TOP SECRET - CORONA/LANYARD

SYSTEM

PERFORMANCE EVALUATION REPORT

MISSION 8003

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TOP SECRET - CORONA/LANYARD

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

FOREWORD

THIS REPORT PREPARED FOR AND BY DIRECTION OF

[redacted]

OFFICE OF

THE SECRETARY OF THE AIR FORCE

Preparing Unit:

Performance Evaluation Team
AF Unit Post Office
Los Angeles 45, California

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

PUBLICATION REVIEW

This report has been reviewed and is approved.

ALBERT W. JOHNSON
Captain, USAF
Team Manager

PERFORMANCE EVALUATION TEAM
REPORT NO [redacted]

ABSTRACT

An evaluation was made of the Lanyard Mission 8003 based on examination and analysis of the flight mission product. The evaluation was performed by the Director of Special Projects Performance Evaluation Team, assisted by personnel of the National Photographic Interpretation Center, Aeronautical Chart and Information Center, and the 6594th Test Squadron (AFSPPL)(AFSC).

It was concluded that the objective to achieve an average ground resolution of five feet was not met. The system did demonstrate in a few instances that is has the potential of achieving the stated goal of five feet from 110 nautical miles. It is believed that the major cause for the nonachievement of system performance goals is that the desired temperature of the lens and the platen support tube was not attained on orbit. This produced an adverse environment for the optics and may have caused a lens element to shift in its mountings during Orbit 9, which could account for the sudden downward shift in RES values occurring at that point.

The cause for the payload failure after normal operation for 22 orbits has been established as a failure in the intervalometer system controlling the main panoramic camera and the stellar-index camera. Corrective measures will be taken before the next flight.

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

The physical condition of the film was generally excellent throughout. A few minor deficiencies were noted and investigative action initiated to correct these before the next launch.

Geopositioning was within acceptable limits, and the objective to obtain mono and stereo photos of specific targets was achieved. The Agena D and the roll joint, which points the camera, functioned satisfactorily. The clock accuracy was within ± 7 milliseconds.

The index camera failed after three frames. The stellar camera exhibited erratic metering but operated for the duration of its mission.

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

TABLE OF CONTENTS

	Page
TITLE PAGE	
FOREWORD	ii
PUBLICATION REVIEW	iii
ABSTRACT	iv
TABLE OF CONTENTS	vi
LIST OF ILLUSTRATIONS	viii
LIST OF TABLES	x
PERFORMANCE EVALUATION TEAM	xi
SECTION I - MISSION 8003 HISTORY	1
SECTION II - PERFORMANCE EVALUATION TEAM OBJECTIVES	4
SECTION III - COMMAND AND GEOPOSITIONING	6
A. Command Structure	6
B. Tracking and Control Response	9
C. Attitude Control	16
D. Geopositioning	19
SECTION IV - SPPL TECHNICAL EVALUATION REPORT 101-1-11 (Photographic Physical Characteristics Evaluation) (This section bound separately)	
SECTION V - TECHNICAL DATA	33
SECTION VI - PET Group Observations	47
A. Camera Performance	47
B. Photographic Quality	56

TABLE OF CONTENTS (Cont)

	Page
C. Exposure Time	56
D. Performance Measurement	57
SECTION VII - NPIC OBSERVATIONS	60
SECTION VIII - SUMMARY	71

