



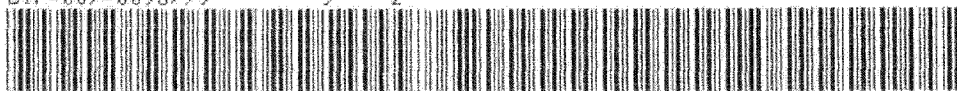
This document consists of 20 pages

S³ PRESENTATION

*Refile
Pro Abe (4/16)
Metric Pan*

BIF-007-0058/75

3 2



25 JANUARY 1975

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SOURCES AND METHODS INVOLVED.

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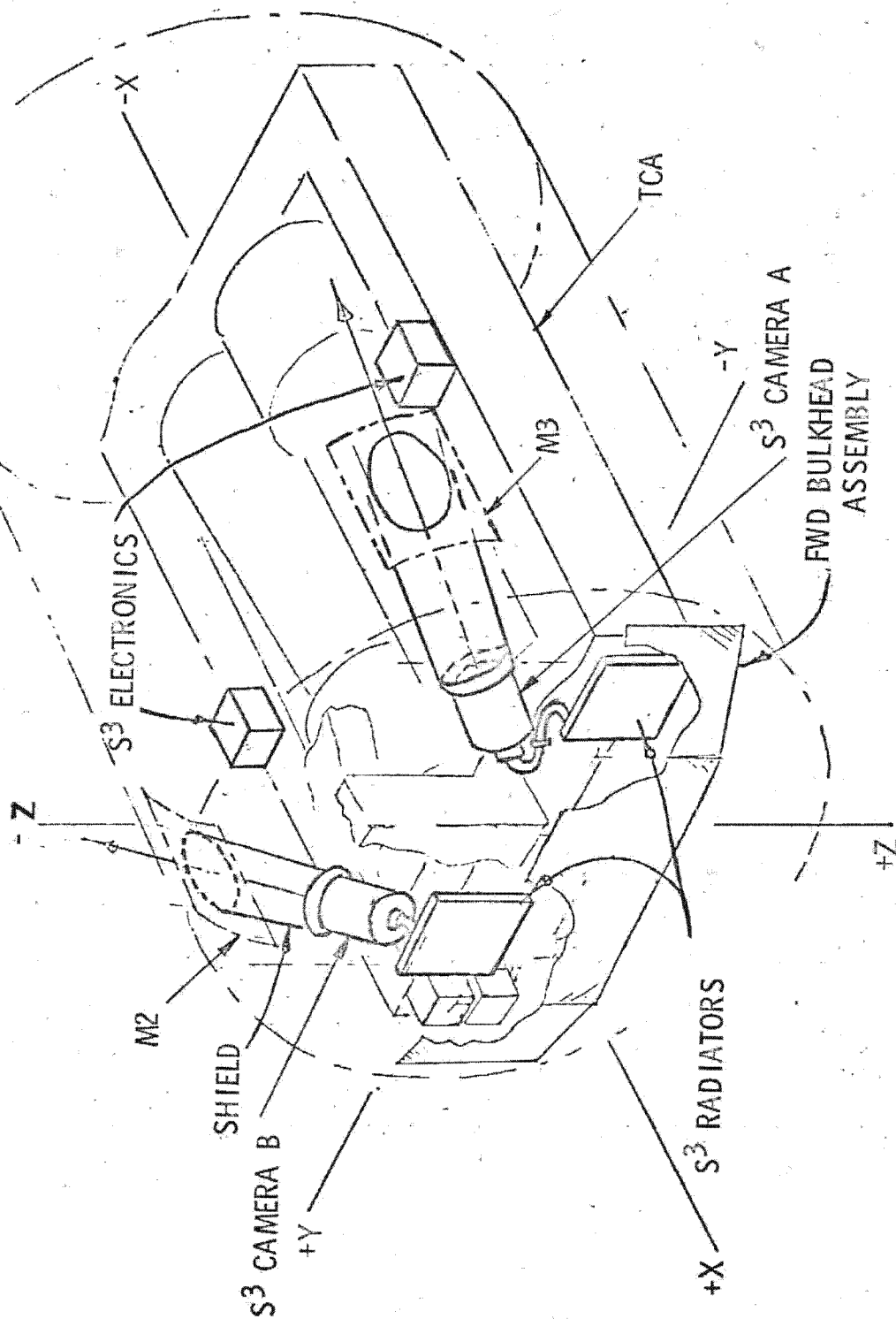
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S³ INSTALLATION

1/16/75 CK

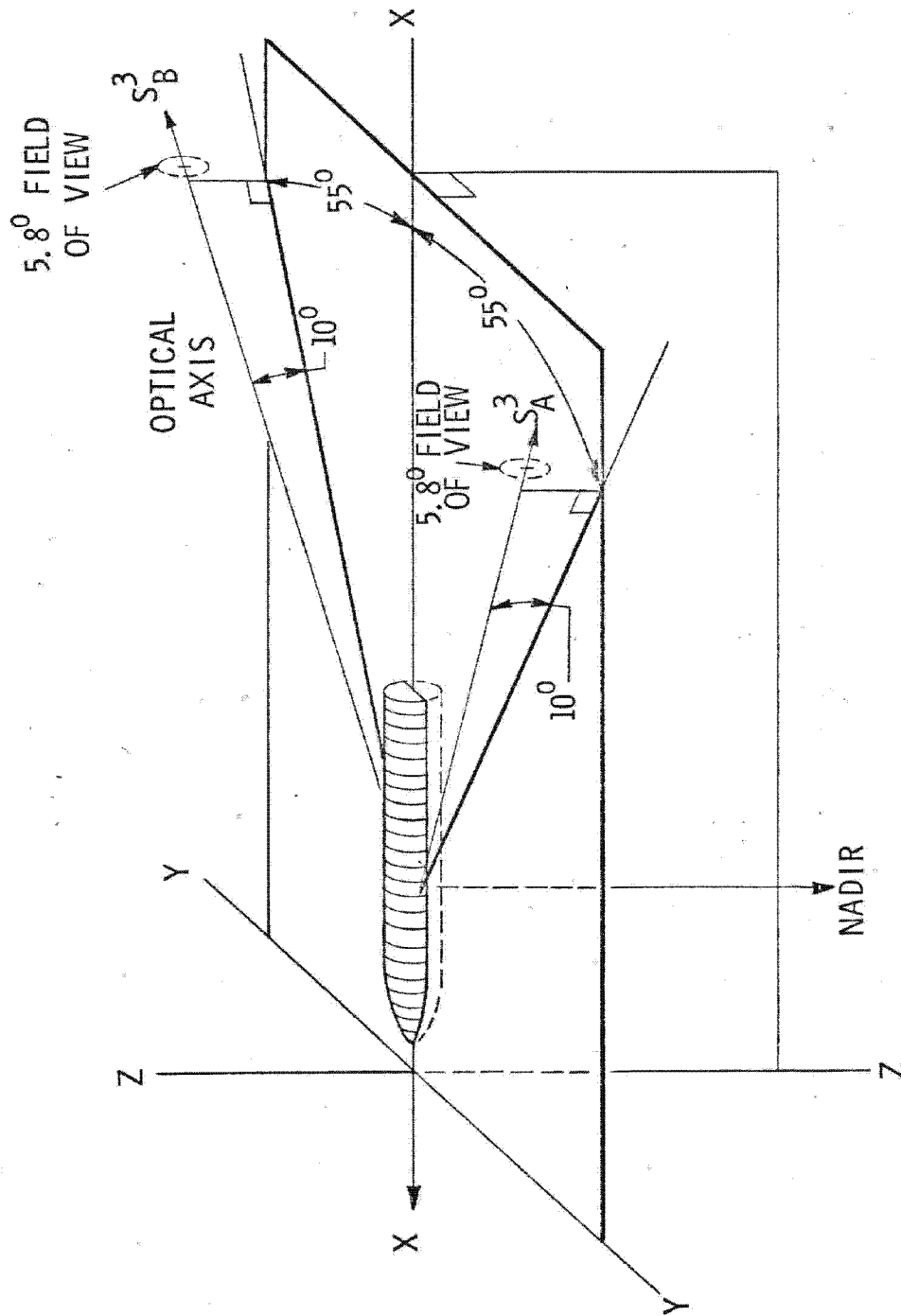
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BIF 007- 0058- 75 •

23081

S³ OPTICAL AXES

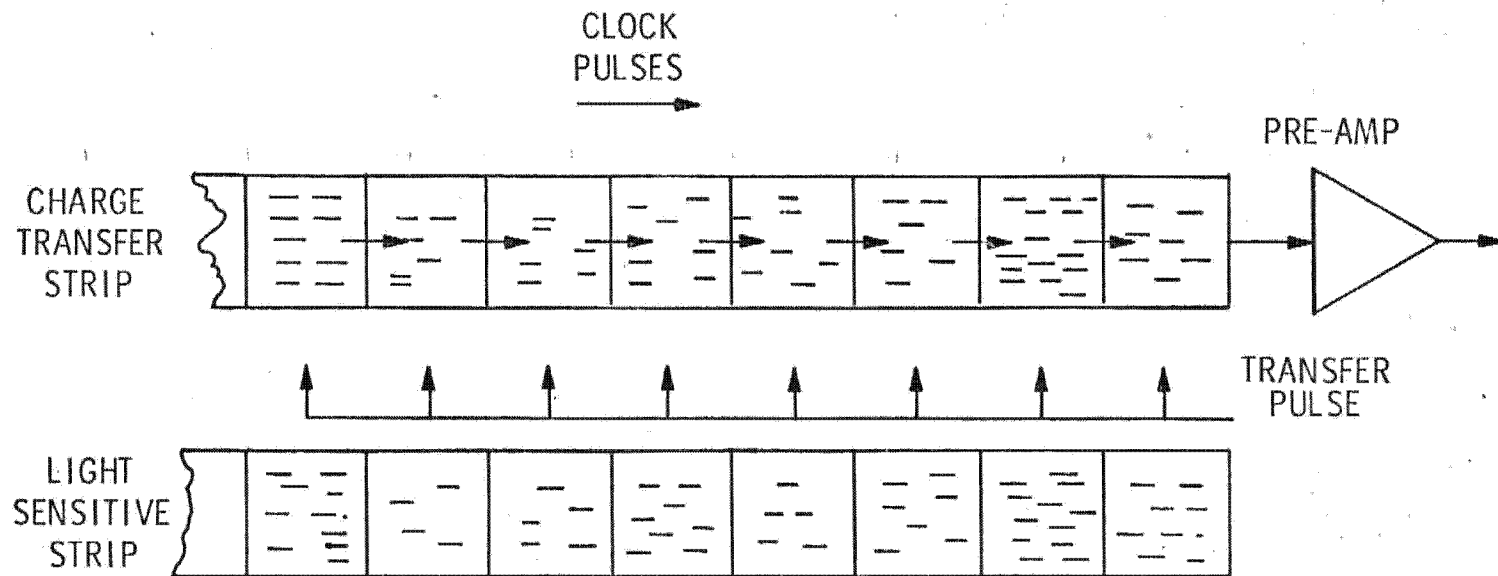


12/12/74 WEK

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28851

CHARGE COUPLED DEVICE (CCD)



CHARACTERISTICS

ELEMENT SIZE $13 \times 17 \mu m$ (1x1728)
 SENSITIVITY 1.2×10^{-14} W/ ELEMENT @ S/N 10:1
 IN 0.5 TO 1μ BAND FOR
 INTEGRATION TIME OF 50 MSEC

9/23/74 TJG

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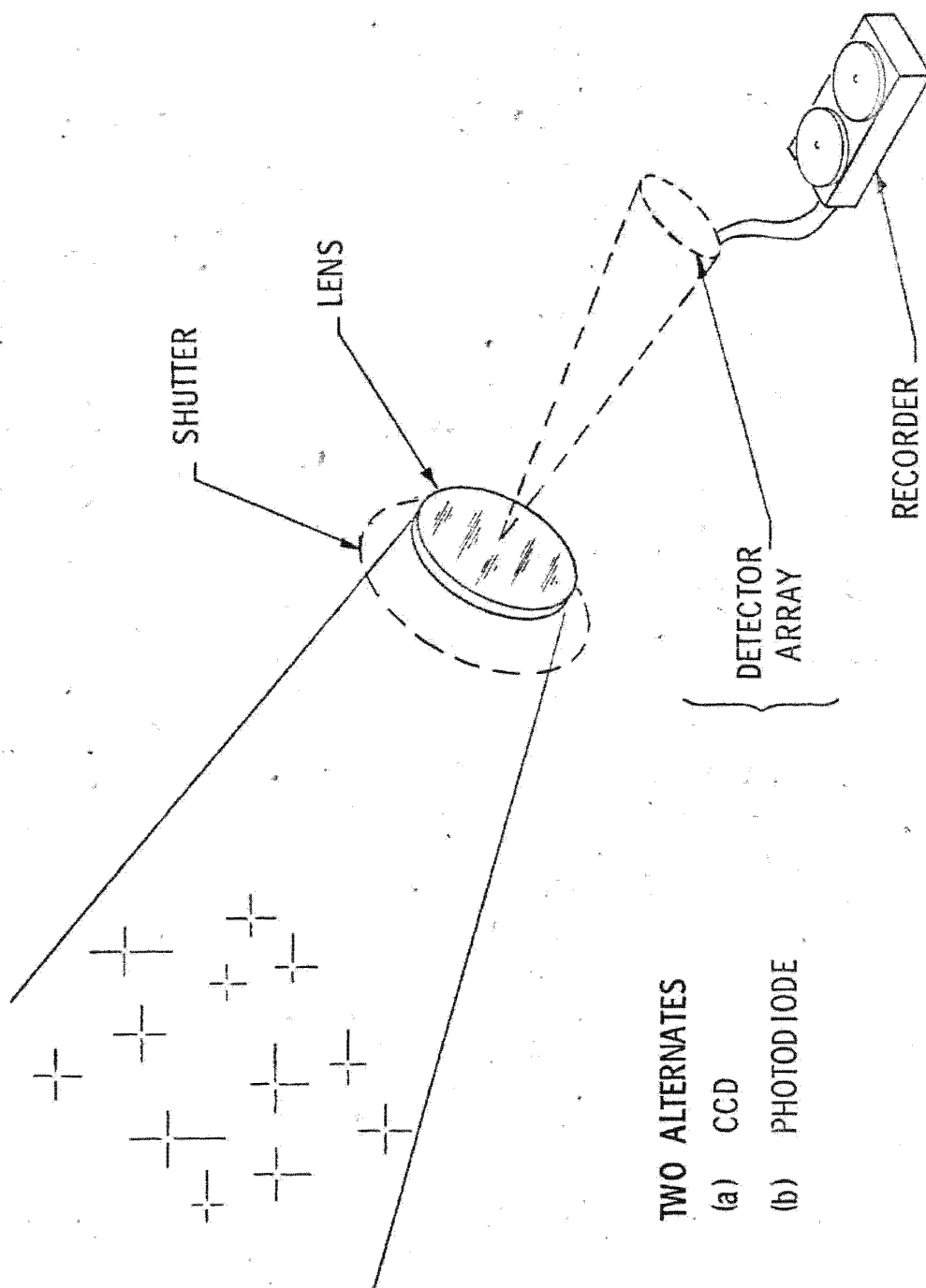
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44

C05127913

S³ ATTITUDE SYSTEM

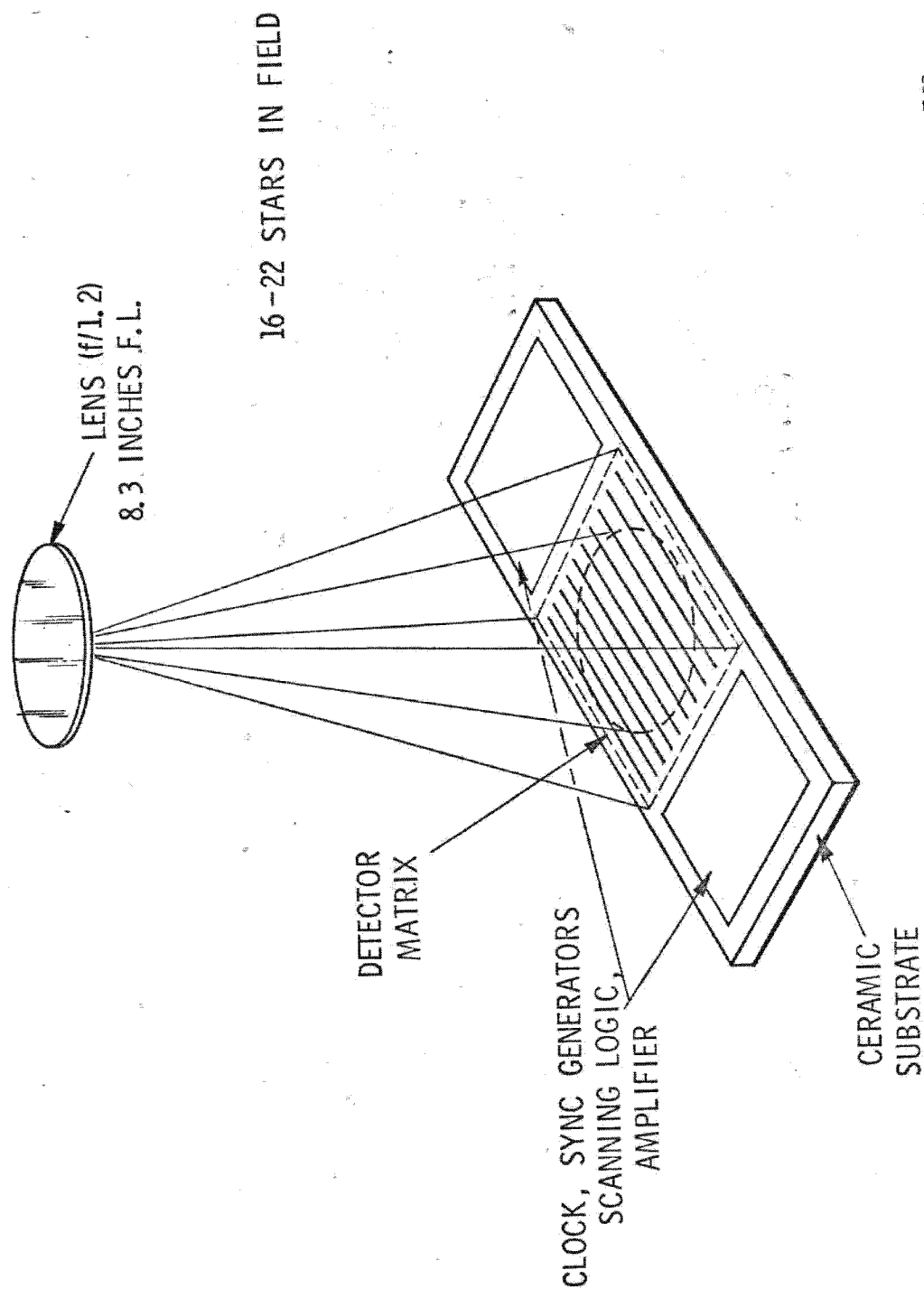
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SOLID STATE CAMERA SCHEMATIC



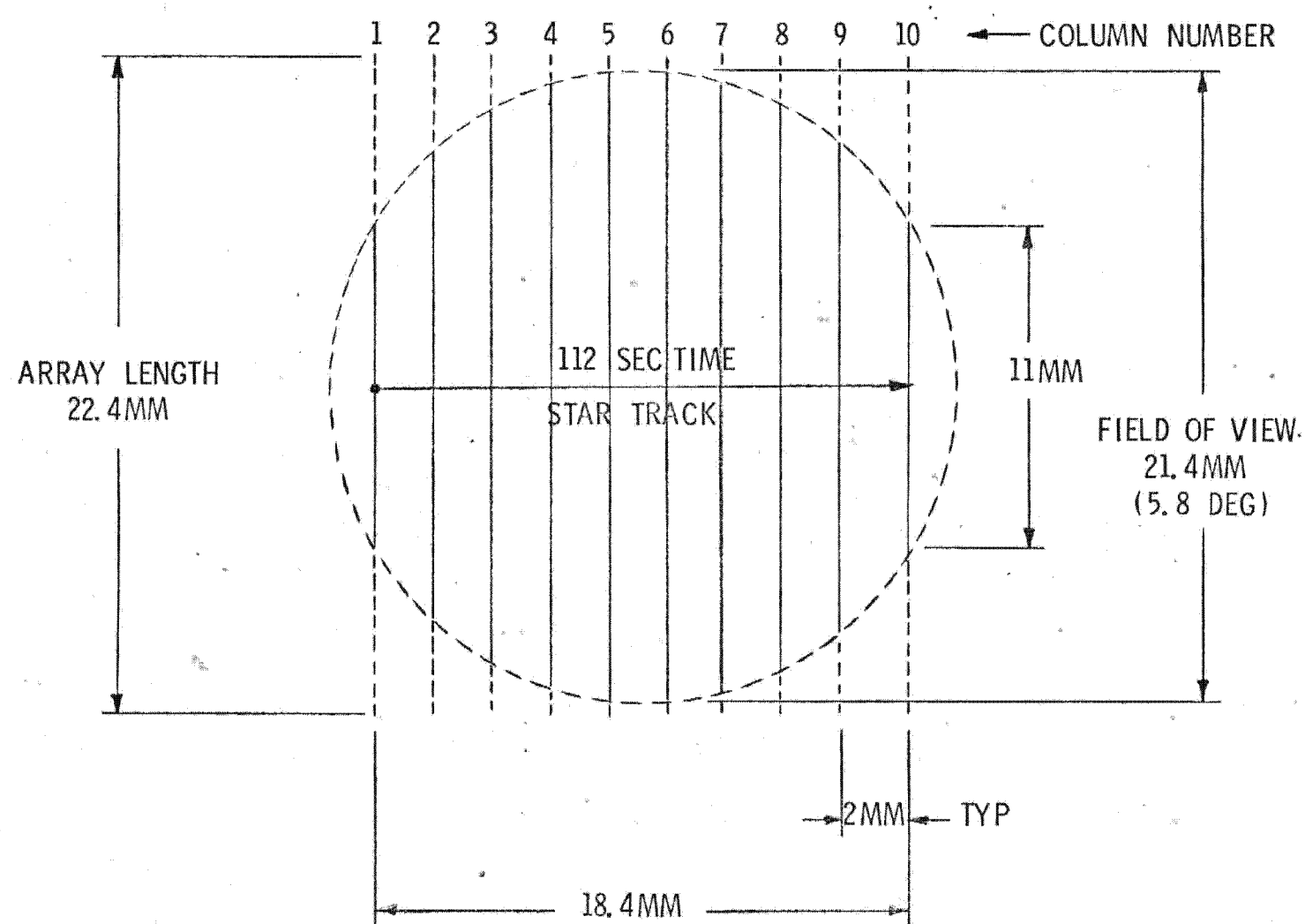
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FOCAL PLANE ARRAY



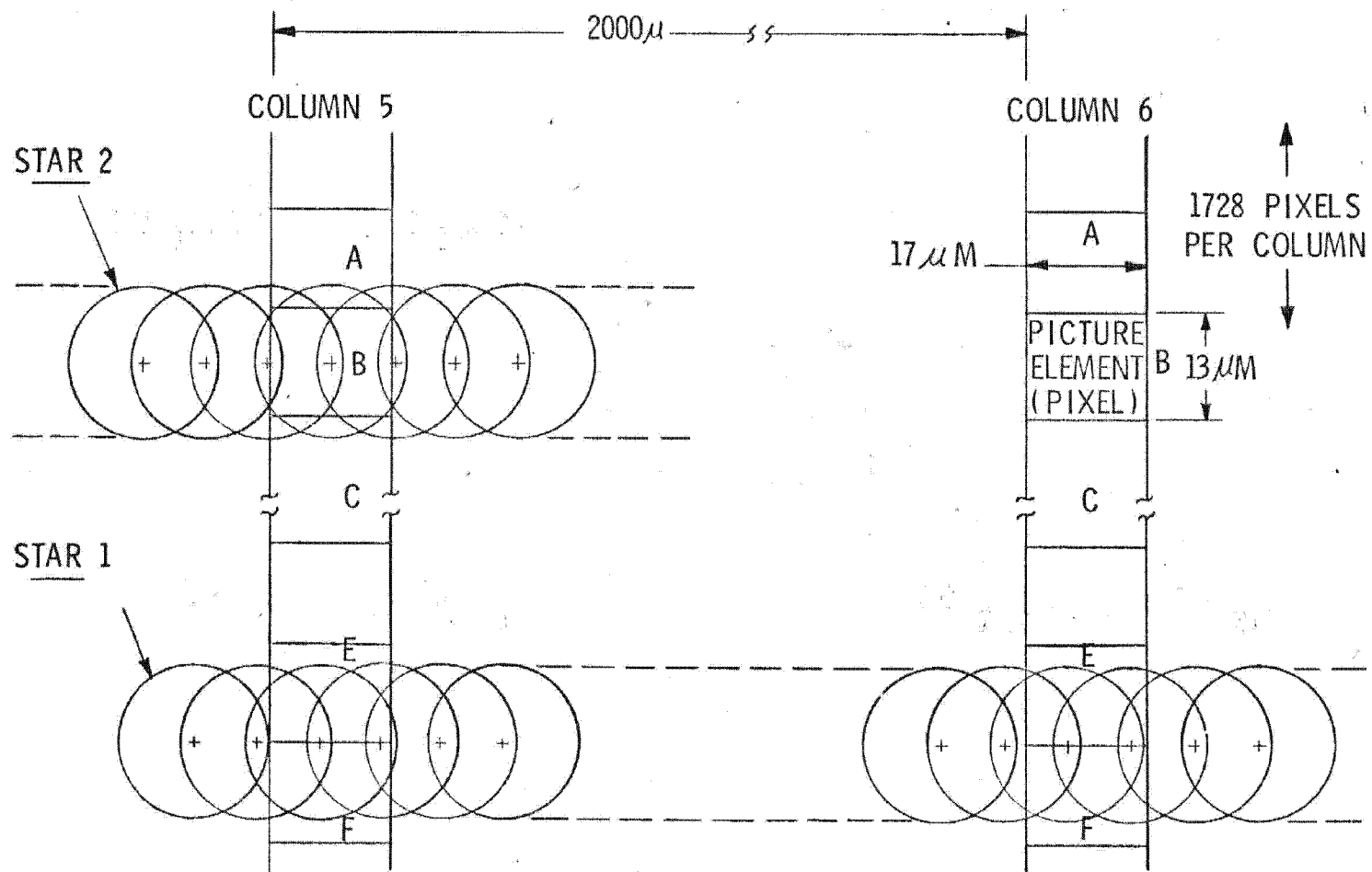
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12/12/74 WEK

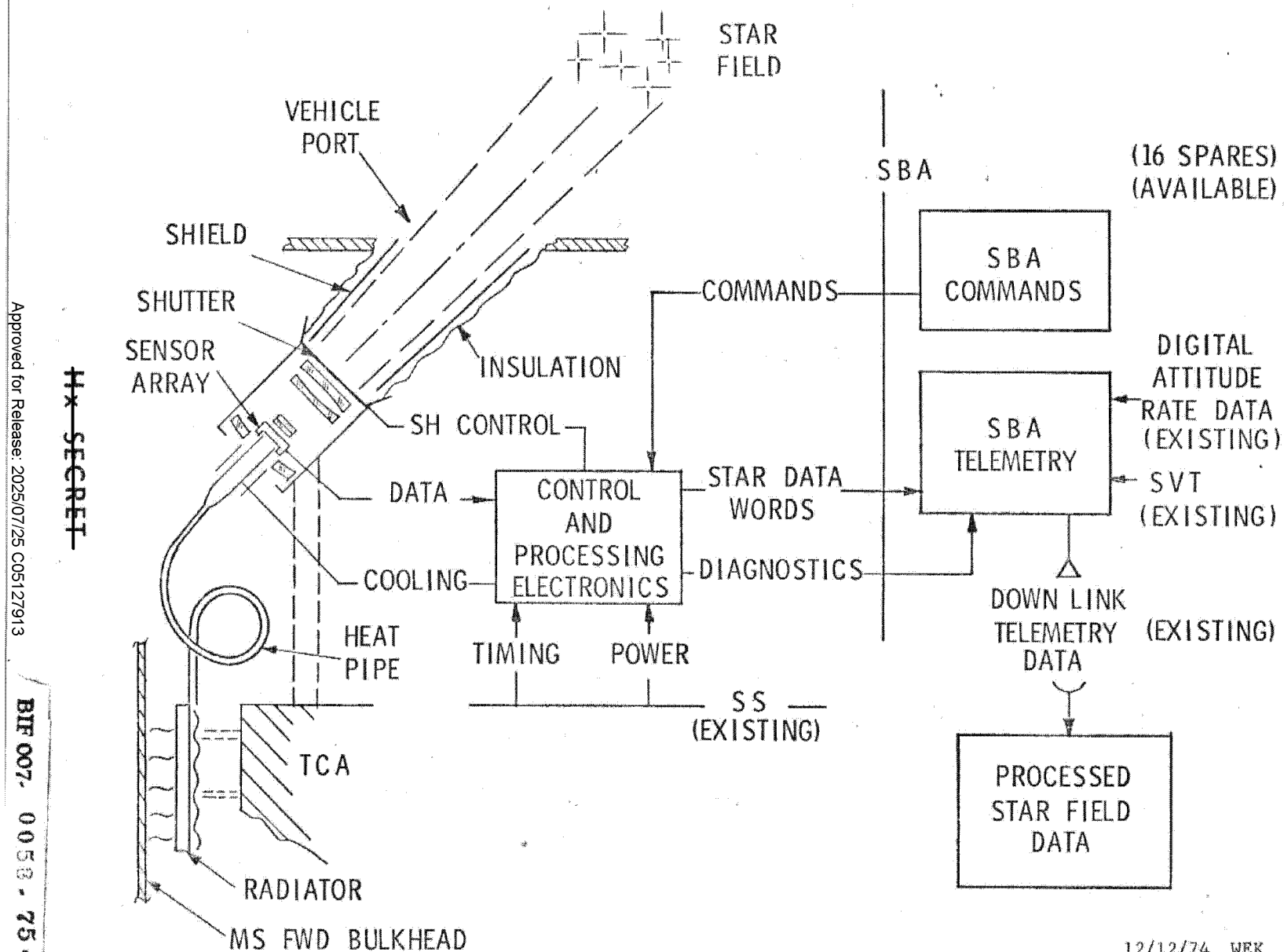
STAR TRACK IN FOCAL PLANE



STAR MOTION IS $8\mu/50$ MS DUE TO VEHICLE PITCH RATE 0.00116 RAD/SEC.

12/12/74 WEK

S³ ATTITUDE CAMERA INTERFACES



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BIF007-0053-75-

12/12/74 WEK

S³/PAN CAMERA POINTING ERROR BUDGET

<u>ERROR SOURCE</u>	<u>POINTING ERROR - ARC SECONDS (1σ)</u>		
	<u>ROLL</u>	<u>PITCH</u>	<u>YAW</u>
STELLAR SENSOR POINTING ERROR	1.7	2.1	1.3
INTERLOCK CALIBRATION ERROR	2.2	2.6	1.8
ENVIRONMENTAL STABILITY	<u>3.0</u>	<u>3.8</u>	<u>3.9</u>
RSS	4.1	5.0	4.5

ARC SECONDS

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STELLAR SENSOR POINTING ERROR

ERROR SOURCE	POINTING ERROR - ARC SEC.* (1σ) (S ³ CAMERA COORDINATES)	
	Y _A	Z _A
CENTROIDING ERROR	5.0	5.0
DETECTOR LOCATION ERROR	2.0	2.0
RESIDUAL OPTICAL DISTORTION	2.0	2.0
FOCAL PLANE RESIDUAL THERMAL ERROR	1.0	1.0
ATTITUDE RATE ERROR	3.7	3.7
FOCAL LENGTH CALIBRATION	<u>1.0</u>	<u>1.0</u>
POINTING ERROR STAR RSS	7.0	7.0

FOR 15 DETECTIONS/FIELD

$$e = \frac{e_0}{\sqrt{N}}$$

1.8 1.8

POINTING ERROR TRANSFERRED TO TCA COORDINATE SYSTEM
USING 2 - S³ SENSORS AT 55° ANGLE TO VEHICLE AXIS

ROLL	1.7	ARC SEC. - 1σ
PITCH	2.1	
YAW	1.3	

* FOR 210 MM F.L. 1 MICRON = 1 ARC SEC.

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INTERLOCK CALIBRATION ERROR
STELLAR/PAN CAMERAS

<u>ERROR SOURCE</u>	<u>POINTING ERROR - ARC SECONDS (1σ)</u>		
	<u>ROLL</u>	<u>PITCH</u>	<u>YAW</u>
STELLAR SENSOR POINTING ERROR	1.7	2.1	1.3
PAN PHOTO MENSURATION ERROR	0.8	0.9	0.7
ANGULAR VIBRATION OF TCA	1.0	1.0	1.0
SVT CORRELATION	-	0.3	-
RSS	2.2	2.6	1.8

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POINTING ERRORS DUE TO ENVIRONMENT EFFECTS

<u>ERROR SOURCE</u>	<u>POINTING ERROR - ARC SECOND (1σ)</u>		
	<u>ROLL</u>	<u>PITCH</u>	<u>YAW</u>
ALIGNMENT CHANGE OF PAN CAMERA LOS TO S ³ SENSOR MTS. DUE TO THERMAL ENVIRONMENT			
SIDE TO SIDE GRADIENT IN TCA ($\Delta T = 2^{\circ}F$)	-	-	3.0
FRONT TO REAR GRADIENT IN TCA ($\Delta T = 3^{\circ}F$)	-	0.9	0.8
TOP TO BOTTOM GRADIENT IN TCA ($\Delta T = 0.2^{\circ}F$)	1.5	1.5	-
DEFORMATION IN TCA DUE TO VEHICLE DISTORTION	1.5	2.0	-
PRIMARY MIRROR TILT ($\Delta T = 0.5^{\circ}F$, METERING RODS)	0.4	0.4	-
FOLD FLAT TILT ($\Delta T = 2.0^{\circ}F$ in TEMP. LEVEL	-	0.7	0.5
RSS ₁	2.2	2.8	3.2

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POINTING ERRORS DUE TO ENVIRONMENT EFFECTS (Continued)

ERROR SOURCE	POINTING ERROR - ARC SECOND (1σ)		
	ROLL	PITCH	YAW
ALIGNMENT CHANGE OF S ³ Sensor LOS TO SENSOR MOUNT ON TCA			
THERMAL GRADIENTS IN SENSOR HOUSING (ΔT = 0.25 F)	1.6	1.6	1.6
THERMAL SHIFT OF FOCAL PLANE DETECTOR ARRAY	<u>1.0</u>	<u>1.0</u>	<u>1.0</u>
RSS ₂	1.9	1.9	1.9
ANGULAR VIBRATION OF TCA RELATIVE TO THE ARM	1.0	1.0	1.0
FOLD FLAT STABILITY WITH OB VELOCITY VARIATION	-	<u>1.5</u>	<u>1.0</u>
RSS ₃	1.0	1.8	1.4
RSS _{tot}	3.0	3.8	3.9

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SS IMPACTS

A. TCA - FRAME

- RELOCATE TWO SERVO BOXES
- MOUNTING FOR TWO S³ CAMERAS
- MOUNTING FOR TWO S³ CAMERA ELECTRONIC BOXES
- MOUNTING FOR TWO THERMAL COOLING RADIATORS

B. ELECTRONIC BOXES

- NO CHANGES

C. CABLES

- SOME BRANCHLINE REROUTING ON TCA
- SEVERAL NEW BRANCHLINES ADDED TO EXISTING CABLES
- S³ CABLES TO FOLLOW EXISTING ROUTINGS TO MINIMIZE NEW TIE POINTS

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1/16/75

CK

SBA IMPACTS

A. COMMANDS

- 12 NSPC'S FROM EACH DECODER

B. TELEMETRY

- 4 SERIAL DIGITAL DATA WORDS
- 20 DISCRETE DIAGNOSTICS
- 22 TEMPERATURE MEASUREMENTS
- DATA RATE - 3000 BITS/SECOND IN MODES B AND C

C. POWER

- AVERAGE FOR TWO S³ CAMERA SYSTEMS 90 WATTS

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SBA IMPACTS (Continued)

D. STRUCTURAL/MECHANICAL

- M2/M3 ACCESS DOORS MODIFIED
 - STRUCTURALLY EQUIVALENT
 - WILL HAVE S³ VIEWPORT
 - WILL HAVE ATTACHMENT FOR S³ VIEWPORT SHIELD
 - MINIMUM MS MODIFICATION
 - AGE DOOR FOR SV INTEGRATION TESTS
- WEIGHT INCREASE PER VEHICLE 150 POUNDS

E. THERMAL

- MODIFICATION TO DOOR INSULATION
- ADDITION TO INTERNAL BLANKETS AROUND S³ VIEWPORT SHIELD
- RADIATOR MAXIMUM RADIANT ENERGY - 5 WATTS (FOR COOLING FP TO 0°C IN 93°F AMBIENT)

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PHOTODETECTOR INVESTIGATION

- WORKING WITH FAIRCHILD AND RETICON
- FAIRCHILD IS CCD AND RETICON IS A PHOTODIODE ARRAY SUPPLIER
- FAIRCHILD PERFORMED SPECIAL SENSITIVITY TEST
- SSC HAS TESTED FIVE SAMPLES OF FAIRCHILD'S 256 ARRAY (CCD-110). RESULTS ARE GOOD.
- PREPARING TO TEST FAIRCHILD'S 1728 ARRAY (ILID-1728)
- RETICON TO DO SPECIAL SENSITIVITY TESTS OF THEIR 1024 LINEAR ARRAY AND RL 1800F ARRAY
- OPTION IS OPEN TO INCLUDE RETICON ARRAY IN DESIGN VERIFICATION EXPERIMENT

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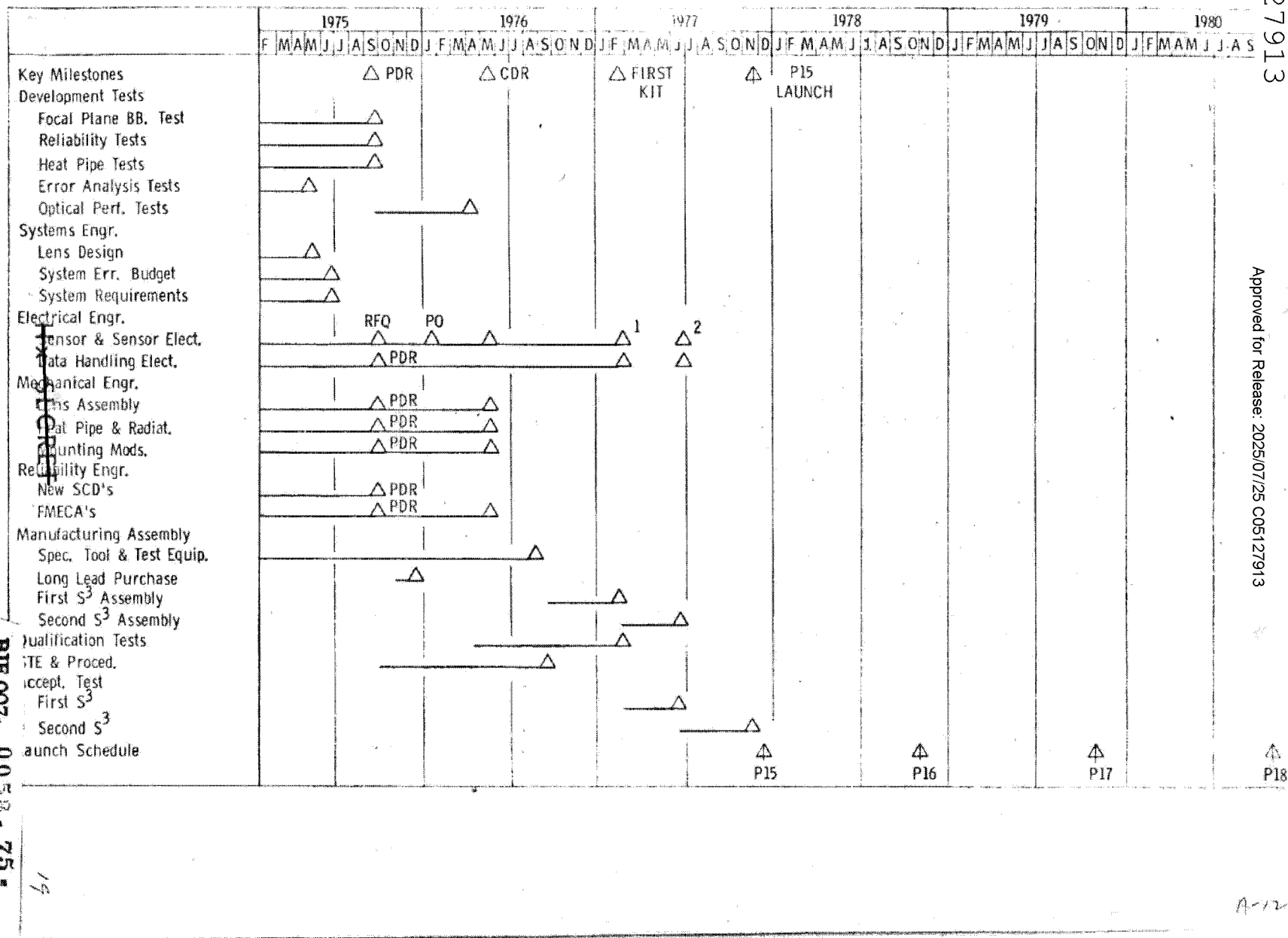
CONCLUSIONS

- S³ IS FEASIBLE
 - NO RISK TO BASIC SYSTEM
 - OPTO/MECH NOT CRITICAL
 - INTERFACE WITH SPACECRAFT IS REASONABLE
 - COMMANDS AND TELEMETRY AVAILABLE
 - DETECTOR IS THE MAJOR CONCERN
- GO AHEAD IS NEEDED

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S³ SCHEDULE

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Col. R. -
1. We really shouldn't let this go without attending. I'll work it.
2. I think the meeting is a good thing later
H.

ZCZCXQAD48 BAA337
PP RUXQAA
DE RUXQBA 175 0371850
ZNY XXXXX KKK ZNN
P 061845Z
BT
XXXXX
ANGL O 354, GUARD 851
ANGL O PASS ETHER
GUARD PASS WHIG

AA 1266/4

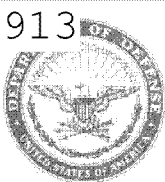
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PRIORITY ETHER, INFO PRIORITY WHIG
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HEXAGON
ETHER FOR J. WEBB; WHIG FOR D. HUTCHINSON; FROM
J. COLLINS
SUBJ: S CUBED STUDY PLAN REVIEW.
A REVIEW OF THE PROPOSED STUDY PLAN FOR THE S CUBED
SYSTEM WILL BE HELD AT CHARGE ON 12-14 FEB 75. IT IS
REQUESTED THAT ETHER HAVE A REPRESENTATIVE AT
THIS MEETING. THE VISIT REQUEST SHOULD BE SENT
THROUGH WHIG FOR APPROVAL.
E-2 IMPDET
~~SECRET~~
BT

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SAPUS		
ED		
SS-1		
SS-2		✓
SS-3		
SS-4		
SS-5		
SS-6		
SS-7	✓	✓
CO-1		
SS-10		✓
PR-1		
PR-2		

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25 FEB 1975

PR

MEMORANDUM FOR NATIONAL RECONNAISSANCE OFFICE

ATTENTION: Lt Col Hutchison

SUBJECT: Capability Requirements for a Metric Panoramic System

1. Reference WHIG 0203, 072320Z Feb 75, subject: Metric Pan Study.
2. In accordance with your request, the following data represents the MC&G metric requirements for an MPS:
 - a. Panoramic camera calibration to reduce orthogonal film distortions to less than 10 micrometers (one sigma).
 - b. Time readout for panoramic exposures to 0.10 milli-seconds (one sigma).
 - c. Attitude readout of each panoramic camera to a precision of 1 (one) arc second accurate to 5-6 arc seconds (one sigma) on each axis throughout limits of scan.
 - d. Continuous attitude rate readout to less than 1.5 arc seconds/second (one sigma).
 - e. Continuous tracking and post-mission determination of the HEXAGON orbit and its ephemeris to within 30 feet (one sigma) in all components.
3. Of the above requirements all, with the exception of item c., are either currently available in HEXAGON or being addressed for incorporation by a specific point in time. The data used in the 17 January 1975 briefing to Dr. Hall (briefing materials attached) assumed errors consistent with the design specifications and projected these errors to the ground in order to define attitude requirements in keeping with the total error budget.

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SCHEDULE OF EXECUTIVE ORDER 11652
EXEMPTION CATEGORY para 5B (2) &
DECLASSIFY ON impossible to determine (3)

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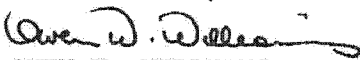
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4. We concur with your desire to determine the best approach for development of the MPS as opposed to just the solid state stellar camera but emphasize the need to initiate and complete the MPS study at the earliest possible date in order to work the funding problem for system incorporation. In keeping with this, we are available to discuss the requirement statement and Study Plan as soon as possible.

