Pattern
12. OOAA Skew Test Point Voltage	+0.9982±0.035	-1.5008±0.035	Volts
13. Disabled Velocity Correction	-0.074	-0.0385	In/Sec@ V_x/h=.054
	806 (+X)	300 (+X)	OHMS

*Out of spec condition. This will not degrade performance, since the adjustment capability of the platen compensates for this condition.

TABLE 5-1 (Cont'd)

Parameter	FWD Camera	AFT Camera	Units
14. OOAA Velocity Fixed Board Value	-0.1313	-0.0730	In/Sec@ V_x/h=.054
	001001	000101	Bit Pattern
15. OOAA Velocity Variable Board Value	+.0292	0	In/Sec@ V_x/h=.054
	100010	000000	Bit Pattern
16. OOAA Velocity Test Point Voltage	+.798±0.035	+0.570±0.035	Volts@ V_x/=.052
17. F & E Trim Resistors	R_1 = 0	R_4 = 1.5	MEGOHMS
	R_2 = 0	R_5 = 0	
	R_3 = 1.1	R_6 = 0	MEGOHMS
18. Steerer Trim Resistors			
ART	301	267	OHMS
FEV	280	249	OHMS
19. Theoretical Tel. Counts for OB Summed Error Zero Eng. Volts	126	126	Counts
20. Theoretical Tel. Counts for MC Summed Error Zero Eng. Volts	126	126	Counts
21. Theoretical Tel. Counts for PL P Mode Summed Error Zero Eng. Volts	126	126	Counts
22. Theoretical Tel. Counts for MC Tach Zero Velocity	126	126	Counts

The flow rates and volume of the pneumatics module have not been included here, because the module was replaced after acceptance (MR 4091). These values will be determined during testing at the WCFO.

5.2 OPERATING CONSTRAINTS

There are no operating constraints relating to operation of S/N 013, other than those listed in the HSSOP document.

5.3 MASS PROPERTIES

Compliance with the mass properties ICD requirements is shown in Table 5-2. The total weight and products and moments of inertia for an empty and full midsection are tabulated in Figures 5-1 through 5-3. Figure 5-4 illustrates the coordinate axes and notation system.

TABLE 5-2

ICD 1420313B SS/SBA MASS PROPERTIES

WEIGHT REQUIREMENT OF SS MIDSECTION S/N 013/SV 10: total integrated SS shall not exceed 6950 LB (Block II, SV-7 to SV-12)

			WEIGHT (LBS)
COMPLIANCE:			
SS MIDSECTION*			3897
FORWARD SECTION FOR SV 010			
S/N 013 FAK		311.0	
**RV POSITION	- 1/S/N 008A	232.35	
	- 2/S/N 024A	219.89	
	- 3/S/N 019	232.77	
	- 4/S/N 031	231.31	
			1227
MATERIAL (FLIGHT LOAD - NOM. WT)			1755
GAS (FLIGHT LOAD)			34
			6913

WEIGHT UNDER ICD LIMIT OF 6950 LB BY 37 LB

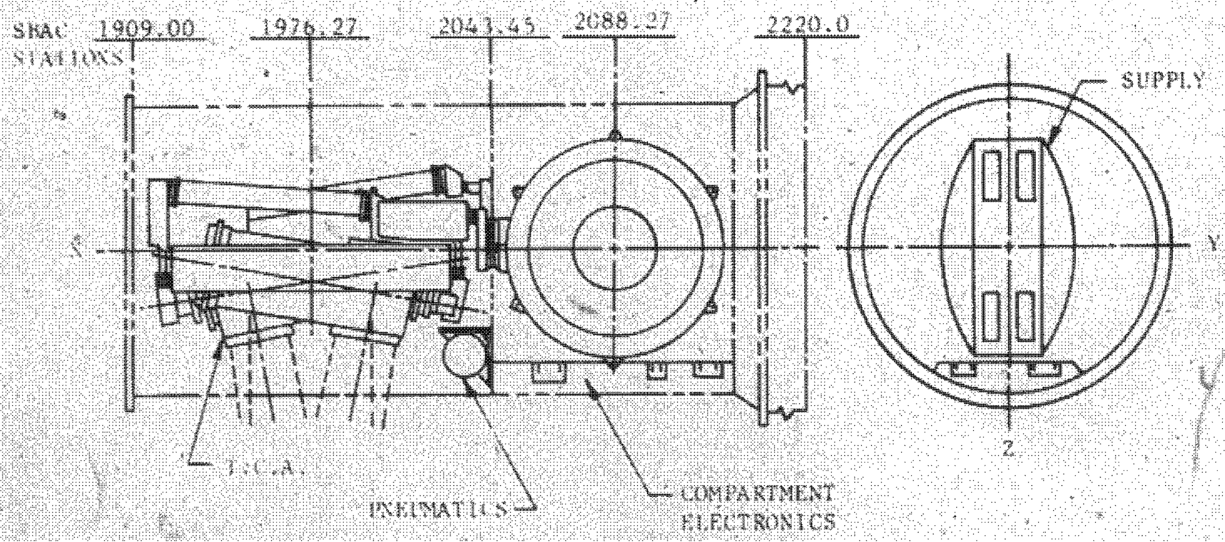
*Final predicted wt. as shipped less material and gas (includes SU caging pin, fences and decontamination control)