LIST OF ILLUSTRATIONS

Number		Page
1	0° Roll, Mono Operation	26
2	0°, Stereo Operation	27
3	15° Roll, Mono Operation	28
4	15° Roll, Stereo Operation	29
5	Mission Coverage Plot	30
6	Mission Coverage Plot	31
7	Actual vs Allowable Exposure	34
8	Frequency Distribution - Brightness Ratio	35
9	Average RES and Brightness Ratio per Frame	36
10	Average RES Variation - Areas 1, 3, and 5	37
11	Temperature Profile - Orbit 8	38
12	Micro-Analyzer Trace - Pass D02, Frame 030	39
13	Micro-Analyzer Trace - Pass D14, Frame 123	40
14	Micro-Analyzer Trace - Pass A18, Frame 012	41
15	Micro-Analyzer Trace - Pass D20, Frame 024	42
16	Micro-Analyzer Trace - Pass D20, Frame 032	43
17	Micro-Analyzer Trace - Pass D21, Frame 045	44
18	V/h Ramp Match	45
19	Typical Vehicle Attitudes	46
20	Measurement Comparison Test	66
21	Attitude Errors and Rate - Pass D06, Frames 001 - 016	67

LIST OF ILLUSTRATIONS (Cont)

Number		Page
22	Attitude Errors and Rate - Pass D06, Frames 017 - 032	68
23	Attitude Errors and Rate - Pass D14, Frames 017 - 032	69
24	Attitude Errors and Rate - Pass D21, Frames 017 - 032	70

LIST OF TABLES

Table		Page
1	Summary of Tracking Residuals	12
2	Look Point Prediction Accuracy (Latitude) . .	15
3	Geoposition Tabulation	23 - 25

PERFORMANCE EVALUATION TEAM

[redacted]

Capt Albert W. Johnson, (Team Manager)

6594 TEST SQUADRON (AFSPPL)

[redacted]

NPIC

Mr. Arthur Lundahl, Director
Technical Staff

ACIC

[redacted]

LMSC

[redacted]

ITEK

[redacted]

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

SECTION I

MISSION 8003 HISTORY

Mission 8003 was launched from Vandenberg Air Force Base 0000:17Z on 31 July 1963.

The satellite vehicle consisted of the "L" panoramic camera with the supporting Stellar Index (S/I) camera, the recovery system, and the Agena. The payload was mated to the Agena by an electro-mechanical roll joint to obtain increased target coverage.

This satellite was boosted into orbit by an improved Thor, Agena D combination. The orbit achieved had the following parameters:

	Actual	Nominal
Inclination	74.94°	75.0
Period	90.59 min.	90.72 ± .15 min.
Perigee	91.87 nm at 52.98° N. Lat.	93.0 + 3.5-5 nm at 50° N. Lat.

Mission 8003 was programmed for a five day operational mission. The primary objective was to demonstrate the system potential for obtaining high quality, large scale photography of selected targets. This involved mono and stereo operations in roll angles of -30°, -15°, 0°, +15°, +30°. The design goal is five foot ground resolution.

Upon injection into orbit, the instrument operated for one burst as programmed to verify lens lock release and otherwise demonstrate proper electric mechanical operation.

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

The orbit attained was very close to the desired orbit and the pass 2 ephemeris was demonstrated to be adequate for mission planning.

Rev 9 telemetry indicated the main camera to be operating normally but the S/I camera to be metering excessively. It was also noted that the desired thermal environment for the payload had not been attained.

The roll joint was left caged until Rev 16 to have a comparison of photography before and after uncage. On Rev 16 it was uncaged as programmed and operation was normal.

Roll maneuvers to obtain photography were successfully executed 13 times. The instrument was rolled back to zero at the end of each pass.

Functional T/M indicated essentially normal operation of the main camera through orbit 22, with the temperatures still high and the S/I camera metering excessively.

On orbit 25, no operation was indicated in response to tracking station real time commands. Also, an increased power drain on the Agena batteries was noted by T/M.

No further operation of the main instrument was indicated in response to real time commands given on subsequent orbits and the increased power drain persisted.

The decision was made to recover on the next appropriate orbit. Recovery was accomplished on orbit 33 at 0250Z, 2 August 1963.

The photographic product recovered consisted of 908 frames (approx. 1900 ft) from the main camera, 500 ft from the index camera, and 250 ft from the stellar camera. About 60% of the main camera coverage was in stereo.