FOR THE DIRECTOR:

Enclosure a/s
(6 paper copies)


OWEN W. WILLIAMS
Acting Deputy Director
Plans, Requirements
and Technology

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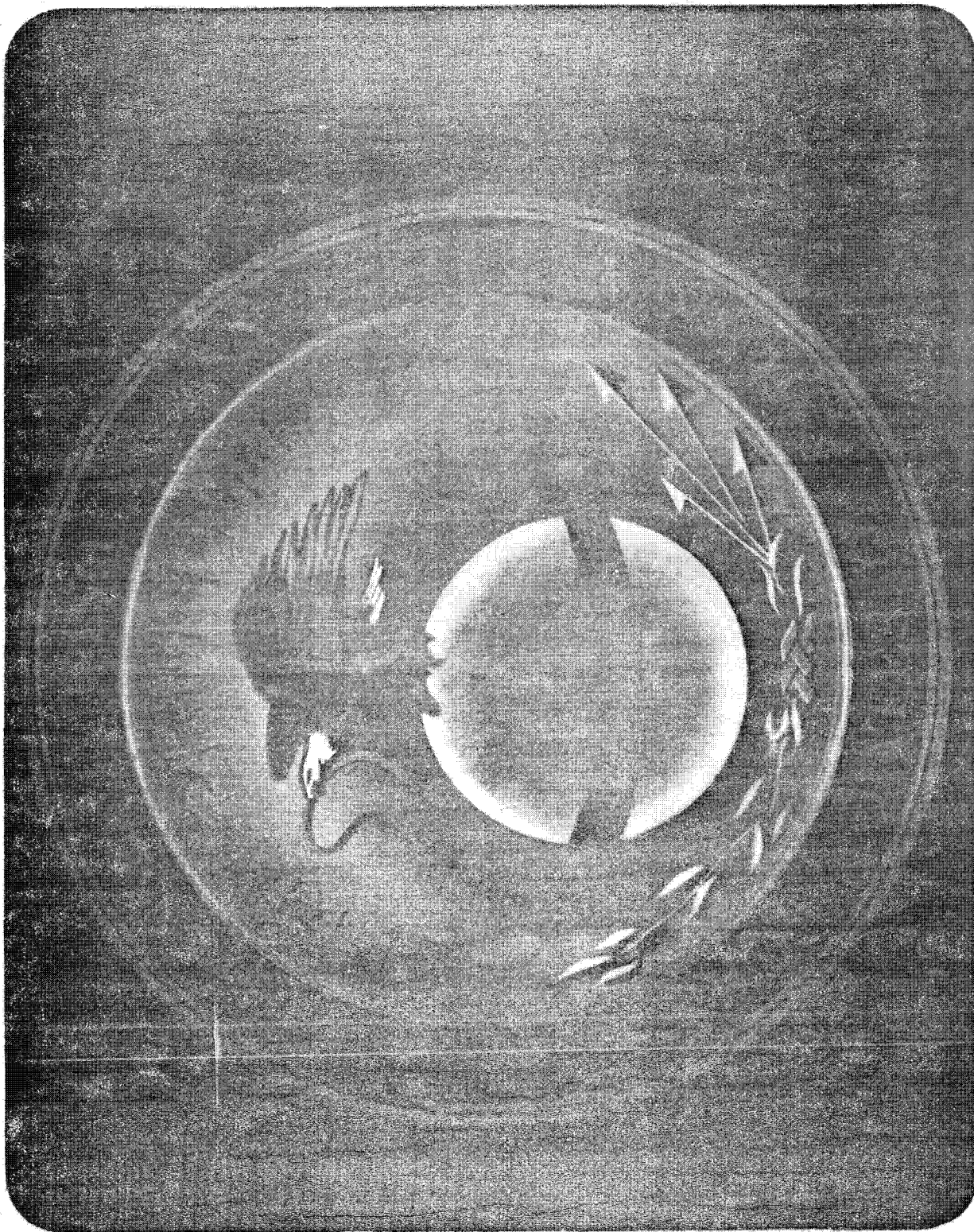
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OBJECTIVE

HORIZONTAL

VERTICAL

METERS @ 90%

UPPER

39.2

22.6

MIDDLE

26.2

22.6

LOWER

22.9

17.5

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ERROR BUDGET

FOR ITEMS UNDERWAY
(METERS @ 90%)

	0°	15°	30°	45°	60°
● HORIZONTAL					
CALIBRATION	1.7	2.5	4.3	7.6	20.9
TIMING	.6	1.4	2.3	3.6	5.7
ORBIT POSITION	19.6	19.6	19.6	19.6	19.6
TOTAL	19.7	19.8	20.2	21.3	29.2

● VERTICAL					
CALIBRATION	6.3	6.9	7.4	7.8	12.9
TIMING	2.8	2.8	2.8	2.8	2.8
ORBIT POSITION	8.2	8.2	8.2	8.2	8.2
TOTAL	10.7	11.1	11.4	11.7	15.5

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ATTITUDE ERROR
PROJECTION
(METERS @ 90%)

● HORIZONTAL	0°	15°	30°	45°	60°
5 ARC SEC.	8.4	9.8	11.3	13.4	16.7
6 ARC SEC.	10.0	10.3	11.3	13.7	19.0
10 ARC SEC.	17.3	17.6	18.5	22.2	28.1
15 ARC SEC.	26.0	26.7	28.2	31.5	40.0

● VERTICAL	0°	15°	30°	45°	60°
5 ARC SEC.	3.3	4.1	5.6	8.6	12.7
6 ARC SEC.	3.3	4.4	6.1	9.0	14.8
10 ARC SEC.	3.3	4.7	8.7	15.2	23.4
15 ARC SEC.	3.3	5.6	12.3	21.9	34.0

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BY *7K-1*
General Declassification

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ERROR BUDGET TOTALS
(METERS @ 90%)

● **HORIZONTAL**

WITH 5 ARC SEC.
6 ARC SEC.
10 ARC SEC.
15 ARC SEC.

	0°	15°	30°	45°	60°
WITH 5 ARC SEC.	21.4	22.1	23.1	25.1	33.7
6 ARC SEC.	22.1	22.4	23.2	25.4	34.8
10 ARC SEC.	26.2	26.5	27.4	30.8	40.5
15 ARC SEC.	32.6	33.2	34.7	38.0	49.5

● **VERTICAL**

WITH 5 ARC SEC.
6 ARC SEC.
10 ARC SEC.
15 ARC SEC.

	0°	15°	30°	45°	60°
WITH 5 ARC SEC.	11.2	11.8	12.7	14.5	20.1
6 ARC SEC.	11.2	11.9	12.9	14.7	21.4
10 ARC SEC.	11.2	12.0	14.3	19.2	28.1
15 ARC SEC.	11.2	12.4	16.8	24.8	37.4



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SATISFACTION

● HORIZONTAL

- WITH 5 ARC SEC.
- 6 ARC SEC.
- 10 ARC SEC.
- 15 ARC SEC.

	UPPER	MIDDLE	LOWER
	0-60°	0-45°	0-30°
	0-60°	0-45°	0-30°
	0-60°	0-15°	---
	0-45°	---	---

● VERTICAL

- WITH 5 ARC SEC.
- 6 ARC SEC.
- 10 ARC SEC.
- 15 ARC SEC.

	0-60°	0-60°	0-45°
	0-60°	0-60°	0-45°
	0-45°	0-45°	0-30°
	0-30°	0-30°	0-30°



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COMPOSITE SATISFACTION

SYSTEM WITH

UPPER

MIDDLE

LOWER

5 ARC SEC.

0-60°

0-45°

0-30°

6 ARC SEC.

0-60°

0-45°

0-30°

10 ARC SEC.

0-45°

0-15°

15 ARC SEC.

0-30°



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BY T.K.F.-1

(S) NATIONAL RECONNAISSANCE OFFICE

WASHINGTON, D.C.

THE NRO STAFF

27 February 1975

MEMORANDUM FOR COLONEL ANDERSON, SP-7

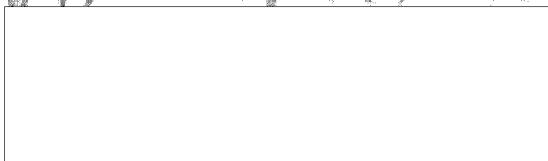
SUBJECT: DMA Accuracy Requirements for Metric Panoramic Materials

The attached memorandum from the Defense Mapping Agency, outlining the accuracy requirements a successful Metric Pan System must meet, is forwarded for your use in the HEXAGON Metric Pan System Study.

Daniel B. Hutchison
DANIEL B. HUTCHISON
Lt Colonel, USAF

Atch
BYE-47518-75, Cy 1A

*BMB - FAX THIS Cy to
SP-7*



SK

31 OCT 75

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HEXAGON

TALENT-KEYHOLE

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25 FEB 1975

MEMORANDUM FOR NATIONAL RECONNAISSANCE OFFICE

ATTENTION: Lt Col Hutchison

SUBJECT: Capability Requirements for a Metric Panoramic System

1. Reference WHIG 0203, 072320Z Feb 75, subject: Metric Pan Study.
2. In accordance with your request, the following data represents the MC&G metric requirements for an MPS:
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 - c. Attitude readout of each panoramic camera to a precision of 1 (one) arc second accurate to 5-6 arc seconds (one sigma) on each axis throughout limits of scan.
 - d. Continuous attitude rate readout to less than 1.5 arc seconds/second (one sigma).
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SCHEDULE OF EXECUTIVE ORDER 11652
EXEMPTION CATEGORY para 5B (2) &
DECLASSIFY ON Impossible to determine 63

HEXAGON

~~TOP SECRET~~HANDLE VIA
BYEMAN-TALENT-KEYHOLE
CONTROL SYSTEMS JOINTLY

~~TOP SECRET~~

4. We concur with your desire to determine the best approach for development of the MPS as opposed to just the solid state stellar camera but emphasize the need to initiate and complete the MPS study at the earliest possible date in order to work the funding problem for system incorporation. In keeping with this, we are available to discuss the requirement statement and Study Plan as soon as possible.

FOR THE DIRECTOR:

Enclosure a/s
(6 paper copies)

Owen W. Williams
OWEN W. WILLIAMS
Acting Deputy Director
Plans, Requirements
and Technology

HEXAGON

BYE-47518-75

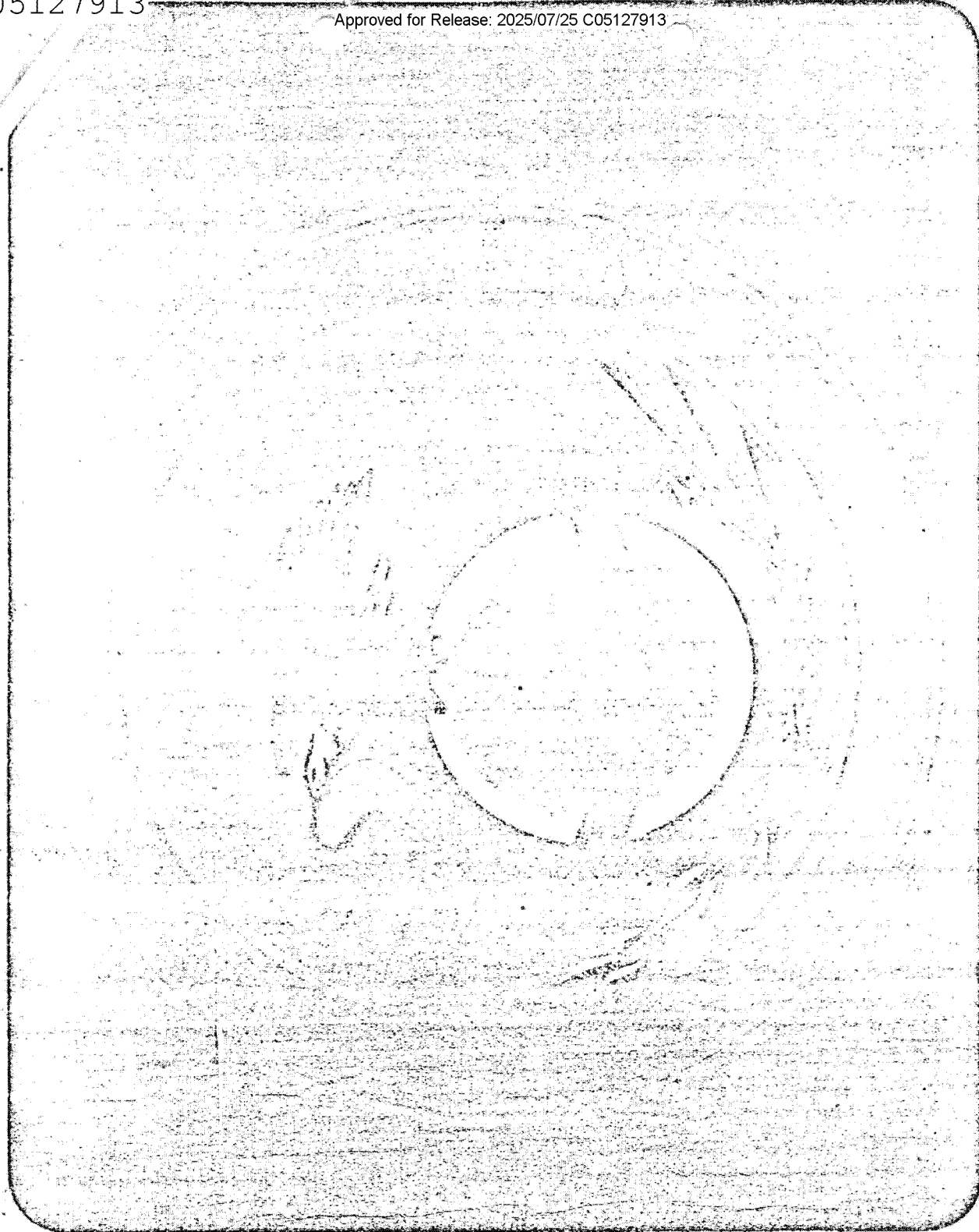
Page 2 of 2 pages
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~~TOP SECRET~~

2

HANDLE VIA
BYEMAN-TALENT-KEYHOLE
CONTROL SYSTEMS JOINTLY

3



4

~~TOP SECRET~~

OBJECTIVE

HORIZONTAL

VERTICAL

METERS @ 90%

UPPER

39.2

22.6

MIDDLE

26.2

22.6

LOWER

22.9

17.5

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~~ERROR BUDGET~~
~~FOR ITEMS UNDERWAY~~
~~(ITEMS @ 90%)~~

HORIZONTAL	0°	15°	30°	45°	60°
	1.7	2.5	4.3	7.6	20.3
CALIBRATION					
TIMING	.6	1.4	2.3	3.6	5.7
ORBIT POSITION	19.6	19.6	19.6	19.6	19.6
TOTAL	19.7	19.8	20.2	21.3	29.3

VERTICAL	0°	15°	30°	45°	60°
	6.3	6.9	7.4	7.8	12.1
CALIBRATION					
TIMING	2.8	2.8	2.8	2.8	2.8
ORBIT POSITION	8.2	8.2	8.2	8.2	8.2
TOTAL	10.7	11.1	11.4	11.7	15.5

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~~ATTITUDE ERROR~~
~~PROJECTION~~
(MEANS @ 90%)

● HORIZONTAL	0°	15°	30°	45°	60°
5 ARC SEC.	8.4	9.8	11.3	13.4	16.7
6 ARC SEC.	10.0	10.3	11.3	12.7	17.0
10 ARC SEC.	17.3	17.6	18.5	22.2	23.1
15 ARC SEC.	26.0	26.7	28.2	31.5	40.0
● VERTICAL	0°	15°	30°	45°	60°
5 ARC SEC.	3.3	4.1	5.6	8.6	12.7
6 ARC SEC.	3.3	4.4	6.1	9.0	14.8
10 ARC SEC.	3.3	4.7	8.7	15.2	23.4
15 ARC SEC.	3.3	5.6	12.3	21.9	31.0

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OR ANY OTHER SPACES
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BY: 7K-1
in Command Identification

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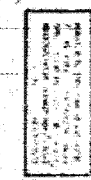
ERROR UNCERT TOTALS

(RATERS @ 90%)

	0°	15°	30°	45°	60°
○ HORIZONTAL					
WITH 5 ARC SEC.	21.4	22.1	23.1	25.1	33.7
6 ARC SEC.	22.1	22.4	23.2	25.4	31.8
10 ARC SEC.	26.2	26.5	27.4	30.8	40.5
15 ARC SEC.	32.6	33.2	34.7	39.0	49.5

○ VERTICAL

WITH 5 ARC SEC.	11.2	11.8	12.7	14.5	20.1
6 ARC SEC.	11.2	11.9	12.9	14.7	21.4
10 ARC SEC.	11.2	12.0	14.3	19.2	20.1
15 ARC SEC.	11.2	12.4	16.8	21.8	37.4



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SATISFACTION

○ HORIZONTAL

	UPPER	MIDDLE	LOWER
WITH 5 ARC SEC.	0-60°	0-45°	0-30°
6 ARC SEC.	0-60°	0-45°	0-30°
10 ARC SEC.	0-60°	0-45°	---
15 ARC SEC.	0-45°	---	---

○ VERTICAL

WITH 5 ARC SEC.	0-60°	0-60°	0-45°
6 ARC SEC.	0-60°	0-60°	0-45°
10 ARC SEC.	0-45°	0-45°	0-30°
15 ARC SEC.	0-30°	0-30°	0-30°

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CHANNELS ONLY



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COMPOSITE SATISFACTION

SYSTEM WITH

UPPER

MIDDLE

LOWER

5 ARC SEC.

0-60°

0-45°

0-30°

6 ARC SEC.

0-60°

0-45°

0-30°

10 ARC SEC.

0-45°

0-15°

15 ARC SEC.

0-30°

GROUP 1
EXCLUDED FROM AUTOMATIC
DOWNGRADING AND
DECLASSIFICATION

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DACOM Transmission Receipt

TRANSMISSION NUM

260

Xmilled

DATE

3 Nov 1975

CLASSIFICATION

TOP SECRET "B" "H" "GK"

To

SP-7

FROM

SS-7

SUBJECT

DMA Requirements

(unclassified only)

NUMBER OF PAGES

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SENDER

Randall

(signature of transmitter)

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Note: Page 9 will not reproduce
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HANDLE VIA

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CONTROL SYSTEM

~~(S)~~ NATIONAL RECONNAISSANCE OFFICE

WASHINGTON, D.C.

THE NRO STAFF

12 March 1975

*Mr. Plummer has seen.**File
Per A.H.
ALC/6*

MEMORANDUM FOR MR. PLUMMER

SUBJECT: Application of SPARS to HEXAGON Metric Pan System

In answer to your question on 5 March, SPARS was considered in the initial Metric Pan Concept Study conducted by SAFSP, and was one of the approaches reported at the 26 June 1974 meeting which summarized the study results.

In the concept study, it was determined that SPARS was not an attractive approach because, as a star crossing sensor, it either required its own inertial measurement unit (IMU) or a complex interface with the HEXAGON IMU. In addition, SPARS as developed for DMSP does not have the accuracy required (15 versus 5 arc seconds).

For the current Metric Pan Study, all of the approaches previously proposed, plus possible new approaches, are under consideration.

Harold P. Wheeler, Jr.
HAROLD P. WHEELER, JR.
Colonel, USAF
Director

HEXAGON

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BYEMAN
CONTROL SYSTEMCLASSIFIED BY BYEMAN - 1 EXEMPT FROM
GENERAL DECLASSIFICATION SCHEDULE OF
EXECUTIVE ORDER 11652 EXEMPTION CATE-
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ANGLO PASS ETHER, CLEAT
HYPO PASS SOLAR

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Pass.

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ETHER, CLEAT, SOLAR, [redacted] WADDY INFO WHIG.
HANDLE VIA BYEMAN CHANNELS ONLY
HEXAGON
ETHER FOR J. WEBB, CLEAT FOR [redacted], SOLAR FOR
[redacted] SPECTRE FOR [redacted] PERCH FOR P. PETTY,
PASS TO [redacted] WADDY PASS TO [redacted] WHIG FOR
D. HUTCHINSON, FROM RASPET.
1. [redacted] WILL PRESENT THE MENSURATION CHANGES THAT
ARE IMPLEMENTED ON SENSOR SUBSYSTEM S/N 17 (SV-14).
THESE CHANGES INCLUDE ONE DEGREE SCAN ANGLE MARKS,
OB ENCODER CALIBRATION, AND CALIBRATION OF THE
FLASHERS TO THE FOCAL PLANE. CHARGE [redacted] AND
ETHER (J. WEBB) HAVE SELECTED 0900, 1 APRIL FOR THIS

PAGE 2 CHARGE 2749 ~~SECRET~~
PRESENTATION AT [redacted]
2. IN ADDITION TO CHARGE, ETHER AND [redacted]
PARTICIPATION BY APPROPRIATE CLEAT, SOLAR, AND [redacted]
PERSONNEL AND [redacted] IS INVITED.
CHARGE CONTACT FOR THIS MEETING IS [redacted] AND
[redacted] CONTACT IS [redacted]
3. [redacted] WILL SUPPLY A PROPOSED AGENDA TO ALL
ADDRESSEES BY 25 MARCH 1975.
E-2 IMPDET
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HEXAGON

ATTN: KWCHARGE - PASS TO J. WEBB, [] W. MAHONEY

KWWHIG, FOR D. HUTCHINSON

REF: KWCHARGE 2749 DATED 19 MARCH 1975

SUBJ: MEETING ON MENSURATION CHANGES

THE AGENDA FOR THE MENSURATION CHANGES MEETING TO BE
HELD ON 1 APRIL AT [] IS AS FOLLOWS:

- INTRODUCTION.
- IMPROVED RESOLUTION FIDUCIAL DOT.
- ONE DEGREE SCAN ANGLE DOT INTERVAL.

PAGE 2 ~~SECRET~~

- CALIBRATION OF IN-TRACK SPACE BETWEEN SCAN ANGLE DOTS.
- OB ENCODER CALIBRATION.
- CALIBRATION OF PRINCIPLE POINT.
- DISCUSSION OF CALIBRATION DATA TRANSMISSION TO USERS.

THE DISCUSSIONS WILL COVER HARDWARE CHANGES, CALIBRATION
TECHNIQUES AND OUTPUT DATA. THE MEETING WILL START AT 0900 AM.

E-2 IMPDET

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CONTROL SYSTEM

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 GUARD PASS WHIG

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Please

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Metric
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WHIG.

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HEXAGON

FOR COL WHEELER [REDACTED] FROM MAJ GEN BRADBURN

COL ANDERSON/LCOL HOFMANN.

SUBJ: STUDY PLAN FOR SOLID STATE SENSOR (S-CUBED)

REF: (1) WHIG 0205, 7 FEB 75. (2) CHARGE 8992, 19 NOV 74

1. THE FOLLOWING INFORMATION IS PROVIDED IN RESPONSE TO REFERENCE (1).

A. DURING 1974 CHARGE CONDUCTED STUDIES TO EVALUATE CANDIDATE HIGH ACCURACY ATTITUDE REFERENCE SYSTEMS FOR DETERMINING HEXAGON ON-ORBIT ATTITUDE TO THE ACCURACY REQUIRED TO PERMIT HEXAGON PAN-CAMERA PHOTOGRAPHY TO BE USED FOR MAPPING AND TARGETING APPLICATIONS. GROUND RULES FOR THESE STUDIES WERE:

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PAGE 2 CHARGE 3747 ~~SECRET~~

(1) MINIMIZE THE COST AND RISK ON THE BASIC HEXAGON MISSION. ✓
 (2) ACCURACY OF THE PANORAMIC CAMERA ATTITUDE SHOULD BE KNOWN ✓
 TO APPROXIMATELY 5 ARC-SECONDS PER AXIS.

B. THE RESULTS OF THESE STUDIES SHOW THAT ALTERNATIVE STAR TRACKING ATTITUDE AND STELLAR CAMERA SYSTEMS EITHER DO NOT HAVE THE ACCURACY REQUIRED TO MEET THE 5 ARC-SECOND GOAL AND/OR REQUIRE SIGNIFICANT MODIFICATIONS TO THE BASIC HEXAGON VEHICLE FOR IMPLEMENTATION. WE FEEL THAT THE S-CUBED CAMERA CONCEPT MEETS THE GROUND RULES OF PARAGRAPH 1.A-(1) AND (2).

C. THE HIGH RISK PORTIONS OF THE S-CUBED CONCEPT SHOULD BE EVALUATED BEFORE ANY LONG RANGE IMPLEMENTATION IS PROGRAMMED. THESE RISK AREAS WERE OUTLINED IN THE S-CUBED STUDY PROPOSED IN REFERENCE (2).

D. BASICALLY, THE HIGH RISK AREAS FALL INTO TWO BROAD CATEGORIES WHICH ARE:

(1) ARE SOLID STATE DETECTOR DEVICES (CHARGE COUPLED DEVICES OR PHOTODIODES) CAPABLE OF MEETING THE CALIBRATION, SENSITIVITY, RELIABILITY, AND STABILITY REQUIREMENTS IMPOSED BY THE DESIGN CONCEPT.

(2) CAN THE OVERALL 5 ARC-SECOND ATTITUDE ACCURACY GOAL BE MET WITH THE COMBINED S-CUBED CAMERA/PANORAMIC CAMERA SYSTEM.

PAGE 3 CHARGE 3747 ~~SECRET~~

IT SHOULD BE NOTED THAT A LARGE PORTION OF THE STUDY EFFORT IS DIRECTED AT DETERMINING THE FOLLOWING GOALS:

4
ING INACCURACIES OF THE CURRENT HEXAGON PANORAMIC CAMERA TWO-CAMERA ASSEMBLY. THIS PORTION OF THE STUDY IS REQUIRED REGARDLESS OF THE ATTITUDE REFERENCE SYSTEM SELECTED.

E. SPECIFICALLY, THE S-CUBED STUDY WILL ADDRESS THE FOLLOWING AREAS:

(1) SOLID STATE FOCAL PLANE. RELIABILITY, MANUFACTURABILITY, ACCURACY, SENSITIVITY, AND STABILITY OF A DEMONSTRATION FOCAL PLANE WILL BE INVESTIGATED. AFTER PRELIMINARY INVESTIGATIONS OF INDIVIDUAL SOLID STATE SENSORS ARE COMPLETED, A COMPLETE FOCAL PLANE ARRAY WILL BE ASSEMBLED FOR TEST PURPOSES.

(2) STAR DETECTION ACCURACY. A BREADBOARD TEST APPARATUS IS PLANNED TO DEMONSTRATE THE CAPABILITY OF THE FOCAL PLANE ASSEMBLY AND ITS ASSOCIATED ELECTRONICS ASSEMBLY TO ACCURATELY LOCATE SIMULATED STAR IMAGES IN THE FIELD OF VIEW.

(3) SENSOR COOLING TECHNIQUE. ESTIMATES ON SEN-

PAGE 4 CHARGE 3747 ~~SECRET~~

SOR DARK CURRENT LEVELS INDICATE SENSOR COOLING IS NECESSARY. THE S-CUBED STUDY WILL EVALUATE THE PROPOSED COOLING TECHNIQUE.

(4) SYSTEM ERROR BUDGET. A LARGE PORTION OF THE S-CUBED STUDY EFFORT WILL BE DIRECTED TOWARD ANALYSIS OF ALL POTENTIAL ERROR SOURCES WHICH WOULD JEOPARDIZE THE 5 ARC-SECOND POINTING ACCURACY GOAL. DETAILED ANALYSIS WILL BE COMPLETED TO EITHER MEASURE OR ESTIMATE EACH ERROR SOURCE. WHERE POSSIBLE, HEXAGON FLIGHT VEHICLES WILL BE INSTRUMENTED DURING FACTORY TEST TO VERIFY THE MAGNITUDE OF ERRORS CAUSED BY OPERATING CHARACTERISTICS OR THERMAL GRADIENTS.

(5) SYSTEM DESIGN. SYSTEM DESIGN OF THE S-CUBED CAMERA SYSTEM WILL BE COMPLETED TO THE EXTENT NECESSARY TO VERIFY THE DESIGN CONCEPT IS FEASIBLE. THIS PRELIMINARY ANALYSIS WILL INCLUDE OPTICAL, ELECTRICAL, THERMAL AND MECHANICAL DESIGN AREAS CONSIDERED HIGH RISK OR POTENTIAL HIGH RISK TO THE OVERALL CONCEPT.

(6) CENTROIDING SOFTWARE. COMPUTER PROGRAMS WILL BE DEVELOPED TO VERIFY THE CAPABILITY TO USE SIMULATED STAR DATA AND CONVERT TO THE REQUIRED ATTITUDE INFORMATION.

- A
GE 3 CHARGE 3747 ~~SECRET~~
2. SCHEDULE MILESTONES FOR THE S-CUBED STUDY PLAN AREA AS FOLLOWS:
- 15 APR 75 - APPROVAL OF CONTRACTOR EOP
 - 1 MAY 75 - REVIEW DETAILED STUDY PLAN
 - 1 SEP 75 - REVIEW PRELIMINARY STUDY RESULTS INCLUDING CONCEPT DESIGN AND ERROR BUDGET ANALYSIS. REVIEW PRELIMINARY SENSOR TEST DATA OBTAINED ON BREAD-BOARD TEST APPARATUS.
 - 1 APR 76 - COMPLETE ALL STUDY ANALYSIS & TESTING
 - 1 JUN 76 - PUBLISH FINAL REPORT
3. STUDY COST IS ESTIMATED TO BE 150K FOR MATERIALS AND SUBCONTRACTS IN FY-75. THE 150K REQUIRED FOR MATERIAL AND SUBCONTRACTS IN FY-75 WILL BE USED TO PROCURE SOLID STATE DETECTORS, THERMAL-ELECTRIC COOLING EQUIPMENT, BREADBOARD ELECTRONICS, AND LABORATORY TEST EQUIPMENT. THIS 150K CAN BE FUNDED FROM THE FUNDS REMAINING AFTER WE HAVE PROTECTED THE SV 17 MAPPING CAMERA SCHEDULE

PAGE 6 CHARGE 3747 ~~SECRET~~
AT ITEK (PER WHIG 0495). ADDITIONAL FY-76 FUNDING REQUIRED TO COMPLETE THE STUDY IS NOT EXPECTED TO EXCEED 350K. FY-76 FUNDS WILL BE USED TO PROCURE AND TEST THE COMPLETE FOCAL PLANE ARRAY. THE LABOR REQUIRED IS WITHIN EXISTING SUSTAINING ENGINEERING ALREADY ON CONTRACT.
SIGNED - MAJ GEN BRADBURN.
E-2 IMPDET
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BT

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Pks Auf
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Metric PAN

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MAY 75

PANORAMIC CALIBRATION

INTRODUCTION

- **Background**
 - **Projected MCS Shortfall**
 - **MCS Coverage Gaps**
 - **Require Pan For Resolution**
- **Objective**
 - **Provide Means To Correct
Pan Film Distortions To 10
Micrometers**

REQUIREMENTS SUMMARY (FEET at 90%)

Product	Horizontal			Vertical			Ground Resolution
	Rel.	Pt. to Pt.	Abs.	Rel.	Pt. to Pt.	Abs.	
MX	—	—	85*	—	—	75*	4
TERCOM (Over 10NM)	218	56	—	20	28	—	6.5
DRLMS II	82	—	—	33	—	—	8
Pave Strike (Over 300 NM)	—	30(CEP)*	—	—	—	—	—

Approved for Release: 2025/07/25 C05127913

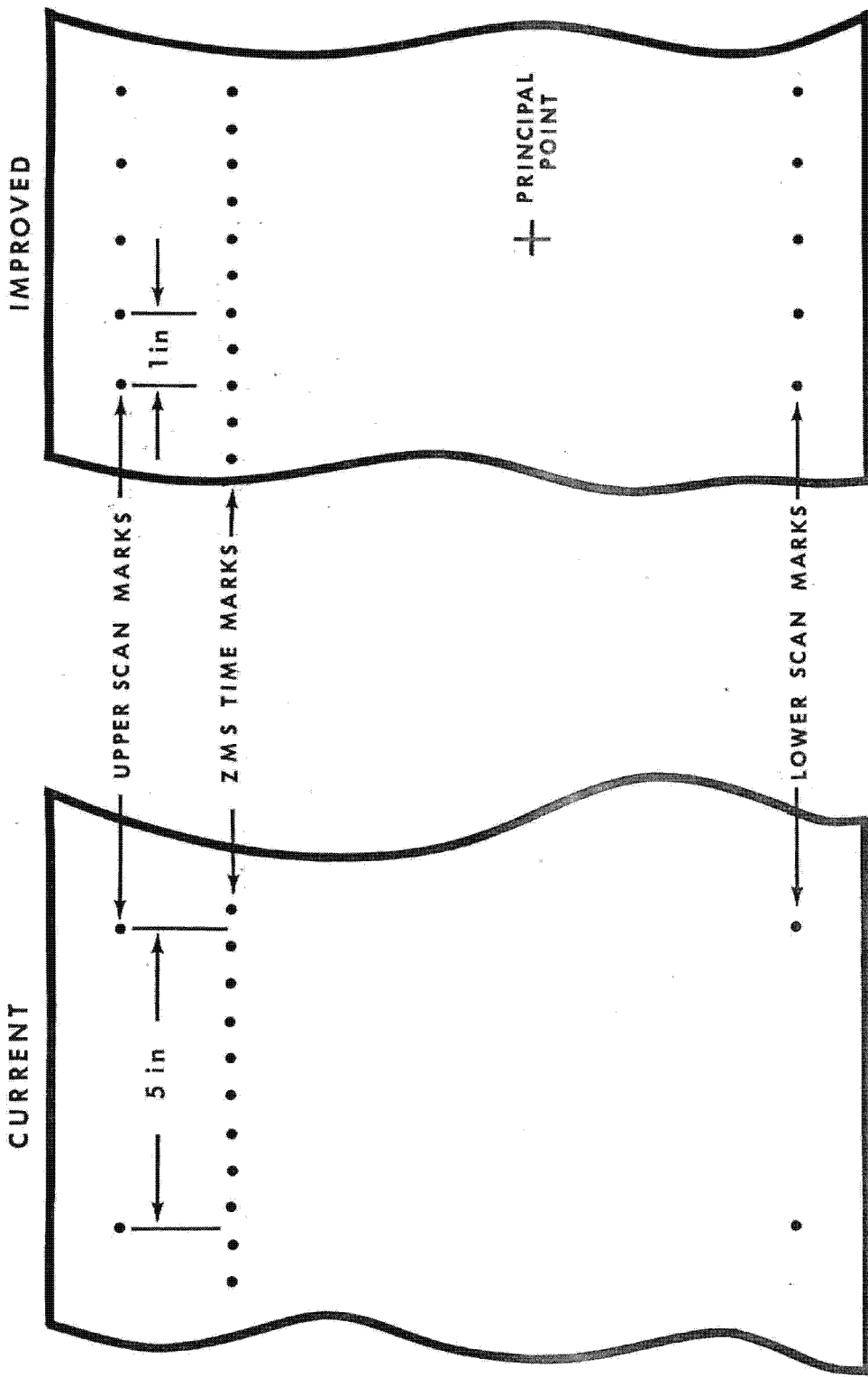
Approved for Release: 2025/07/25 C05127913

* Technical Objectives

CALIBRATION IMPROVEMENTS

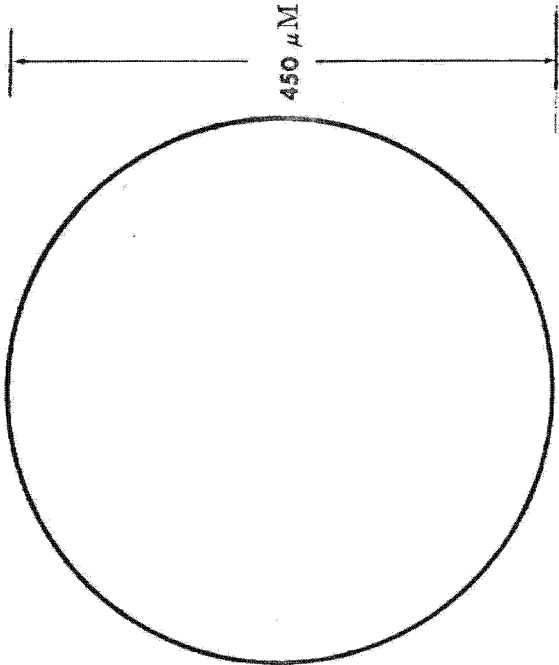
- Improved Fiducial Dot
- One Degree Scan Angle Interval
- In-Track Dimension Between Scan Marks
- Encoder Calibration
- Principal Point Calibration

FORMAT COMPARISON

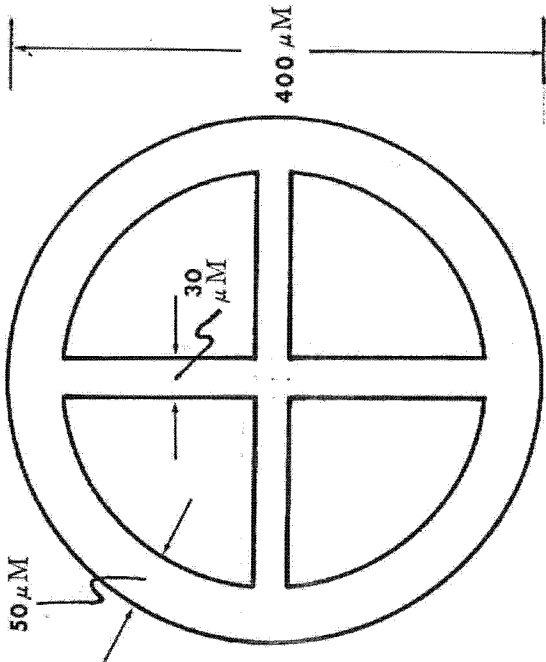


FIDUCIAL DOT

CURRENT



IMPROVED



ERROR BUDGET COMPARISON

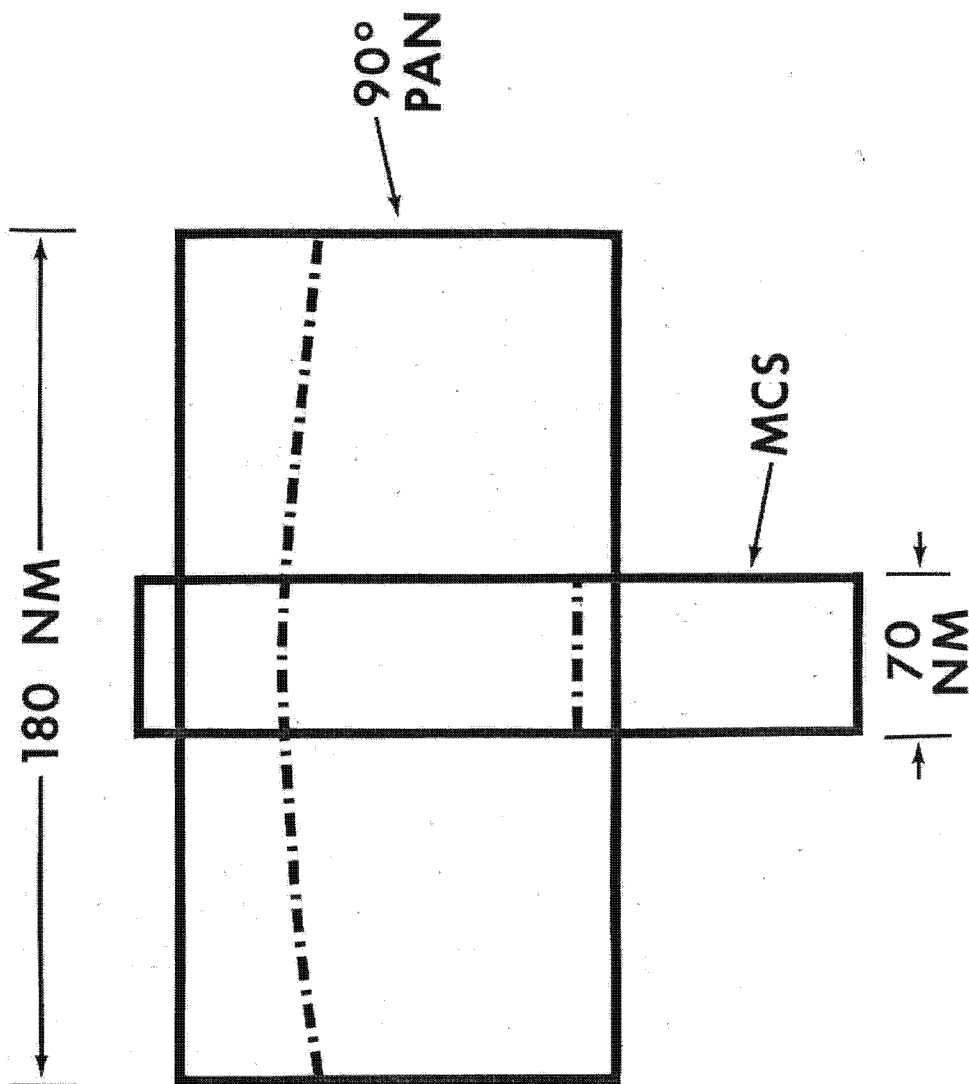
(MICROMETERS @ ONE SIGMA)

Source	<u>Current</u>		<u>Improved</u>	
	In-Track	Cross-Track	In-Track	Cross-Track
Mensuration	11	11	2	2
Encoder	-	40	-	5
In-Track (Scale)	19	-	3	-
Distortion & Velocity	3	2	4	1
Other	6	8	6	8
TOTAL	23	42	8	10

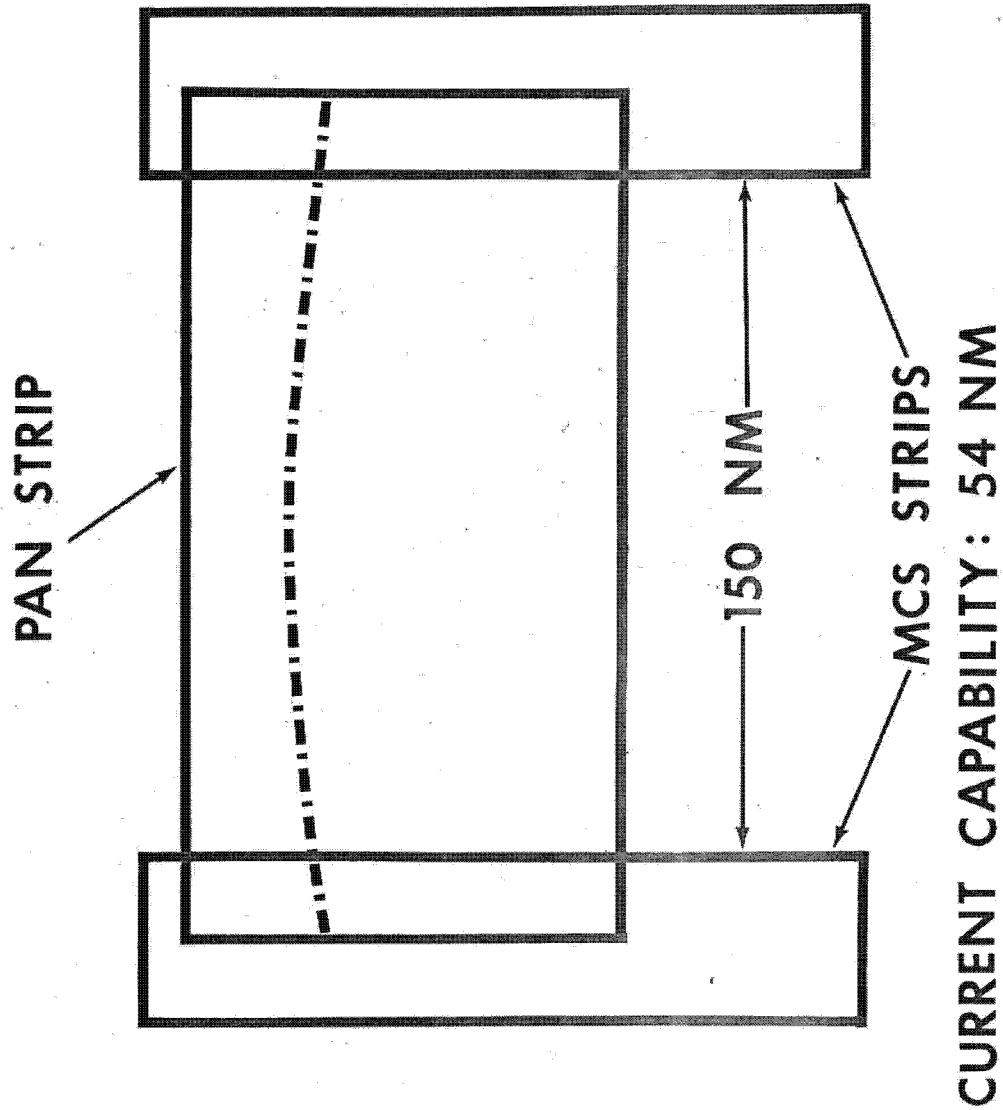
CALIBRATION BENEFITS

- Reduces MCS Shortfall
 - Augmenting MCS Coverage
 - Bridging MCS Slivers & Gaps
- Increase Production Efficiency
- Prerequisite for Metrcal Pan System

AUGMENTING MCS COVERAGE



BRIDGING MCS SLIVERS & GAPS



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CONTROL SYSTEM

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ETHER, INFO WHIG.
HANDLE VIA BYEMAN CHANNELS ONLY
HEXAGON

ETHER FOR J. WEBB, FOR A. PETTY, WHIG
FOR D. HUTCHISON, FROM J. COLLINS.

SUBJECT: SOLID STATE SENSOR STUDY REVIEW

1. A SPECIAL REVIEW OF THE SOLID STATE SENSOR STUDY
WILL BE HELD AT CHARGE ON 10 AND 11 JUNE 1975, BEGINNING
AT 0900 HOURS. THE PURPOSE IS TO REVIEW THE STUDY
OBJECTIVES AND THE GENERAL TECHNICAL DESIGN OF THE
SENSOR CONCEPT. IN ADDITION, THE SENSOR ERROR BUDGET
WILL BE REVIEWED IN DETAIL AND THE PROPOSED DATA TRANS-
MISSION/PROCESSING/FORMAT WILL BE DISCUSSED

PAGE 2 CHARGE 5211 ~~SECRET~~

2. ATTENDEE NAMES AND CLEARANCES SHOULD BE SENT TO
CHARGE IN ADVANCE OF THE VISIT. POINT OF CONTACT IS
J. COLLINS.
E-2 IMPDET

~~SECRET~~

BT

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CONTROL SYSTEM

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BYEMAN
CONTROL SYSTEM~~(S)~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

THE NRO STAFF

11 August 1975

Metric Pan
PRO AG 4/6

MEMORANDUM FOR MR. JOE WEBB, DEFENSE MAPPING AGENCY

SUBJECT: Final Report on Artificial Star Field Calibration of
HEXAGON Pan Cameras

Subject report is forwarded for your retention.

Daniel B. Hutchison
DANIEL B. HUTCHISON
Lt Colonel, USAFAttachment
BIF 381W-035/75, Cy 6*withdrawn*

HEXAGON

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BYEMAN
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GUARD 347, CATOR 272, HYPO 071

GUARD PASS WHIG

CATOR PASS CHARGE

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File # A67e(4)(6)
Hatch
Mollman is out of town
until Monday.
is handling this.

~~SECRET~~ 191930Z AUG 75 CITE ETHER 0516.
PRIORITY CHARGE INFO WHIG SOLAR (ZEN) CLEAT.
HANDLE VIA BYEMAN CHANNELS ONLY
HEXAGON/OPS
CHARGE FOR [REDACTED] WHIG FOR LTC HUTCHISON; SOLAR FOR
W. MAHONEY, [REDACTED] CLEAT FOR [REDACTED] AND
[REDACTED]

SUBJ: ATTITUDE RATE DATA FOR MC&G PRODUCTION.
REF: COMPARATIVE STUDY MEETING HELD AT KWJORM 27-28
MARCH 1975.

1. RESULTS PRESENTED AT THE REFERENCED CONTRACT REVIEW
MEETING DEMONSTRATED THE ACCURACY DEPENDENCE OF PAN
TRIANGULATION UPON INCLUDING ATTITUDE RATE DATA IN THE
SOLUTION.

WORKING COPY

PAGE 2 ETHER 0516 ~~SECRET~~

2. FOR THE ABOVE, AS WELL AS MCS ATTITUDE DETERMINATION
REFINEMENT AND QUALITY CONTROL, KWETHER CITED A NEED TO
ACQUIRE ATTITUDE RATE DATA FOR ALL HEXAGON PAN AND MCS
OPERATIONS TO SUPPORT MC&G PRODUCTION.

3. [REDACTED] A KWCHARGE DESIGNATED ATTENDEE AT
REFERENCED MEETING, ASSUMED THE ACTION TO EXPLORE EXTRACT-
ING AND PROVIDING REQUESTED INFORMATION AND, IN CONVERSA-
TIONS SUBSEQUENT TO THE MEETING, INDICATED SUCH CAPABILITY
COMPLETED.

4. CONSEQUENTLY, THIS MESSAGE CONSTITUTES A KWETHER
REQUEST FOR ATTITUDE RATE DATA ON A ROUTINE BASIS (INCLUDING
CURRENT, SUBSEQUENT, AND PAST MISSIONS, AS AVAILABLE).
FURTHER REQUEST COORDINATION MEETING WITH APPROPRIATE
PERSONNEL BE SCHEDULED TO ESTABLISH SPECIFIC DATA REQUIRE-
MENTS, FORMATS, AND TRANSMITTAL PROCEDURES.