**Predicted RV/TU assignments

5.4 ICD COMPLIANCE

S/N 013 meets all applicable ICD requirements, with the following exception: ICD 1420304 - Paragraph 3.5.7.

This paragraph requires that the sensor subsystem shall provide not less than 1 megohm resistance between the primary +28 volt return and command line returns. The PDS presently in S/N 013 violates this requirement with regard to the commanded ESD return line. It is planned to replace the PDS with a higher configuration which will eliminate this anomaly.

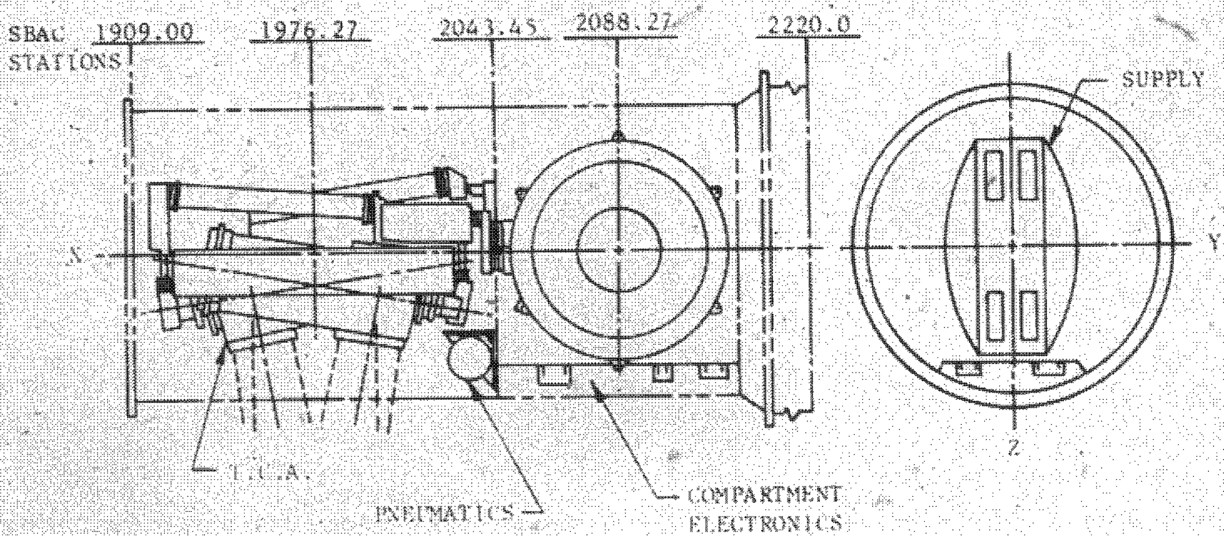


SCALE: None, Configuration as Weighed.

SUMMARY

ITEM DESCRIPTION		MEASURED WEIGHT (LBS)
Weight as lifted		9406.2
Handling fixture		1090.3
Forward handling ring		989.4
AFT handling ring		721.4
Film on Reel FWD	±1000	848.4 ± 3.9
Film on Reel AFT	±1000	848.1 ± 3.9
Gas - Total remaining in two tanks		0
Weight of SBAC Mid Structure		1045.9
Sway Bar		1.9
SU Decontamination Control		6.3
Total Weight of SS Midsection "Empty"		3867.1 ± 7.8