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

SECTION II

PERFORMANCE EVALUATION TEAM OBJECTIVES

The Performance Evaluation Team was assembled after the recovery to compile a consolidated evaluation of Mission 8003. The report was made under the management of the Program [redacted] Team members from Space Systems Division monitored the mission and participated in the evaluation.

The team compiled data from analysis of the photographs for inclusion in a final report for the [redacted]. This analysis covers the fields of command, geoposition, and photography. In all cases the record was studied to determine how well the results compared with the planned mission. For example: the command summary shows that the camera was operated at a specified time to obtain a photograph of a target, the best-fit ephemeris locates the actual position of the satellite at that system time and observation from the photographs indicates the actual geographic position. Further analysis compared actual and commanded camera speeds and burst times. Finally, an analysis of the film itself indicated how well the camera system operated in producing high resolution and acceptable film densities. Where available, telemetry was used to confirm system operation. The preliminary evaluation was submitted to the associate contractors in the form of tabulated data and some pertinent commentary.

The Aeronautical Chart and Information Center (ACIC) performed geoplot of the mission coverage and related predicted versus actual coverage and qualified differences with their knowledge of map accuracies.

The National Photographic Interpretation Center provided a subjective image evaluation with respect to its suitability for intelligence purposes.

The 6594th Test Squadron (AFSPPL) provided photometric data, administrative and reproduction support, and was host to the team during the evaluation.

The associate contractors and system engineering organizations furnished team members and performed the system and payload analysis.

SECTION III

COMMAND AND GEOPOSITIONING

A. Command Structure

The Lanyard Command system is comprised of the Type 8 Orbital Timer, a V/H Programmer, and a command decoder. The basic type 8 programmer is loaded before flight with the commands as a function of elapsed time to turn the camera system on and off, and to control certain system function. The timer may be periodically reset by real time commands from the ground to ensure that desired operations are obtained. Real time commands are also used to select programs, V/H ramps, and similar functions. A complete description of payload real time and orbital timer commands follows:

R E A L T I M E C O M M A N D S

No	A/P	Command
4		Command Operate Applies power to decoder, pulls lens cell retaining pin, executes a stereo pulse operation
8	A	V/H ramp selector An 11 position switch is stepped to select any 1 of 11 ramps
9	B	Program 1, 2, or 3 selector A 3 position switch is stepped to select either program 1, 2, or 3.
10	C	Ramp start-time selector An 11 position switch is stepped to select any 1 of 11 stored start times for the V/H programmer

11 D Operation Enable/Disable. Intermix deck selector. Stereo override. A 4 position switch provides the following command possibilities:

Position 1 - Enables stored program commands for panoramic instr operation. Selects intermix sequence from Deck 1

Position 2 - Disables all stored program commands for panoramic instr and roll joint operation unless in intermix mode. Selects intermix sequence from Deck 2.

Position 3 - Override all stored program stereo commands to mono operation. Intermix on Deck 1

Position 4 - Override all stored program stereo commands to mono operation. Intermix on Deck 2

12 E Orbit ON/OFF intermix start point selector
An 11 position switch is stepped to the desired starting point to set up an automatic sequence of operation enable/disable commands for succeeding orbits. Switch is stepped through sequence after setup by one punch per orbit in orbital timer track 14. There are 2 decks on the switch. Selected by RTC 11, wired as follows:

	SWITCH POSITION										
	1	2	3	4	5	6	7	8	9	10	11
Deck 1	0	1	0	0	1	1	1	0	1	0	1
Deck 2	1	0	1	1	0	0	0	1	0	1	0

1=On for Orbit
0=Off for Orbit

15 F Program 4, 5 selector. Fixed roll angle selector. Stepping off home position 11 disables operation in Progs 1,2,3. An 11 position switch is stepped to provide the following control:

SWITCH POSITION										
1	2	3	4	5	6	7	8	9	10	11
+30	+15	0	-15	-30	+30	+15	0	-15	-30	Home
PROGRAM 4					PROGRAM 5					

ORBITAL TIMER COMMANDS

Track	Function
14	Orbit counter for intermix, V/H prog start and yaw program reset
**	Roll to zero all programs
17	Clock interrogate, telemetry enable - continuous channels
27	V/H Programmer start
28	Instrument on-program 4-(roll selected in flight)
29	Stellar/Index cameras on
30	Stellar/Index cameras off

31 Roll execute-programs 4 and 5
32 Instrument off - program 4
33 Instrument on - program 5 -(roll selected in flight)
34 Instrument off - program 5

ENABLE			EXECUTE		
35	36	37	38	39	Program 1 - Stored roll program
40	41	42	43	44	Program 2 - Stored roll program
45	46	47	48	49	Program 3 - Stored roll program
			1	0	Roll to zero position
0	0	1	1	0	Roll to minus 15 degree position
0	1	0	1	0	Roll to minus 30 degree position
	1	1	1	0	
1	0	0	1	0	
1	0	1	1	0	Roll to plus 15 degree position
1	1	0	1	0	Roll to plus 10 degree position
1	1	1	1	0	(Binary matrix checkout)
				1	Temp sensor power off
0	0	1	0	1	Panoramic instrument on stereo pulse
0	1	0	0	1	Panoramic instrument off continuous mode
0	1	1	0	1	Panoramic instrument on stereo continuous
1	0	0	0	1	Temp sensor power on
1	0	1	0	1	Panoramic instrument on mono pulse
1	1	0	0	1	Reset panoramic instrument
1	1	1	0	1	Panoramic instrument on mono continuous

50 Yaw program
51 Tape recorder read in
52 Tape recorder off

** Varies, 15(FTV 1167), 26(FTV 1168), 16(FTV 1172 + Subsequent)

NOTES

1. An S/I camera operation preceding the first panoramic instrument operation pulls the lens cell retaining pin.
2. Roll joint is uncaged by first zero roll command in progs 1, 2, or 3

SEPARATION COMMAND

Inflight reset — Eject instrument doors (Main and S/I)

GUIDANCE TIMER COMMANDS

+28V to SS/L	Eject instrument doors (Redundant), Apply power to decoder. Unstow lens cell
Arm	Slew S/I payload
Transfer -	Actuate water seal
Separation	

B. Tracking and Control Response

1. The nominal orbital parameters achieved on FTV-1167 L-3 resulted in an ideal control situation. Program 1, based on the nominal orbital period, was used throughout the 22 orbit operation. The IMC control settings used during the mission were the nominal settings established prior to launch. A ramp change was made on orbit 23 to compensate for a slightly faster than nominal cycling rate determined on data acquired on orbit 16. Illustration 23 shows the quality of the obtained fit. The only payload commands used during the 22 orbit mission were for "intermix" control; for selection of the active orbits within the flight program.

2. The tracking network provided early convergence on the achieved orbit. This resulted in accurate prediction of coverage block locations from the initial prediction based on tracking data acquired through orbit 2. Updated tracking data (through orbit 9) was used for the prediction of block locations for orbits 13 through 22.

3. Block location predictions are based on H-timer control so that the timer is maintained in perfect synchronism with the orbit. Deviations between the predicted block locations and the actual block locations are due to imperfect H-timer control.

4. One gross timer mismatch occurred during the mission on orbit 6. This mismatch was a result of timer adjustments given based on orbit 2 tracking data which were in effect until the next tracking station acquisition at orbit 7 [redacted]. This mismatch resulted in a 57 mile latitude error in operation 6 DM 1, essentially missing one-half of the mono block.