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PRD

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metac
plan

SATS pto ASD, 20 Oct 75

BRIEFING OUTLINE

- BACKGROUND

- S³ STUDY ACCOMPLISHMENT

- FUNDS REQUIRED

- RISK ASSESSMENT

- CONCLUSIONS

OTHER CONSIDERATIONS

- S³ DECISION PROBABLY PUTS ITEK OUT OF GOVERNMENT BUSINESS
- S³ DEVELOPMENT + SV-17 AND 18 COSTS ARE ABOUT THE SAME AS MAPPING CAMERAS FOR SV-17 AND 18
- SUBSEQUENT S³ COSTS WOULD BE SIGNIFICANTLY LOWER THAN ITEK MAPPING CAMERAS
- DUE TO ITEK BUSINESS OUTLOOK WE ARE AT LEAST AS CONFIDENT IN S³ COSTS AS WE ARE IN ITEK COSTS

BACKGROUND

- DMA/SP-6 STUDIES ON METRIC PAN IDENTIFIED:
 - IMPROVED INTERNAL GEOMETRY KNOWLEDGE
 - IMPROVED GEOGRAPHIC REFERENCE
 - IMPROVED ATTITUDE REFERENCE
- CHANGES IN PROCESS
 - NAVPAC (SV-13)
 - 1° SCAN ANGLE DOTS (SV-14)
 - FIDUCIAL X-HAIRS (SV-14)
 - OB CALIBRATION (SV-14)
- REMAINING REQUIREMENT IS TO DETERMINE THE ATTITUDE TO
5-10 ARC SECONDS

ROM ESTIMATES OF S³ FUNDING REQUIREMENTS

<u>FY-76</u>	<u>7T</u>	<u>77</u>	<u>78</u>	<u>79</u>	<u>80</u>	<u>81</u>	<u>TOTAL</u>
6.5	2.0	5.9	4.0	3.2	2.3	0.26	24.16
1.24 (75 AND 76 COMMITMENT TO ITEK)							<u>1.24</u>
							25.40

- NEAR YEARS OK (76-77)
- OTHER YEARS COST WILL BE REFINED AFTER DESIGN COMPLETION (AUG 76)
- DOES NOT INCLUDE COST TO NRO DUE TO IMPACT ON ITEK

CONCLUSIONS

- COST, SCHEDULE AND PERFORMANCE RISKS ARE ACCEPTABLE
- WE ARE READY TO PROCEED ON AN S³ DEVELOPMENT FOR SV-17 AND 18
- DECISION TO PROCEED SHOULD BE BASED ON OVERALL SITUATION

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WASHINGTON, D.C.

THE NRO STAFF

FILE

PRO ~~ALF~~

A6 e(4)b

MEMORANDUM FOR MR. PLUMMER

SUBJECT: Itek's Analysis of the Metric Pan

A copy of Itek's briefing to Dr. Cook and Dr. Hall which raised questions about the utility and feasibility of the Metric Pan System (MPS) is at TAB A. Itek had two main points:

A. An MPS with a 5 arc second attitude error would not be useful, and

B. The ability to hold the error to 5 seconds is doubtful.

We had DMA double check the vertical positional error claimed by Itek due to the 5 second attitude error, and they determined that Itek must have been assuming a scan angle of 60°. As DMA's 25 February 1975 input to us shows (TAB B), a 5 second MPS will not meet the requirement outside 45° scan. DMA has considered this in their collection analysis, as we take little imagery outside 45°.

Lt Colonel Hutchison, Colonel Anderson (SP's HEXAGON Program Manager), and Dr. Howard of Aerospace reviewed the Perkin-Elmer error budget and supporting analyses and test results at the Danbury plant on 16 October 1975. As the result of that review, it was concluded that the largest concern of Itek's, 20 microns of non-linear smear, was invalid. It was also concluded, however, that Perkin-Elmer's 4.9 second error budget might be optimistic, more suitable for a goal than a hard specification. A summary of Perkin-Elmer's analysis is at TAB C.

At this point DMA stated that their analysis (TAB B) shows that 5 seconds is acceptable as a goal, if 10 seconds is set as the limit. Based on this 5 to 10 second requirement set by DMA, SAFSP concluded that the MPS was a low risk program.

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PAGE 1 OF 2 PAGES

It is our understanding that Itek has presented their analysis to ASD(I) and generated enough concern for Dr. Hall to delay sending a Mapping Camera System/MPS decision memorandum until after he has consulted with you.

In summary, we have shown the Itek Analysis to be invalid, and it is recommended that it be so reflected in your discussion with Dr. Hall. There is no technical reason that this decision memorandum should be further delayed.

HAROLD P. WHEELER, JR.
Colonel, USAF
Director

Attachments

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ABSOLUTE POSITIONING
(METERS, (17))

REQUIREMENTS

CAPABILITY

1965 USIB	6/75 J SOP		75/55 EXPECTED FUTURE REQMT (1,4)
	Current FIRM	TECHNICAL OBJECTIVE	
64	29 64 62	36 12	29 10.7
64	29 64 62	36 12	29 10.7
55	17 46 29	32 14	18 10.6

CURRENT FRAME(1)	FRAME WITH GEOPACK	3 SEC PAN WITH GEOPACK		5 SEC PAN WITH GEOPACK	
		10	11	12	16
✓ 19	135	13	10	12	16
19		13	11	12	16
✓ 14	15	12	13	9	12

∇_x
 ∇_y
 ∇_z

- NOTES (1) SOURCE: DMA
(2) ABSOLUTE ATTITUDE DETERMINATION
(3) GEOPACK OPERATIONAL ON SV-13 (1977)
(4) COVERAGE 3000 HARD TARGETS IN DENIED AREAS

DMA
SAYS
~10.4

TAB A

RELATIVE POSITIONING
(METERS, 1 ∇)

REQUIREMENTS

1:50,000 CLASS A MAP	PAVE STRIKE	1:250,000 CLASS A MAP
12	13	59
12	13	59
3	9	15
10-20 N. MI	300 N. MI.	20 N. MI.
SELECTED		WORLD WIDE

~~CAPABILITY~~

CURRENT FRAME	~~2 SEC PAN~~	5 SEC PAN
8	2	4
8	4 - 7	8 - 14
6 ⁽¹⁾	8 ⁽²⁾	15 ⁽²⁾

∇_x

∇_y

∇_z

IST.

OVERAGE
REQUIRED

NOTES

- 1) PRODUCTION ACTUALS
- 2) BEST-CASE ESTIMATE INCLUDING ATTITUDE
ERROR AND 10 μ M MENSURATION ERROR
ONLY; ONLY 2 MODELS

SOURCES OF UNCERTAINTY IN PAN CALIBRATION

- STUDY 10176 (1974) - ADVANCED PAN CAMERA BREADBOARD TEST
+ 20 MICRONS DYNAMIC FILM STRETCH
- STUDY 10092 (1975) - PAN CALIBRATION VERIFICATION (SV 7)
UNEXPLAINED INCONSISTENCY BETWEEN SCAN
ANGLE AND TIMING MARK POSITIONS

1.6 μ $\rightarrow$ 1 sec

SOURCES OF PAN ERROR

	<u>SEC</u>
DYNAMICS BETWEEN SCAN ANGLE MARKS	2.5
✓ .001 INCH BEARING RUNOUT .0002 μ per	2.0 $\Rightarrow$ 1.5
13 BIT ENCODER (1% CALIBRATION ACCURACY)	1.0
STELLAR TO PAN BORESIGHT (KNEE)	2.0
CALIBRATION	2.2
STELLAR TO PAN BORESIGHT STABILITY	1.0
ATTITUDE SENSOR INTERNAL STABILITY	1.0
SCAN RATE UNCERTAINTY	1.8
PLATEN-LENS LOCK UNCERTAINTY	2.0 < 1
R SS TOTAL	4.9

CONCLUSION: 5 SEC REQUIRES UNREALISTIC ERROR BUDGET

REASONS FOR MORE FRAME CAMERAS

- UNCERTAINTY IF PAN CAN BE CALIBRATED TO REQUIRED ACCURACY
- IMPROVED ABSOLUTE POSITIONING WITH GEOPACK STARTING IN 1977
- ECONOMY IN MAP PRODUCTION
- RELIABILITY - LOSS OF SINGLE PAN MEANS NO MAPPING
 - LOSS OF SINGLE STELLAR HAS 3X IMPACT ON PAN COMPARED TO FRAME
- DEDICATED COVERAGE FOR MAPPING REQUIREMENTS

~~TOP SECRET~~BYEMAN
CONTROL SYSTEM~~(S)~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

THE NRO STAFF

27 February 1975

MEMORANDUM FOR COLONEL ANDERSON, SP-7

SUBJECT: DMA Accuracy Requirements for Metric Panoramic Materials

The attached memorandum from the Defense Mapping Agency, outlining the accuracy requirements a successful Metric Pan System must meet, is forwarded for your use in the HEXAGON Metric Pan System Study.

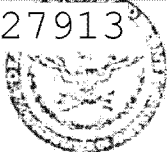
Daniel B. Hutchison
DANIEL B. HUTCHISON
Lt Colonel, USAF

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HEXAGON

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GORY 582 DECLASSIFY ON IMP DET.~~TOP SECRET~~CONTROL NO. TAB B
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PAGE 1 OF 1 PAGES



PR

25 FEB 1975

MEMORANDUM FOR NATIONAL RECONNAISSANCE OFFICE

ATTENTION: Lt Col. Hutchison

SUBJECT: Capability Requirements for a Metric Panoramic System

1. Reference WHIG 0203, 072320Z Feb 75, subject: Metric Pan Study.
2. In accordance with your request, the following data represents the MC&G metric requirements for an MPS:
 - a. Panoramic camera calibration to reduce orthogonal film distortions to less than 10 micrometers (one sigma).
 - b. Time readout for panoramic exposures to 0.10 milli-seconds (one sigma).
 - c. Attitude readout of each panoramic camera to a precision of 1 (one) arc second accurate to 5-6 arc seconds (one sigma) on each axis throughout limits of scan.
 - d. Continuous attitude rate readout to less than 1.5 arc seconds/second (one sigma).
 - e. Continuous tracking and post-mission determination of the HEXAGON orbit and its ephemeris to within 30 feet (one sigma) in all components.
3. Of the above requirements all, with the exception of item c., are either currently available in HEXAGON or being addressed for incorporation by a specific point in time. The data used in the 17 January 1975 briefing to Dr. Hall (briefing materials attached) assumed errors consistent with the design specifications and projected these errors to the ground in order to define attitude requirements in keeping with the total error budget.

Page 1 of 2 pages
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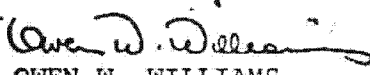
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4. We concur with your desire to determine the best approach for development of the MPS as opposed to just the solid state stellar camera but emphasize the need to initiate and complete the MPS study at the earliest possible date in order to work the funding problem for system incorporation. In keeping with this, we are available to discuss the requirement statement and Study Plan as soon as possible.

FOR THE DIRECTOR:

Enclosure a/s
(6 paper copies)


OWEN W. WILLIAMS
Acting Deputy Director
Plans, Requirements
and Technology

Page 2 of 2 pages
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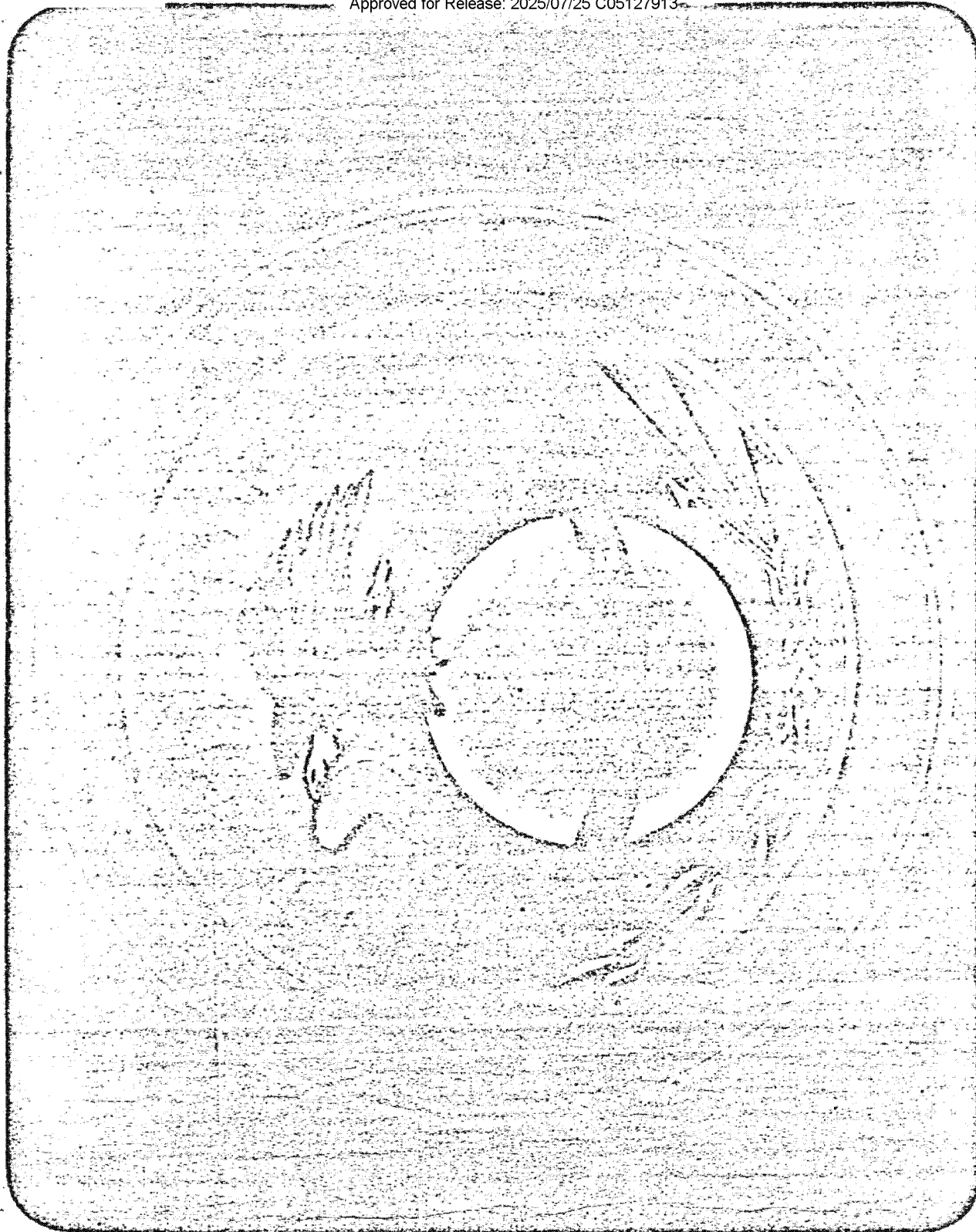
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SATISFACTION

● HORIZONTAL

	UPPER	MIDDLE	LOWER
WITH 5 ARC SEC.	0-60°	0-45°	0-30°
6 ARC SEC.	0-60°	0-45°	0-30°
10 ARC SEC.	0-60°	0-15°	---
15 ARC SEC.	0-45°	---	---

● VERTICAL

WITH 5 ARC SEC.	0-60°	0-60°	0-45°
6 ARC SEC.	0-60°	0-60°	0-45°
10 ARC SEC.	0-45°	0-45°	0-30°
15 ARC SEC.	0-30°	0-30°	0-30°

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OBJECTIVE

HORIZONTAL

VERTICAL

METERS @ 90%

FT 15

UPPER

128.6 39.2

18.3

22.6

74 13.74

MIDDLE

86 26.2

12.2

22.6

74 13.74

LOWER

75 22.9

10.7

17.5

59 10.64

GROUP 2-21
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OTHERWISE IN THIS
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○ HORIZONTAL

WITH 5 ARC SEC.

6 ARC SEC.

10 ARC SEC.

15 ARC SEC.

	0°	15°	30°	45°	60°
WITH 5 ARC SEC.	21.4	22.1	23.1	25.1	33.7
6 ARC SEC.	22.1	22.4	23.2	25.4	31.8
10 ARC SEC.	26.2	26.5	27.4	30.8	40.5
15 ARC SEC.	32.6	33.2	34.7	38.0	49.5

○ VERTICAL

WITH 5 ARC SEC.

6 ARC SEC.

10 ARC SEC.

15 ARC SEC.

	0°	15°	30°	45°	60°
WITH 5 ARC SEC.	11.2	11.8	12.7	14.5	20.1
6 ARC SEC.	11.2	11.9	12.9	14.7	21.4
10 ARC SEC.	11.2	12.0	14.3	19.2	23.1
15 ARC SEC.	11.2	12.4	16.8	24.8	37.4


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**ATTITUDE ERROR
PROJECTION**

(MEYERS @ 90%)

alone

● HORIZONTAL	0°	15°	30°	45°	60°
5 ARC SEC.	8.4	9.8	11.3	13.4	16.7
6 ARC SEC.	10.0	10.3	11.3	13.7	19.0
10 ARC SEC.	17.3	17.6	18.5	22.2	28.1
15 ARC SEC.	26.0	26.7	28.2	31.5	40.0

● VERTICAL	0°	15°	30°	45°	60°
5 ARC SEC.	3.3	4.1	5.6	8.6	12.7
6 ARC SEC.	3.3	4.4	6.1	9.0	14.8
10 ARC SEC.	3.3	4.7	8.7	15.2	23.4
15 ARC SEC.	3.3	5.6	12.3	21.9	34.0

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BY *7K-1*

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ERROR BUDGET
FOR ITEMS UNDERWAY
 (METERS @ 90%)

*ie, internal
NAPAC*

● HORIZONTAL	0°	15°	30°	45°	60°
CALIBRATION	1.7	2.5	4.3	7.6	20.9
TIMING	.6	1.4	2.3	3.6	5.7
ORBIT POSITION	19.6	19.6	19.6	19.6	19.6
TOTAL	19.7	19.8	20.2	21.3	29.2

● VERTICAL					
CALIBRATION	6.3	6.9	7.4	7.8	12.9
TIMING	2.8	2.8	2.8	2.8	2.8
ORBIT POSITION	8.2	8.2	8.2	8.2	8.2
TOTAL	10.7	11.1	11.4	11.7	15.5

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 BY: 100-100000-100000

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COMPOSITE SATISFACTION

SYSTEM WITH

UPPER

MIDDLE

LOWER

5 ARC SEC.

0-60°

0-45°

0-30°

6 ARC SEC.

0-60°

0-45°

0-30°

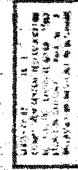
10 ARC SEC.

0-45°

0-15°

15 ARC SEC.

0-30°



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SATOR PASS CHARGE

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COM	X	X
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RF-1		
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1. 3-0000 PRELIMINARY BUDGET UNDER BUDGET IS AS FOLLOWS (MEASUREMENT UNITS ARE IN \$1000000):

	ROLL	PITCH	YAW
STELLAR SENSOR POINTING ERROR	1.4	1.8	1.3
INTERLOCK CALIBRATION ERROR	1.9	2.2	1.9
ENVIRONMENTAL STABILITY	3.3	4.3	4.4
	---	---	---
RES ID	4.1	4.9	4.9

2. THE STELLAR SENSOR POINTING ERROR IS MADE UP OF THE FOLLOW-
ING ERROR SOURCES:

ERROR SOURCE	POINTING ERROR (S-CUBED CAMERA COORDINATES)	
	Y	Z
CENTROIDING ERROR	2.3	2.3
DETECTOR LOCATION ERROR	1.6	1.6
RESIDUAL OPTICAL DISTORTION	1.6	1.6
FOCAL PLANE RESIDUAL THERMAL ERROR	1.3	1.3
STAR CATALOG UNCERTAINTY	0.5	0.5
	Y	Z
POINTING ERROR/STAR R S S	3.2	3.2
FOR 9 DEFINITIONS/FIELD	1.1	1.1
ATTITUDE CONTROL SYSTEM	1.2	1.2
---	---	---
S-CUBED POINTING ERROR R S S	1.6	1.6

POINTING ERROR TRANSFERRED TO TCA COORD. SYSTEM

ROLL	1.4
PITCH	1.3
YAW	1.3

~~SECRET~~
SECRET
GROUP 1 EXCLUDED
EXCLUDED FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION
EXCLUDED FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION

786 C

~~SECRET~~CHANGE IN ~~SYSTEM~~
CONTROL SYSTEM

3. THE INTERLOCK CALIBRATION ERROR IS MADE UP OF THE FOLLOWING ERROR SOURCES:

ERROR SOURCE	POINTING ERROR		
	ROLL	PITCH	YAW
STELLAR SENSOR POINTING ERROR	1.4	1.3	1.3
PAN PHOTO MEASUREMENT ERROR	0.3	0.9	1.0
ANGULAR VIBRATION OF TCA	1.0	1.0	1.0
SVT CORRELATION		0.3	

R S S	1.9	2.2	1.9
-------	-----	-----	-----

4. THE PAN PHOTO MEASUREMENT ERROR, WHICH IS ONE OF THE ERROR SOURCES OF THE INTERLOCK CALIBRATION ERROR SHOWN ABOVE, IS MADE UP OF THE FOLLOWING ERROR SOURCES. (MEASUREMENT ERRORS ARE IN MICRONS AND CONVERTED TO ARC SECONDS).

ERROR SOURCE	ERROR - MICRONS	CROSS TRACK	IN-TRACK
--------------	-----------------	-------------	----------

- | | | | |
|--|---|--|----|
| 1. 0.3 BOBBLE DUE TO BEARING RUNOUT PLUS VIBRATION OF OPTICAL ELEMENTS | 5 | | 12 |
| 2. FOCAL LENGTH CALIBRATION ERROR AND SCAN ANGLE MARK CALIBRATION | | | |

PAGE 4 5519 ~~SECRET~~

ERRORS (WITH P14 IMPROVEMENTS)

5	4
---	---

3. ERRORS IN MEASUREMENT OF IMAGE COORDINATES AND FIDUCIAL MARK COORDINATES (WITH P14 IMPROVEMENTS)

3.5	3.5
-----	-----

4. PLATEN SKEW ANGLE ERROR

(DEPARTURE FROM PROGRAMMED IMC)

9

5. PLATEN THERMAL EXPANSION AND

AND UNCALIBRATED OPTICAL DISTORTION

5	5
---	---

TOTAL R S S

13 MICRONS	14 MICRONS
------------	------------

ASSUMING 4 STARS

6.5 MICRONS	7 MICRONS
-------------	-----------

ERROR (ARC-SECONDS)

0.9	0.9
-----	-----

5. ENVIRONMENTAL STABILITY ERRORS ARE MADE UP OF THE FOLLOWING ERROR SOURCES:

ERROR SOURCE	POINTING ERROR		
	ROLL	PITCH	YAW
ALIGNMENT CHANGE OF PAN CAMERA LOS TO S-CUBED SENSOR MTS. DUE TO THERMAL ENVIRONMENT SIDE TO SIDE GRADIENT IN TCA (2 DEGREES F.)	1.7	2.0	3.5

~~SECRET~~CHANGE IN ~~SYSTEM~~

~~SECRET~~
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PAGE 5 ~~6519 SECRET~~

FRONT TO REAR GRADIENT IN TCA
(3 DEGREES F.)

0.6 0.3 1.2

TOP TO BOTTOM GRADIENT IN TCA
(0.2 DEGREES F.)

0.6 1.9

DEFORMATION IN TCA DUE TO VEHICLE
DISTORTION

1.5 1.5

PRIMARY MIRROR TILT (0.5 DEGREES F.
METERING RODS)

0.4 0.4

FOLD FLAT TILT (2.0 DEGREES F IN
TEMP. LEVEL)

--- 0.7 0.5

R S S 1

2.5 3.1 3.7

ALIGNMENT CHANGE OF S-CUBED SENSOR
LOS TO SENSOR MOUNT ON TCA THERMAL
GRADIENTS IN SENSOR HOUSING (0.5
DEGREES F.)

1.6 1.6 1.6

THERMAL SHIFT OF FOCAL PLANE DETECTOR
ARRAY

1.9 1.9 1.9

R S S 2

1.9 1.9 1.9

ANGULAR VIBRATION OF TCA RELATIVE TO
THE AM FOLD FLAT STABILITY WITH DB

PAGE 6 ~~6519 SECRET~~
VELOCITY VARIATION

1.5 1.0

R S S 3

1.4 1.8 1.4

TOTAL R S S

3.3 4.0 4.4

6. THIS DATA IS A SUMMARY OF THE S-CUBED ERROR BUDGET ANALYSIS
AND TEST PROGRAM PRESENTATION MADE ON OCTOBER 18, 1975. THE
ANALYSIS IS BASED ON THE S-CUBED CONFIGURATION PRESENTED AT THE
CONCEPT DESIGN REVIEW ON JUNE 19, 1975.

E-2 IMPDET

~~SECRET~~

BT

NNNN 231426

~~SECRET~~
HANDLE VIA ~~SECRET~~
CONTROL SYSTEM

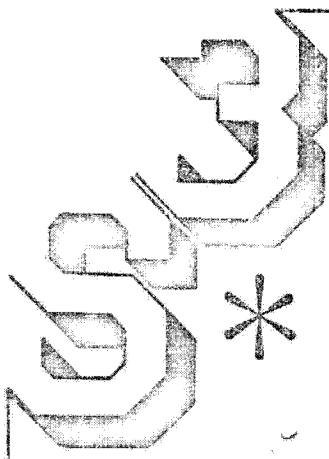


PRO A6f

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BIF 007-0607-75

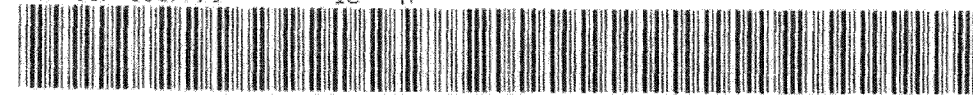
This document consists of 71 pages



TECHNICAL REVIEW

BIF-007-0607/75

1C H



WARNING NOTICE - SENSITIVE INTELLIGENCE
SOURCES AND METHODS INVOLVED.

NATIONAL SECURITY INFORMATION
UNAUTHORIZED DISCLOSURE
SUBJECT TO CRIMINAL SANCTIONS

CLASSIFIED BY BYEMAN 1
EXEMPT FROM GENERAL DECLASSIFICATION
SCHEDULE OF EXECUTIVE ORDER 11652
EXEMPTION CATEGORY 5B (1), (3), OR (4)
AUTOMATICALLY DECLASSIFIED ON: _____
IMPOSSIBLE TO DETERMINE

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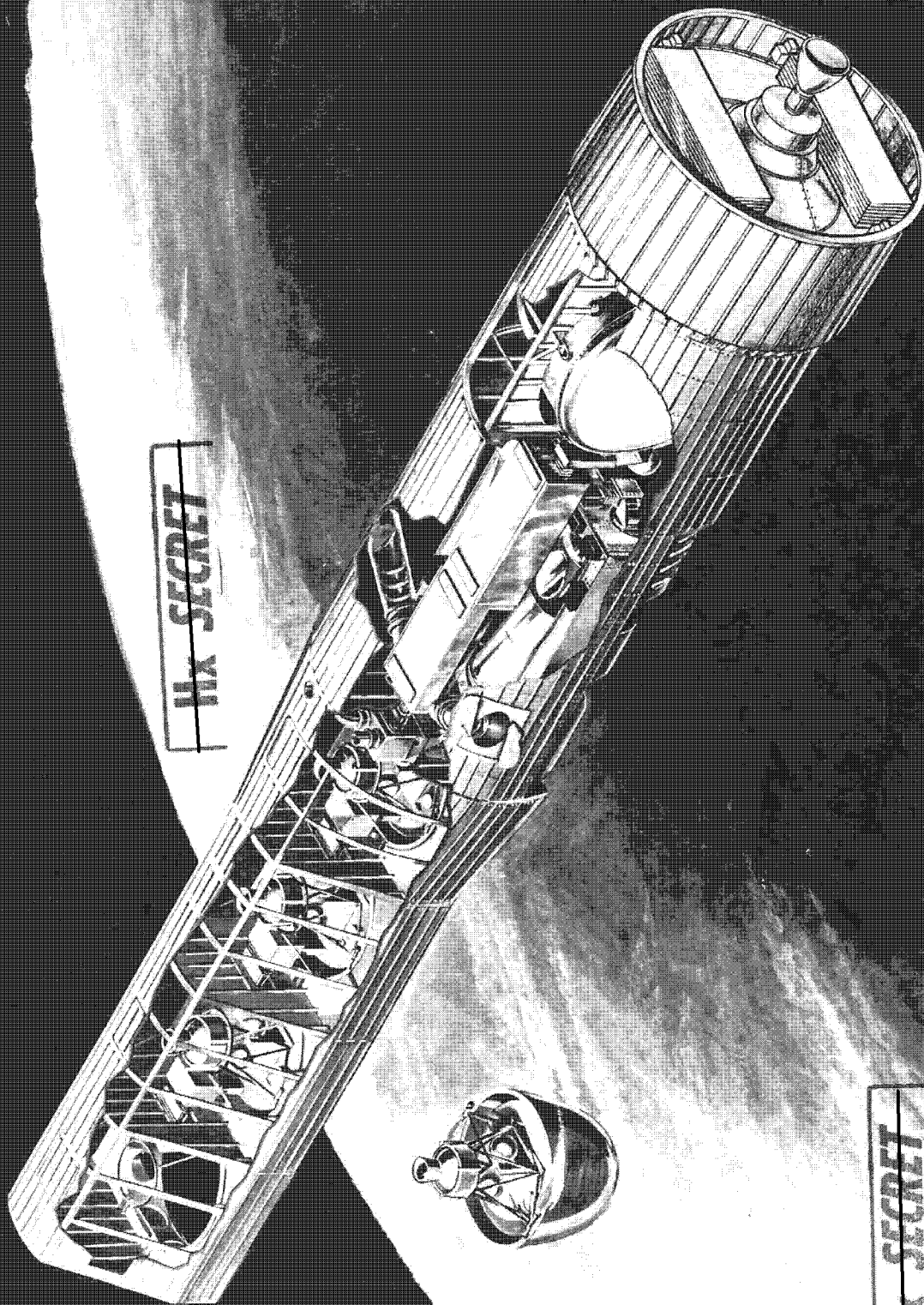
BIF 007-0607-75

AGENDA

1. S³ SUBSYSTEM INTRODUCTION
2. PROGRAM HIGHLIGHTS
3. ACCURACY VERIFICATION TESTS
 - STELLAR SENSOR POINTING ERRORS
 - INTERLOCK CALIBRATION ERRORS
 - ENVIRONMENTAL STABILITY ERRORS
4. SYSTEM DESIGN AND PERFORMANCE TESTS
 - MECHANICAL DESIGN
 - INTERFACE
 - ELECTRICAL
5. SCHEDULE
6. SUMMARY

10/13/75 WEK

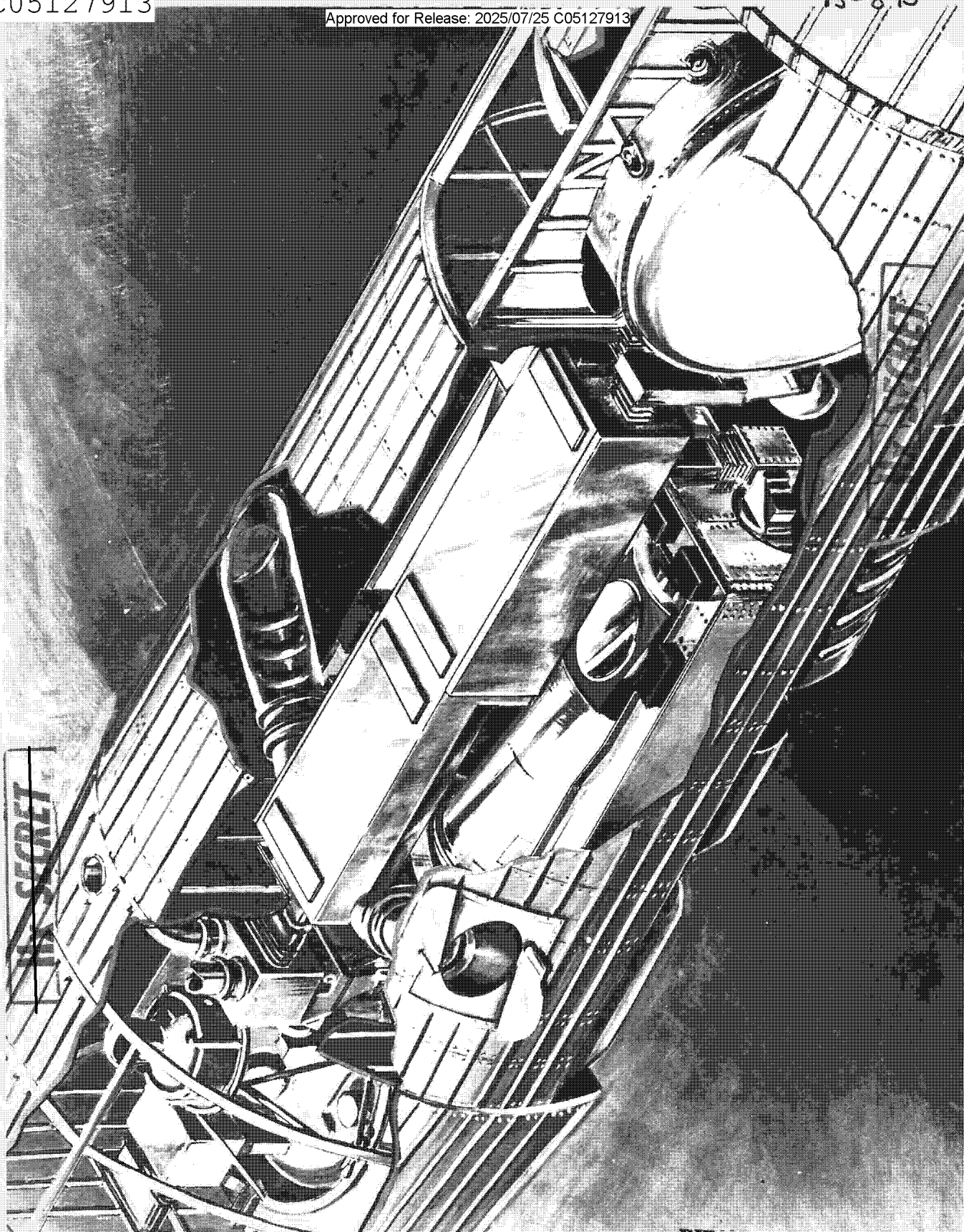
SENSOR SUBSYSTEM



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HX SECRET

BIE 007- 0607- 75



BIF 007- 0607- 75

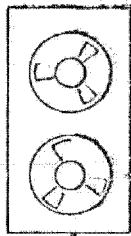
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RECEIVING SYSTEM

REORDER

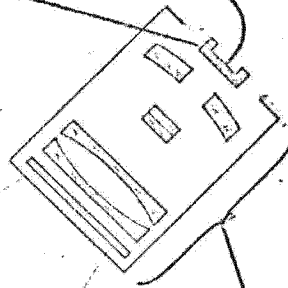


TELETYPE
TRANSMITTER

RECEIVER

ELECTRONICS

3 DETECTOR



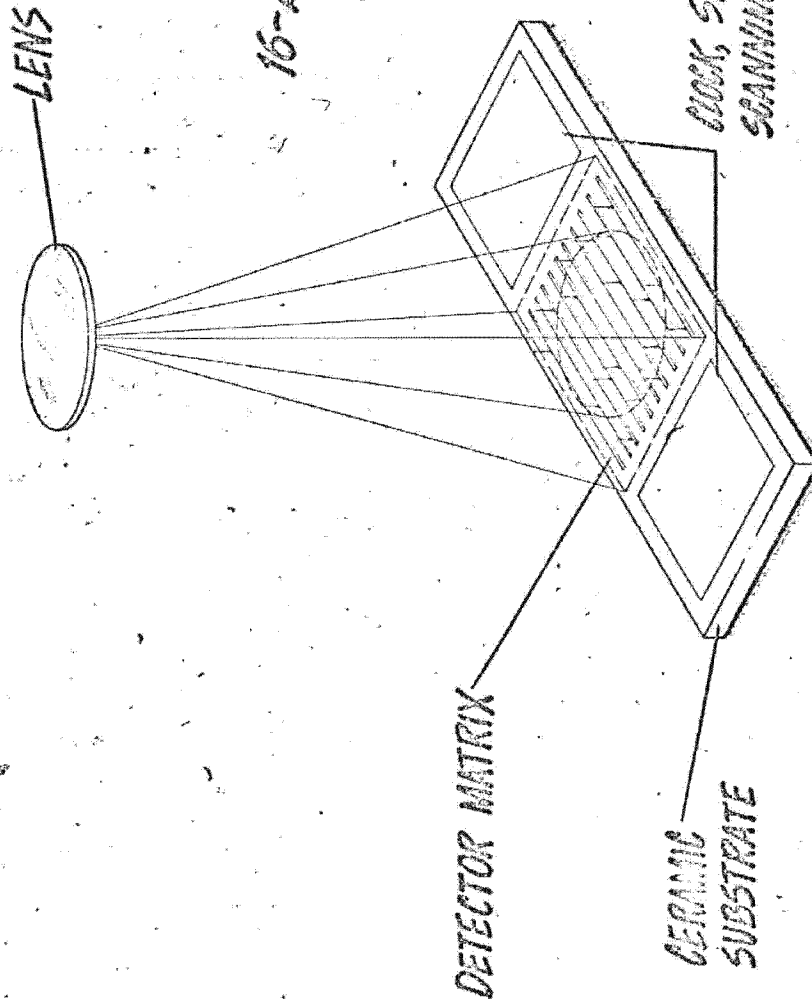
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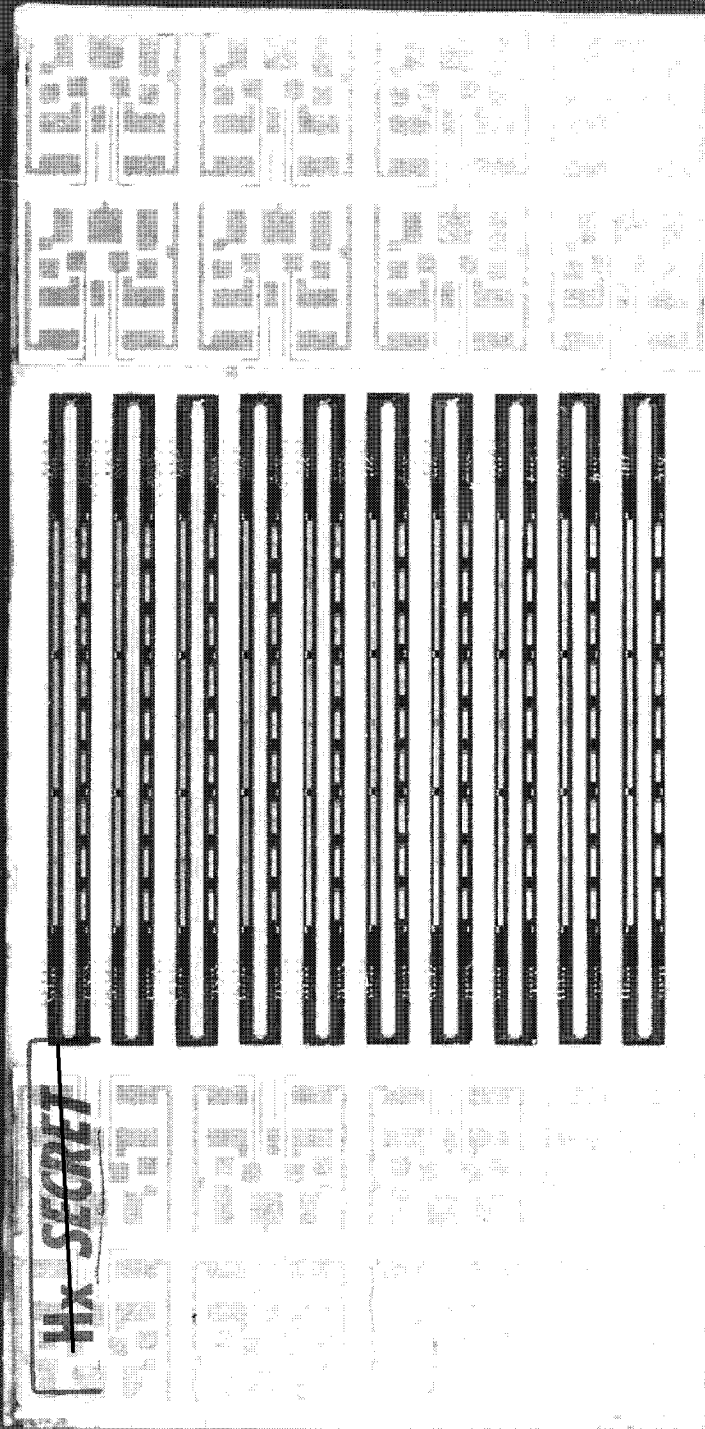
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BIF 007-060775

6" FOCAL PLANE

16-22 STARS IN FIELD





BIF 007- 0607- 75

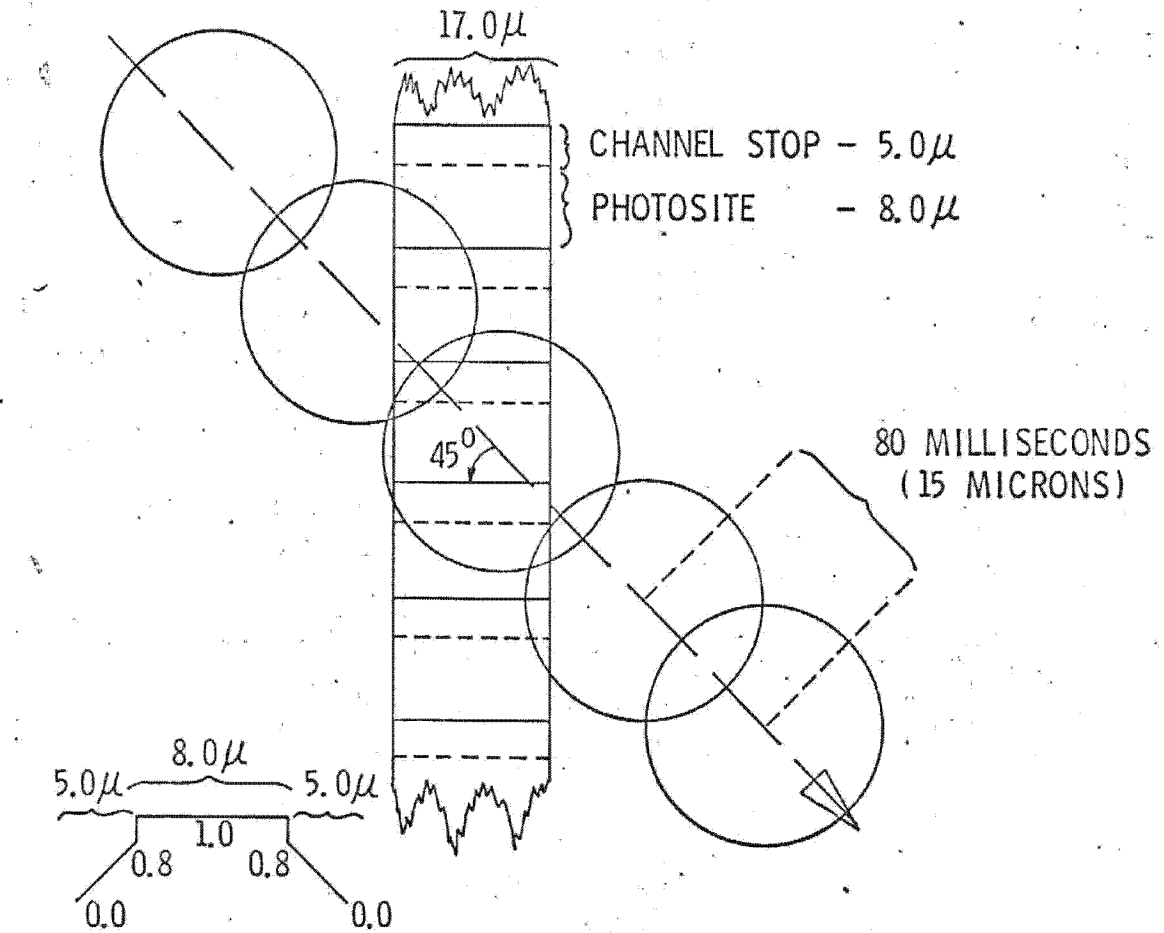
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CENTROID GEOMETRY

1728 LINEAR ARRAY



PIXEL RESPONSE PROFILE

6/12/75 JSP

SV TIME TIES IT ALL TOGETHER

RECONNAISSANCE PAN PHOTOGRAPHY

- SV TIME FROZEN 5^0 INTO FRAME.
- SV TIME PRINTED AT CENTER OF FRAME.
- IMAGE TO SV TIME MEASUREMENTS ACCURATE TO 0.34 ARC-SEC ($10'$) WITH P-14 IMPROVEMENTS.

S³ LOS DATA

- S³ TELEMETRY DATA
 - PHOTODETECTOR ID
 - AMPLITUDE
 - SV ATTITUDE DATA
 - SV TIME
- GROUND DATA REDUCTION
 - DETERMINE STAR LOCATIONS ON FOCAL PLANE AS FUNCTION OF SV TIME.
 - ESTIMATE NOMINAL STAR LOCATIONS ON FOCAL PLANE AS A FUNCTION OF SV TIME.
 - DIFFERENCE IS ATTITUDE ERROR.