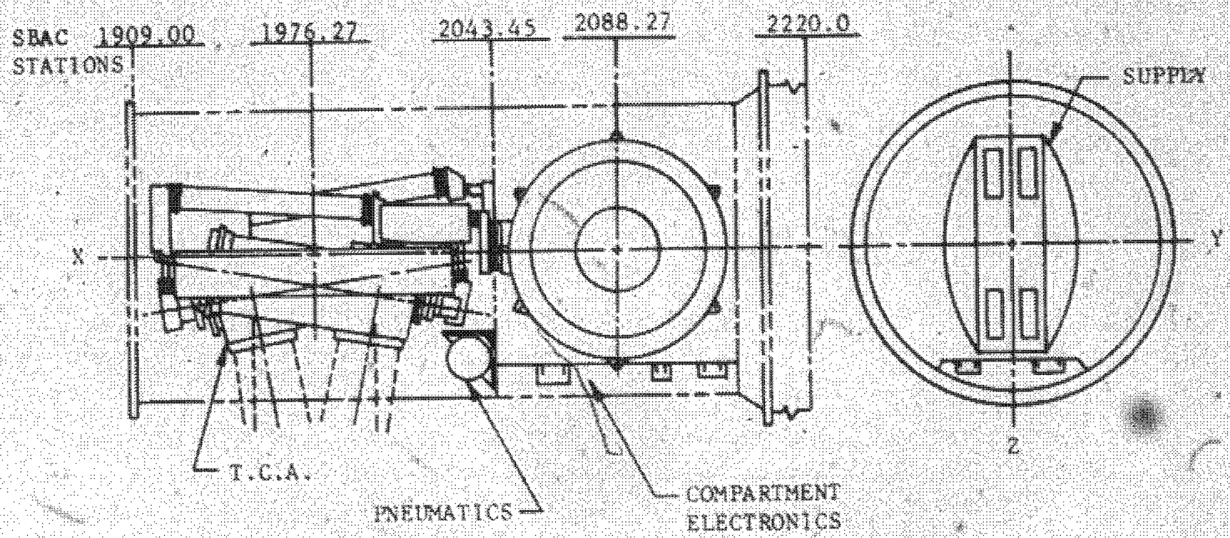
Figure 5-1. Total Weight, Products and Moments of Inertia, Empty SS, MS.



SUMMARY

PARAMETER		VALUE	
WEIGHT	=	3897	LBS
X BAR	=	2020.1	INCHES
Y BAR	=	0.8	INCHES
Z BAR	=	8.1	INCHES
IXO: ROLL MOMENT OF INERTIA	=	652.9	SLUG FT^2
IYO: PITCH MOMENT OF INERTIA	=	3382.0	SLUG FT^2
IZO: YAW MOMENT OF INERTIA	=	3469.1	SLUG FT^2
IXY: PRODUCT OF INERTIA	=	-29.1	SLUG FT^2
IXZ: PRODUCT OF INERTIA	=	30.9	SLUG FT^2
IYZ: PRODUCT OF INERTIA	=	-27.7	SLUG FT^2

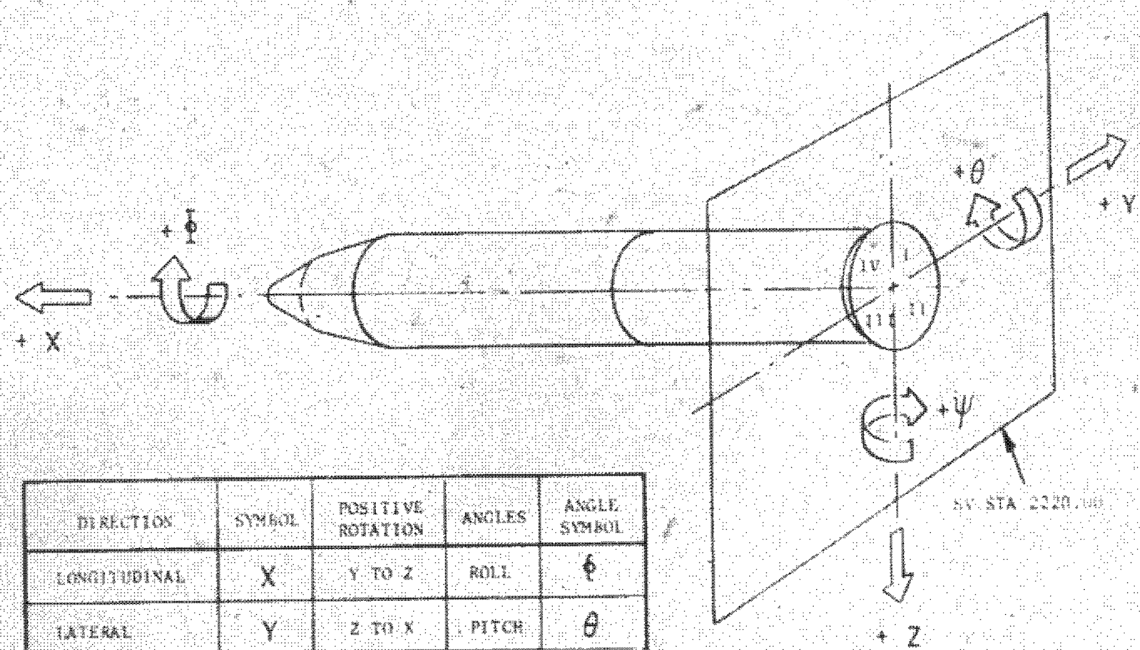
Figure 5-2. Total Weight, Products and Moments of Inertia, SS, MS Empty.