5. This type of timer mismatch was anticipated during the early portions of the flight due to lack of precise determination of the orbital parameters

6 The reset command given at orbit 16 [redacted] was in effect until orbit 22 [redacted]. Time mismatch during this period was essentially constant and amounted to approximately a 3 5 to 4 seconds bias in all operations during this period This is considered an excessive bias to be present in the timer system after the orbit has been determined, and the cause for the bias requires further investigation. The average latitude bias of all operations that were available for evaluation was 14 15 nautical miles or an equivalent timer mismatch of 3 53 seconds

7 The performance estimate, computed and issued 15 hours after recovery, provided an accurate summary of the actual block locations The average latitude difference between the performance estimate excluding the known timer error and the actual center of block locations as determined from maps (considering all error sources) was 5.0 nautical

miles. Longitudinal errors were generally 2 nautical miles or less.

8. In summary, the orbital determination, block center predictions, and post flight Performance Estimate were satisfactory. The need for better H-timer control or alignment is indicated, based on the somewhat limited data obtained on this mission.

9. Image motion compensation control was adequate. Improvement in instrumentation or techniques is in-order to improve on the response time to non-nominal cycling characteristics.

10. Orbital Tracking Performance

The actual orbital parameters were determined very early in the mission, as seen by the tracking data "residuals". These residuals represent the apparent error of any set of tracking points when combined into the previously processed tracking data. As seen in Table I, Summary of Tracking Residuals, the actual parameters were converged upon by orbit 7. This is due in part to the fact that the actual orbital parameters were essentially nominal.

11. No degradation in tracking performance is in evidence due to the lower heights over the tracking stations on the descending side of the orbit.

TABLE I

SUMMARY OF TRACKING DATA RESIDUALS

Station	Rev	RMS feet
[redacted]	1.3	2151.[illegible]
	7.1	[illegible]78[illegible].86
	8.2	6969.28
	9.2	622[illegible].27
	9.1	568[illegible].96
	10.2	590[illegible].86
	11.1	[illegible]912.0[illegible]
	13.3	[illegible]529.85
	16.3	[illegible]
	17.3	7338.19
	23.1	[illegible]061.78

In summary, vehicle tracking was [illegible] on this mission.

12. Accuracy of Target Coverage

Accurate targeting is a function of several factors of which the dominant factors are:

a. Precise mission programming

b. Precise orbital determination

c. Precise control of the H-timer

d. Nominal instrument cycling performance

H-timer control (and therefore targeting) is concerned with latitude control only. There is no provision or technique for longitude control of the system.

13. It was anticipated that precise orbital control of the H-timer would not be achieved in the early portion of the

flight, basically due to the lack of precise determination of the actual orbit. This prediction was essentially confirmed by the timer mismatch that accumulated between orbit 2 [redacted] and orbit 7 [redacted] and is evident by a large latitude targeting error on orbit 6. The error was removed by timer reset at orbit 7 [redacted] The H-timer control after orbit 16 was not as good as had been expected, particularly considering the early convergence of the actual orbit. The average H-timer mismatch to the actual orbit between orbits 16 and 22 was 4.3 seconds. A review of the timer performance data obtained during the flight (reported by TWX) does not indicate any timing errors greater than 1 second. A post flight analysis of timer performance is in process and should provide more precise determination of the actual timer performance.

14. Based on 33 plotted block centers, the average latitude error as compared to the original designated points was 12.6 N. miles. The maximum error was 57 miles on orbit 6, due to timer settings based on early orbital data.

15. Pitch and roll angle data has been reviewed for the possible targeting errors due to vehicle attitude. The vehicle was generally stable, with roll angles averaging approximately 20' of arc, and pitch excursions approximately twice as much. The maximum pitch angle at block center was -1°53' resulting in a -3 mile in-track aiming error. A roll angle of 0.5 degree at 30° roll position at 120 N. mile altitude would result in a 1.4 mile cross track aiming error.

16. A tabulation of the center of block differences between the planned and actual latitudes is given in the Geoposition Tabulation Table No III, pages 23 to 25.

17. Look Point Prediction Evaluation

Look Points for the center of each block were predicted at intervals throughout the mission.