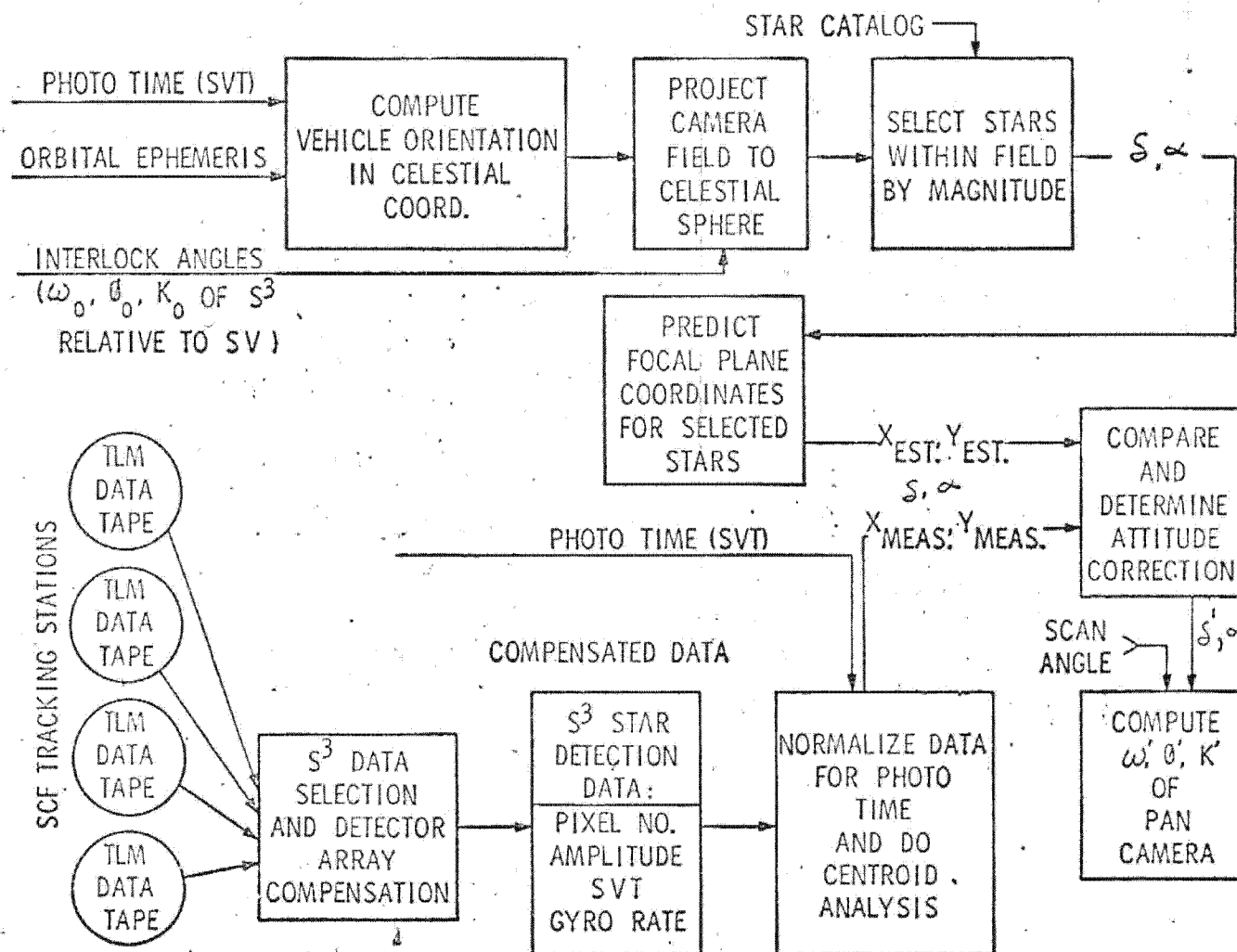
SV TIME

TIES TOGETHER THE RECONNAISSANCE PAN PHOTOS
AND

S³ ATTITUDE ERROR DATA

7/11/75 WEK

GROUND DATA PROCESSING



6/11-12/75 WEK

WHY A SOLID STATE STELLAR (S³) CAMERA ON HEXAGON?

- AREA PHOTOGRAPHED IS ABOUT SEVEN TIMES AREA PHOTOGRAPHED BY PRESENT SI CAMERA.
- MORE ACCURATE MAPS MADE MORE EASILY
 - PAN CAMERA PROVIDES HIGH RESOLUTION IMAGERY.
 - RPIE SYSTEM BEING DEVELOPED TO OVERLAY HIGH RESOLUTION PAN PHOTOGRAPHY ONTO SI CAMERA IMAGERY.
 - MAPS AND ORTHOPHOTOS ARE MADE FROM PAN PHOTOGRAPHY.
 - ACCURATE POINTING DATA ON PAN PHOTOGRAPHY ELIMINATES NEED TO TRANSFER PAN PHOTOGRAPHY ONTO SI PHOTOGRAPHY.
 - OUTPUT DATA IS DIGITAL AND EASY TO USE IN OFF-LINE DATA PROCESSING.
- EASY AND SAFE MODIFICATION.
- INEXPENSIVE

10/13/75 WEK

BEGINNING

MEETING IN AUTUMN OF 1972 TO DISCUSS PAYLOAD MODIFICATIONS
TO IMPROVE MAPPING CAPABILITY

- SYSTEM PROGRAM OFFICE
- DEFENSE MAPPING AGENCY
- SENSOR SYSTEM CONTRACTOR
- DUANE BROWN ASSOCIATES.

RESULT WAS CHANGES TO MAKE REFERENCE MARKS ON FILM MORE
ACCURATE AND CALIBRATE OPTICAL BAR LINE-OF-SIGHT TO OPTICAL
BAR ENCODER.

- DEFENSE MAPPING AGENCY HAD FOUND PAN
PHOTOGRAPHY PROVIDED EXCELLENT RELATIVE
MAPPING DATA.
- ADDING ATTITUDE MONITOR AS PART OF PAN
CAMERA WOULD PROVIDE ABSOLUTE MAPPING
CAPABILITY.

10/13/75 WEX

S³ PROGRAM HIGHLIGHTS

1. PROGRAM DEFINITION PHASE

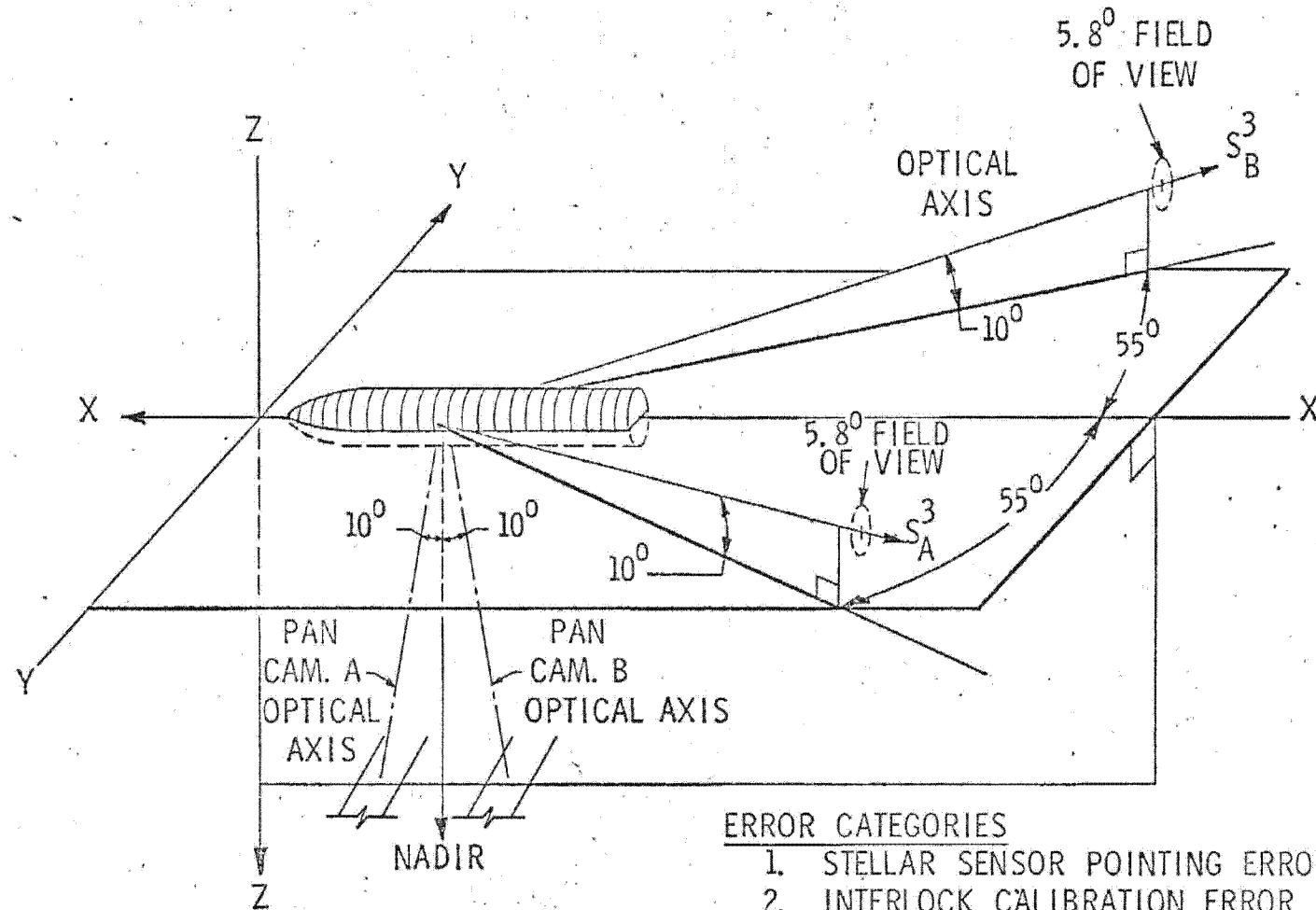
- SYSTEM CONFIGURATION STUDIES
- OPTICAL DESIGN STUDIES
- TECHNICAL RISK EVALUATION PLANS
- EQUIPPED PHOTODETECTOR TEST LABORATORY
- ERROR BUDGET ANALYSIS

2. RISK EVALUATION PHASE

- INTERFACE MEETING WITH SBAC
- SV-9 ON-ORBIT CALIBRATION TESTS
- FRAME DEFORMATION TESTS
- MIDSECTION DEFORMATION TESTS
- FOCAL PLANE COOLER PERFORMANCE TESTS
- PHOTODETECTOR PERFORMANCE TESTS

10/13/75 WEK

S³ OPTICAL AXES



ERROR CATEGORIES

1. STELLAR SENSOR POINTING ERROR
2. INTERLOCK CALIBRATION ERROR
3. ENVIRONMENTAL STABILITY ERROR

10/13/75 WEK

STELLAR SENSOR POINTING ERRORS

1. HARDWARE CALIBRATION ERRORS

• PHOTODETECTOR LOCATION

- LABORATORY TESTS DEMONSTRATE PIXEL POSITION DETERMINATION TO BETTER THAN 1.7 MICRONS

- PRECISION POSITION TABLE

- 7-MICRON SPOT

- ERROR BUDGET: 2 MICRONS

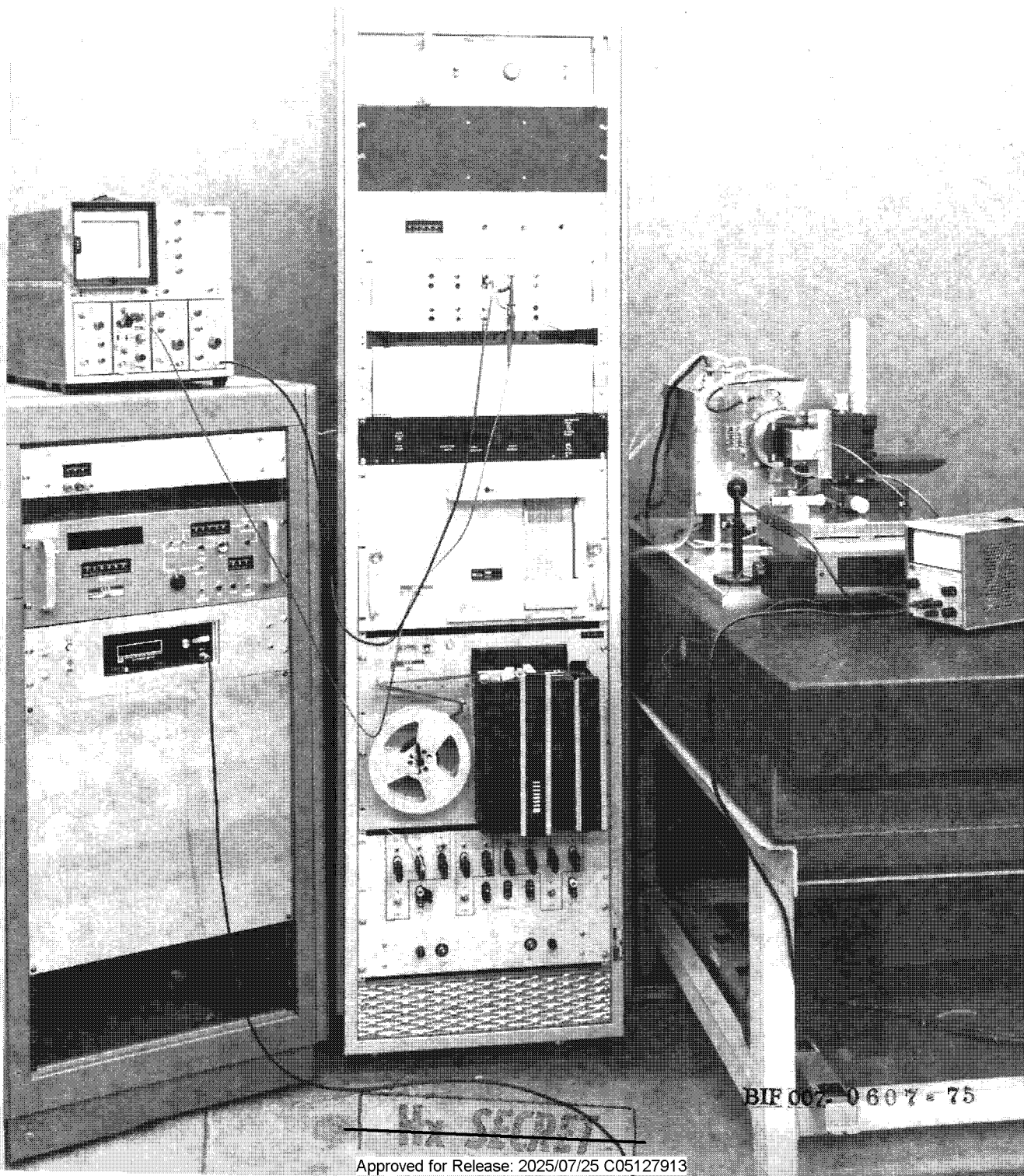
• OPTICS DISTORTION AND FOCAL LENGTH

- ERROR BUDGET ALLOWS ERRORS EQUIVALENT TO 2 MICRONS ON FOCAL PLANE.

- PRESENT STELLAR CAMERA HAS BIGGER FIELD OF VIEW AND HAS ERROR OF ONLY 2 MICRONS.

10/13/75 WEK

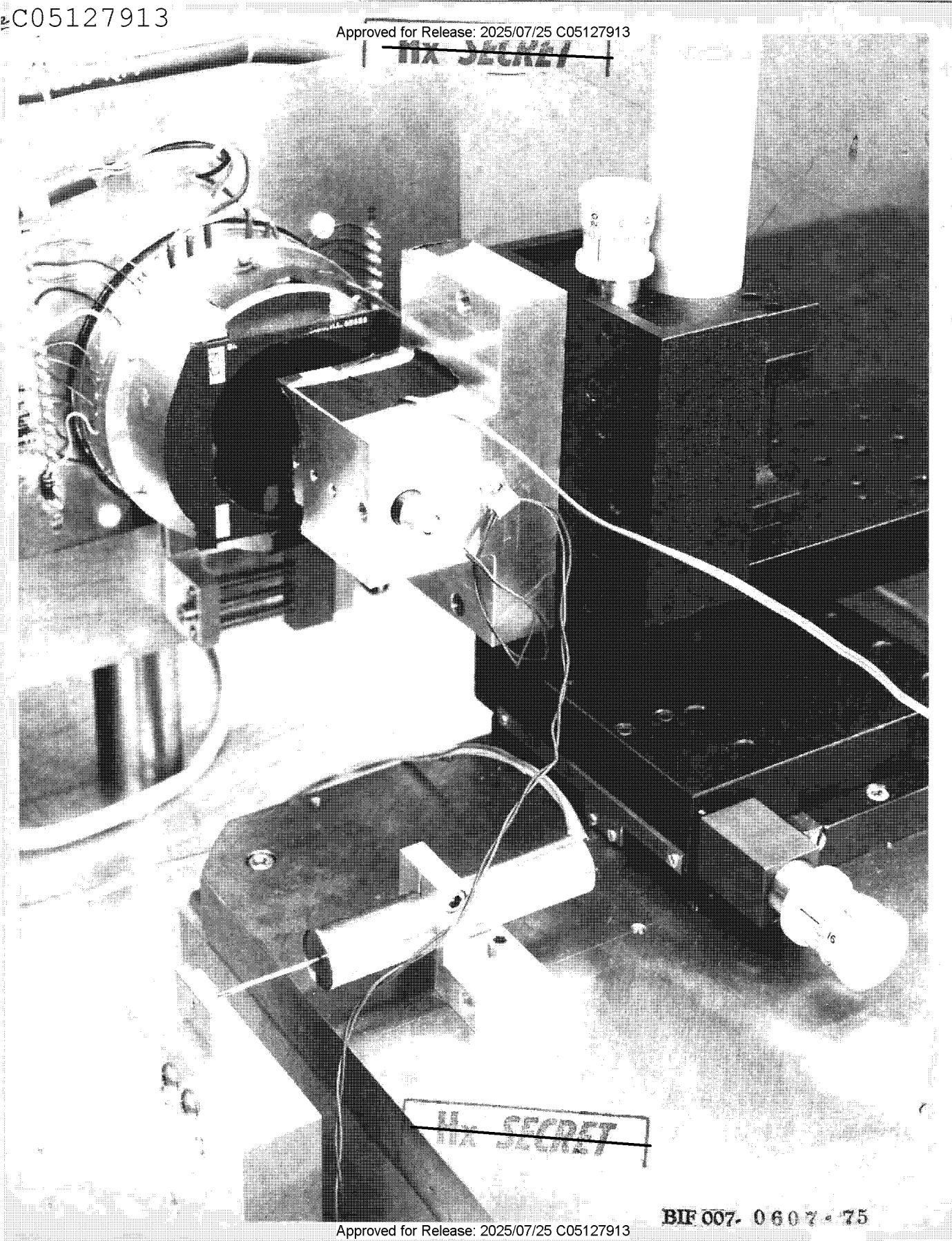
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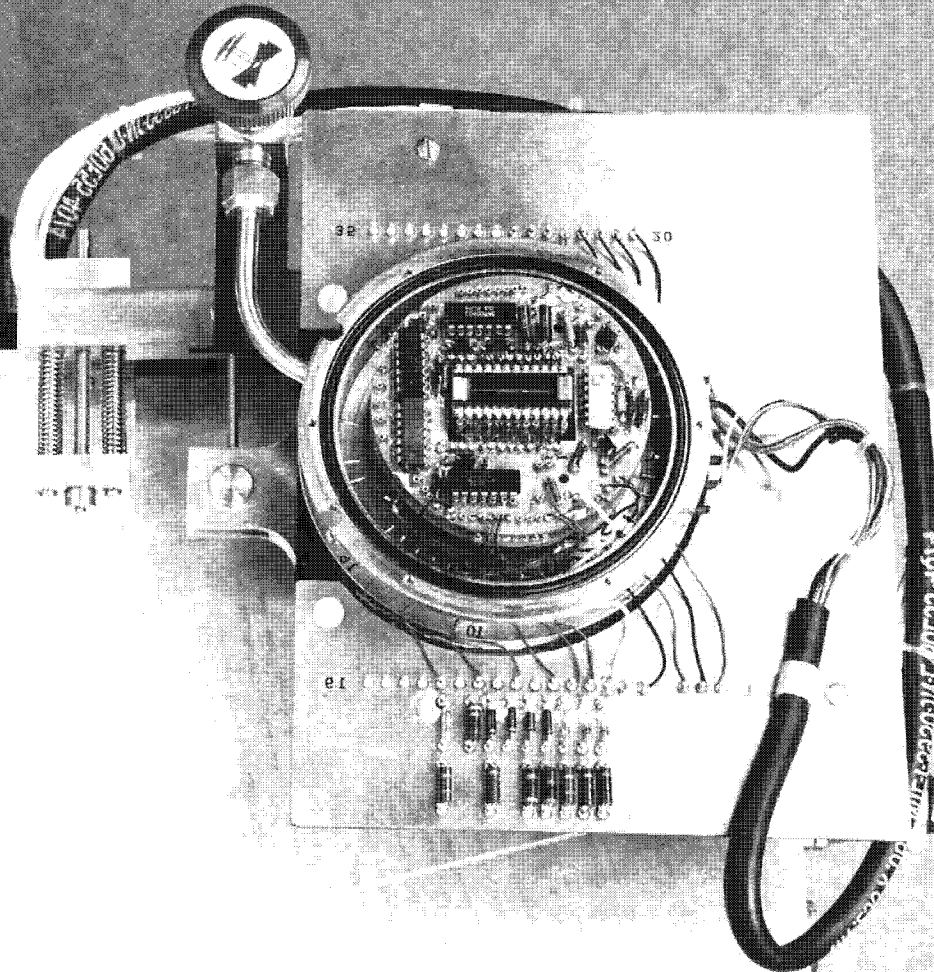
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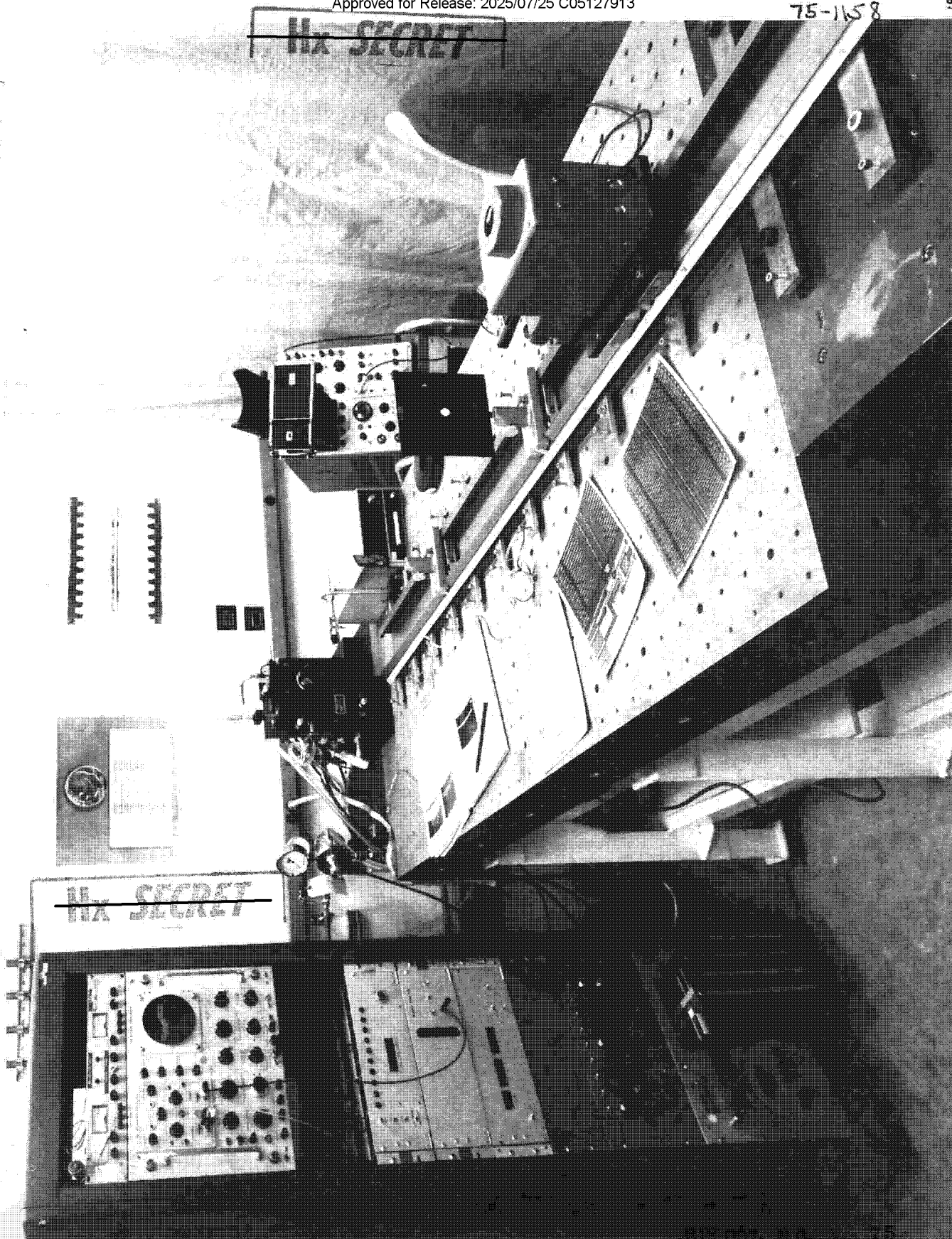


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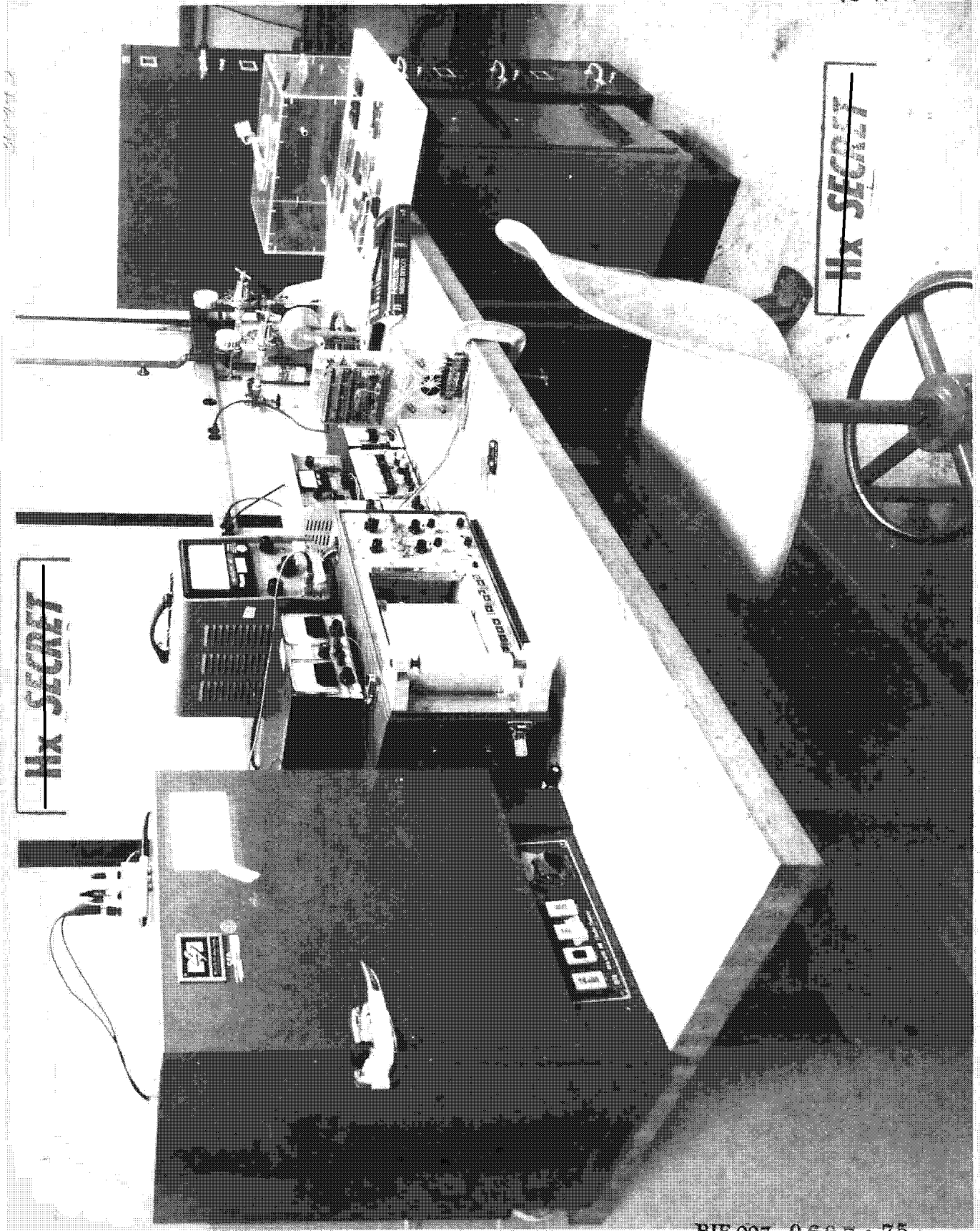
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75-1658



STELLAR SENSOR POINTING ERRORS (CON'T)

2. HARDWARE PERFORMANCE ERRORS

• ATTITUDE CONTROL SYSTEM

- ACS DATA USED TO INTERPOLATE
- USING ACS SPEC. VALUES YIELDS ERROR 1.2 ARC-SECONDS
- MEASURED PERFORMANCE IS 0.5 ARC-SECONDS
- ERROR BUDGET: 1.2 ARC-SECONDS

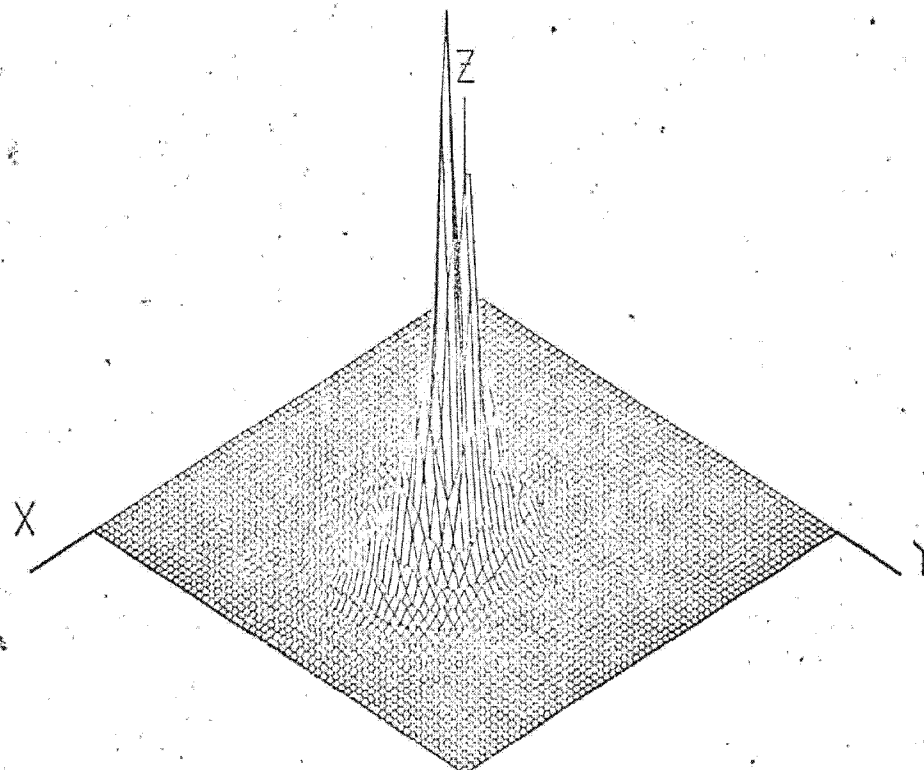
• FOCAL PLANE DETECTION AND DATA REDUCTION

• DETAILED ANALYSIS MODEL

- OPTICS AND OPTICAL ERRORS
 - FOCAL PLANE DETECTORS AND DETECTOR ERRORS
 - ANALOG TO DIGITAL CONVERTER AND ELECTRONIC ERRORS
 - TELEMETRY ERRORS
-
- MODEL PREDICTS 1.5 MICRONS (1 σ) FROM PERFORMANCE DATA
 - LABORATORY TESTS DEMONSTRATE 1.6 MICRONS OR LESS
 - ERROR BUDGET: 1.5 MICRONS

10/13/75 WEK

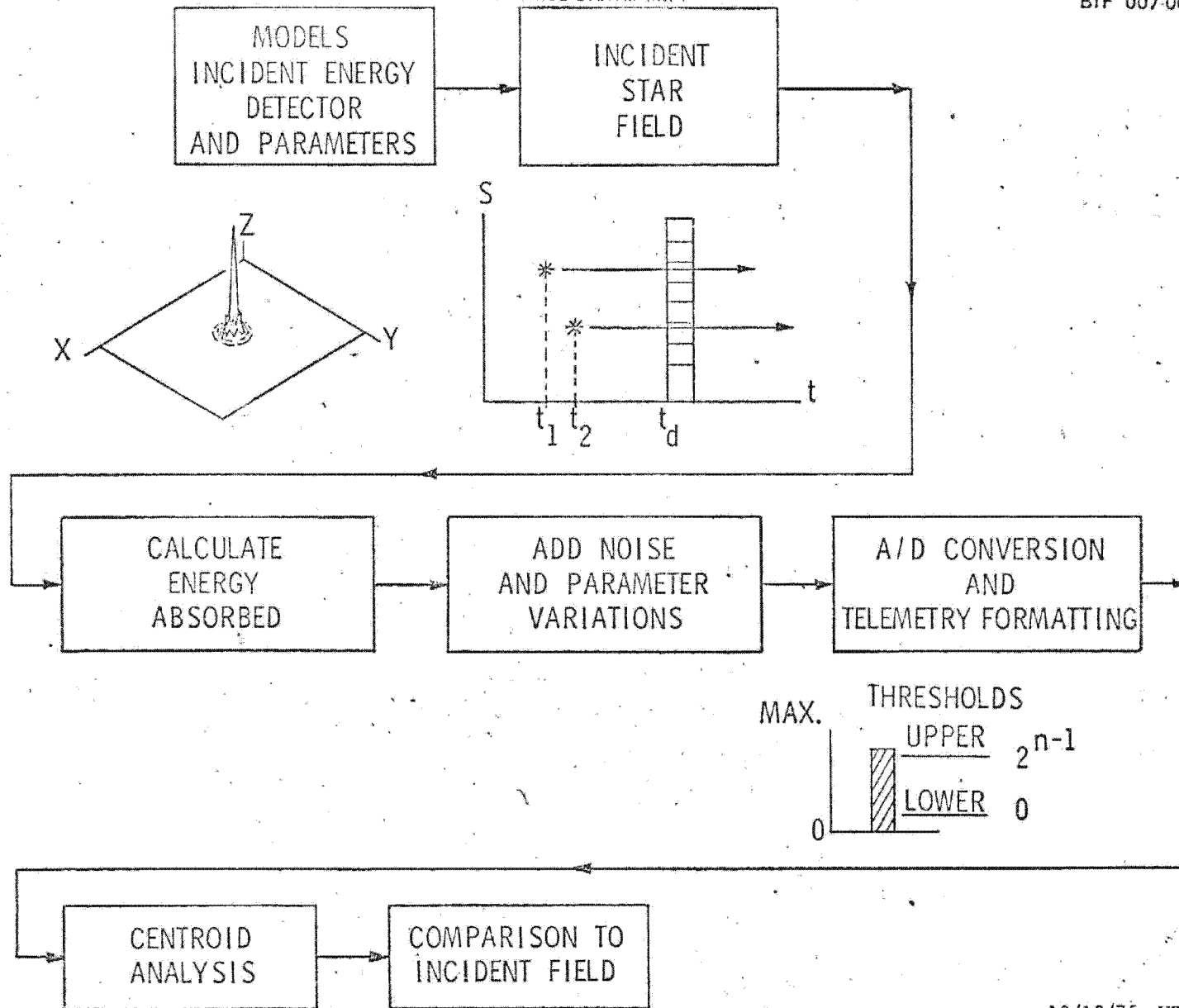
ST 1675 DESIGN B-O CLASS STAR IMAGE



POLYCHROMATIC POINT SPREAD FUNCTION

	BFL	Y	Z
FIELD POSITION		2.4150	0.0000
PARAXIAL	35.8408	10.6657	-0.0000
WAVELENGTH	SENSITIVITY		
0.5500	0.2000		
0.6500	0.2000		
0.7500	0.2400		
0.8500	0.1500		
0.9500	0.0700		

6/11-12/75 JSP



STELLAR SENSOR POINTING ERRORS (CON'T)

3. STAR CATALOG ERROR

- SMITHSONIAN CATALOG ACCURATE TO 0.5 ARC-SEC TO 12th MAGNITUDE.
- USE STARS TO 8th MAGNITUDE.
- ERROR BUDGET: 0.5 ARC-SECONDS.

4. CONCLUSION

- ERRORS COMBINE TO OVER 3 ARC-SECONDS.
- LARGE NUMBER AVERAGING $\left(\frac{1}{\sqrt{N}}\right)$ DUE TO MULTIPLE STARS.
- FINAL RESULT: 1.8 ARC-SECONDS.

10/13/75 WEK

ON-ORBIT CALIBRATION

- CALIBRATE INTERLOCK ANGLES ON-ORBIT.
- MANEUVER SV TO ACQUIRE STARS WITH PAN CAMERAS AND S³ SENSORS SIMULTANEOUSLY.
- ALTERNATE PROCEDURE IS TO PHOTOGRAPH A CALIBRATED GROUND TEST RANGE IN THE NORMAL PHOTOGRAPHIC MODE WHILE OPERATING S³ SENSORS.
- ON-ORBIT CALIBRATION ELIMINATES LAUNCH RESIDUAL DEFORMATION ERRORS, GRAVITY RELEASE DEFORMATION ERRORS AND INITIAL THERMAL GRADIENT ERRORS.

2/12/75 LK

MECHANICAL REPEATABILITY TESTS (SN 017)

● GRAVITY REVERSAL

ROTATION OF TCA

TCA TEST POINTS RETURNED WITHIN 2 ARC-SECONDS
MEASUREMENT ACCURACY.

● OB MOUNTS

175-POUND LOAD PLACED ON OB

OB RETURNED WITHIN ACCURACY OF MEASUREMENT

< 1 ARC-SECOND, THEODOLITE

< 0.0001 INCH ~ 0.5 ARC-SECOND, DIAL INDICATOR.

10/13/75 WEK

SV-9 STELLAR PHOTOGRAPHY EXPERIMENT

PURPOSES:

- DEMONSTRATE THE ABILITY TO ACQUIRE STELLAR IMAGERY ON THE PAN PHOTOGRAPHY.
- VERIFY PHOTOMETRIC ANALYSES TO ENABLE EXTRAPOLATION FOR THE VARIOUS CALIBRATION MODES.

CONCLUSIONS:

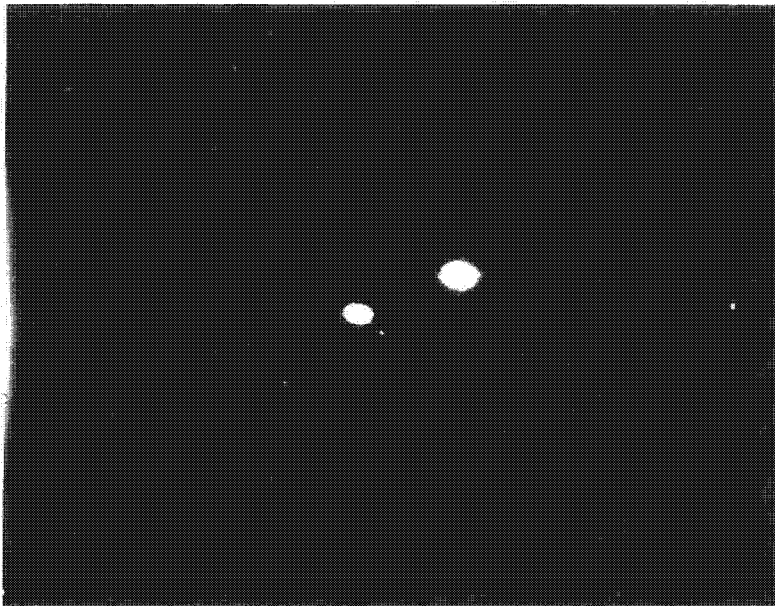
- ACQUIRED STARS AGREED WITH ANALYSIS PREDICTIONS.
- INTERLOCK CALIBRATION CAN BE PERFORMED USING STELLAR PHOTOGRAPHY ON THE PAN CAMERAS.
- DISTORTION CALIBRATION OF THE PAN CAMERAS CAN BE PERFORMED IF MORE SENSITIVE FILM IS USED.

6/11-12/75 LK

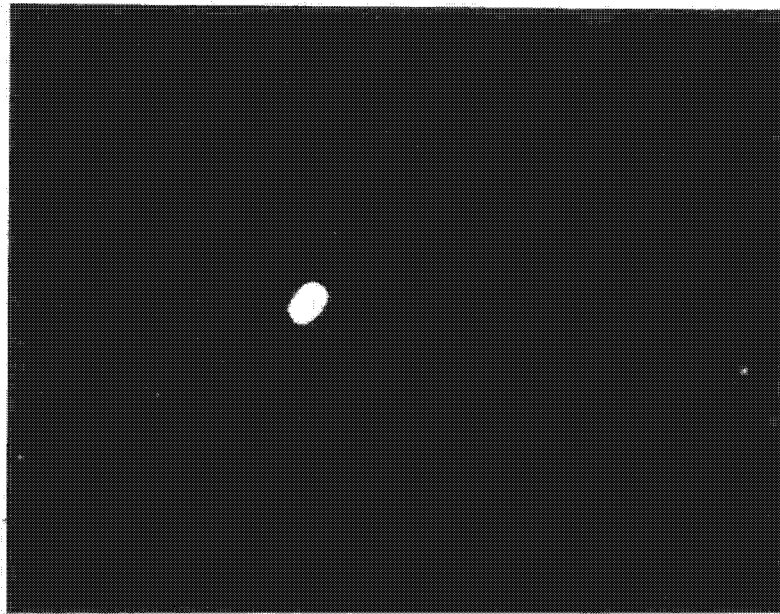
30495

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STAR IMAGES



ALPHA CENTAURI
M 0.3, 1.7



CANOPUS
M - 0.9

2011-12-18 14:14

76-718

~~TOP SECRET~~

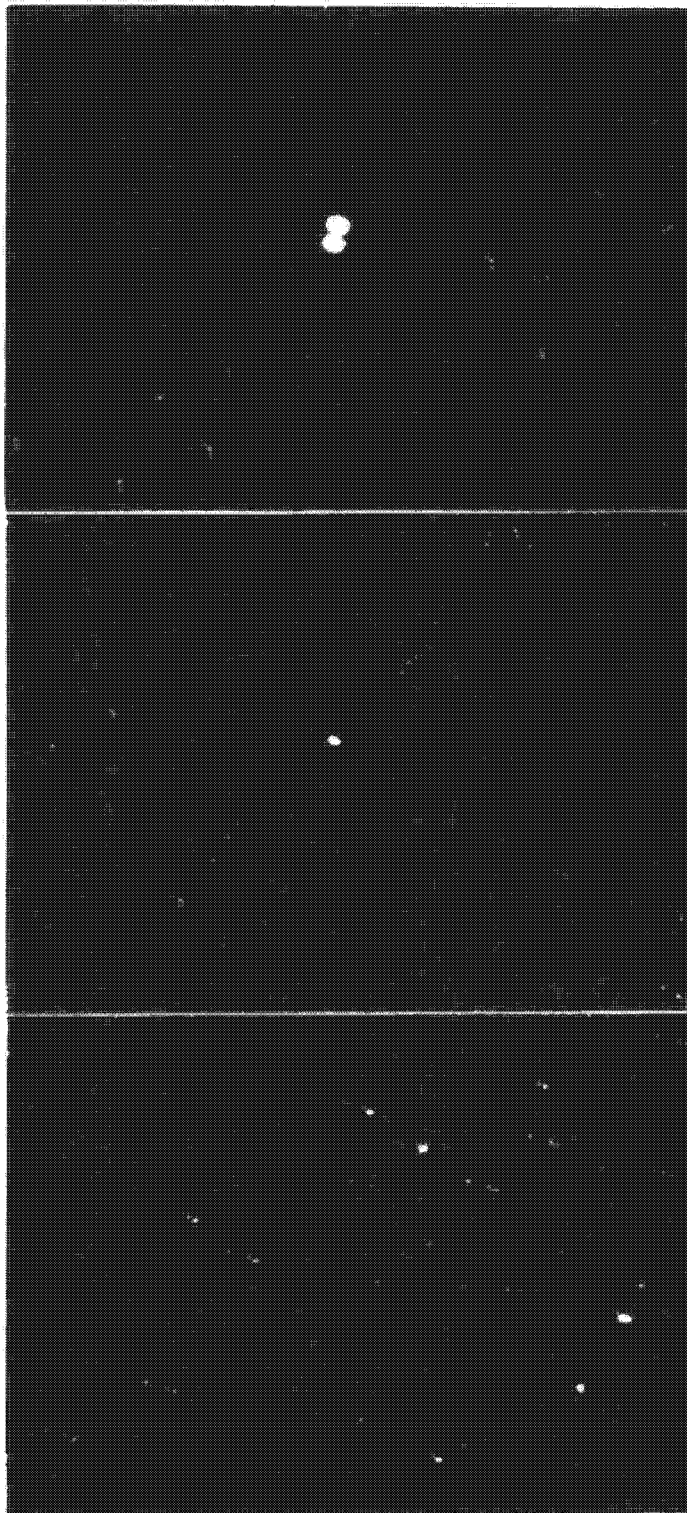
BIF 007- 0607- 75 *

30496

~~HX SECRET~~

STAR IMAGES

50 MICRONS



SPURIOUS
ARTIFACTS

BOSS # 16551
M 4.3

ALPHA CRUCIS
M 1.6, 2.1

~~HX SECRET~~

BIF 007- 0807 10

INTERLOCK CALIBRATION ERROR
STELLAR/PAN CAMERAS

ERRORS IN THE CALIBRATION OF THE ANGLES BETWEEN THE
S³ CAMERAS LINE-OF-SIGHT AND PAYLOAD CAMERAS LINE-OF-SIGHT

1. PAN CAMERA IMAGE MEASUREMENT ERRORS

• IMAGE PLACEMENT ERRORS

• OPTICAL BAR WOBBLE MEASURED ON 5076

- IN-TRACK 8 MICRONS (1 σ) (7.6 MICRONS $\rightarrow$ 1 ARC-SECOND)
- CROSS-TRACK 4 MICRONS (1 σ)
- ERROR BUDGET: IN-TRACK 12 MICRONS; CROSS-TRACK 5 MICRONS

• PLATEN SERVO ERROR

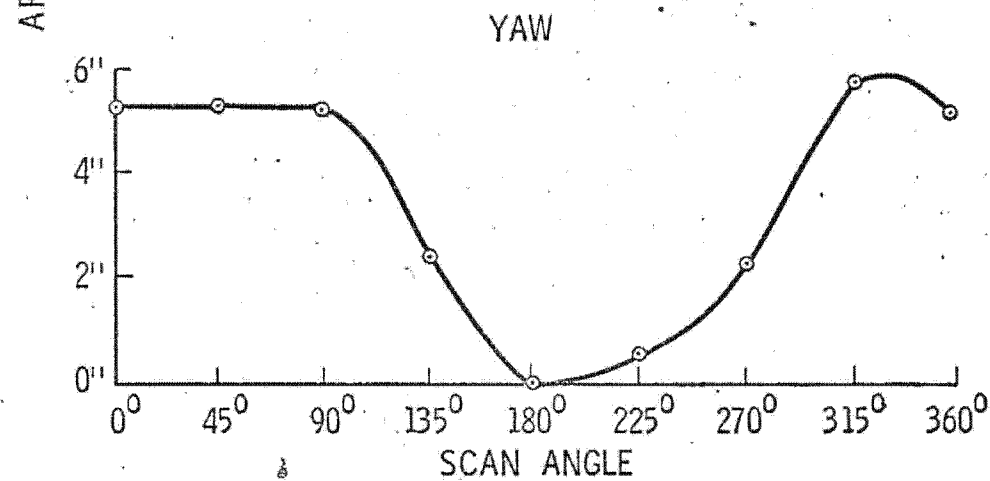
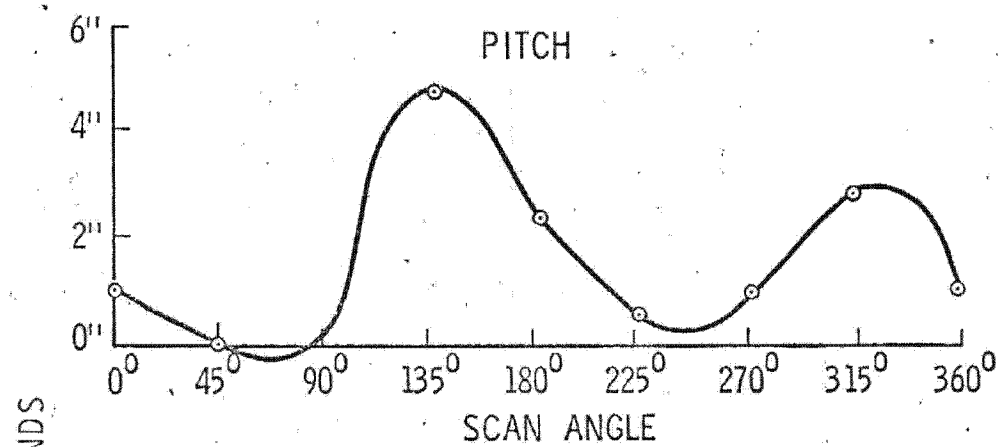
- SPEC. PERFORMANCE 30 ARC-SEC YIELDS 9 MICRONS BUDGET
- MEASURED PERFORMANCE IS LESS THAN 20 ARC-SECONDS OR LESS THAN 6 MICRONS.