SUMMARY

PARAMETER		VALUE	
WEIGHT	=	5686	LBS
X BAR	=	2041.1	INCHES
Y-BAR	=	0.5	INCHES
Z BAR	=	5.8	INCHES
IXO: ROLL MOMENT OF INERTIA	=	838.3	SLUG FT^2
IYO: PITCH MOMENT OF INERTIA	=	4877.2	SLUG FT^2
IZO: YAW MOMENT OF INERTIA	=	4845.7	SLUG FT^2
IXY: PRODUCT OF INERTIA	=	-42.3	SLUG FT^2
IXZ: PRODUCT OF INERTIA	=	-115.6	SLUG FT^2
IYZ: PRODUCT OF INERTIA	=	-26.5	SLUG FT^2

Figure 5-3. Total Weight, Products and Moments of Inertia, SS, Full Chute.



DIRECTION	SYMBOL	POSITIVE ROTATION	ANGLES	ANGLE SYMBOL
LONGITUDINAL	X	Y TO Z	ROLL	Φ
LATERAL	Y	Z TO X	PITCH	θ
VERTICAL	Z	X TO Y	YAW	ψ

Figure 5-4. Coordinate Axes and Notation System.

Performance Predictions

Approved for Release: 2025/07/25 C05126959

SECTION 6

SENSOR SUBSYSTEM ON ORBIT PERFORMANCE PREDICTION

6.1 The object of this performance prediction computation is to predict the camera system's resolution capability on orbit, based on Chamber-A measurements, Chamber-D measurements, or budgeted values of errors where applicable. The Performance Prediction Program (PERF) is designed to create, for each location considered in the photographic format, 500 samples whose statistics represent actual system performance. For each sample, the amounts of defocus, in-track smear, and cross-track smear are determined by means of a random number generator. In-track and cross-track resolutions are computed by intersecting the resulting transfer functions with the film AIM (Aerial Image Modulation) curve. The average values of the resulting geometrical mean resolutions for the two cameras at 47°F, 70°F, and 93°F at 9 locations in the photographic format are shown in Tables 6-1 through 6-6.

6.2 The major data inputs to PERF were as follows:

a. Image Motion Errors
   1. Mechanization Errors - Chamber-A synch-flash measurements
   2. Vehicle Induced Errors - budget
   3. Residual Errors - computed fixed knowns

b. Defocus Errors
   1. Dynamic Defocus - Chamber-A line target measurements
   2. Thermal Defocus - Chamber-A line target measurements
   3. Flight Focus Calibration - budget

c. Optical Quality
   1. Polychromatic Optical Transfer Function - computed from Chamber-D measurements at each temperature
   2. Optical Quality Factor for thermal and dynamic effects - budget

d. Target Characteristics

1. Brightness - 600 ft - lamberts
2. Contrast - 2:1 at camera entrance pupil

TABLE 6-1

FWD CAMERA 47°F PERFORMANCE PREDICTION

FIELD ANGLE	SCAN ANGLE		
	-45°	0°	+45°
-2.5°	141	183	169
0°	171	184	174
+2.5°	159	193	151

TABLE 6-2

FWD CAMERA 70°F PERFORMANCE PREDICTION

FIELD ANGLE	SCAN ANGLE		
	-45°	0°	+45°
-2.5°	141	183	154
0°	170	191	169
+2.5°	159	188	138

TABLE 6-3

FWD CAMERA 93°F PERFORMANCE PREDICTION

FIELD ANGLE	SCAN ANGLE		
	-45°	0°	+45°
-2.5°	128	162	134
0°	147	175	159
+2.5°	126	161	136

TABLE 6-4

AFT CAMERA 47°F PERFORMANCE PREDICTION

FIELD ANGLE	SCAN ANGLE		
	-45°	0°	+45°
-2.5°	149	175	136
0°	164	183	161
+2.5°	137	172	143

TABLE 6-5

AFT CAMERA 70°F PERFORMANCE PREDICTION

FIELD ANGLE	SCAN ANGLE		
	-45°	0°	+45°
-2.5°	148	178	132
0°	166	190	165
+2.5°	132	178	149

TABLE 6-6

AFT CAMERA 93°F PERFORMANCE PREDICTION

FIELD ANGLE	SCAN ANGLE		
	-45°	0°	+45°
-2.5°	136	169	143
0°	155	183	172
+2.5°	128	170	161