• FOCAL LENGTH CALIBRATION AND OPTICAL BAR DISTORTION

- MEASUREMENTS ON 5080 SHOWED 2 MICRONS.
- ERROR BUDGET: 5 MICRONS

10/13/75 WEK

OB 5076 LOS "WOBBLE" WITH OB VERTICAL



INTERLOCK CALIBRATION ERROR (CONT'D)

1. PAN CAMERA IMAGE MEASUREMENT ERRORS (Continued)

• IMAGE MEASUREMENT ERRORS

- MEASUREMENTS MADE USING MAN ENGINE YIELD ACCURACY BETTER THAN 3 MICRONS.
- MICRODENSITOMETER EXPECTED TO BE BETTER.
- ERROR BUDGET: 3.5 MICRONS (1σ).

- LARGE NUMBER AVERAGING $\left(\frac{1}{\sqrt{N}}\right)$ REDUCES MEASUREMENT ERRORS

ASSUMING 4 STARS YIELDS ERROR BUDGET: 0.6 ARC-SECONDS.

2. ANGULAR VIBRATION OF TCA

- CHAMBER A DATA MEASURED 1 ARC-SECOND PEAK.
- SBAC STRUCTURAL ANALYSIS PREDICTS 1 ARC-SECOND.
- ERROR BUDGET: 1 ARC-SECOND.

10/13/75 WEK

INTERLOCK CALIBRATION ERROR (CONT'D)

3. SATELLITE VEHICLE TIME CORRELATION

- SVT ACCURATE TO 1 MILLISECOND.
- $0.001 \times 240 \text{ ARC-SECONDS/SECOND (t)} = 0.24 \text{ ARC-SECONDS.}$
- ERROR BUDGET: 0.3 ARC-SECONDS.

4. STELLAR SENSOR POINTING ERROR

- PREVIOUSLY DISCUSSED TO BE 1.8 ARC-SECONDS.

CONCLUSION

- ERROR BUDGET RESULTS IN 2.2 ARC-SECONDS PREDICTED ERROR.
- MEASURED DATA SHOWS BETTER PERFORMANCE.

10/13/75 WEK

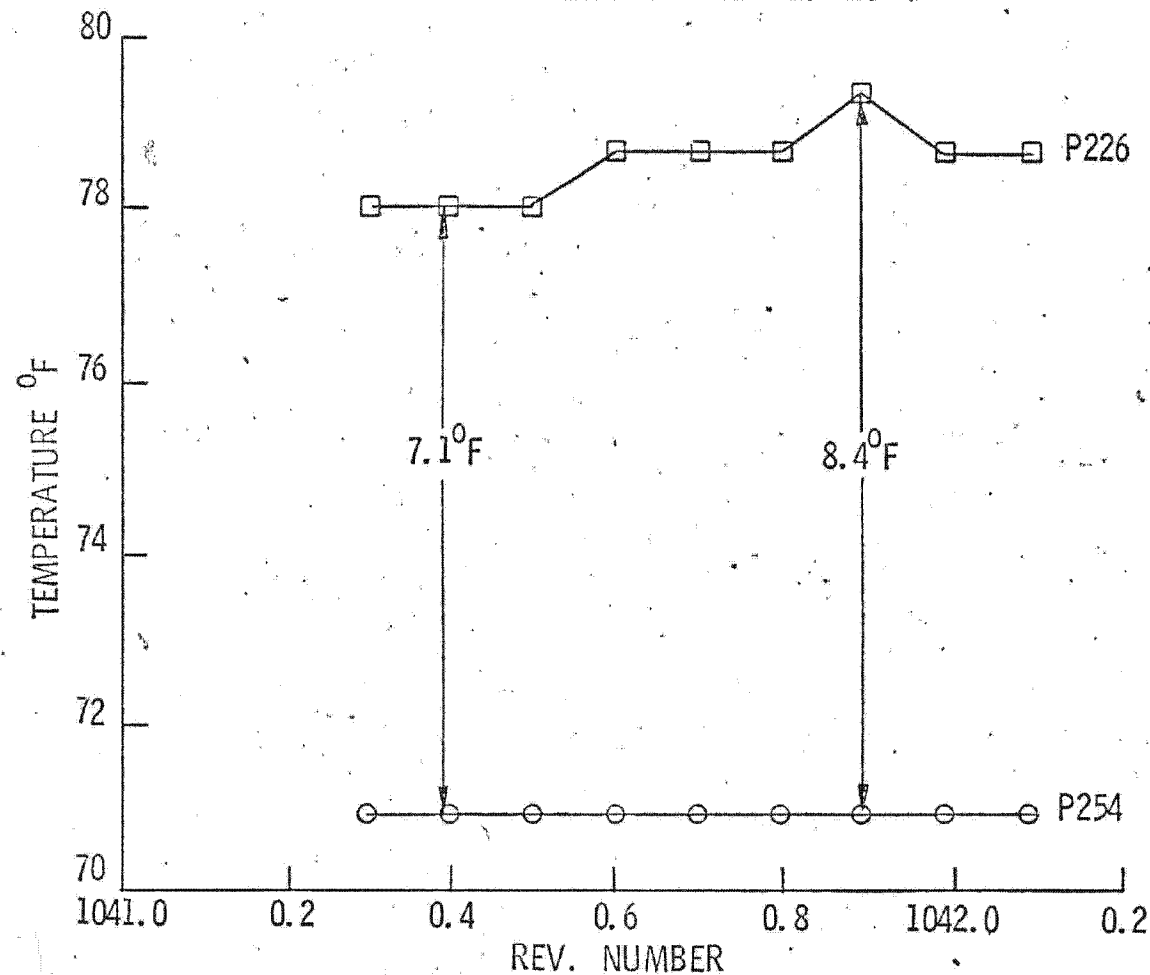
ENVIRONMENTAL EFFECTS

1. THERMAL

- SIDE TO SIDE TWO CAMERA ASSEMBLY GRADIENT
 - ICD SPECIFIES 1.5°F CHANGE DURING MISSION
 - ERROR BUDGET ALLOWS 2°F
 - SV-4; $\beta > 30^{\circ}$; CHANGE WAS 1.3°F
- FRONT TO REAR TWO CAMERA ASSEMBLY GRADIENT
 - ICD SPECIFIES 2°F CHANGE DURING MISSION
 - ERROR BUDGET ALLOWS 3°F
- TOP TO BOTTOM TWO CAMERA ASSEMBLY GRADIENT
 - ICD SPECIFIES 0.2°F CHANGE DURING MISSION
 - ERROR BUDGET ALLOWS 0.25°F
- NASTRAM MODEL USED FOR ANALYSIS
 - VERIFIED BY THERMAL BENDING TEST

10/13/75 WEK

SIDE-TO-SIDE TEMPERATURE DIFFERENCE ON TCA FRAME FOR SELECTED REV. OF SV-4

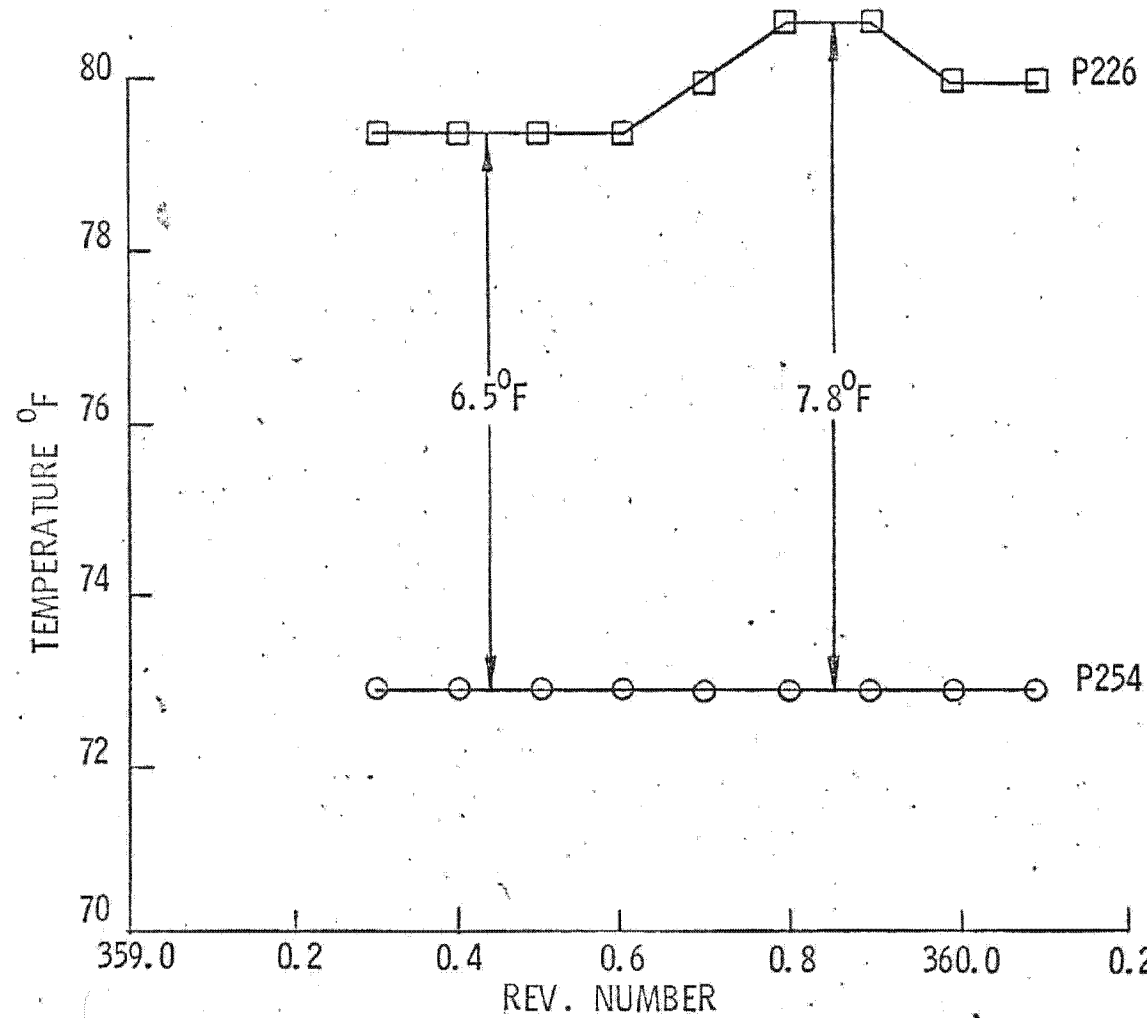


REV. NUMBER 1041 ($\beta = 33^\circ$)

2/12/75 LK

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 HANDLED VIA CYCLOPS
 SIDE-TO-SIDE TEMPERATURE DIFFERENCE ON
 TCA FRAME FOR SELECTED REV. OF SV-4

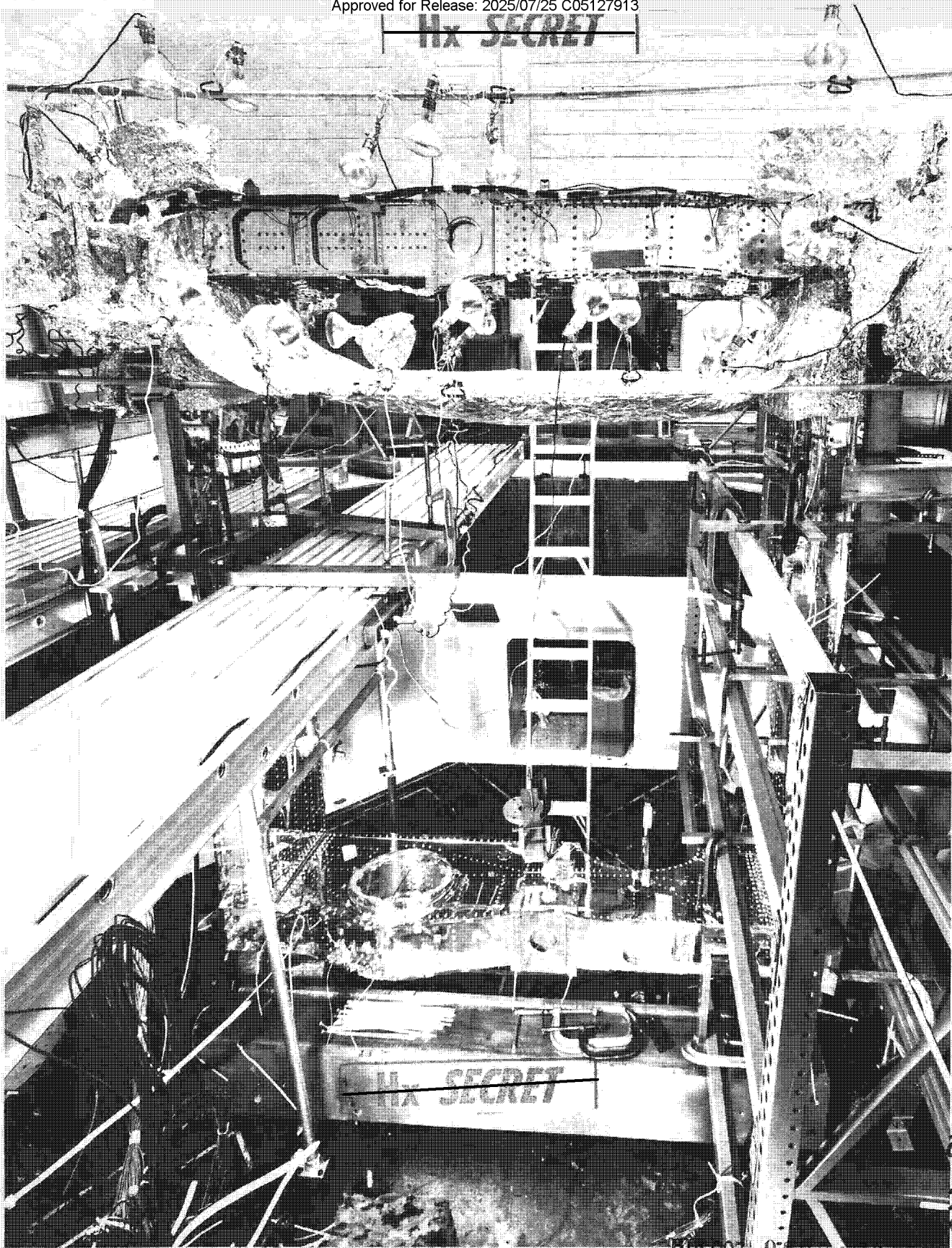
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REV. NUMBER 359 ($\beta = 31^\circ$)

2/12/75 LK

Hx SECRET



75-710

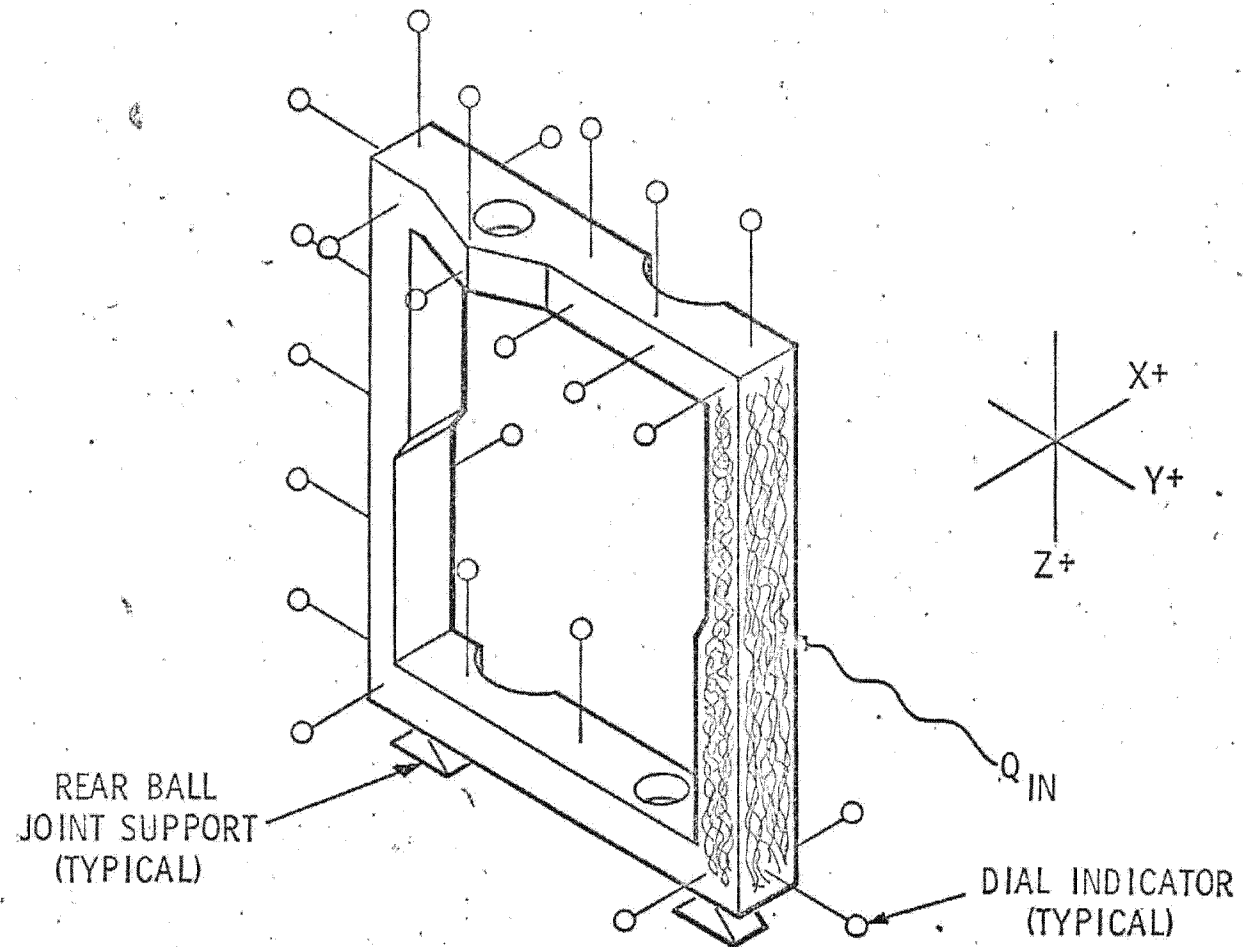
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FRAME BENDING TEST DIAL INDICATOR DATA
HEAT SYMMETRICALLY APPLIED INTO B-SIDE FRAME



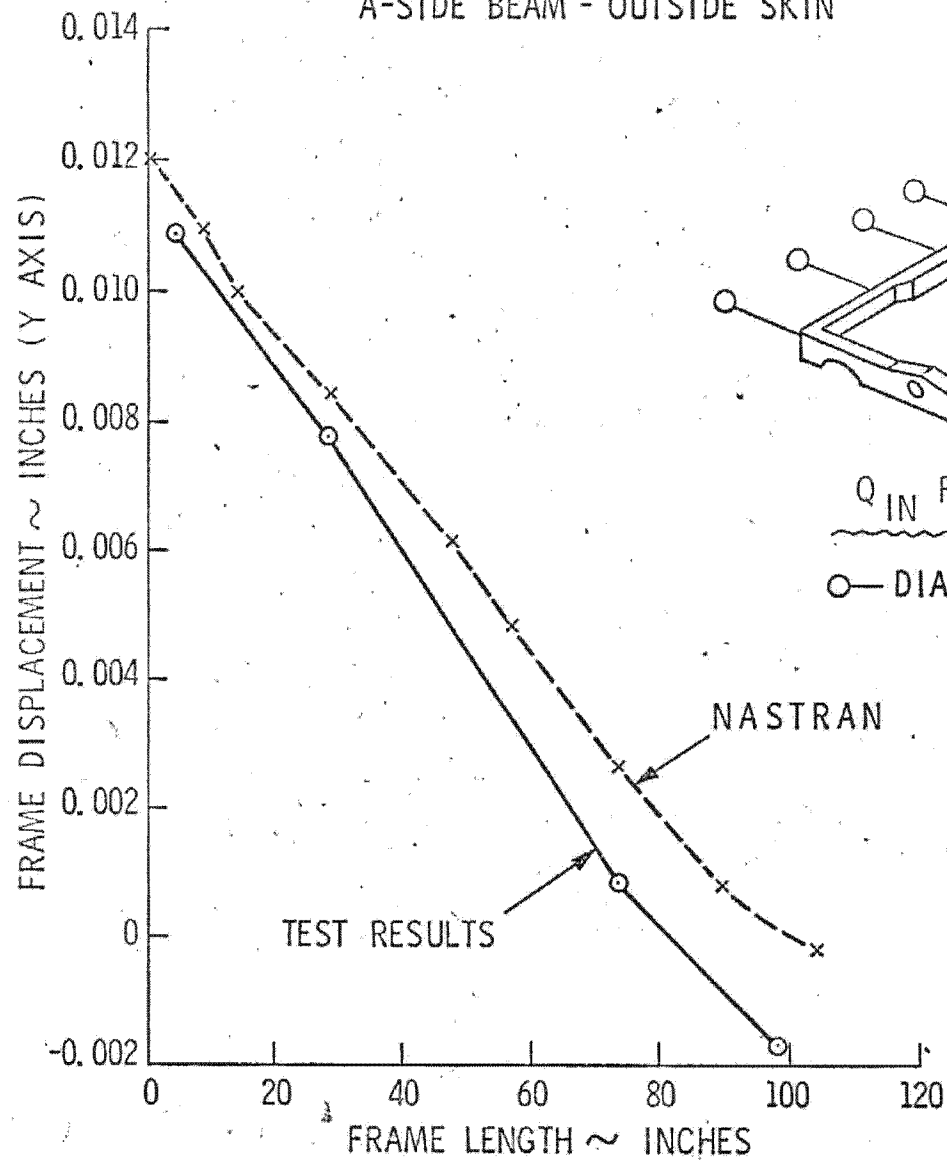
Approved for Release: 2025/07/25 C05127913

Approved for Release: 2025/07/25 C05127913

C05127913

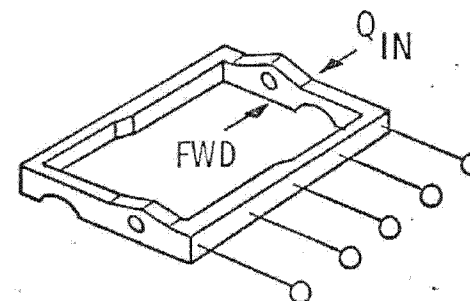
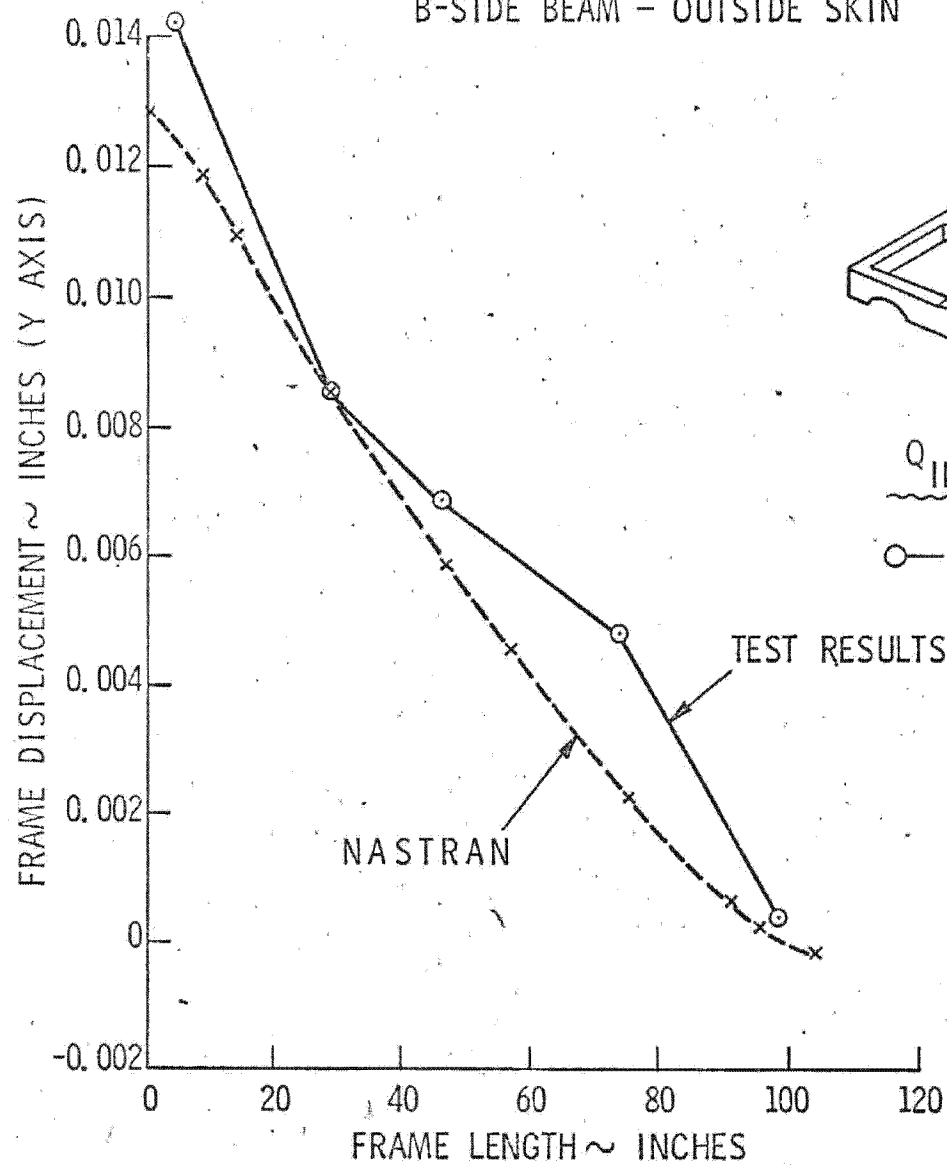
Handwritten signature (12)

A-SIDE BEAM - OUTSIDE SKIN



10/13/75 WEK

B-SIDE BEAM - OUTSIDE SKIN



Q_{IN} FWD BEAM

○ DIAL INDICATOR

TEST RESULTS

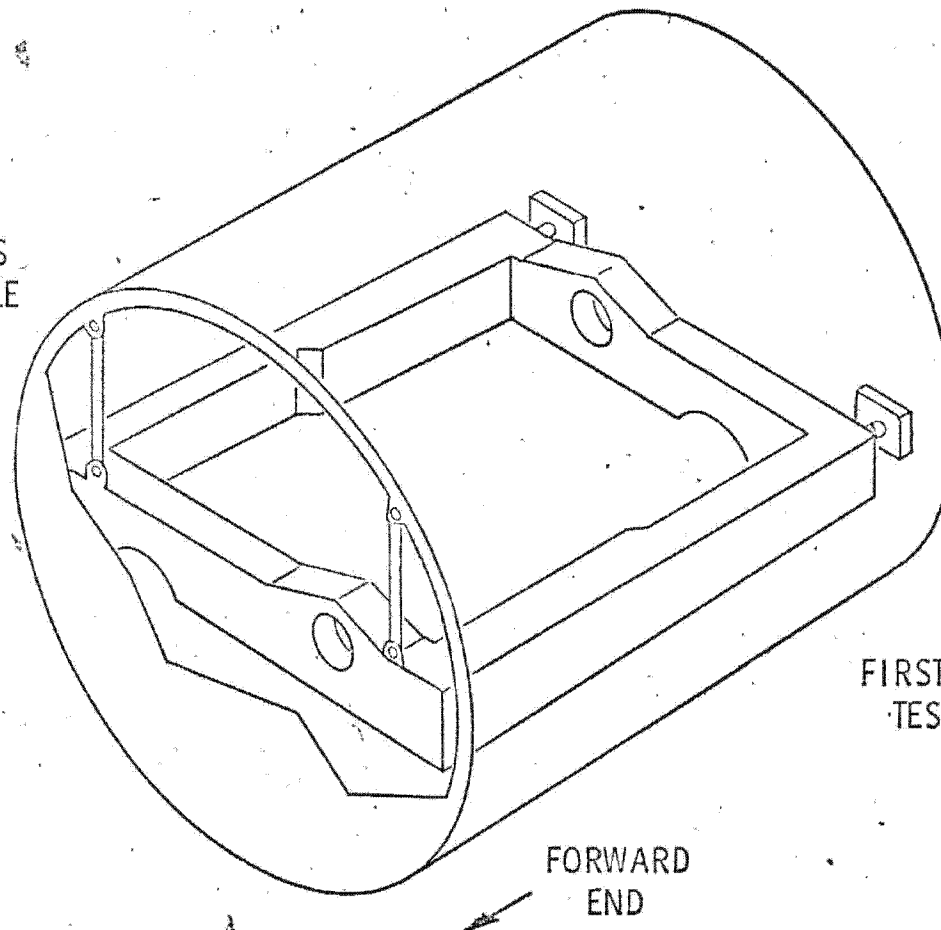
NASTRAN

10/13/75 WEK

ENVIRONMENT EFFECTS (CONT'D)

VEHICLE DISTORTION

TCA TWISTS
WHEN VEHICLE
TWISTS

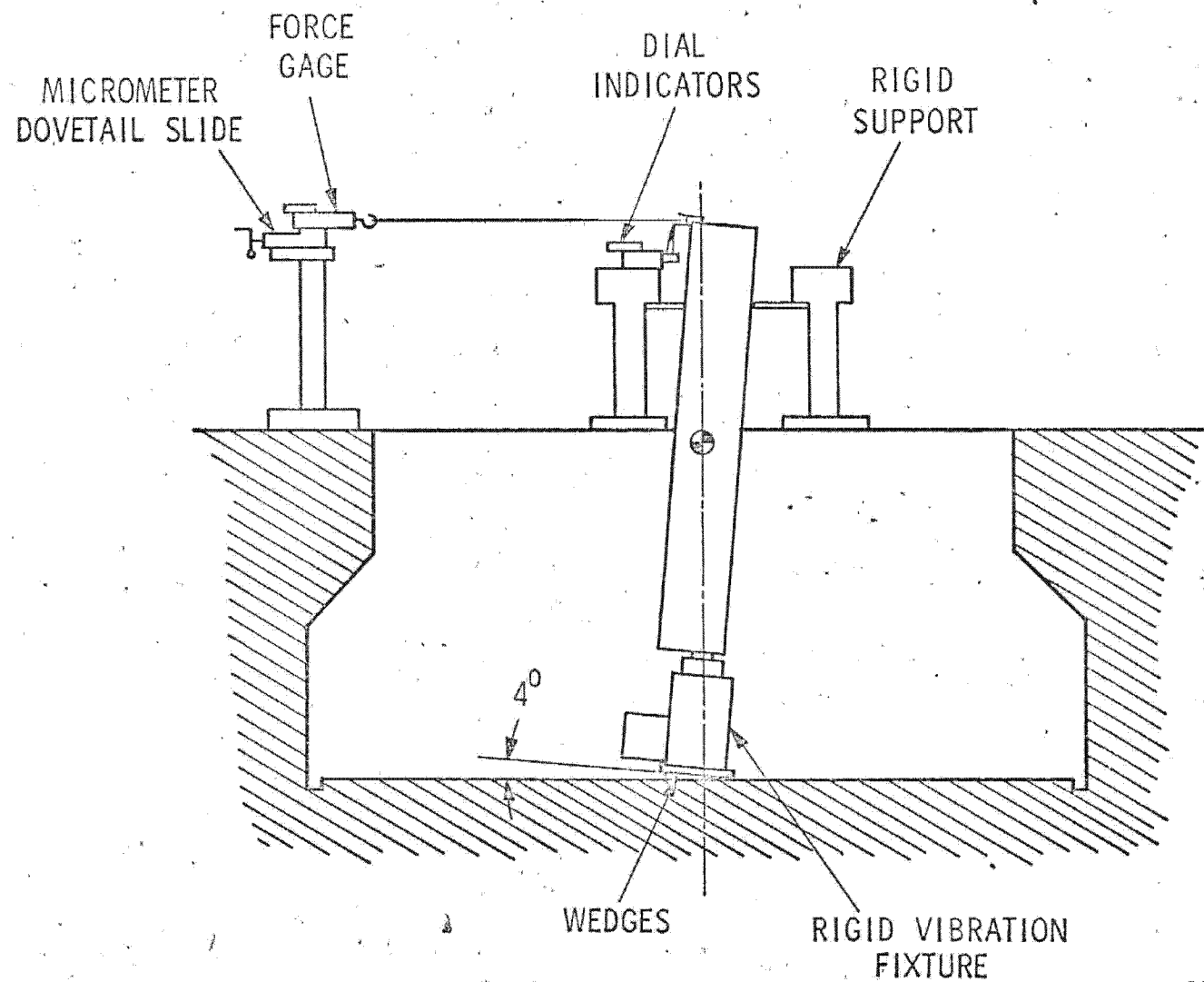


FIRST CHAMBER A
TEST VERIFIED
MOTION

FORWARD
END

10/13/75 WEK

TEST SETUP IN ENVIRONMENTAL LAB PIT



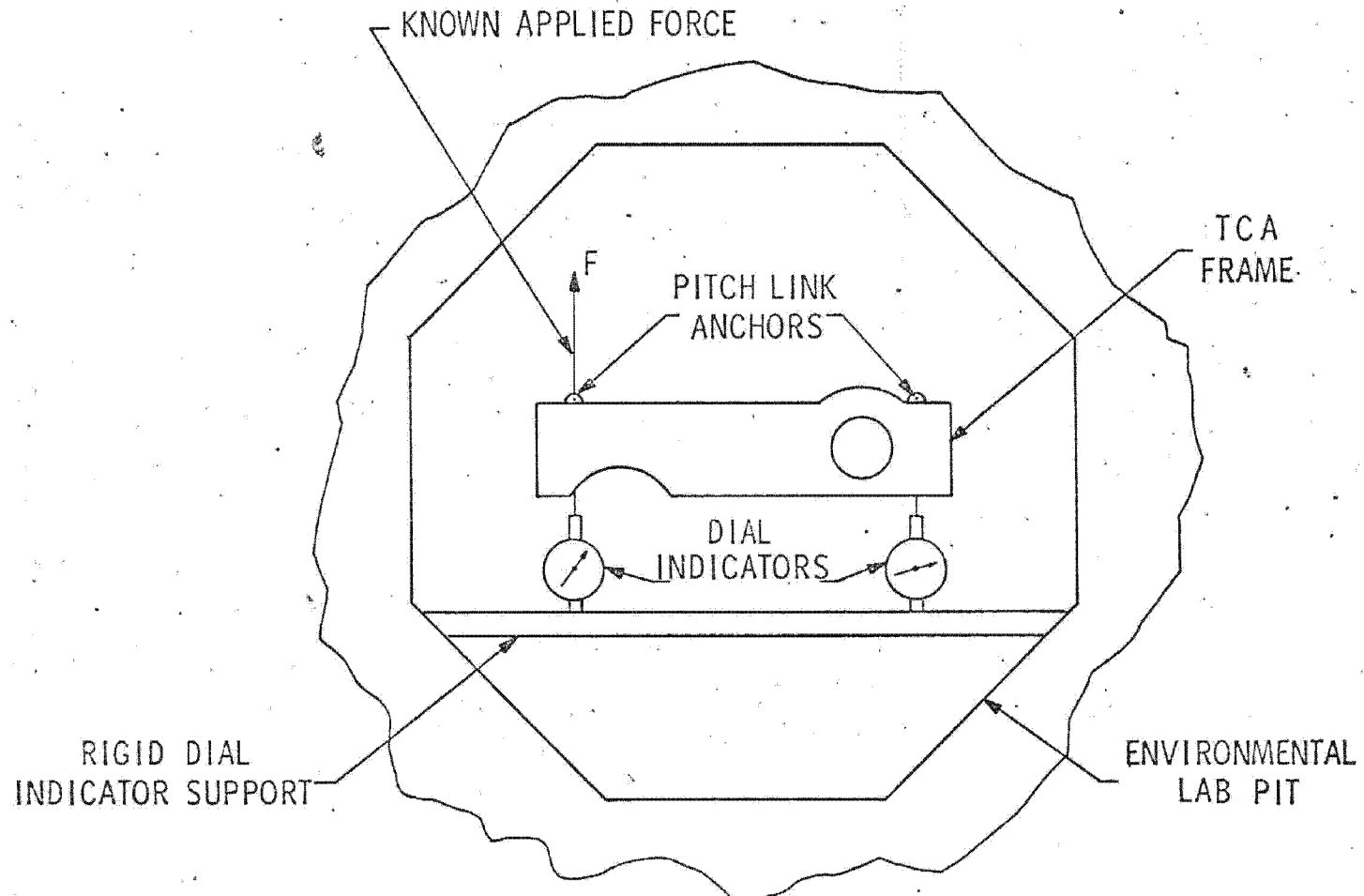
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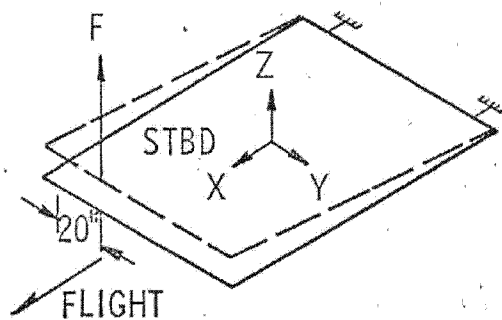
BIF 007-0607-75

SCHEMATIC REPRESENTATION OF TCA FRAME TEST

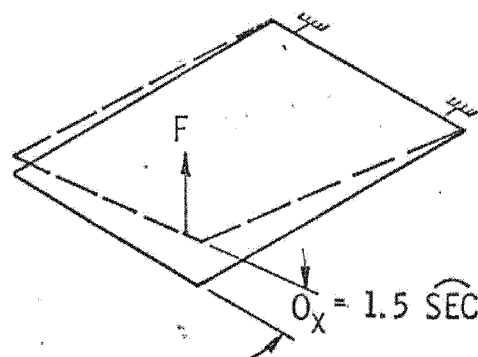


NOTE: DIFFERENCE IN DIAL INDICATOR READINGS FOR A KNOWN APPLIED FORCE PERMITS AN EVALUATION OF TCA FRAME TWIST ABOUT THE ROLL AXIS.

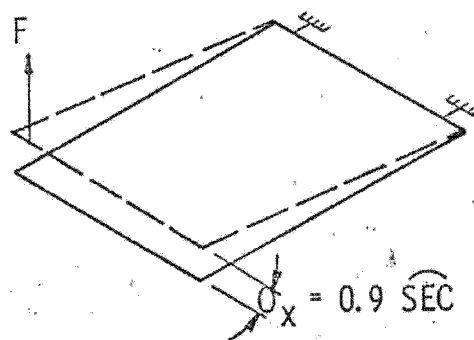
10/13/75 WEK



CASE 2A - Z-AXIS DISPLACEMENT OF FORWARD FRAME MEMBER AT CENTER OF COMPLIANCE. (NO TWIST ABOUT THE X-AXIS.)



CASE 2B - Z-AXIS DISPLACEMENT OF 0.004 INCH AT PORT PITCH LINK ANCHOR. (CAUSES 1.5 SEC TWIST ABOUT X-AXIS.)

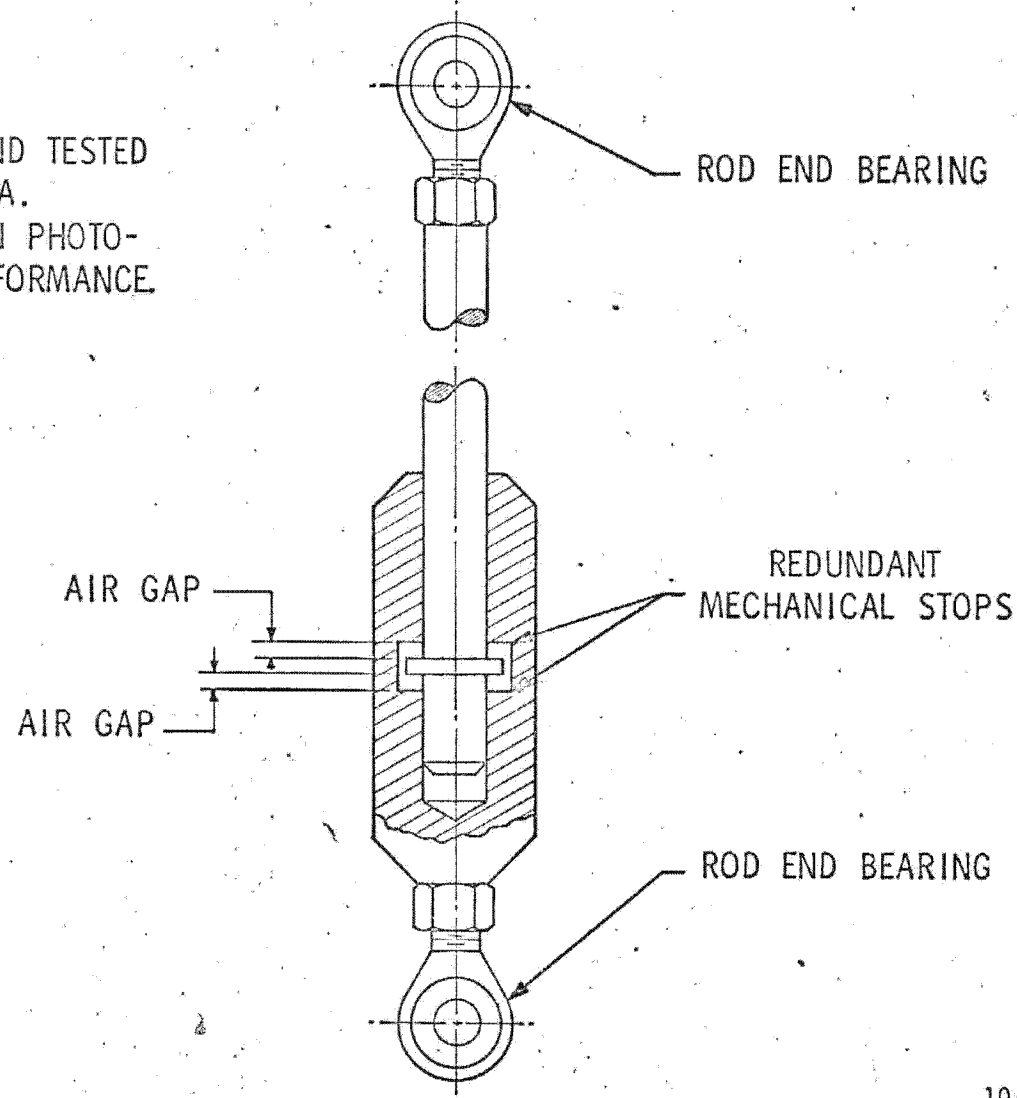


CASE 2C - Z-AXIS DISPLACEMENT OF 0.004 INCH AT STARBOARD PITCH LINK ANCHOR. (CAUSES 0.9 SEC TWIST ABOUT THE X-AXIS.)

6/10/12/13/14/15/16/17/18/19/20/21/22/23/24/25/26/27/28/29/30

SCHEMATIC REPRESENTATION OF MODIFIED PITCH LINK

SIMULATED AND TESTED
IN CHAMBER A.
NO EFFECT ON PHOTO-
GRAPHIC PERFORMANCE



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ENVIRONMENT EFFECTS (CONT'D)

1. THERMAL (CONT'D)

• VEHICLE DISTORTION (CONT'D)

- ONLY ERROR REMAINING DUE TO FRICTION IN BALL JOINTS.
- ERROR BUDGET ALLOWS 1.5 SEC ROLL AND 1.0 SEC PITCH.

• OPTICAL BAR PRIMARY MIRROR TILT

- ICD SPECIFIES 0.5° F CHANGE DURING MISSION
- ERROR BUDGET ALLOWS 0.5° F (0.4 ARC-SECONDS ERROR)

• FOLD FLAT TILT

- ICD SPECIFIES 2° F CHANGE DURING MISSION
- ERROR BUDGET ALLOWS 2° F (0.7 ARC-SECONDS ERROR)

• S³ CAMERA

THERMAL EFFECTS ALLOWANCE 1.9 ARC-SECONDS (1σ)

10/13/75 WEK

ENVIRONMENTAL EFFECTS (CONT'D)

2. ANGULAR VIBRATION OF TCA RELATIVE TO ARM

ERROR IS 1 ARC-SECOND BY SBAC ANALYSIS AND
MEASURED IN CHAMBER A.

3. FOLD FLAT STABILITY

- TEST CONDUCTED ON OPTICAL BAR 5076.
- TO BE CALIBRATED.
- ERROR BUDGET ALLOWS 1.5 ARC-SECONDS.

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FOLD MIRROR DEFLECTION Vs. SPEED WITH OB VERTICAL

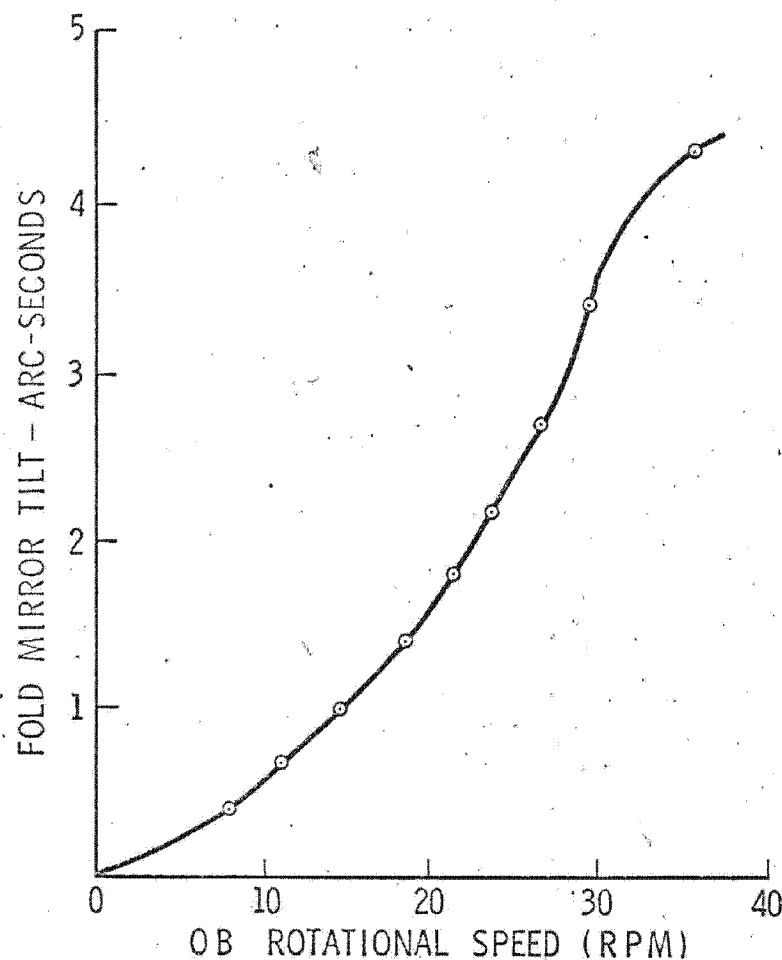
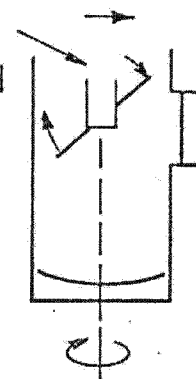


IMAGE MOTION AND
TILT DIRECTION WITH
DECREASING SPEED



NOTE: TILT OCCURRED IN-TRACK ONLY.

THE LOS VARIATION WOULD BE
TWICE THE MIRROR TILT SHOWN
ABOVE.

DISPLACEMENT IN FOCAL PLANE
IS $\sim 2 \times 5 \times 10^{-6} \times 60 \times 25.4 \times 10$
 $15 \mu / \text{ARC-SECOND}.$

ENVIRONMENT EFFECTS (CONT'D)

4. CONCLUSION

• ENVIRONMENTAL ERRORS COMBINE AS FOLLOWS:

<u>ROLL</u>	<u>PITCH</u>	<u>YAW</u>
3.3 SEC	4.0 SEC	4.4 SEC

• ALL ERROR CATEGORIES COMBINE AS FOLLOWS:

	<u>ROLL</u>	<u>PITCH</u>	<u>YAW</u>
STELLAR SENSOR POINTING ERROR	1.4 SEC	1.8 SEC	1.3 SEC
INTERLOCK CALIBRATION ERROR	1.9 SEC	2.2 SEC	1.8 SEC
ENVIRONMENTAL STABILITY	3.3 SEC	4.0 SEC	4.4 SEC
RSS	4.1 SEC	4.9 SEC	4.9 SEC

• PRACTICAL SOLUTIONS HAVE BEEN FOUND.

• VERIFICATION TESTS SUPPORT ERROR BUDGET.

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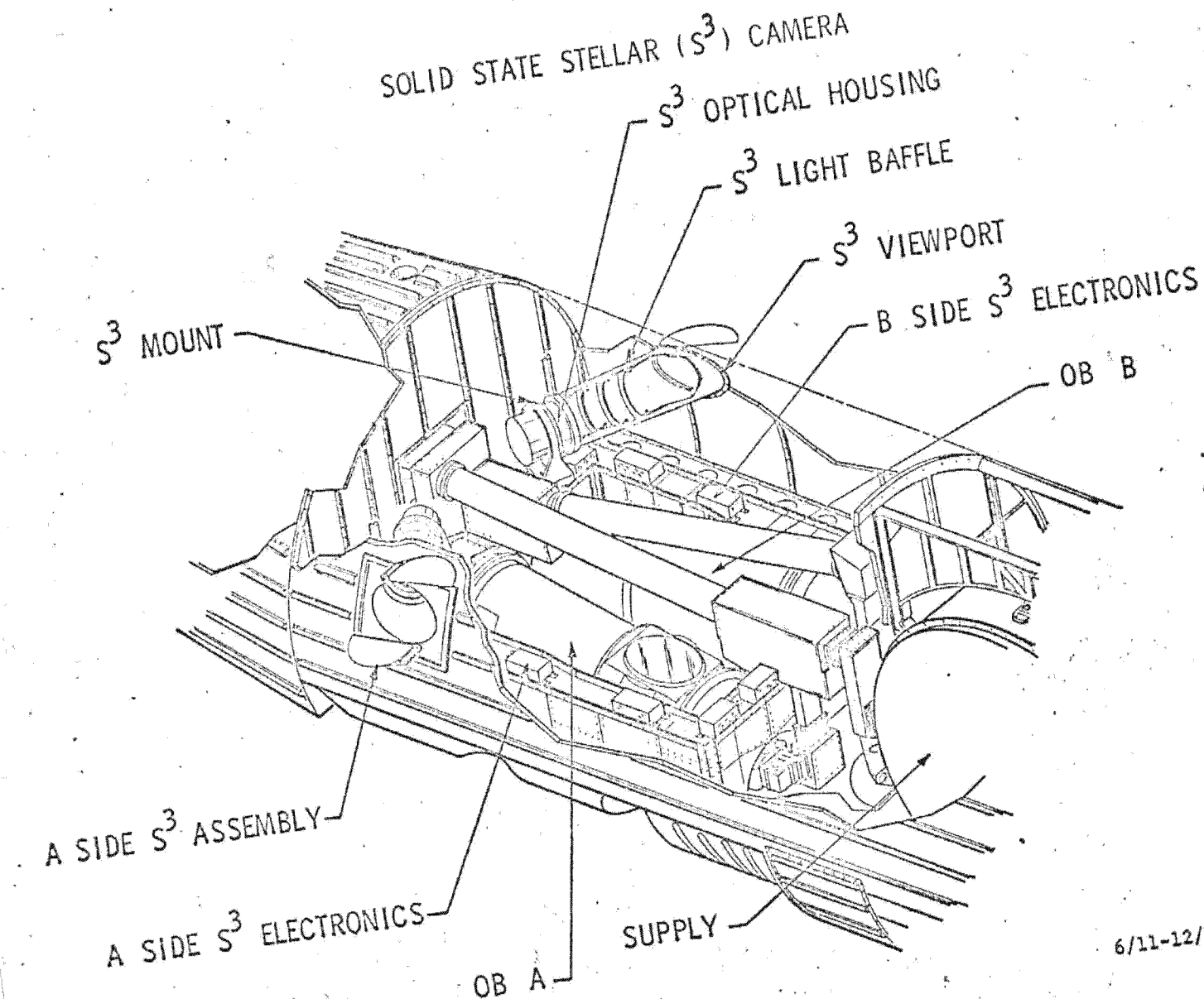
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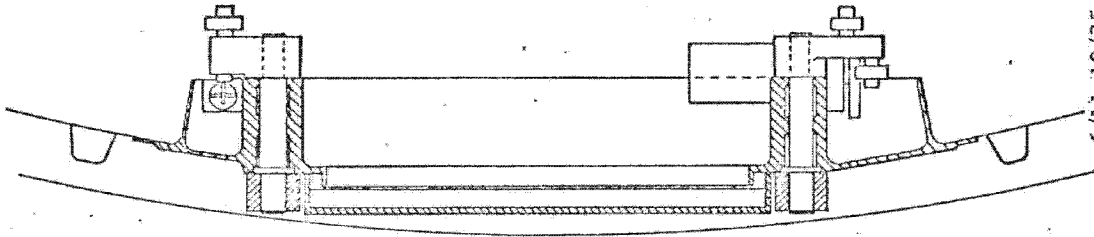
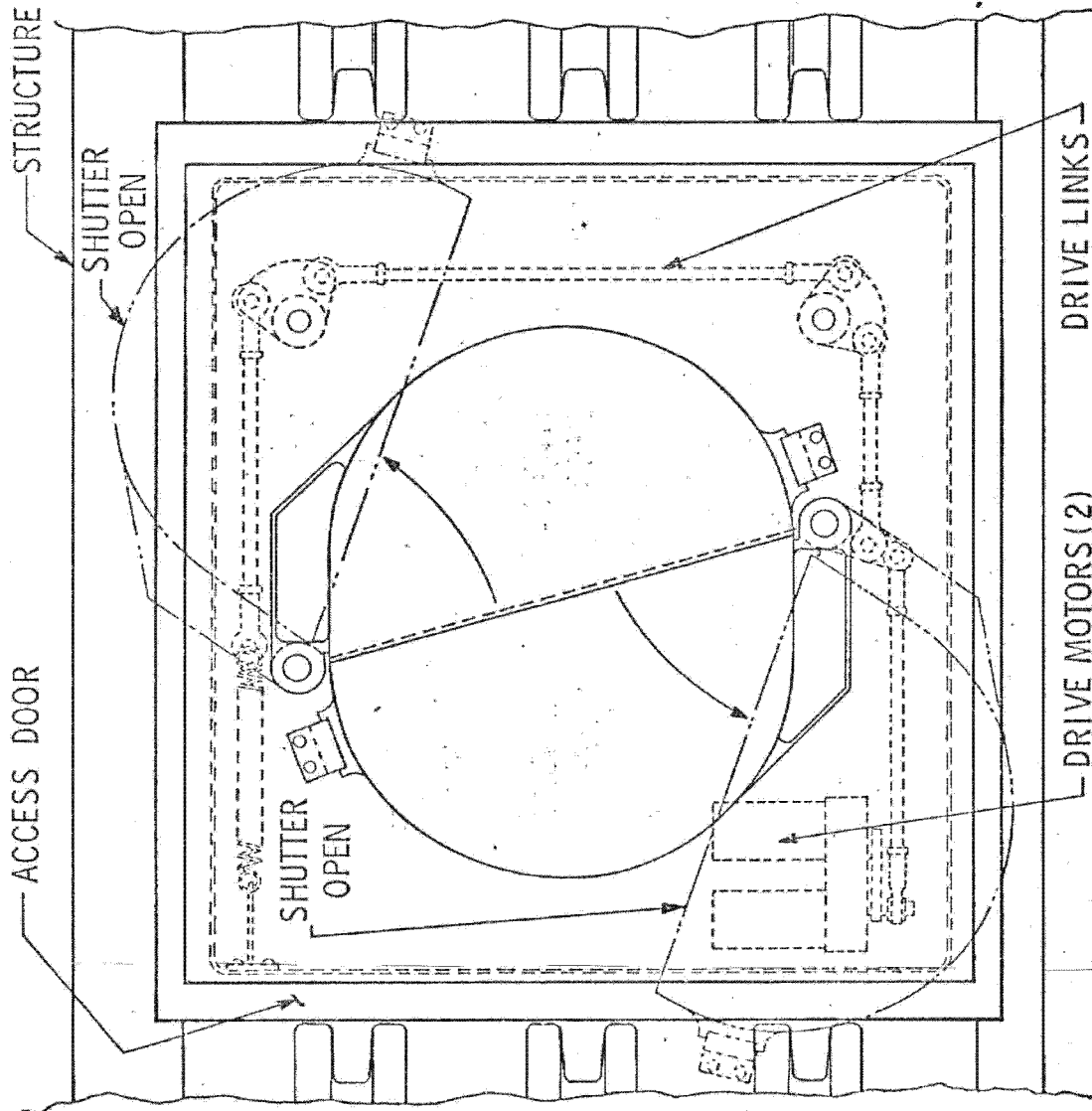


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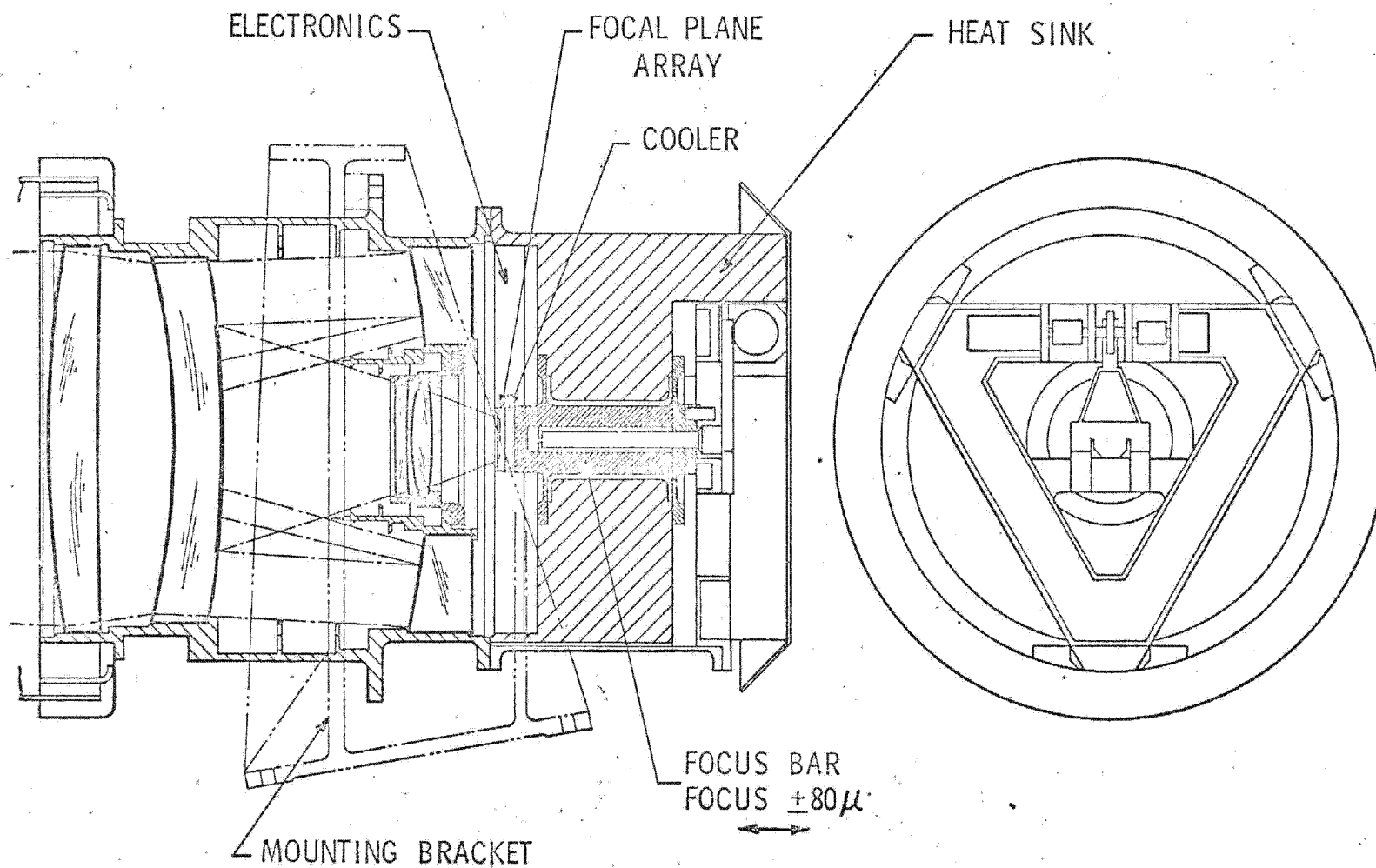
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S³ VIEWPORT SHUTTER ASSEMBLY



6/11-12/75 GFW

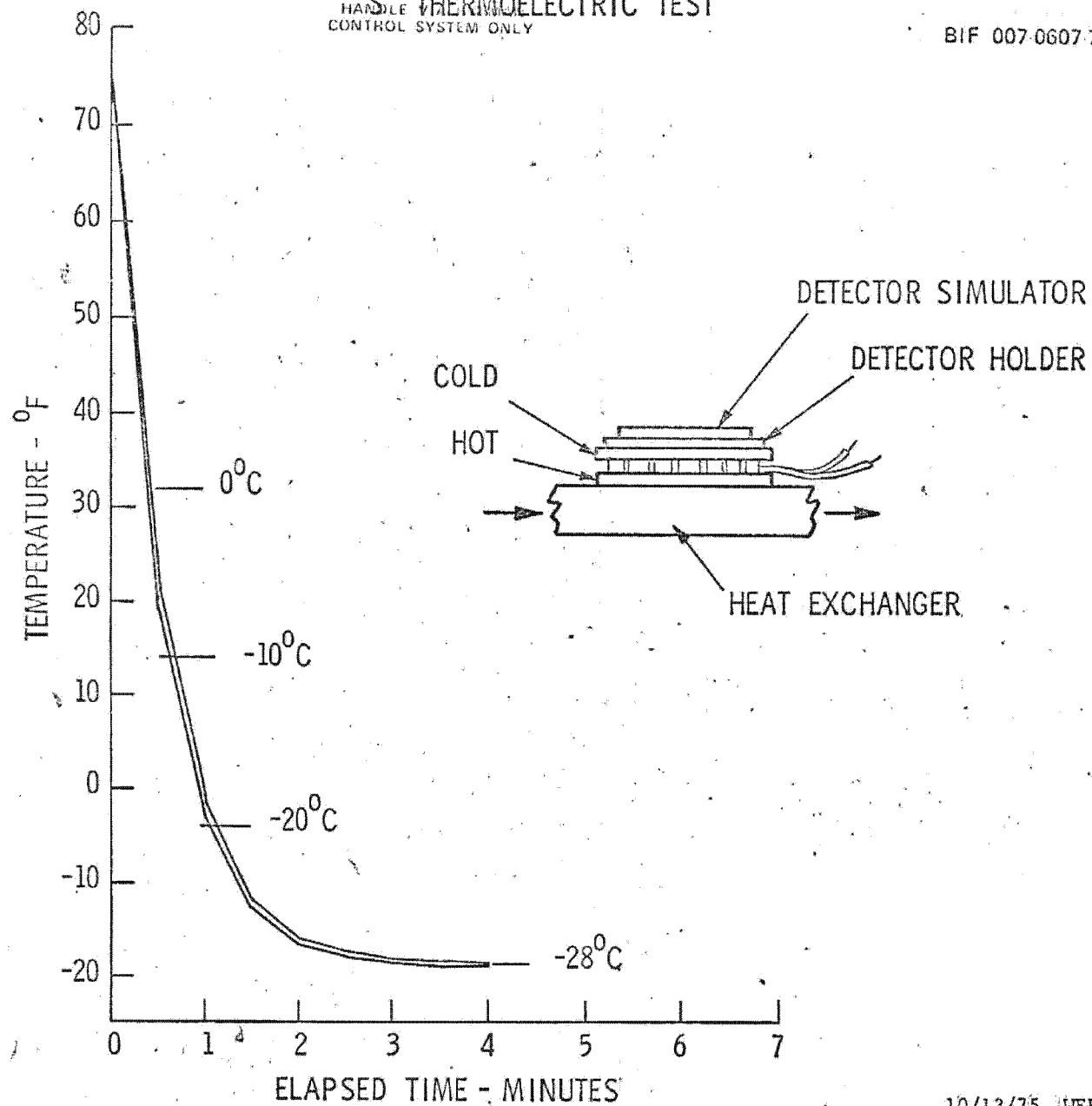
S³ LENS ASSEMBLY



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6/11-12/75 GFW

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10/13/75 WEK

INTERFACE CHANGES

I. REVIEW WITH SBAC FEB 20, 1975

- ALL THE CHANGES WERE DISCUSSED
- ALL CHANGES WERE DETERMINED TO BE PRACTICAL AND REASONABLE TO ACCOMMODATE
- ADDING S³ REQUIRES REMOVING SOME OTHER PAYLOAD
 - COMMAND PROGRAMMER IS COMPLETELY COMMITTED
 - BOOSTER CAPABILITY IS COMPLETELY COMMITTED.

II. MECHANICAL

- TCA VOLUME INCREASE
 - LENS ASSEMBLIES MOUNTED ON FRAME
 - SUN SHIELD MOUNTED BETWEEN FRAME AND DOOR
- M-2 AND M-3 ACCESS DOOR MODIFICATIONS
 - SHUTTER
 - SHUTTER DRIVE MECHANISM

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INTERFACE CHANGES (Cont'd.)

III. ELECTRICAL

A. TELEMETRY S^3 A STELLAR DATA 32 BITS 40 SPS S^3 B STELLAR DATA 32 BITS 40 SPS2560 BITS/SECONDSTATUS DISCRETES, TEMPERATURE
MONITORS AND ELECTRONIC MONITORS 500 BITS/SECOND3060 BITS/SECONDB. COMMANDS S^3 A ON/OFF S^3 B ON/OFF S^3 A CAPPING SHUTTER OPEN / CLOSED S^3 B CAPPING SHUTTER OPEN / CLOSED S^3 A FOCAL PLANE ADVANCE / RETREAT S^3 B FOCAL PLANE ADVANCE / RETREATC. POWER

192 WATTS.

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INTERFACE CHANGES (Cont'd.)

IV. MASS PROPERTIES

132 POUNDS/CAMERA

264 POUNDS/SX

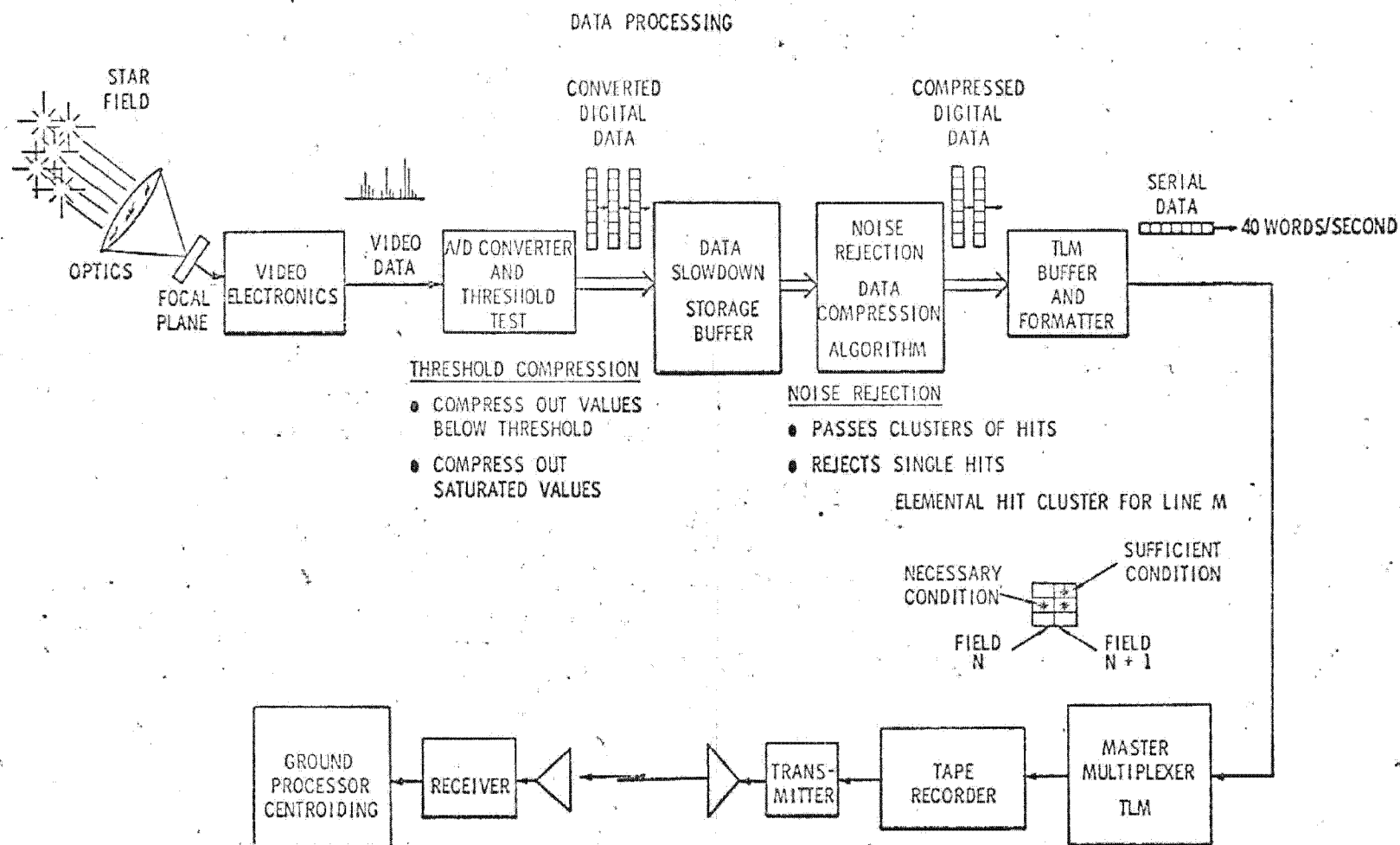
V. THERMAL

A. MODIFICATION TO M-2 AND M-3 DOOR INSULATION.

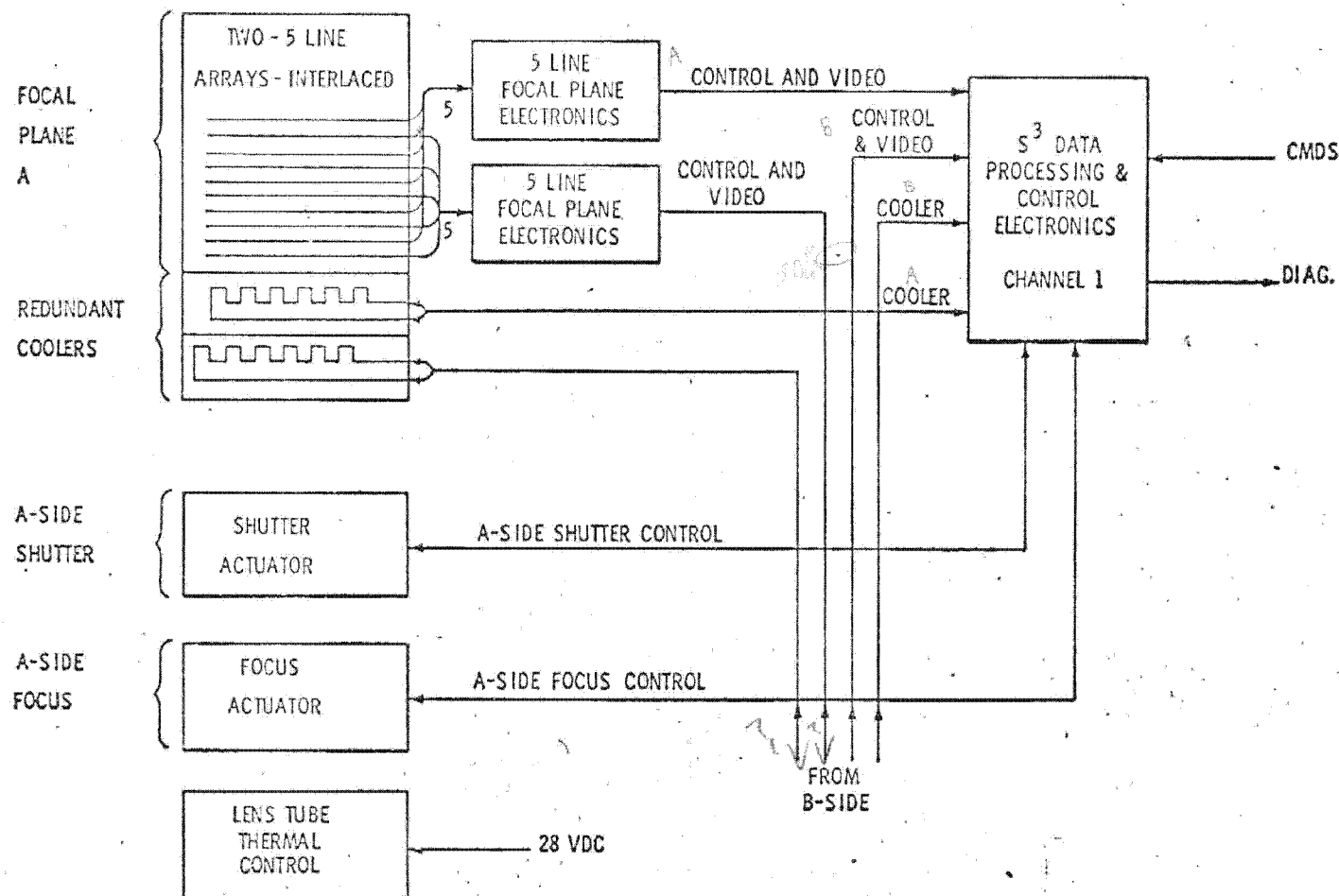
B. ADDITION OF INSULATION BLANKETS AROUND SUN SHIELD
AND LIGHT BAFFLE.

C. ELECTRONIC POWER DISSIPATION.

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S³ ELECTRONICS

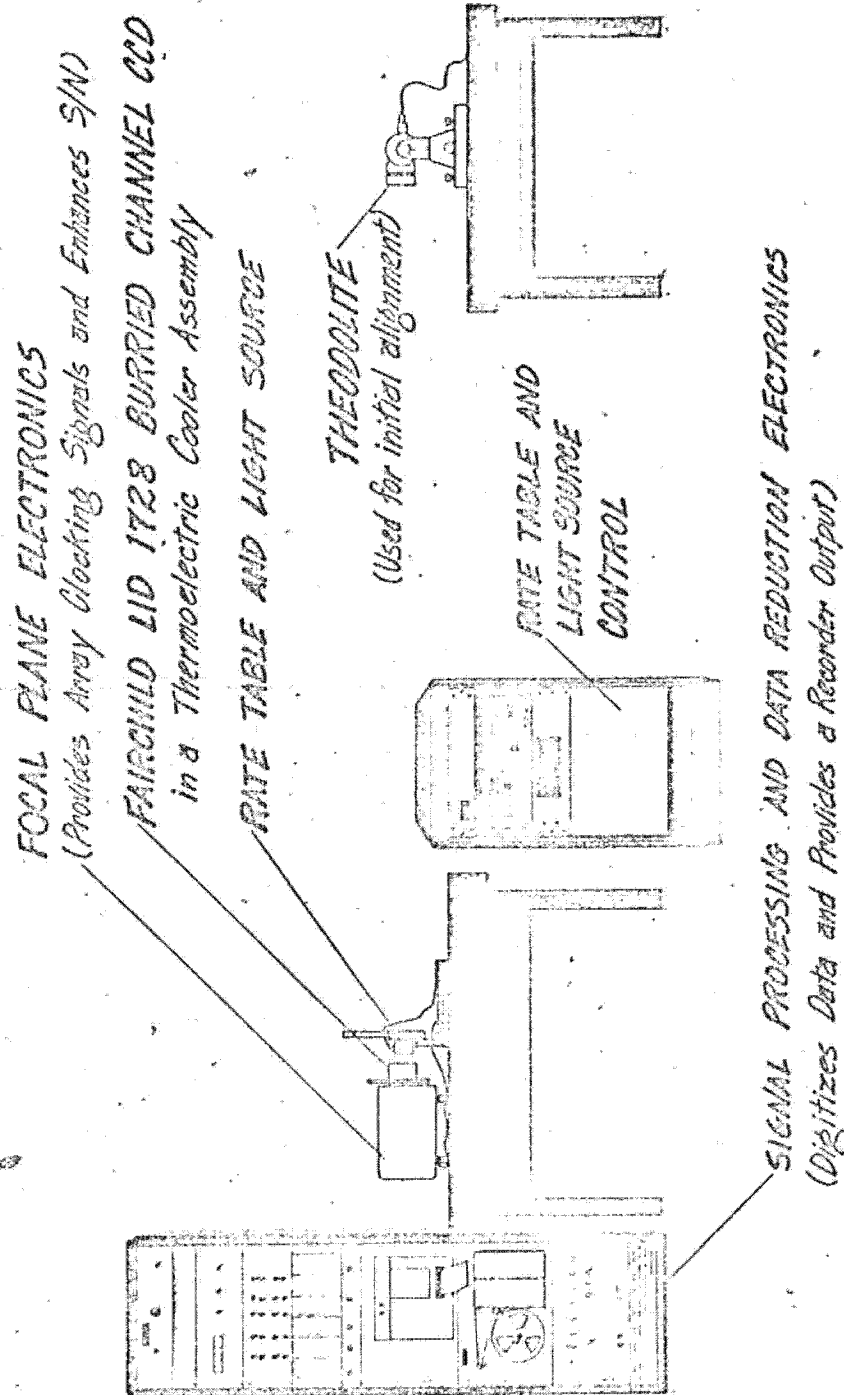


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1. RESPONSIVITY
 2. NOISE
 3. DARK CURRENT
 4. ARRAY TEMPERATURE CONTROL
 5. SIGNAL PROCESSING
 6. DARK CURRENT CORRECTION
 7. PIXEL CHARACTERIZATION
 8. CENTROIDING

FUNCTIONAL TESTS AND OBJECTIVES

- SINGLE LINE ARRAY AND FOCAL PLANE ELECTRONICS FUNCTIONAL TEST
 - MEASURE TIMING AND VOLTAGE LEVELS OF OUTPUT SIGNALS
 - MEASURE AND ADJUST RESPONSIVITY
 - MEASURE DARK NOISE AND DARK CURRENT
- SIGNAL PROCESSING AND DATA CONVERSION ELECTRONICS
 - VERIFY PROPER TIMING AND VOLTAGE LEVELS OF OUTPUT SIGNALS
 - VERIFY ANALOG/DIGITAL CONVERSION AND PRINTOUT
 - MEASURE AND ADJUST THRESHOLD LEVEL
 - VERIFY PRINTOUT OF PIXEL LOCATION, FIELD NUMBER, TABLE POSITION, AND RADIOMETRIC DATA
- INTEGRATED TEST
 - MEASURE DARK CURRENT AND PROGRAM DARK CURRENT CORRECTION MEMORY
 - VERIFY DARK CURRENT CANCELLATION
 - MEASURE RESPONSIVITY
 - MEASURE LINEARITY
 - MEASURE NOISE

6/11-12/75 - SJA

ENGINEERING TEST AND OBJECTIVES

- MEASUREMENT OF ARRAY CHARACTERISTICS
 - DETERMINE THE CENTER OF SELECTED PIXELS
 - DETERMINE PIXEL SENSITIVITY PROFILE
 - DETERMINE CROSS-TALK BETWEEN SELECTED PIXEL AND ADJACENT PIXELS
- CENTROIDING
 - DEMONSTRATE ACCURACY THAT CAN BE ACHIEVED BY THE PHOTODETECTOR ARRAY, ELECTRONIC BREADBOARD, AND DATA REDUCTION SOFTWARE

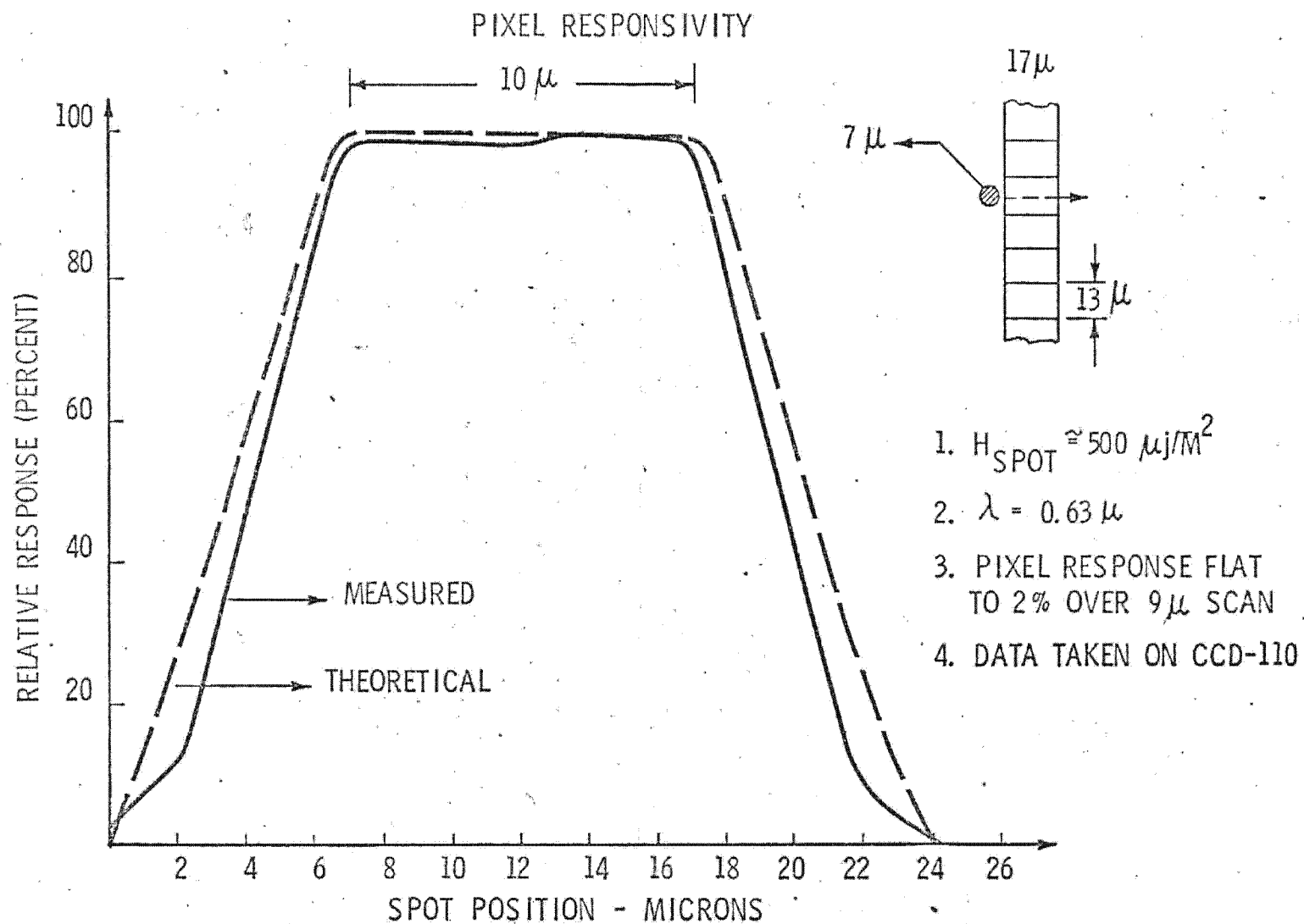
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NOISE SUMMARY
(ELECTRONS)²

PARAMETER	RETICON RL1872F	FAIRCHILD LID 1728
DARK SIGNAL @ -10°C	900	300
BULK STATE	N/A	136
ARRAY OUTPUT	$(400\sqrt{1})^2 = (400)^2$	$(400\sqrt{0.25})^2 = (200)^2$
PROCESSOR	$(400)^2$ *	50,000 - 40,000
RMS NOISE	566	78.3
NEE (CALC)	0.81 $\mu\text{j}/\text{M}^2$	0.31 $\mu\text{j}/\text{M}^2$
NEE (OBS)	1.2 $\mu\text{j}/\text{M}^2$	0.35 $\mu\text{j}/\text{M}^2$

* LOW NOISE CIRCUITRY TO BE DEVELOPED
CHIP DEVELOPMENT INCLUDES REDUCTION OF VIDEO LINE
CAPACITY AND RESISTANCE

6/11-12/75 SJA



SJA 6/11/12/75

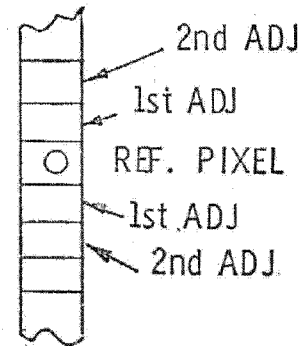
CROSSTALK MEASUREMENTS

WAVELENGTH (0.1 μ)	1 ST ADJ PIXEL		2 ND ADJ PIXEL	
	P-E	FC ⁽¹⁾	P-E	FC ⁽¹⁾
BLUE	$\lambda = 0.45$ < 1 %	$\lambda = 0.55$ 5 %	$\lambda = 0.43$ 0	$\lambda = 0.55$ 0
$\lambda = 0.63$	6.7 %	7 %	0.9 %	1 %
$\lambda = 0.9$	20 %	21 %	6.5 %	7 %

1. FAIRCHILD REPORT - "SLOW SCAN OPERATION OF LONG LINEAR CCD ARRAYS"

2. ENERGY = 1/2 SATURATION

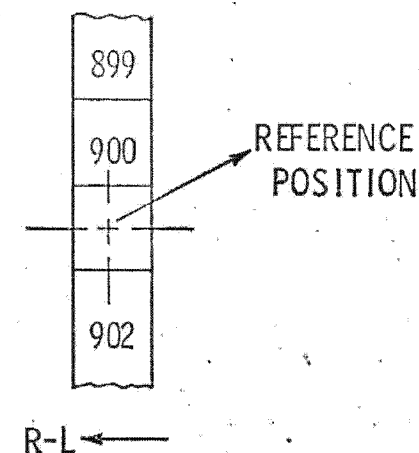
3. DATA FROM CCD-110 (LID 256)



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SUMMARY OF CENTROIDING RUNS

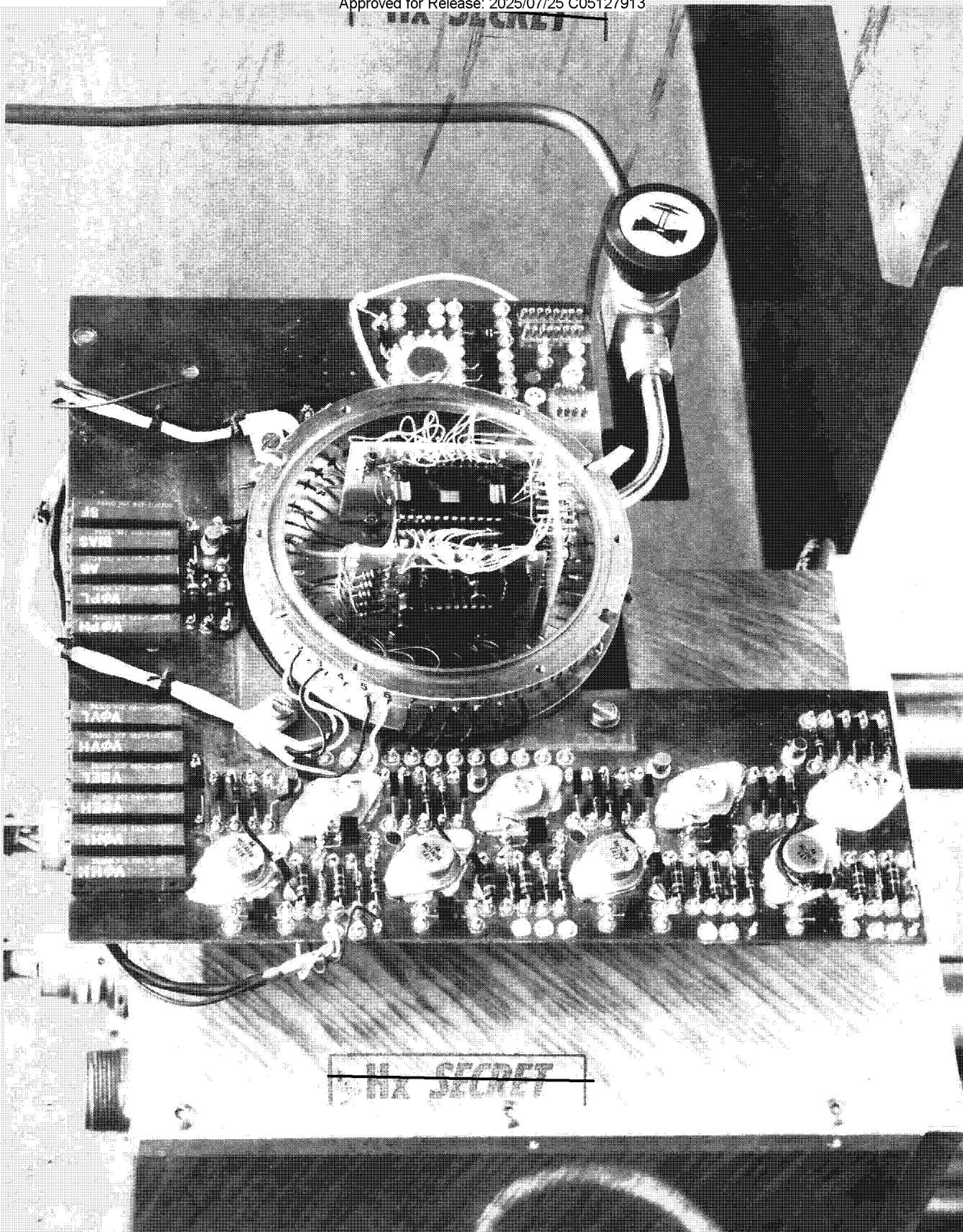
RUN NO.	ΔY	ΔX	SCAN	H_{SPOT}
1	$+0.13 \mu$	-0.42μ	L-R	$350 \mu j/m^2$
2	0.	$+1.62 \mu$	R-L	$350 \mu j/m^2$
3	0.	-0.35μ	L-R	$350 \mu j/m^2$
4	$+0.13 \mu$	$+1.59 \mu$	R-L	$350 \mu j/m^2$

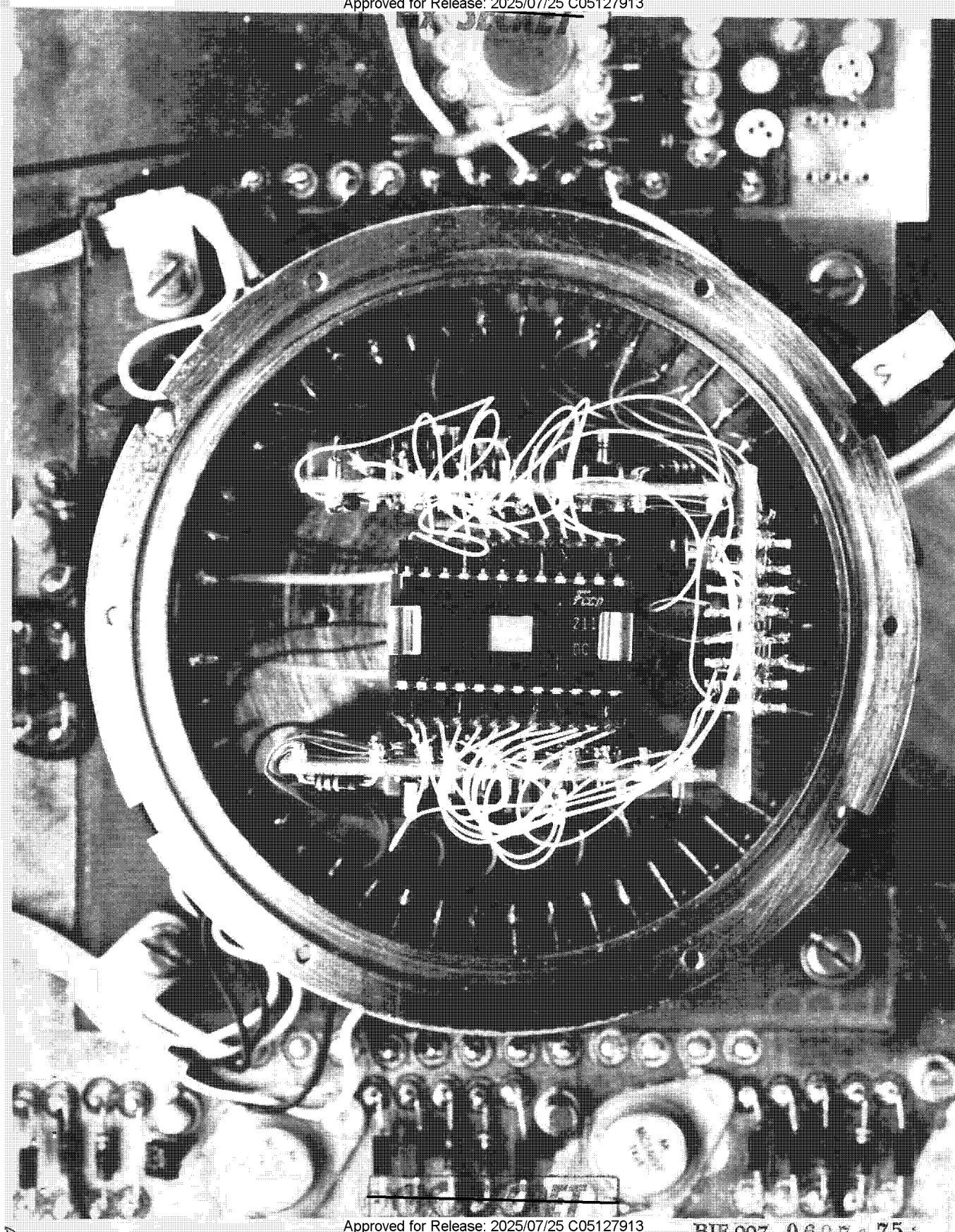


1. REFERENCE POSITION ESTABLISHED BY A MANUAL CENTROID WITH 2μ STEPS.
2. PREDICTED ERROR: 2.0μ RANDOM (1 SIGMA) (ΔX OR ΔY)

1.0/10/15

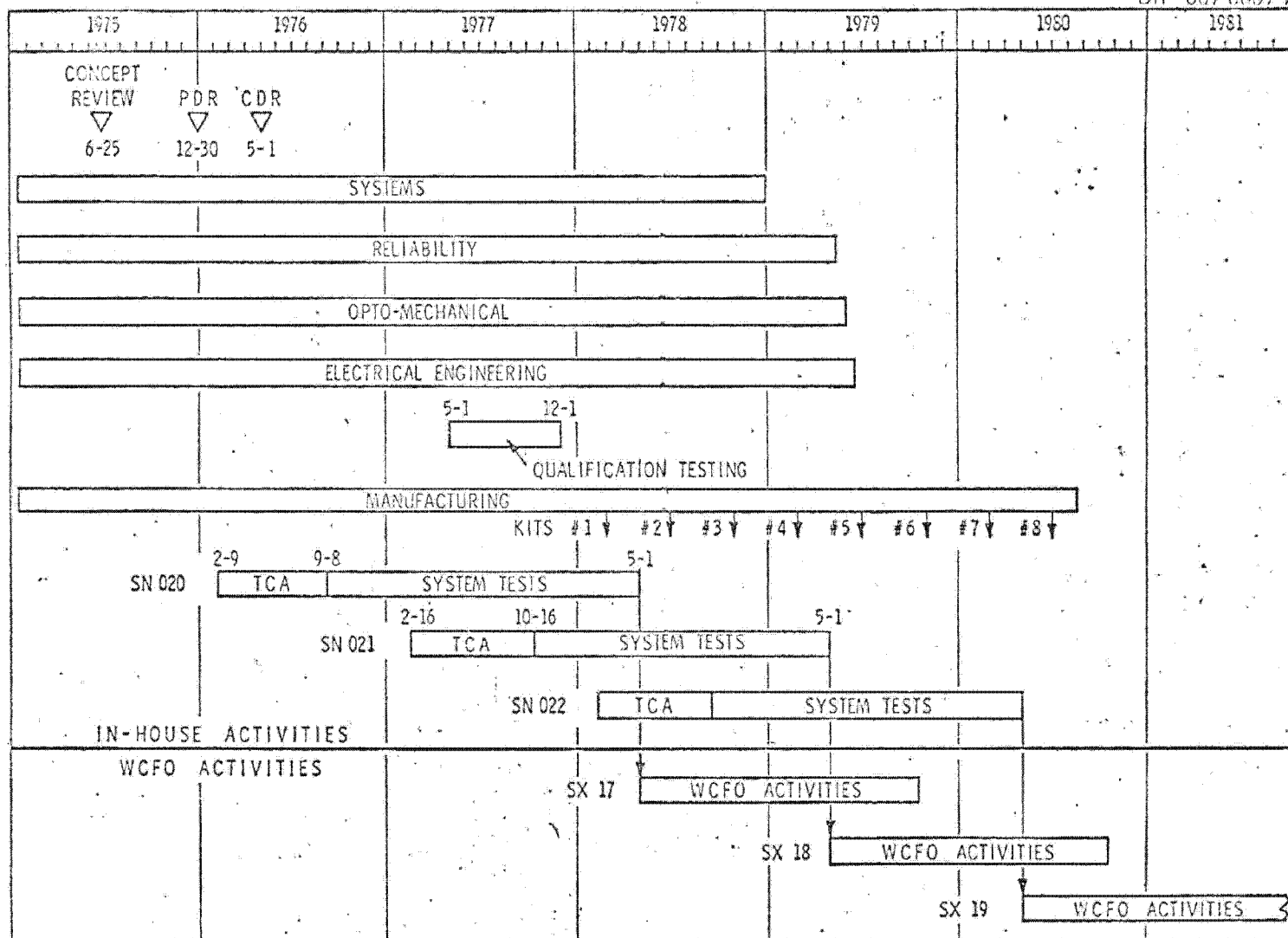
SJA 6/11/12/75

~~HA SECRET~~~~HA SECRET~~



S³ TOP LEVEL SUMMARY SCHEDULE
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S³ PLAN ACTIVITIESGFY '76 (7/01/75 - 6/30/76)

- COMPLETE FOCAL PLANE PROTOTYPE PROCUREMENT AND EVALUATION.
- COMPLETE PRELIMINARY DESIGN REVIEW AND ALSO COMPLETE THE CRITICAL DESIGN REVIEW.
- PREPARE TEST REQUIREMENTS AND DO THE DETAIL DESIGN OF ALL SPECIAL TEST EQUIPMENT, AND PREPARE ALL MANUFACTURING, QUALIFICATION, ASSEMBLY AND TEST PLANS.

GFY '76 (T) (7/01/76 - 9/30/76)

- START PRODUCTION.
- PROCURE TEST EQUIPMENT.
- PLACE ELECTRONICS SUBCONTRACTS.

GFY '77 (10/01/76 - 9/30/77)

- GO INTO PRODUCTION ON ALL SUBASSEMBLIES.
- DELIVER FIRST UNITS FOR ENGINEERING EVALUATION AND QUALIFICATION TESTS.
- START QUALIFICATION TESTS.

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S³ PLAN ACTIVITIES (CONTINUED)

GFY '78 (10/01/77 - 9/30/78)

- FINISH QUALIFICATION TESTS, DELIVER FLIGHT S³ SUBSYSTEMS FOR SV 17 AND SV 18.
- DELIVER SV 17's MIDSECTION WITH S³ INSTALLED AND ACCEPTED.

GFY '79 (10/01/78 - 9/30/79)

- DELIVER SV 18's MIDSECTION.
- LAUNCH SV 17 AND SUPPORT OPERATIONS.

GFY '80 (10/01/79 - 9/30/80)

- FIELD SUPPORT AND LAUNCH OF SV 18.

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SUMMARY

- S³ ON HEXAGON IS AN ATTRACTIVE SOLUTION TO THE NATIONAL MAPPING REQUIREMENT.
- A PROGRAM IS DEFINED.
- A CONCEPT HAS BEEN CONFIGURED, ANALYZED AND VERIFICATION TESTS PERFORMED.
- PHOTODETECTORS ARE READY.
- P-17 IS EASILY ACHIEVABLE.

10/13/75 WEK



NNNN
 OP RUXQBA,RUXQIA
 DE RUXQAA 470 2902220
 ZNY XXXXX KKK ZNM
 O P 1722 19Z
 BT
 XXXXX
 CATOR 606, ANQLO 400
 CATOR PASS CHARGE
 ANQLO PASS ETHER

~~SECRET~~
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 CONTROL SYSTEM

Wwa

6045

for AEF
Hutch

Sub 988/w

AA 8380/w

~~SECRET~~ 1722 19Z OCT 75 CITE WHIG 1600.
 IMMEDIATE CHARGE INFO PRIORITY ETHER.
 HANDLE VIA BYEMAN CHANNELS ONLY
 HEXAGON

CHARGE FOR GENERAL KULPA/COLONEL ANDERSON, INFO
 ETHER FOR WILLIAMS FROM COLONEL WHEELER
 SUBJECT: KWETHER'S REQUIREMENTS FOR HEXAGON METRIC
 PAN SYSTEM.

REFERENCE: TELECON HUTCHISON 17 OCT 1975.

THE FOLLOWING POLICY HAS BEEN ESTABLISHED BY THE
 DIRECTOR, KWETHER, WITH RESPECT TO THE METRIC
 PAN SYSTEM AND IS BEING TRANSMITTED AT HIS REQUEST.

1. RELAXATION OF THE ATTITUDE ERROR TO 10 ARC
 SECONDS IN EACH COMPONENT WILL SATISFY CURRENT
 KWETHER REQUIREMENTS.

WORKING COPY

PAGE 2 CITE WHIG 1600 ~~SECRET~~

2. A FIVE ARC SECOND GOAL, IF ACHIEVED, WILL SATISFY
 THE TECHNICAL OBJECTIVES AS STATED BY DDR&E.

3. KWETHER STILL PREFERS DEVELOPMENT OF THE METRIC
 PAN SYSTEM, WITH A SECOND CHOICE OF THE MAPPING
 CAMERA SYSTEM.

E-2 IMPDET

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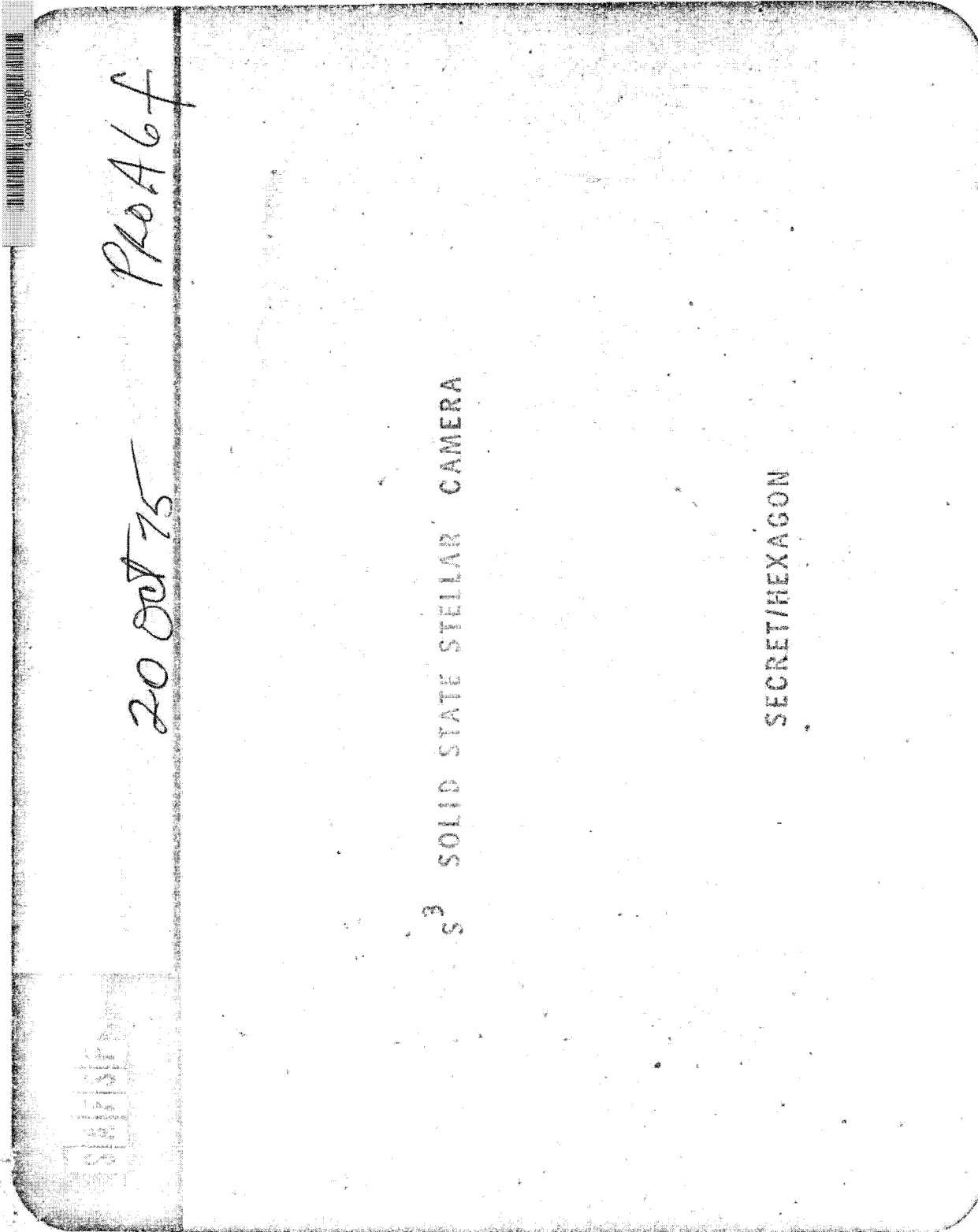
BT

Randy

DISTRIBUTION		
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 CONTROL SYSTEM



SATISF

BRIEFING OUTLINE

- BACKGROUND
- 5³ STUDY ACCOMPLISHMENT
- FUNDS REQUIRED
- RISK ASSESSMENT
- CONCLUSIONS

BACKGROUND

- DMA/SP-6 STUDIES ON METRIC PAN IDENTIFIED:
 - IMPROVED INTERNAL GEOMETRY KNOWLEDGE
 - IMPROVED GEOGRAPHIC REFERENCE
 - IMPROVED ATTITUDE REFERENCE
- CHANGES IN PROCESS
 - NAVTAC (SV-13)
 - 1° SCAN ANGLE DOTS (SV-14)
 - FIDUCIAL X-HAIRS (SV-14)
 - OB CALIBRATION (SV-14)
- REMAINING REQUIREMENT IS TO DETERMINE THE ATTITUDE TO 5-10 ARC SECONDS

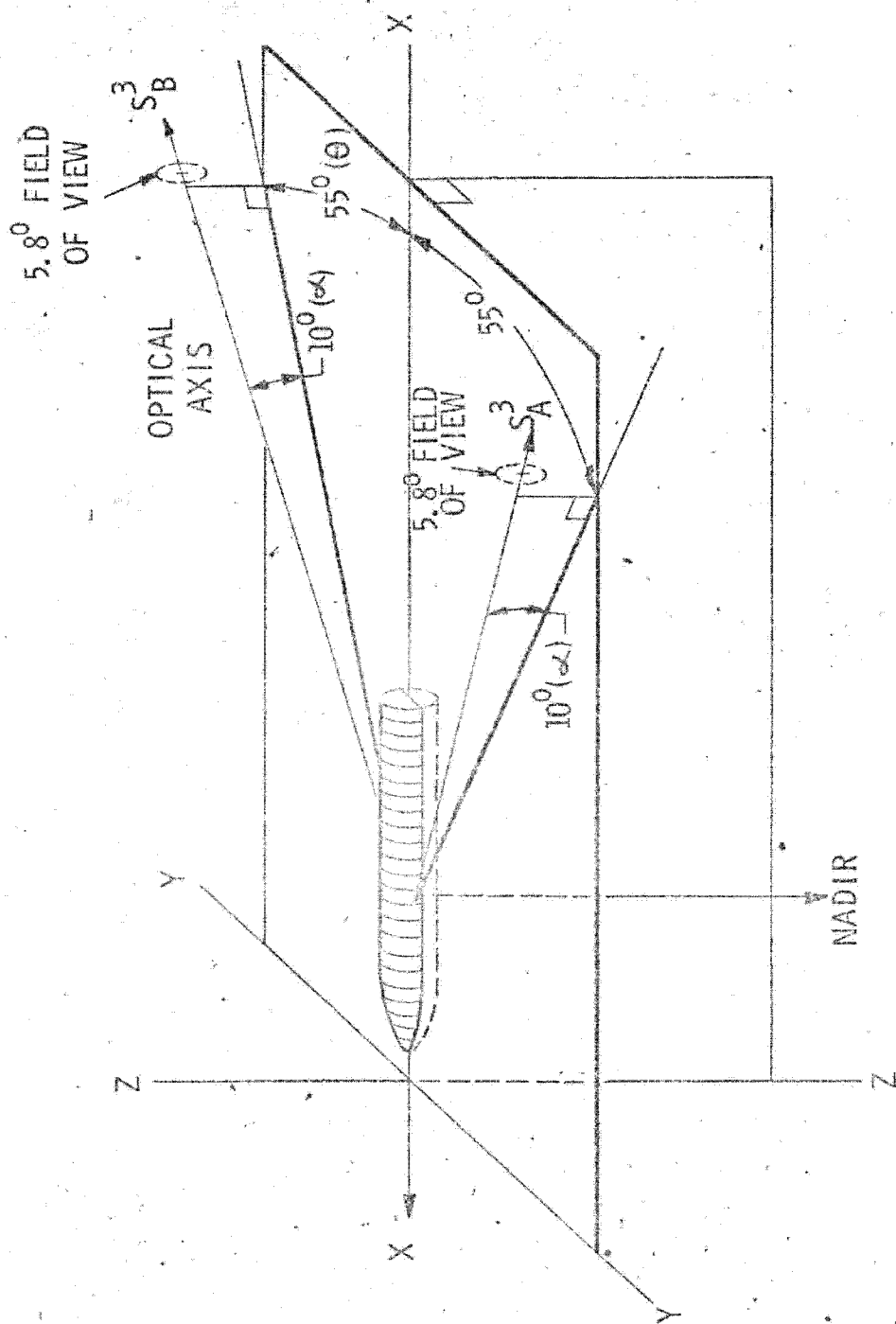
ATTITUDE REFERENCE CONCEPTS

0 STAR TRACKERS - REQUIRED EXTENSIVE INTEGRATION TO GYROS
- ACCURACY

0 STELLAR INDEX CAMERAS - FILM PATH COMPLEXITY

0 STELLAR INDEX ON INTEROP - UNDESIRABLE IMPACT ON
PRIMARY VEHICLE

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12/12/74 WER

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PREVIOUS RISK AREAS

CALIBRATION STABILITY

TCA QUAL & VID MODES

SIGNAL TO NOISE RATIO

CHIP DEV/QUAL/PROD

STUDY OBJECTIVES

- 0 PURCHASE AND TEST SOLID STATE DEVICES
- 0 DEVELOPE ERROR BUDGET BASED ON
 - LABORATORY TESTS
 - TCA THERMAL/VIBRATION TESTS
 - DETAILED ANALYSIS
- 0 DEMONSTRATE COOLING TECHNIQUE
- 0 PRELIMINARY DESIGN
 - FOCAL PLANE
 - MECHANICAL
 - ELECTRONIC
 - OPTICAL

~~SECRET/HEXAGON~~

STUDY SCHEDULE

- 0 BEGAN SEPT 74
- 0 COMPLETION FOR JULY 75 DECISION FOR SV-17 & 18
- 0 DIRECTION TO CONSIDER FOR BLOCK IV ONLY
- 0 REVISED COMPLETION DATE OF 31 DEC 75
- 0 FOCAL PLANE DEMONSTRATION DELAYED TO SPRING 76

~~SECRET/HEXAGON~~

STUDY PROGRESS TO DATE

o DETECTOR TESTING

- TESTED LINEAR 1728 x 1 CCD's
- TESTED LINEAR 1800 x 1 PHOTO-DIODES
- TESTING 244 x 190 AREA ARRAY
- SUCCESSFULLY COOLED DETECTORS TO -10° C
- BEGIN SENSITIVITY AND ACCURACY MEASUREMENTS
- RELIABILITY PROGRAM UNDERWAY

o ERROR BUDGET ANALYSIS

- TCA THERMAL TESTS COMPLETED
- TCA VIBRATION MEASURED
- DETAILED ANALYSIS PERFORMED
- PRELIMINARY REPORT PUBLISHED

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STUDY PROGRESS (continued)

- o PERFORMED SV-9 STELLAR EXPERIMENT
- o COMPLETED PRELIMINARY DESIGN
- o OPTIMIZING DESIGN FOR AREA ARRAY
CHEAPER
LIGHTER
SMALLER

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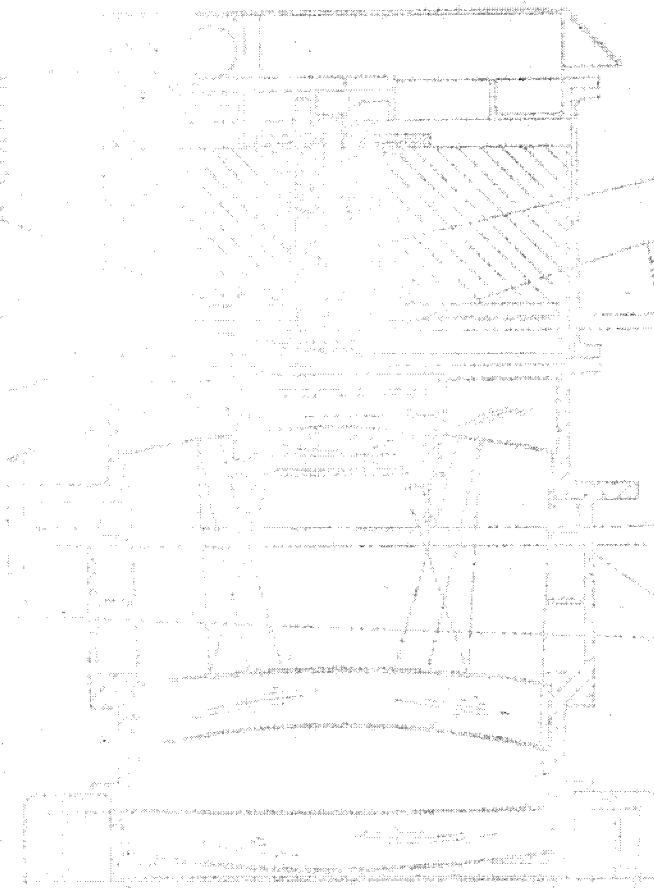
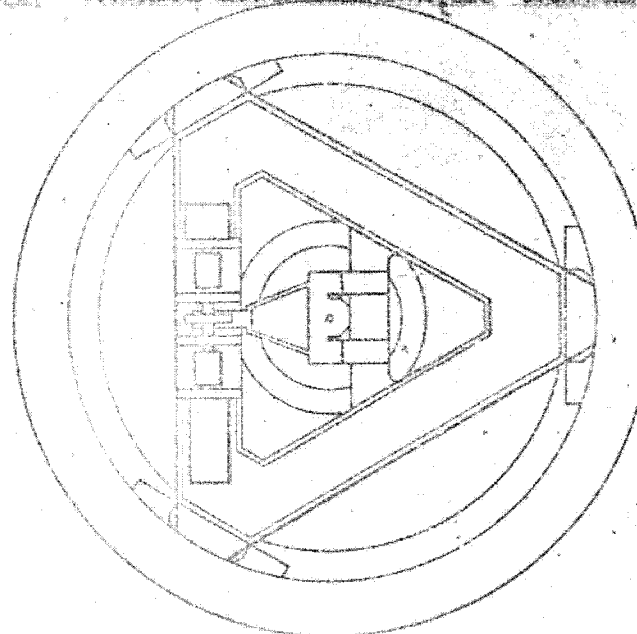
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SHIELD ASSEMBLY

HEAT SINK
FOCUS BAR
FOCUS BAR

FOCUS BAR

FOCUS BAR



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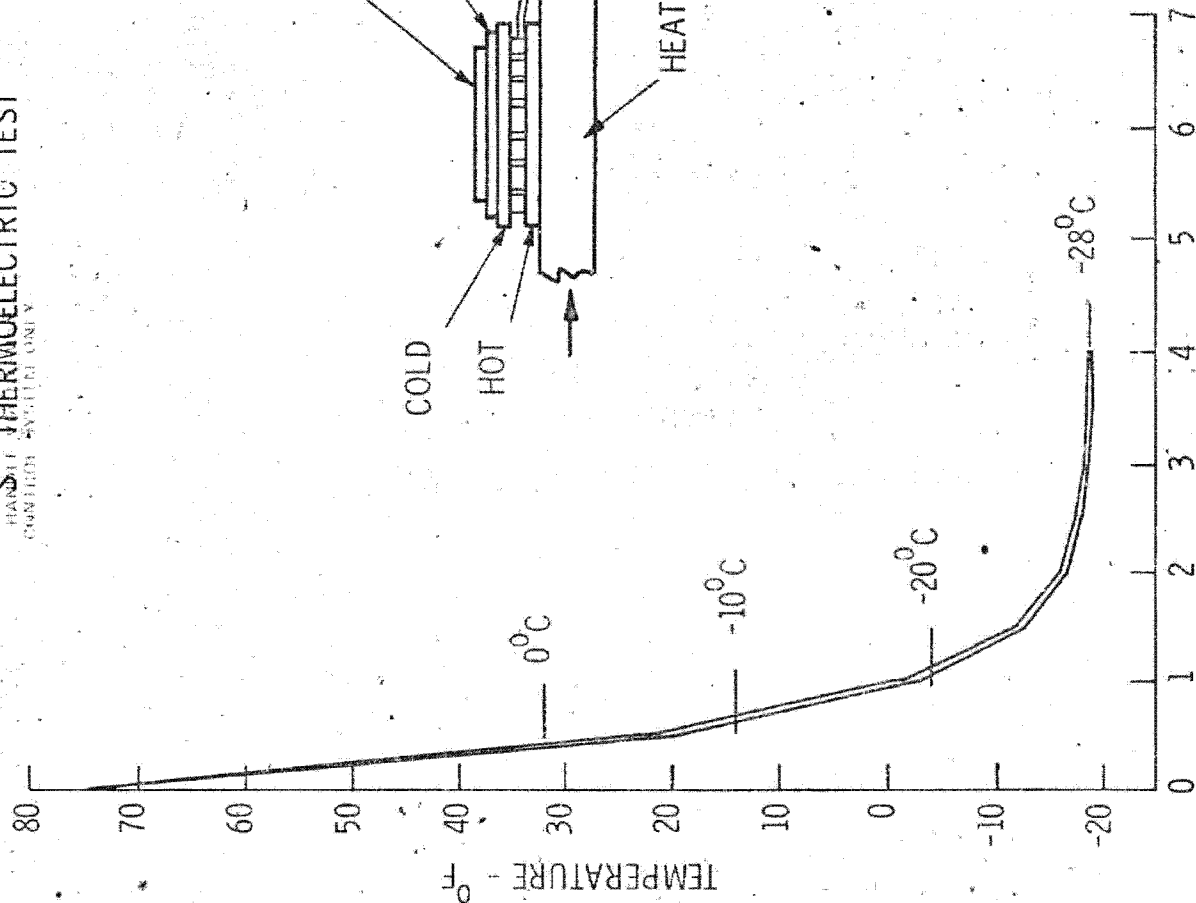
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3. THERMOELECTRIC TEST

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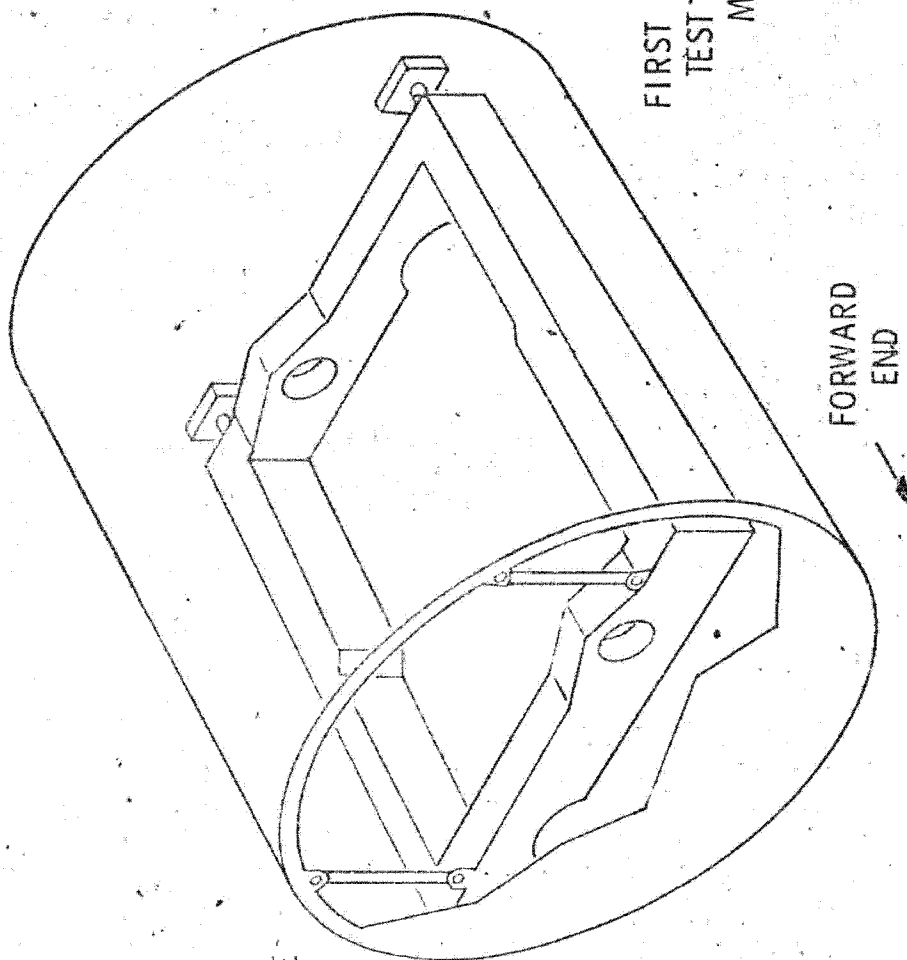
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ENVIRONMENT EFFECTS (CONT'D)

VEHICLE DISTORTION



TCA TWISTS
WHEN VEHICLE
TWISTS

FIRST CHAMBER A
TEST-VERIFIED
MOTION

FORWARD
END

10/13/75 WPK

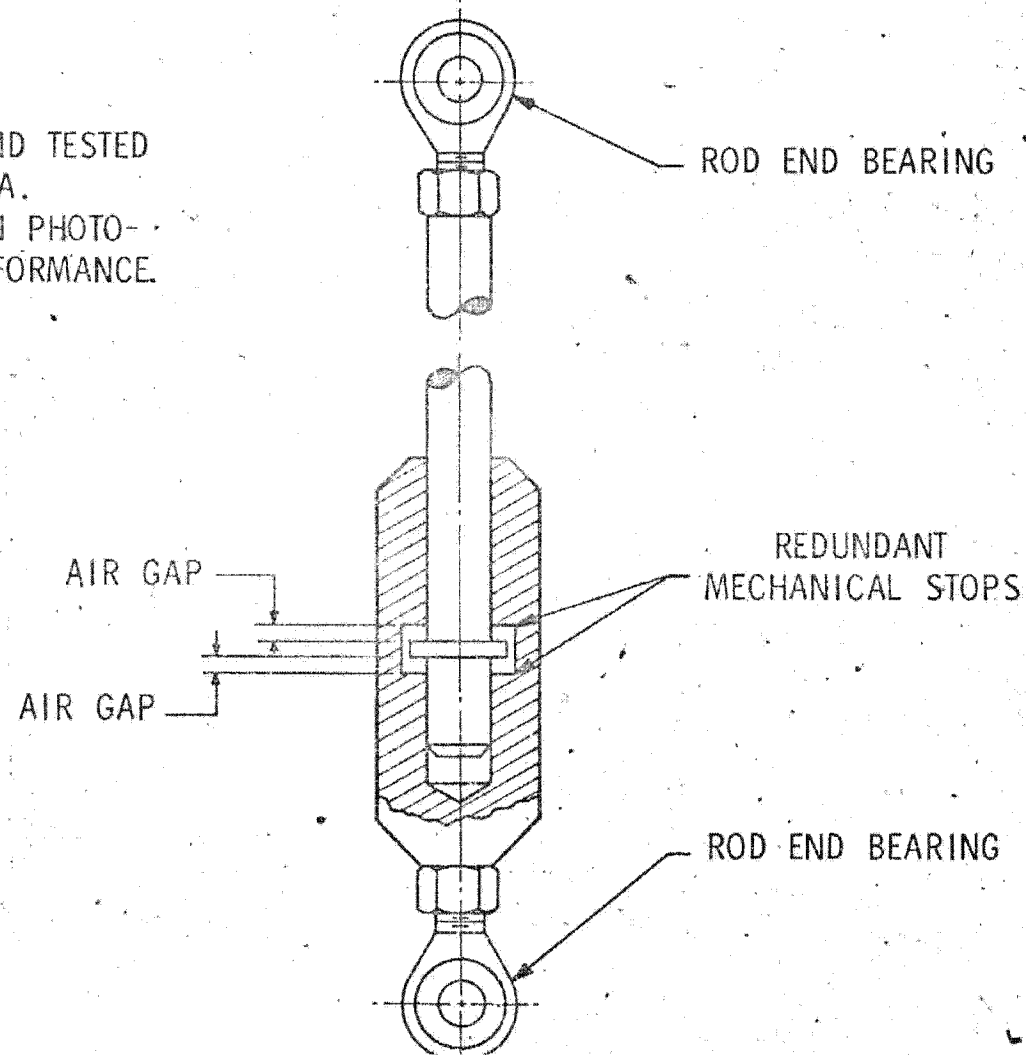
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SCHEMATIC REPRESENTATION OF MODIFIED PITCH LINK

SIMULATED AND TESTED
IN CHAMBER A.
NO EFFECT ON PHOTO-
GRAPHIC PERFORMANCE.



SAFIS P

10 LINE HYBRID FOCAL PLANE PROPOSALSMARTIN-DENVERFAIRCHILDRETICONCCDPHOTODIODECCDPHOTODIODE

222K

271K

370K

245K

- MARTIN HAS GIVEN A VERBAL QUOTE OF 90K FOR A 4 LINE ARRAY

STUDY EFFORT REMAINING

0 SELECT OPTIMUM FOCAL PLANE CONFIGURATION

0 FABRICATE FP ASSEMBLY

0 REFINE ERROR ANALYSIS

0 COMPLETE RELIABILITY TESTING

0 PUBLISH FINAL REPORT

~~SECRET/HEXAGON~~

REASONS FOR REVISING RISK ASSESSMENT

- o FOCAL PLANE NOW EXTERNAL TO LENS
- o BETTER COOLING ARRANGEMENT
- o 10 LINE ARRAY REPLACED BY 4 LINE OR AREA ARRAY
- o FIRM PROPOSALS FOR FOCAL PLANE
- o ERROR ANALYSES COMPLETE
- o SATISFACTORY VIBRATION PERFORMANCE DEMONSTRATED
- o ON ORBIT CALIBRATION CAPABILITY DEMONSTRATED
- o CCD PERFORMANCE HAS BEEN DEMONSTRATED
- o ELECTRONICS HAVE BEEN BREADBOARDED

SAFISP

RISK ASSESSMENT

<u>SCHEDULE</u>	<u>COST</u>	<u>PERFORMANCE</u>
LOW •/SV-17	5 ARC SEC	10 ARC SEC
	LOW	SOME HOPE
		LOW

• BASED ON A STRETCHED SCHEDULE WITH LAUNCH OF SV-17
IN 1980

SAFISP

ROM ESTIMATES OF S³ FUNDING REQUIREMENTS

<u>FY-76</u>	<u>7T</u>	<u>77</u>	<u>78</u>	<u>79</u>	<u>80</u>	<u>81</u>	<u>TOTAL</u>
6.5	2.0	5.9	4.0	3.2	2.3	0.26	24.16
1.24 (75 AND 76 COMMITMENT TO ITEK)							<u>1.24</u>
							25.40

- NEAR YEARS OK (76-77)
- OTHER YEARS COST WILL BE REFINED AFTER DESIGN COMPLETION (AUG 76)
- DOES NOT INCLUDE COST TO NRO DUE TO IMPACT ON ITEK

OTHER CONSIDERATIONS

- S³ DECISION COULD PUT ITEK OUT OF GOVERNMENT BUSINESS
- S³ DEVELOPMENT + SV-17 AND 18 COSTS ARE ABOUT THE SAME AS MAPPING CAMERAS FOR SV-17 AND 18
- SUBSEQUENT S³ COSTS WOULD BE SIGNIFICANTLY LOWER THAN ITEK MAPPING CAMERAS
- DUE TO ITEK BUSINESS OUTLOOK WE ARE AT LEAST AS CONFIDENT IN S³ COSTS AS WE ARE IN ITEK COSTS

S/A/F/S/M

CONCLUSIONS

- COST, SCHEDULE AND PERFORMANCE RISKS ARE ACCEPTABLE
- WE ARE PREPARED TO PROCEED ON AN S³ DEVELOPMENT FOR SV-17 AND 18
- DECISION TO PROCEED SHOULD BE BASED ON OVERALL SITUATION

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~~(S)~~ NATIONAL RECONNAISSANCE OFFICE

WASHINGTON, D.C.

THE NRO STAFF

20 October 1975

MEMORANDUM FOR THE RECORD *RM*

SUBJECT: Trip Report: Lt Col Hutchison to Perkin Elmer Corp
for Meeting on the S³ Metric Pan

Subject meeting was the result of NRO pressure to reassess the Mapping Camera System (MCS) program for SV-17 and 18 in view of cost increases. This led to our setting 20 October 1975 as a deadline for considering the Metric Pan System (MPS) as an alternative. *for 72 and 18 such an alternative* would only be possible if the progress of the MPS study laid on last March was such that SAFSP could confidently assign a low risk to the program.

The meeting on 16 October was to give Col Anderson a last minute update on the progress of the MPS study. He invited me and DMA along to ease the briefing load on 20 October, when he is scheduled to brief Mr. Plummer.

The PE briefings consisted of: 80% error analysis, 10% hardware testing to support the analysis, 5% preliminary design and 5% a laboratory tour to show focal plane array test setups. A copy of PE's charts is being provided; the following subparagraphs summarize the briefings:

A. Error analysis. The error analysis appears much more sophisticated than the one available last winter, indicating good progress. Aerospace has been participating and there is evidence that most of the subtleties have at least been identified. One major area, roll distortion of the two-camera assembly (TCA) due to hotdogging, will require the redesign of a roll link. A vibration qual test of the TCA, and perhaps the midsection, will be required. Many of the critical error budgets, such as optical bar vibration and bearing wobble have been verified by test. The bottom line of the error analysis is a 5 arc second RSS one sigma specification on-orbit. Aerospace thinks that this is an optimistic analysis, and I cannot disagree. The consensus was that the program risk would be low only if the performance spec could be relaxed to 5 to 10 arc seconds versus 5 arc seconds. The contractor stated he would sign up to 5 arc seconds, however.

Pro. A64(4)(6) ✓

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All of the items addressed in the Itek briefing to Dr. Cook were reviewed. The first two items on Itek's error source list were judged by all to be invalid: the first because such a phenomenon does not exist, and if it did, it would cause noticable and unacceptable image degradation due to uncompensated image motion; the second because the specified acceptance value for the bearings is 0.0002" TIR, not 0.001". The error budget is as stated above.

The top-level analysis by Itek was biased, in that they showed vertical errors for 60° scan angle, the worst case. DMA's analysis is what counts, and they say they will get an acceptable product, if the TCA attitude error is 5-10 arc seconds.

B. The hardware testing to support the error analysis has been successful. Thermal, photographic, and mechanical tests have been performed. So far, only the pitch link problem has resulted in basic system design changes.

C. The preliminary design work is at a reasonably advanced stage. A preliminary interface review with LMSC, covering thermal, mass properties, power, telemetry, and command, has uncovered no hard problems. It is probable that SMFT, S³, GEOPAC, MCS and one 989 subsat are incompatible on SV-16. This would mean that S³ could not be incorporated early (SV-16 versus 17) if SMFT were approved. In my view, and the contractor's, they are about three months away from a preliminary design review. The contractor estimated almost 100 man-months of effort invested so far in the S³ project, and the amount of progress seemed to justify that statement.

D. The laboratory tour showed that PE is ready to do sophisticated focal plane array testing on an automated basis. They have brassboard electronics and cooling for all of the arrays under consideration, and have already collected considerable data on linear photodiode and CCD arrays. They have a two dimensional CCD matrix set up for testing, but tests have not yet started.

When I questioned Col Anderson about the purchase of a 4 or 10 line linear array for testing, he said, "The \$150K provided last year wouldn't cover it." When I asked about the \$350K authorized in FY 76, he said he wasn't aware of it. [redacted] was also unaware of the existing \$350K budget. *may*

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In summary, given the relaxed attitude accuracy requirement approved by DMA, the contractor's current state of knowledge, the lead time for SV-17, and a budget of \$25.4 million, I judge the S³ project to be of low risk.



DANIEL B. HUTCHISON
Lt Colonel, USAF

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ATTENDEES - 16 OCTOBER 1975

Col Anderson, SAFSP-7, HEXAGON

Lt Col Powell, SAFSP-7

[REDACTED]

[REDACTED]

Don Howard, Aerospace

Tom Coffee, Aerospace

Ken Daugherty, DMA

[REDACTED] DMA

Bill Keeney, PE

Jerry Braden, PE

Vic Abraham, PE

Paul Pelly, PE

Bernie Maclin, PE

Charlie Karatzas, PE

Lt Col Hutchison, NRO

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ABSOLUTE POSITIONING
(METERS, 1 ∇)

REQUIREMENTS

1965 USIB	6/75 J SOP		EXPECTED FUTURE REQMT (1, 4)
	FIRM	TECHNICAL OBJECTIVE	
64	64	36	29
64	64	36	29
55	46	32	18

CAPABILITY

CURRENT FRAME(1)	FRAME WITH GEOPACK ⁽³⁾	8 SEC PAN ⁽²⁾ WITH GEOPACK	5 SEC PAN ⁽²⁾ WITH GEOPACK
		10 11 13	11 11 16
19	13		
19	13		
14	12		

- NOTES (1) SOURCE: DMA
(2) ABSOLUTE ATTITUDE DETERMINATION
(3) GEOPACK OPERATIONAL ON SV-13 (1977)
(4) COVERAGE 3000 HARD TARGETS IN DENIED AREAS

DMA
SAYS
~10.4

RELATIVE POSITIONING
(METERS, 1 σ)

REQUIREMENTS

1:50,000 CLASS A MAP	PAVE STRIKE	1:250,000 CLASS A MAP
12	13	59
12	13	59
3	9	15
10-20 N. MI	300 N. MI.	20 N. MI.
SELECTED		WORLD WIDE

NOTES

- 1) PRODUCTION ACTUALS
- 2) BEST-CASE ESTIMATE INCLUDING ATTITUDE
ERROR AND 10 MM MENSURATION ERROR
ONLY; ONLY 2 MODELS

CAPABILITY

CURRENT
FRAME

8

8

6⁽¹⁾

~~2 SEC
PAN~~

~~2~~

~~4 - 7~~

~~8⁽²⁾~~

5 SEC
PAN

4

8 - 14

15⁽²⁾

∇_x

∇_y

∇_z

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ST.

COVERAGE
REQUIRED

SOURCES OF UNCERTAINTY IN PAN CALIBRATION

- STUDY 10176 (1974) - ADVANCED PAN CAMERA BREADBOARD TEST
+ 20 MICRONS DYNAMIC FILM STRETCH
- STUDY 10092 (1975) - PAN CALIBRATION VERIFICATION (SV 7)
UNEXPLAINED INCONSISTENCY BETWEEN SCAN
ANGLE AND TIMING MARK POSITIONS

1.6 μ $\rightarrow$ 1 sec

SOURCES OF PAN ERROR

	<u>SEC</u>
DYNAMICS BETWEEN SCAN ANGLE MARKS	2.5
✓ .001 INCH BEARING RUNOUT .0002" per	2.0 $\Rightarrow$ 1.5
13 BIT ENCODER (1% CALIBRATION ACCURACY)	1.0
STELLAR TO PAN BORESIGHT (KNEE)	2.0
CALIBRATION	1.0 $\Rightarrow$ 2.2
STELLAR TO PAN BORESIGHT STABILITY	1.0
ATTITUDE SENSOR INTERNAL STABILITY	1.0 $\Rightarrow$ 1.5
SCAN RATE UNCERTAINTY	1.8
PLATEN-LENS LOCK UNCERTAINTY	2.0 < 1
RSS TOTAL	4.9

CONCLUSION: 5 SEC REQUIRES UNREALISTIC ERROR BUDGET

REASONS FOR MORE FRAME CAMERAS

- UNCERTAINTY IF PAN CAN BE CALIBRATED TO REQUIRED ACCURACY
- IMPROVED ABSOLUTE POSITIONING WITH GEOPACK STARTING IN 1977
- ECONOMY IN MAP PRODUCTION
- RELIABILITY - LOSS OF SINGLE PAN MEANS NO MAPPING
 - LOSS OF SINGLE STELLAR HAS 3X IMPACT ON PAN COMPARED TO FRAME
- DEDICATED COVERAGE FOR MAPPING REQUIREMENTS

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NOTES ON ITEK MEETING

1415 HOURS

15 OCTOBER 1975

Attendees

Dave Cook, Itek

 DMA

Ken Daugherty, DMA

Rich Manet, Itek (617)862-0941

George Wood, Itek

Dr. Cook

Lt Col Hutchison

SUBJECT: "Accuracy Limitations of S³"

Dr Cook's summary -

Most important - sources of pan error leading to
the 5 sec budget.

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 GUARD PASS WHIG
 GATOR PASS CHARGE

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SECDEF		X
AFSI		
FILE		

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ATTN: KWHIG, FOR HUTCHISON

KWCHARGE

SUBJ: PRELIMINARY 3-CUBED ERROR BUDGET SUMMARY

1. 3-CUBED PRELIMINARY SUMMARY ERROR BUDGET IS AS FOLLOWS

(MEASUREMENT UNITS ARE ARC SECONDS):

	ROLL	PITCH	YAW
STELLAR SENSOR POINTING ERROR	1.4	1.3	1.3
INTERLOCK CALIBRATION ERROR	1.9	2.2	1.9
ENVIRONMENTAL STABILITY	3.3	4.4	4.4
	---	---	---
R S S	4.1	4.9	4.9

PAGE 6519 3 2 3 2 7

2. THE STELLAR SENSOR POINTING ERROR IS MADE UP OF THE FOLLOWING ERROR SOURCES:

ERROR SOURCE	POINTING ERROR (3-CUBED CAMERA COORDINATES)	
	Y	Z
CENOIDING ERROR	2.3	2.3
DETECTOR LOCATION ERROR	1.6	1.6
RESIDUAL OPTICAL DISTORTION	1.6	1.6
FOCAL PLANE RESIDUAL THERMAL ERROR	1.3	1.3
STAR CATALOG UNCERTAINTY	0.5	0.5
	Y	Z
POINTING ERROR/STAR R S S	3.2	3.2
FOR 9 DETECTIONS/FIELD	1.1	1.1
ATTITUDE CONTROL SYSTEM	1.2	1.2
	---	---
3-CUBED POINTING ERROR R S S	1.6	1.6
POINTING ERROR TRANSFERRED TO TCA COORD. SYSTEM		
ROLL	1.4	
PITCH	1.3	
YAW	1.3	

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3. THE INTERLOCK CALIBRATION ERROR IS MADE UP OF THE FOLLOWING ERROR SOURCES:

ERROR SOURCE	POINTING ERROR		
	ROLL	PITCH	YAW
STELLAR SENSOR POINTING ERROR	1.4	1.3	1.3
PAN PHOTO MEASUREMENT ERROR	3.8	2.9	1.0
ANGULAR VIBRATION OF ICA	1.5	1.2	1.0
SVT CORRELATION	---	2.3	---
R S S	1.9	2.2	1.9

4. THE PAN PHOTO MEASUREMENT ERROR, WHICH IS ONE OF THE ERROR SOURCES OF THE INTERLOCK CALIBRATION ERROR SHOWN ABOVE, IS MADE UP OF THE FOLLOWING ERROR SOURCES. (MEASUREMENT ERRORS ARE IN MICRONS AND CONVERTED TO ARC SECONDS).

ERROR SOURCE	ERROR - MICRONS	
	CROSS TRACK	IN-TRACK
1. DE Wobble DUE TO BEARING RUNOUT PLUS VIBRATION OF OPTICAL ELEMENTS	5	12
2. FOCAL LENGTH CALIBRATION ERROR AND SCAN ANGLE MARK CALIBRATION		

PAGE 4

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ERRORS (WITH P14 IMPROVEMENTS)

3. ERRORS IN MEASUREMENT OF IMAGE COORDINATES AND FLUCIAL MARK COORDINATES (WITH P14 IMPROVEMENTS)
4. PLATEN SKEW ANGLE ERROR (DEPARTURE FROM PROGRAMMED INC)
5. PLATEN THERMAL EXPANSION AND UNCALIBRATED OPTICAL DISTORTION

3	4
3.5	3.5
9	
5	5
---	---

TOTAL R S S

ASSUMING 4 STARS

ERROR (ARC-SECONDS)

13 MICRONS	14 MICRONS
6.5 MICRONS	7 MICRONS
2.9	2.9

5. ENVIRONMENTAL STABILITY ERRORS ARE MADE UP OF THE FOLLOWING ERROR SOURCES:

ERROR SOURCE	POINTING ERROR		
	ROLL	PITCH	YAW
ALIGNMENT CHANGE OF PAN CAMERA LOS TO S-CUBED SENSOR MTS. DUE TO THERMAL ENVIRONMENT SIDE TO SIDE GRADIENT IN ICA (2 DEGREES F.)	1.7	2.3	3.5

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AGE 5 ~~6519 SECRET~~FRONT TONREAD GRADIENT IN TCA
(3 DEGREES F.)

0.6 0.3 1.2

TOP TO BOTTOM GRADIENT IN TCA
(0.2 DEGREES F.)

0.6 1.9

DEFORMATION IN TCA DUE TO VEHICLE
DISTORTION

1.5 1.0

PRIMARY MIRROR TILT (0.5 DEGREES F.
METERING RODS)

0.4 0.4

FOLD FLAT TILT (2.0 DEGREES F IN
TEMP. LEVEL)

--- 0.7 0.5

R S S 1

2.5 3.1 3.7

ALIGNMENT CHANGE OF S-CUBED SENSOR
LOS TO SENSOR MOUNT ON TCA THERMAL
GRADIENTS IN SENSOR HOUSING (0.5
DEGREES F.)

1.6 1.6 1.6

THERMAL SHIFT OF FOCAL PLANE DETECTOR
ARRAY

1.0 1.0 1.0

R S S 2

1.9 1.9 1.9

ANGULAR VIBRATION OF TCA RELATIVE TO
THE ARM FOLD FLAT STABILITY WITH QBPAGE 6 ~~6519 SECRET~~

VELOCITY VARIATION

1.5 1.0

R S S 3

1.0 1.8 1.4

TOTAL R S S

3.3 4.0 4.4

6. THIS DATA IS A SUMMARY OF THE S-CUBED ERROR BUDGET ANALYSIS
AND TEST PROGRAM PRESENTATION MADE ON OCTOBER 16, 1975. THE
ANALYSIS IS BASED ON THE S-CUBED CONFIGURATION PRESENTED AT THE
CONCEPT DESIGN REVIEW ON JUNE 10, 1975.

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WASHINGTON, D.C.



THE NRO STAFF

24 October 1975

MEMORANDUM FOR MR. PLUMMER

SUBJECT: Itek's Analysis of the Metric Pan

Mr. Plummer has seen
WHEELER

A copy of Itek's briefing to Dr. Cook and Dr. Hall which raised questions about the utility and feasibility of the Metric Pan System (MPS) is at TAB A. Itek had two main points:

A. An MPS with a 5 arc second attitude error would not be useful, and

B. The ability to hold the error to 5 seconds is doubtful.

We had DMA double check the vertical positional error claimed by Itek due to the 5 second attitude error, and they determined that Itek must have been assuming a scan angle of 60°. As DMA's 25 February 1975 input to us shows (TAB B), a 5 second MPS will not meet the requirement outside 45° scan. DMA has considered this in their collection analysis, as we take little imagery outside 45°.

Lt Colonel Hutchison, Colonel Anderson (SP's HEXAGON Program Manager), and Dr. Howard of Aerospace reviewed the Perkin-Elmer error budget and supporting analyses and test results at the Danbury plant on 16 October 1975. As the result of that review, it was concluded that the largest concern of Itek's, 20 microns of non-linear smear, was invalid. It was also concluded, however, that Perkin-Elmer's 4.9 second error budget might be optimistic, more suitable for a goal than a hard specification. A summary of Perkin-Elmer's analysis is at TAB C.

At this point DMA stated that their analysis (TAB B) shows that 5 seconds is acceptable as a goal, if 10 seconds is set as the limit. Based on this 5 to 10 second requirement set by DMA, SAFSP concluded that the MPS was a low risk program.

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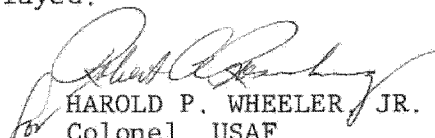
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It is our understanding that Itek has presented their analysis to ASD(I) and generated enough concern for Dr. Hall to delay sending a Mapping Camera System/MPS decision memorandum until after he has consulted with you.

In summary, we have shown the Itek Analysis to be invalid, and it is recommended that it be so reflected in your discussion with Dr. Hall. There is no technical reason that this decision memorandum should be further delayed.



HAROLD P. WHEELER, JR.
Colonel, USAF
Director

Attachments

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ACTION ~~_____~~INFORMATION ~~_____~~ *X jld.*

TICKLER _____

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SUSPENSE _____

ITEK ANALYSIS OF METRIC
PLAN; SAF/SS COMMENTS

- FINDS ITEK ANALYSIS INCORRECT
- RECOMMENDS THAT DECISION ON
MAPPING CAMERA SYSTEM / MPS
NOT BE DELAYED.
- A DISCUSSION WITH DR HALL APPEARS
APPROPRIATE. CHUCK

*all that has happened
no action reqd.*

*Mr. Plummer has seen
R*

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SS-7

Advise Mr P of
Any new problems
from 3 Nov Week
ITEK visit to Hall

R

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H

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WASHINGTON, D.C.

THE NRO STAFF

27 February 1975

MEMORANDUM FOR COLONEL ANDERSON, SP-7

SUBJECT: DMA Accuracy Requirements for Metric Panoramic Materials

The attached memorandum from the Defense Mapping Agency, outlining the accuracy requirements a successful Metric Pan System must meet, is forwarded for your use in the HEXAGON Metric Pan System Study.

Daniel B. Hutchison
DANIEL B. HUTCHISON
Lt Colonel, USAF

Atch
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PR

25 FEB 1975

MEMORANDUM FOR NATIONAL RECONNAISSANCE OFFICE

ATTENTION: Lt Col. Hutchison

SUBJECT: Capability Requirements for a Metric Panoramic System

1. Reference WHIG 0203, 072320Z Feb 75, subject: Metric Pan Study.
2. In accordance with your request, the following data represents the MC&G metric requirements for an MPS:
 - a. Panoramic camera calibration to reduce orthogonal film distortions to less than 10 micrometers (one sigma).
 - b. Time readout for panoramic exposures to 0.10 milli-seconds (one sigma).
 - c. Attitude readout of each panoramic camera to a precision of 1 (one) arc second accurate to 5-6 arc seconds (one sigma) on each axis throughout limits of scan.
 - d. Continuous attitude rate readout to less than 1.5 arc seconds/second (one sigma).
 - e. Continuous tracking and post-mission determination of the HEXAGON orbit and its ephemeris to within 30 feet (one sigma) in all components.
3. Of the above requirements all, with the exception of item c., are either currently available in HEXAGON or being addressed for incorporation by a specific point in time. The data used in the 17 January 1975 briefing to Dr. Hall (briefing materials attached) assumed errors consistent with the design specifications and projected these errors to the ground in order to define attitude requirements in keeping with the total error budget.

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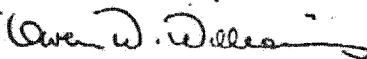
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4. We concur with your desire to determine the best approach for development of the MPS as opposed to just the solid state stellar camera but emphasize the need to initiate and complete the MPS study at the earliest possible date in order to work the funding problem for system incorporation. In keeping with this, we are available to discuss the requirement statement and Study Plan as soon as possible.

FOR THE DIRECTOR:

Enclosure a/s
(6 paper copies)


OWEN W. WILLIAMS
Acting Deputy Director
Plans, Requirements
and Technology

HEXAGON

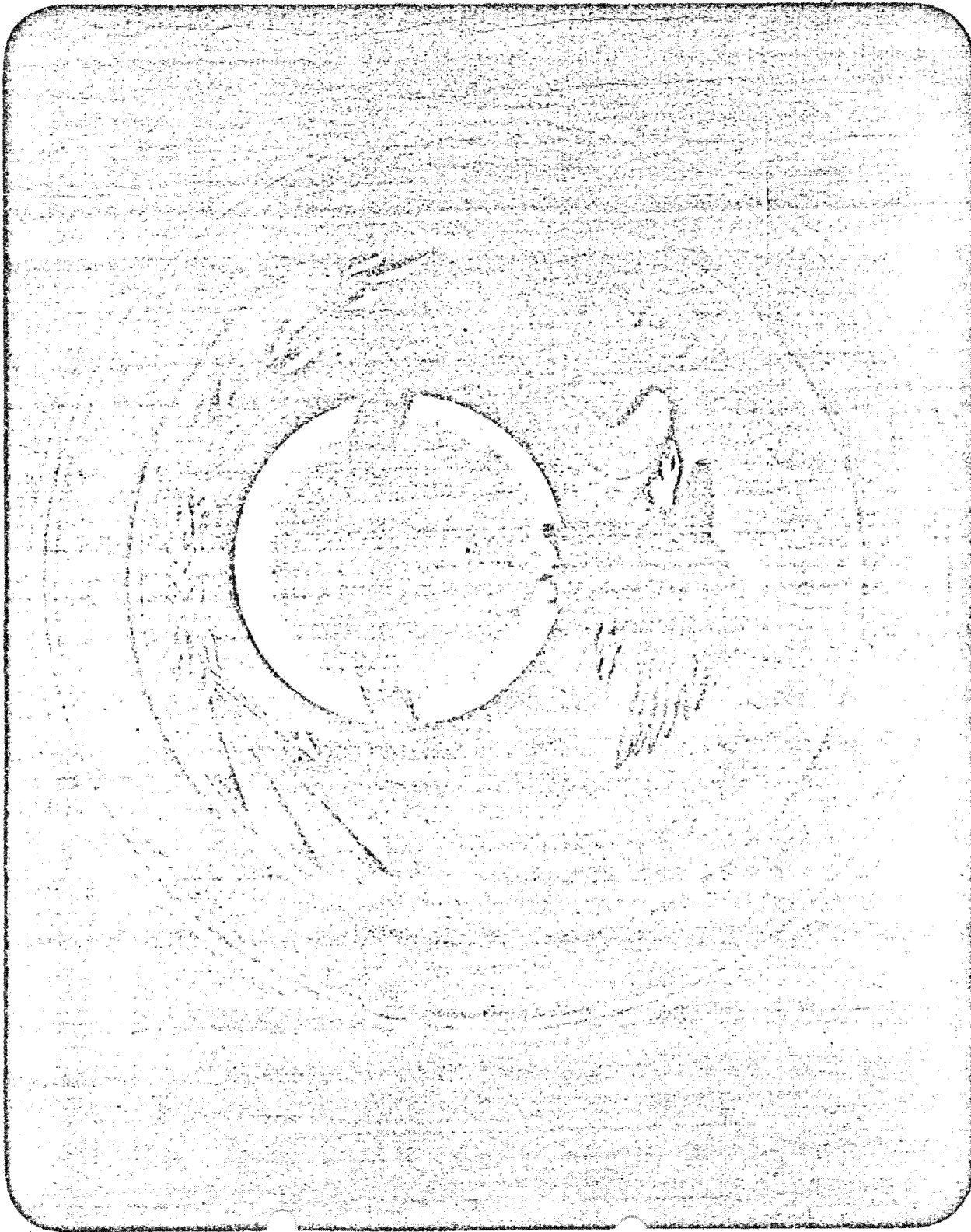
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OBJECTIVE

HORIZONTAL VERTICAL
METERS @ 90%

UPPER 39.2 22.6

MIDDLE 26.2 22.6

LOWER 22.9 17.5

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ERROR BUDGET
FOR ITEMS UNDERWAY
(MEAS @ 90%)

HORIZONTAL	0°	15°	30°	45°	60°
CALIBRATION	1.7	2.5	4.3	7.6	20.9
TIMING	.6	1.4	2.3	3.6	5.7
ORBIT POSITION	19.6	19.6	19.6	19.6	19.6
TOTAL	19.7	19.8	20.2	21.3	29.2

VERTICAL	6.3	6.9	7.4	7.8	12.9
CALIBRATION	2.8	2.8	2.8	2.8	2.8
TIMING	8.2	8.2	8.2	8.2	8.2
ORBIT POSITION	10.7	11.1	11.4	11.7	15.5
TOTAL					

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DECLASSIFICATION

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ATTITUDE ERROR PROJECTION (MEYERS @ 90%)

● HORIZONTAL	0°	15°	30°	45°	60°
5 ARC SEC.	8.4	9.8	11.3	13.4	16.7
6 ARC SEC.	10.0	10.3	11.3	13.7	19.0
10 ARC SEC.	17.3	17.6	18.5	22.2	28.1
15 ARC SEC.	26.0	26.7	28.2	31.5	40.0
● VERTICAL	0°	15°	30°	45°	60°
5 ARC SEC.	3.3	4.1	5.6	8.6	12.7
6 ARC SEC.	3.3	4.4	6.1	9.0	14.8
10 ARC SEC.	3.3	4.7	8.7	15.2	23.4
15 ARC SEC.	3.3	5.6	12.3	21.9	34.0

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ERROR BUDGET TOTALS
(MEIERS @ 90%)

	0°	15°	30°	45°	60°
○ HORIZONTAL					
WITH 5 ARC SEC.	21.4	22.1	23.1	25.1	33.7
6 ARC SEC.	22.1	22.4	23.2	25.4	31.8
10 ARC SEC.	26.2	26.5	27.4	30.8	40.5
15 ARC SEC.	32.6	33.2	34.7	38.0	42.5

○ VERTICAL					
WITH 5 ARC SEC.	11.2	11.8	12.7	14.5	20.1
6 ARC SEC.	11.2	11.9	12.9	14.7	21.4
10 ARC SEC.	11.2	12.0	14.3	19.2	23.1
15 ARC SEC.	11.2	12.4	16.8	24.8	37.4

HANDLE VIA
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SATISFACTION

● HORIZONTAL

	UPPER	MIDDLE	LOWER
WITH 5 ARC SEC.	0-60°	0-45°	0-30°
6 ARC SEC.	0-60°	0-45°	0-30°
10 ARC SEC.	0-60°	0-15°	---
15 ARC SEC.	0-45°	---	---

● VERTICAL

WITH 5 ARC SEC.	0-60°	0-60°	0-45°
6 ARC SEC.	0-60°	0-60°	0-45°
10 ARC SEC.	0-45°	0-45°	0-30°
15 ARC SEC.	0-30°	0-30°	0-30°

GROUP 1
EXCLUDED FROM AUTOMATIC
DOWNGRADING AND
DECLASSIFICATION

HANDLE VIA
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BY 7K-1

~~TOP SECRET~~

COMPOSITE SATISFACTION

SYSTEM WITH	UPPER	MIDDLE	LOWER
5 ARC SEC.	0-60°	0-45°	0-30°
6 ARC SEC.	0-60°	0-45°	0-30°
10 ARC SEC.	0-45°	0-15°	----
15 ARC SEC.	0-30°	----	-----

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GROUP 1
EXCLUDED FROM AUTOMATIC
DOWNGRADING AND
DECLASSIFICATION
SCHEDULE

RV 7/1

ABSOLUTE POSITIONING
(METERS, 1ST)

REQUIREMENTS

1965 USIB	6/75 J SOP		EXPECTED FUTURE REQMT (1, 4)
	FIRM	TECHNICAL OBJECTIVE	
64	64	36	29
64	64	36	29
55	46	32	18

CAPABILITY

CURRENT FRAME(1)	FRAME WITH GEOPACK ⁽³⁾	~~3 SEC PAN⁽²⁾ WITH GEOPACK~~	5 SEC PAN ⁽²⁾ WITH GEOPACK
19	13	10	11
19	13	11	11
14	12	13	16

x
y
z
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- NOTES (1) SOURCE: DMA
(2) ABSOLUTE ATTITUDE DETERMINATION
(3) GEOPACK OPERATIONAL ON SV-13 (1977)
(4) COVERAGE 3000 HARD TARGETS IN DENIED AREAS

DMA
SAYS
~10.4

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RELATIVE POSITIONING
(METERS, 1 ∇)

REQUIREMENTS

1:50,000 CLASS A MAP	PAVE STRIKE	1:250,000 CLASS A MAP
12	13	59
12	13	59
3	9	15
10-20 N. MI	300 N. MI.	20 N. MI.
SELECTED		WORLD WIDE

CAPABILITY

CURRENT FRAME	~~2 SEC PAN~~	5 SEC PAN
8	~~2~~	4
8	~~4 - 7~~	8 - 14
6 ⁽¹⁾	~~8⁽²⁾~~	15 ⁽²⁾

∇_x

∇_y

∇_z

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IST.

OVERAGE
REQUIRED

NOTES

- 1) PRODUCTION ACTUALS
- 2) BEST-CASE ESTIMATE INCLUDING ATTITUDE
ERROR AND 10 MM MENSURATION ERROR
ONLY; ONLY 2 MODELS

SOURCES OF UNCERTAINTY IN PAN CALIBRATION

- STUDY 10176 (1974) - ADVANCED PAN CAMERA BREADBOARD TEST
+ 20 MICRONS DYNAMIC FILM STRETCH
- STUDY 10092 (1975) - PAN CALIBRATION VERIFICATION (SV 7)
UNEXPLAINED INCONSISTENCY BETWEEN SCAN
ANGLE AND TIMING MARK POSITIONS

1.6 μ $\rightarrow$ 1 sec

SOURCES OF PAN ERROR

	<u>SEC</u>
DYNAMICS BETWEEN SCAN ANGLE MARKS	<u>2.5</u>
$\rightarrow$.001 INCH BEARING RUNOUT .0002" per	2.0 $\Rightarrow$ 1.5
$\rightarrow$ 13 BIT ENCODER (1% CALIBRATION ACCURACY)	1.0
STELLAR TO PAN BORESIGHT (KNEE) CALIBRATION	2.0 $\rightarrow$ 2.2
STELLAR TO PAN BORESIGHT STABILITY	1.0
ATTITUDE SENSOR INTERNAL STABILITY	<u>1.0</u> $\rightarrow$ 1.5
SCAN RATE UNCERTAINTY	1.8
PLATEN-LENS LOCK UNCERTAINTY	<u>2.0</u> < 1
RSS TOTAL	4.9

CONCLUSION: 5 SEC REQUIRES UNREALISTIC ERROR BUDGET

REASONS FOR MORE FRAME CAMERAS

- UNCERTAINTY IF PAN CAN BE CALIBRATED TO REQUIRED ACCURACY
- IMPROVED ABSOLUTE POSITIONING WITH GEOPACK STARTING IN 1977
- ECONOMY IN MAP PRODUCTION
- RELIABILITY - LOSS OF SINGLE PAN MEANS NO MAPPING
 - LOSS OF SINGLE STELLAR HAS 3X IMPACT ON PAN COMPARED TO FRAME
- DEDICATED COVERAGE FOR MAPPING REQUIREMENTS

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BYEMAN

CONTROL SYSTEM

~~(S)~~ NATIONAL RECONNAISSANCE OFFICE

WASHINGTON, D.C.

THE NRO STAFF

31 October 1975

MEMORANDUM FOR THE RECORD

SUBJECT: Briefing to Mr. Goulder

The attached briefing was given to Mr. Goulder, ASD(I), on 28 October 1975. His comments indicated that he was pleased with the briefing, but that he still feels that the MPS is more resource than DMA needs. He also seemed to feel that the PE approach is too sophisticated.

[Signature]
DANIEL B. HUTCHISON
Lt Colonel, USAF

Attachment

HEXAGON

10-31-75

WORKING PAPERS

✓

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GENERAL DECLASSIFICATION SCHEDULE OF
EXECUTIVE ORDER 11652 EXEMPTION CATE-
GORY 5B2 DECLASSIFY ON IMP DET.

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ATTITUDE REFERENCE CONCEPTS

- STAR TRACKERS - REQUIRED EXTENSIVE INTEGRATION TO GYROS
- ACCURACY
- STELLAR INDEX CAMERAS - FILM PATH COMPLEXITY
- STELLAR INDEX ON INTEROP - UNDESIRABLE IMPACT ON
PRIMARY VEHICLE

MAPPING CAMERA SYSTEM STATUS

(\$ MILLIONS)

	APPROVED PROGRAM	(1) CURRENT PROGRAM	(2) INCREASE
MCS ACQUISITION -			
MAPPING CAMERAS (SV 17 & 18)	\$17.2	\$22.3	\$ 5.1
RECOVERY VEHICLES	<u>2.2</u>	<u>3.9</u>	<u>1.7</u>
SUBTOTAL	\$19.4M	\$26.2M	\$+6.8M
FUND PROTECTION -			
MCS/SPACECRAFT INTEGRATION		\$ 2.3M	
UNDEFINED STUDIES	<u> </u>	<u>0</u>	<u> </u>
SUBTOTAL	\$ 6.0M	\$ 2.3M	\$-3.7M
TOTAL	\$25.4M	\$28.5M	\$+3.1M

NOTES:

(1) BASED ON CONTRACTOR ESTIMATES

(2) BASED ON NEGOTIATED CONTRACT

HEXAGON KENNEN

CURRENT NRP MC&G ALTERNATIVES

(\$ IN MILLIONS)

	<u>FY76</u>	<u>FY77</u>	<u>FY77</u>	<u>FY78</u>	<u>FY79</u>	<u>FY80</u>	<u>FY81</u>	<u>TOTAL</u>
APPROVED PROGRAM	9.7	-	9.7	2.0	2.0	2.0	-	25.4
CURRENT ALTERNATIVES:								
MAPPING CAMERAS FOR								
HEX 17 AND 18*	9.7	-	7.1	4.6	3.2	3.0	.9	28.5
METRIC PAN SYSTEM								
HEX 17 AND 18*	7.7	2.0	5.9	4.0	3.2	2.3	.3	25.4

* DOES NOT INCLUDE NAVPAC HARDWARE OR INTEGRATION

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S³ SOLID STATE STELLAR CAMERA

HEXAGON

BRIEFING OUTLINE

- BACKGROUND
- S³ STUDY ACCOMPLISHMENT
- FUNDS REQUIRED
- RISK ASSESSMENT
- CONCLUSIONS

BACKGROUND

- DMA/SP-6 STUDIES ON METRIC PAN IDENTIFIED:
 - IMPROVED INTERNAL GEOMETRY KNOWLEDGE
 - IMPROVED GEOGRAPHIC REFERENCE
 - IMPROVED ATTITUDE REFERENCE
- CHANGES IN PROCESS
 - NAVPAC (SV-13)
 - 1° SCAN ANGLE DOTS (SV-14)
 - FIDUCIAL X-HAIRS (SV-14)
 - OB CALIBRATION (SV-14)
- REMAINING REQUIREMENT IS TO DETERMINE THE ATTITUDE TO
5-10 ARC SECONDS

PREVIOUS RISK AREAS

CALIBRATION/STABILITY

TCA QUAL & VIB MODES

SIGNAL TO NOISE RATIO

CHIP DEV/QUAL/PROD

HEXAGON

STUDY OBJECTIVES

- PURCHASE AND TEST SOLID STATE DEVICES
- DEVELOP ERROR BUDGET BASED ON
 - LABORATORY TESTS
 - TCA THERMAL/VIBRATION TESTS
 - DETAILED ANALYSIS
- DEMONSTRATE COOLING TECHNIQUE
- PRELIMINARY DESIGN
 - FOCAL PLANE
 - MECHANICAL
 - ELECTRONIC
 - OPTICAL

HEXAGON

STUDY SCHEDULE

- BEGAN SEPTEMBER 74
- COMPLETION FOR JULY 75 DECISION FOR SV-17 & 18
- DIRECTION TO CONSIDER FOR BLOCK IV ONLY
- REVISED COMPLETION DATE OF 31 DEC 75
- FOCAL PLANE DEMONSTRATION DELAYED TO SPRING 76

HEXAGON

STUDY PROGRESS TO DATE

- DETECTOR TESTING
 - TESTED LINEAR 1728 x 1 CCD's
 - TESTED LINEAR 1800 x 1 PHOTO-DIODES
 - TESTING 244 x 190 AREA ARRAY
 - SUCCESSFULLY COOLED DETECTORS TO -10°C
 - BEGUN SENSITIVITY AND ACCURACY MEASUREMENTS
 - RELIABILITY PROGRAM UNDERWAY
- ERROR BUDGET ANALYSIS
 - TCA THERMAL TESTS COMPLETED
 - TCA VIBRATION MEASURED
 - DETAILED ANALYSIS PERFORMED
 - PRELIMINARY REPORT PUBLISHED

HEXAGON

STUDY PROGRESS (CONT'D)

- PERFORMED SV-9 STELLAR EXPERIMENT
- COMPLETED PRELIMINARY DESIGN
- OPTIMIZING DESIGN FOR AREA ARRAY
CHEAPER
LIGHTER
SMALLER

KENNEN HEXAGON

NRP MAPPING REQUIREMENTS REVIEW

- ASD(I) - 17 JAN 1975 - APPROVED ACQUISITION OF MAPPING CAMERAS FOR HEXAGON MISSION 17 AND 18. DIRECTED DNRO STUDY OF METRIC PAN MODIFICATION.
- CURRENT STATUS REVIEW:
 - MAPPING CAMERA COST INCREASES
 - SCHEDULE STRETCH OF HEXAGON MISSIONS 17 AND 18 BY ONE YEAR
 - METRIC PAN STUDY STATUS
 -
- DMA REQUIREMENTS SATISFACTION
- REQUEST ASD(I) DIRECTION PRIOR TO 1 NOVEMBER 1975 MCS VS. MPS ACQUISITION

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27 Oct 75 ~~TOP SECRET~~

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MAPPING CAMERA SYSTEMS SUPPORT (C-911442)
(Approval Subject to NSA funding)

	<u>FY76</u>	<u>FY77</u>	<u>FY78</u>	<u>FY79</u>	<u>FY80</u>	<u>FY81</u>	<u>TOTAL</u>
<u>RELATED TO HEXAGCI PROGRAM (Data provided in current FY budget)</u>							
Metric capability on Panoramic camera effective w/ Vehicle 17 on the Alternate 1 Schedule.	9.7	-	8.3	1	1.5	2.3	0.3 25.4
NAVPAC hardware for Vehicles 16-18 on the Alternate 1 Schedule.	1.0	-	2.2	0.9	1	0.1	0.1 4.2
NAVPAC integration on Vehicles 16-18 on the Alternate 1 Schedule.	-	-	0.5	0.3	0.2	0.1	0.1 1.2
Subtotal	10.7	0	11.6	2.7	2.8	0.5	0.5 30.8

CONCLUSIONS

- COST, SCHEDULE AND PERFORMANCE RISKS ARE ACCEPTABLE
- WE ARE PREPARED TO PROCEED ON AN S³ DEVELOPMENT FOR SV-17 AND 18
- DECISION TO PROCEED SHOULD BE BASED ON OVERALL SITUATION

OTHER CONSIDERATIONS

- S³ DECISION COULD PUT ITEK OUT OF GOVERNMENT BUSINESS
- S³ DEVELOPMENT + SV-17 AND 18 COSTS ARE ABOUT THE SAME AS MAPPING CAMERAS FOR SV-17 AND 18
- SUBSEQUENT S³ COSTS WOULD BE SIGNIFICANTLY LOWER THAN ITEK MAPPING CAMERAS
- DUE TO ITEK BUSINESS OUTLOOK WE ARE AT LEAST AS CONFIDENT IN S³ COSTS AS WE ARE IN ITEK COSTS

ROM ESTIMATES OF S³ FUNDING REQUIREMENTS

<u>FY-76</u>	<u>7T</u>	<u>77</u>	<u>78</u>	<u>79</u>	<u>80</u>	<u>81</u>	<u>TOTAL</u>
6.5	2.0	5.9	4.0	3.2	2.3	0.26	24.16
1.24 (75 AND 76 COMMITMENT TO ITEK)							<u>1.24</u>
							25.40

- NEAR YEARS OK (76-77)
- OTHER YEARS COST WILL BE REFINED AFTER DESIGN COMPLETION (AUG 76)
- DOES NOT INCLUDE COST TO NRO DUE TO IMPACT ON ITEK

RISK ASSESSMENT

<u>SCHEDULE</u>	<u>COST</u>	<u>PERFORMANCE</u>	
		<u>5 ARC SEC</u>	<u>10 ARC SEC</u>
LOW */SV-17	LOW	SOME HOPE	LOW

* BASED ON A STRETECHED SCHEDULE WITH LAUNCH OF SV-17
IN 1980

REASONS FOR REVISING RISK ASSESSMENT

- FOCAL PLANE NOW EXTERNAL TO LENS
- BETTER COOLING ARRANGEMENT
- 10 LINE ARRAY REPLACED BY 4 LINE OR AREA ARRAY
- FIRM PROPOSALS FOR FOCAL PLANE
- ERROR ANALYSES COMPLETE
- SATISFACTORY VIBRATION PERFORMANCE DEMONSTRATED
- ON ORBIT CALIBRATION CAPABILITY DEMONSTRATED
- CCD PERFORMANCE HAS BEEN DEMONSTRATED
- ELECTRONICS HAVE BEEN BREADBOARDED

HEXAGON

STUDY EFFORT REMAINING

- SELECT OPTIMUM FOCAL PLANE CONFIGURATION
- FABRICATE FP ASSEMBLY
- REFINE ERROR ANALYSIS
- COMPLETE RELIABILITY TESTING
- PUBLISH FINAL REPORT

10 LINE HYBRID FOCAL PLANE PROPOSALS

<u>MARTIN-DENVER*</u>		<u>FAIRCHILD</u>	<u>RETICON</u>
<u>CCD</u>	<u>PHOTODIODE</u>	<u>CCD</u>	<u>PHOTODIODE</u>
282K	271K	379K	245K

* MARTIN HAS GIVEN A VERBAL QUOTE OF 90K FOR A 4 LINE ARRAY

~~TOP SECRET~~HANDLE VIA
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CONTROL SYSTEM~~(S)~~ NATIONAL RECONNAISSANCE OFFICE

WASHINGTON, D.C.



THE NRO STAFF

31 October 1975

MEMORANDUM FOR MR. PLUMMER

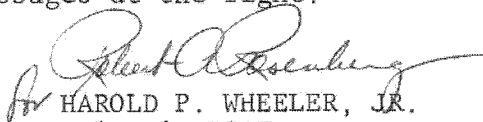
SUBJECT: HEXAGON Mapping Decisions

As the result of our 20 October meeting, Dr. Hall issued the decision memorandum at TAB A, asking for the termination of the mapping camera system (MCS) for SV-17 and 18 and establishment of the metric pan system (MPS) as the baseline for these two missions. In response, we sent the message at TAB B, directing termination of the new MPS procurement. SAFSP's resulting direction to Itek is at TAB C.

The messages at the right direct implementation of the MPS as the HEXAGON baseline, establish a 15 January 1976 milestone for a detailed program and technical staff review prior to major fund commitment (greater than \$1 million), and inform DMA of our actions. The program review is needed to assess the final technical and programmatic results of the MPS study.

The Director's Report for the November ExCom properly reflects the above actions.

Recommend you sign the messages at the right.


HAROLD P. WHEELER, JR.
Colonel, USAF
Director

Attachments

Hall Memo (TAB A)
WHIG 1632 (TAB B)
CHARGE 9620 (TAB C)

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GENERAL DECLASSIFICATION SCHEDULE OF
EXECUTIVE ORDER 11652 EXEMPTION CATE-
GORY 5B2 DECLASSIFY ON IMP DET.~~TOP SECRET~~

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INTELLIGENCE

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ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D. C. 20301

24 OCT 1975

MEMORANDUM FOR THE DIRECTOR, NATIONAL RECONNAISSANCE OFFICE

SUBJECT: Proposed Change to the Overhead Mapping Program

I have reviewed the options you presented for providing a metric mapping capability in conjunction with the currently approved HEXAGON program. Our assessment of the technical, cost and schedule risk that you presented in the 20 October meeting is that the risk is now acceptable to change the baseline configuration for HEXAGON vehicles 17 and 18 to the Metric Pan System (MPS). Vice Admiral Cramer also indicated his preference for this course of action at the meeting. The termination of the Mapping Camera System procurement for vehicles 17 and 18 and applying the MC&G program element funds for MPS procurement is approved.

Please relay to your staff appreciation for their timely support in this matter. As a result, we were able to accommodate the restructuring of the program prior to Defense Mapping Agency budget submittal.

Albert C. Hall
Albert C. Hall

Copies to:
Mr. Colby
VADM Cramer

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Classified by BYEMAN-1
EXEMPT FROM GENERAL DECLASSIFICATION SCHEDULE OF
EXECUTIVE ORDER 11652. EXEMPTION CATEGORY Para 5B(2)&(3)
DECLASSIFY ON Impossible to determine

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SUL 771/ww
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IMMEDIATE CHARGE.

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BUDGET SECUR.

FOR KULPA/HOFMANN/CAMPELL FROM WHEELER.

SUBJECT: DECISION ON METRIC PAN SYSTEM FOR HEXAGON.

1. MR. A. HALL, ON 24 OCT 75, SIGNED A MEMO WHICH APPROVES THE METRIC CAPABILITY FOR THE HEXAGON PANOPANIC CAMERAS ON VEHICLES 17 & 18. APPROVAL TO PROCEED IS SUBJECT TO DUMO CONCURRENCE.

2. AS A RESULT OF THIS DECISION, ALL WORK CONNECTED WITH THE MCS FOR HEXAGON VEHICLES 17 & 18 SHOULD BE TERMINATED AT ONCE. ISSUE APPROPRIATE STOP WORK ORDERS IMMEDIATELY.

3. PROVIDE UPDATED ESTIMATES OF THE TERMINATION COST IMPACTS, AS SOON AS POSSIBLE BUT NOT LATER THAN 28 NOV 75.

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ACORN 1630, GUARD 956
GUARD PASS WHIG

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~~SECRET~~ 293135Z OCT 75 CITE CHARGE 9620.
PRIORITY ACORN, INFO PRIORITY:WHIG.
HANDLE VIA BYEMAN CHANNELS ONLY
HEXAGON
DELIVER BY 0303 29 OCT 75
FOR: D. JONES/J. R. MANENT INFO: [] H. WHEELER
FROM: D. CAMPBELL
SUBJECT: MODIFICATIONS NO. P00030 AND P00035 TO
CONTRACT [] AND PROPOSAL FOR MCS
FOR VEHICLES 17 & 18 TO THE HEXAGON PROGRAM.
THIS CONFIRMS VERBAL CONVERSATION 23 OCT 75 WITH MR.
DANA JONES OF YOUR COMPANY. DIRECTION HAS BEEN GIVEN
TO HQ SAFSP NOT TO PROCURE THE MAPPING CAMERA
SYSTEM FOR VEHICLES 17 & 18. THEREFORE YOU ARE
DIRECTED TO CEASE WITH ANY EFFORT AND INCURRANCE

~~SECRET~~
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10/1/88

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HUTCH
Pro Abe
Metric Pan



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~~SECRET~~ 032331Z NOV 75 CITE WHIG 1671.
PRIORITY CHARGE.
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HEXAGON

CHARGE FOR BRIG GEN KULPA FROM MR. PLUMMER
SUBJECT: HEXAGON MAPPING DECISIONS
REFERENCE: WHIG 1632, 232210Z OCT 75
1. IN RESPONSE TO A DECISION BY ASD(I), I AM HEREBY
DIRECTING THAT THE METRIC PAN SYSTEM (MPS) BE
INCORPORATED INTO THE HEXAGON BASELINE FOR SV-17 AND
18. THE REFERENCED MESSAGE DIRECTED TERMINATION OF
THE MAPPING CAMERA SYSTEM (MCS) FOR THOSE MISSIONS.
2. WHILE THE DECISION FOR MPS ON SV-17 AND 18 HAS BEEN
MADE, AND IS SO REFLECTED IN THE KWETTER BUDGET, THIS
DECISION WILL BE REVIEWED BEFORE MAJOR EXPENDITURES

Ready

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PAGE 2 WHIG 1671 ~~SECRET~~
(GREATER THAN \$1 MILLION) ARE REQUIRED. REQUEST YOU
SUPPORT A MAJOR MILESTONE REVIEW ON 15 JANUARY 1976,
PRIOR TO PROCEEDING FROM THE STUDY PHASE TO THE PROCURE-
MENT PHASE OF THE MPS PROGRAM. YOU SHOULD PROVIDE A
DETAILED PROGRAM REVIEW, INCLUDING TECHNICAL APPROACH,
SCHEDULE, AND REVISED COSTS.

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SOCOMM MESSAGEFORM				IC/ N CENTER																																	
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D R A P T E R	TYPED NAME AND TITLE LT COL HUTCHISON		PHONE 71817	SIGNATURE <i>J. Plummer</i>																																	
				TYPED (or stamped) NAME AND TITLE																																	
SECURITY CLASSIFICATION ~~SECRET~~			REGRADING INSTRUCTIONS E-2 IMPDET																																		

SOCOMM Form 173

1 Aug 71

Approved for Release: 2025/07/25 C05127913

C05127913

SOCOMM		Approved for Release: 2025/07/25 C05127913		SECURITY CLASSIFICATION	
CONTINUATION SHEET				~~SECRET~~	
PRECEDENCE	RELEASED BY	DRAFTED BY		PHONE	
ACTION	PRIORITY				
INFO					
(GREATER THAN \$1 MILLION) ARE REQUIRED. REQUEST YOU SUPPORT A MAJOR MILESTONE REVIEW ON 15 JANUARY 1976, PRIOR TO PROCEEDING FROM THE STUDY PHASE TO THE PROCUREMENT PHASE OF THE MPS PROGRAM. YOU SHOULD PROVIDE A DETAILED PROGRAM REVIEW, INCLUDING TECHNICAL APPROACH, SCHEDULE, AND REVISED COSTS. E-2 IMPDET					
CONTROL NO.	TOR/TOD	PAGE NO.	NO. OF PAGES	MESSAGE IDENTIFICATION	INITIALS
		2	2		
REGRADING INSTRUCTIONS			SECURITY CLASSIFICATION		
			~~SECRET~~		

~~SECRET~~
HANDLE VIA BYEMAN
CONTROL SYSTEM

Hotch
Pro A 6 e(4)b
Metric Pan



PP RUDGAA RUDRIA
DE RUDGAA 795 388811
ZNY XXXXX KKK ZHH
P 032332Z
BT
XXXXX
ANGLO 417, CATOR 718
CATOR PASS CHARGE
ANGLO PASS ETHER

SWB568/c
AA *07/7*
RC

~~SECRET~~ 032332Z NOV 75 CITE WHIG 1672.
PRIORITY ETHER INFO PRIORITY CHARGE.
HANDLE VIA BYEMAN CONTROL CHANNELS ONLY
HEXAGON
ETHER FOR VADM CRAMER, CHARGE FOR BRIG GEN KILPA FROM
MR PLUMMER
SUBJECT: HEXAGON MAPPING DECISIONS
REFERENCE: WHIG 1632, 232218Z OCT 75
IN RESPONSE TO A DECISION BY ASD(1), I HAVE DIRECTED
THAT THE METRIC PAN SYSTEM (MPS) BE INCORPORATED INTO THE
HEXAGON BASELINE FOR SV-17 AND 18. THE REFERENCED MES-
SAGE, NOT SENT TO KWETHER, DIRECTED TERMINATION OF THE
MAPPING CAMERA SYSTEM (MCS) FOR THOSE MISSIONS.
E-2 IMPDET
~~SECRET~~
BT

~~SECRET~~
HANDLE VIA BYEMAN
CONTROL SYSTEM

Early

DISTRIBUTION		
SAFSS	A	I
SAFUS		
DD		
SS-1		
SS-2		
SS-3		
SS-4		
SS-5		
SS-6		
SS-7		
COMP		
SS-1/RF		
RF-11		
FILE		

WORKING COPY

SOCOMM MESSAGEFORM				Approved for Release: 2025/07/25 C05127913		CENTER	
SECURITY CLASSIFICATION				795		KKK	
~~SECRET~~				RECD. SAFSS			
TYPE MSG		BOOK	MULTI	SINGLE		1975 OCT 34 PM 6:32	
PRECEDENCE				DTS			
ACTION		PRIORITY					
INFO		PRIORITY					
FROM: WHIG						SPECIAL INSTRUCTIONS	
TO: ^{Amala} ETHER - 417						HANDLE VIA BYEMAN CONTROL SYSTEM	
INFO: ^{Chase} CHARGE - 718						DISTRIBUTION:	
SECRET CITE <u>1672</u>						DNRO X	
HANDLE VIA BYEMAN CONTROL CHANNELS ONLY						DDNRO X	
HEXAGON						SS-1 X	
ETHER FOR VADM CRAMER, CHARGE FOR BRIG GEN KULPA FROM						SS-2 EXEC	
MR PLUMMER						SS-2 ADMIN X	
SUBJECT: HEXAGON MAPPING DECISIONS						SS-3	
REFERENCE: WHIG 1632, 232218Z OCT 75						SS-4 X	
IN RESPONSE TO A DECISION BY ASD(I), I HAVE DIRECTED						SS-5	
THAT THE METRIC PAN SYSTEM (MPS) BE INCORPORATED INTO THE						SS-5C	
HEXAGON BASELINE FOR SV-17 AND 18. THE REFERENCED MES-						SS-6	
SAGE, NOT SENT TO KWETHER, DIRECTED TERMINATION OF THE						SS-7 X	
MAPPING CAMERA SYSTEM (MCS) FOR THOSE MISSIONS.						SS-8	
E-2 IMPDET						COMP X	
						RF X	
						FILE 7	
DATE		TIME		MONTH		YEAR	
						75	
PAGE NO.		NO. OF		PAGE NO.		NO. OF	
1		PAGES 1		1		PAGES 1	
TYPED NAME AND TITLE		PHONE		SIGNATURE			
LT COL HUTCHISON		71817					
SECURITY CLASSIFICATION		REGRADING INSTRUCTIONS		TYPED (or stamped) NAME AND TITLE			
~~SECRET~~		E-2 IMPDET					

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1 Aug 71

Approved for Release: 2025/07/25 C05127913

SOCOMM MESSAGEFORM

SECURITY CLASSIFICATION

TYPE MSG

BOOK

MULTI

SINGLE

PRECEDENCE

ACTION

PRIORITY

INFO

PRIORITY

FROM: WHIG

TO: ETHER

INFO: CHARGE

SECRET

CITE

HANDLE VIA BYEMAN CONTROL CHANNELS ONLY

HEXAGON

ETHER FOR VADM CRAMER, CHARGE FOR BRIG GEN KULPA FROM MR. PLUMMER

SUBJECT: HEXAGON MAPPING DECISIONS

REFERENCE: WHIG 1632, 232218Z OCT 75

IN RESPONSE TO A DECISION BY ASD(I), I HAVE DIRECTED THAT THE METRIC PAN SYSTEM (MPS) BE INCORPORATED INTO THE HEXAGON BASELINE FOR SV-17 AND ¹⁸ ~~17~~. THE REFERENCED MESSAGE, NOT SENT TO KWETHER, DIRECTED TERMINATION OF THE MAPPING CAMERA SYSTEM (MCS) FOR THOSE MISSIONS.

E-2 IMPDET

SPECIAL INSTRUCTIONS

HANDLE VIA

BYEMAN

CONTROL SYSTEM

DISTRIBUTION:

DNRO	X
DDNRO	X
SS-1	X
SS-2 EXEC	
SS-2 ADMIN	X
SS-3	
SS-4	X
SS-5	
SS-5C	
SS-6	
SS-7	X
SS-8	
COMP	X
RF	X
FILE	7

DATE

TIME

MONTH

YEAR 75

PAGE NO. 1

NO. OF PAGES 1

DRAFT

TYPED NAME AND TITLE

PHONE

71817

SIGNATURE

TYPED (or stamped) NAME AND TITLE

SECURITY CLASSIFICATION

REGADING INSTRUCTIONS

SOCOMM Form 173

1 Aug 71

Approved for Release: 2025/07/25 C05127913

ZNY XXXXX BSB ZIN
P 031805Z
BT
XXXXX
#BLO 414
#BLO PASS ETHER

METRIC
3 Nov 75

SECRET
HANDLE VIA BYEMAN CONTROL CHANNELS ONLY
Hatch

SWA038K AA 8692

~~SECRET~~ 031805Z NOV 75 CITE WHIG 1665.
PRIORITY ETHER.
HANDLE VIA BYEMAN CONTROL CHANNELS ONLY
SECUR
ETHER FOR O. WILLIAMS, K. DAHERTY FROM D. HUTCHISON
SUBJECT: CAPABILITY REQUIREMENTS FOR A METRIC PAND-
RANIC SYSTEM
REFERENCE: BYE-47518-75, 25 FEB 75
1. DURING THE RECENT DISCUSSIONS WITH ASD (I), ONE
CONTRACTOR PRODUCED ANALYTICAL RESULTS THAT WERE AT
VARIANCE WITH YOURS OF THE REFERENCE, AND WE COULD NOT
READILY REPRODUCE YOUR ANALYSIS. REQUEST YOU PROVIDE
WHIG WITH A TECHNICAL REPORT WHICH SHOWS IN DETAIL THE
ANALYSIS WHICH CORRECTS ORBIT, TIMING, ATTITUDE AND
CALIBRATION ERRORS WITH POSITIONAL ERRORS. THIS
REPORT IS NEEDED BY 15 JANUARY 1975.

WORKING COPY

DISTRIBUTION		
SAPM	A	I
SAPM		
DD		
SS-1		
SS-2		
SS-3		
SS-4		
SS-5		
SS-6		
SS-7		
COM		
SS-1/2/3		
RF-11		
FILE		

PAGE 2 WHIG 1665 ~~SECRET~~
2. ALSO DURING THE RECENT DISCUSSIONS, YOU STATED
THAT THE ATTITUDE REQUIREMENT COULD BE STATED AS 5
ARC SECONDS AS A GOAL WITH 10 ARC SECONDS AS NEEDED TO
MEET CURRENT REQUIREMENTS. REQUEST YOU CONFIRM THIS
FOR THE RECORD.
B-2 IMPDET
~~SECRET~~
BT

SECRET
HANDLE VIA BYEMAN CONTROL CHANNELS ONLY