Prediction Schedule

Tracking Data Through Rev.	Look Point Prediction
2	Orbits 1 to 20
9	Orbits 13 to 35
25	Orbits 27 to 81

The early convergence of the tracking data on the actual orbit resulted in good accuracy starting with the initial prediction based on data acquired through rev 2. Using data acquired through orbit 29 as a standard, a comparison is made between the predictions made at orbit 2 and orbit 9. This indicates that an average error in the latitude of the block center of 3.84 N. miles is removed by updating. Look Point Predictions are made assuming that the H-timer is precisely matched to the orbit attained. Deviations between the predicted look points and the actual block center are a result of mismatch between the orbit and the actual timer performance.

TABLE II

Look Point Prediction Accuracy (Latitude)

Operation	Rev 25 vs Rev 2	Rev 25 vs Rev 9
13 AM 1	-3 N.M.	-3
14 DS 1	5	0
14 DM 2	3	-3
15 DM 1	6	0
16 DS 1	3	-2
16 DS 2	3	-3
17 DS 1	5	1
18 AS 1	-7	-1
18 AS 2	-7	-1
18 DM 3	4	1
19 AS 1	-8	-4
19 AS 2	-8	-5
19 AS 3	-6	-4
19 DS 4	4	0
20 DM 1	4	0
20 DS 2	4	-1

18. Performance Estimate Accuracy

The Post flight Performance Estimate is a product issued after recovery giving the best estimate of each block location. The main differences between this post flight estimate and the predictions are that the estimate uses the best orbital parameter data available after recovery and actual timer performance instead of a simulated perfect timer. The timer correlation data is derived from the "post orbit command summaries" that are part of the operational reporting system. The average latitude error that existed between the estimate and 33 plotted points was 5.0 n.m. or slightly over one second in actual timer performance. The Performance Estimate was a good appraisal of actual mission targeting. Table III, Geoposition Tabulation, contains in the last column the actual latitude differences between the Performance Estimate and the plotted block locations.

C. Attitude Control

1. Vehicle attitude data given in this report is that obtained from the vehicle attitude stabilization system which furnished signals to the main panoramic data block. Additional and more accurate attitude data will become available when the stellar camera film is analyzed. It is estimated that this information should become available to Project within thirty days. NPIC is the agency responsible for photogrammetric reduction of the stellar film.

2. For Mission 8003, the dead-bands of the vehicle guidance system were set for ± 1/2 degree in pitch, roll, and yaw. Stabilization adjustment rates were set for a 90% probability of 10 degrees per hour in pitch, 30 degrees per hour in roll, and 10 degrees per hour in yaw. Preflight calculations showed that the lens IMC drive would induce a 15 degree per hour pitch rate.

3. Vehicle attitude was examined on a frame-by-frame basis in each pass and was plotted for purposes of analysis. These show that the vehicle was generally stable throughout the mission life within the limits required by the main panoramic camera system to obtain high resolution photography.

4. In the roll axis, deviations were minor and confined largely to the dead-band limits. During recognizable periods in Pass D01 and Pass A09 when the roll attitude control gas jets were activated, the roll rate was below the permitted rate of 30 degrees per hour. During periods when the roll attitude was within the dead-band limits, roll rates vary from essentially 0 degrees per hour to a once observed maximum of 120 degrees per hour.

5. In the pitch axis, there appears to be a constant negative (nose-down) error of approximately one-half degree.

6. The most extreme errors in vehicle attitude are exhibited in passes D14 and D15. In pass D14 pitch error reaches a minus two degrees during operation 1, a series of six stereoscopic bursts programmed to occur continuously, and then recovers to nearly zero. A pitch rate of 130 degrees per hour occurs during this period. In pass D15 the error reaches minus 1 1/2 degrees near the end of operation 1. Pass D15 was a series of five monoscopic bursts programmed to occur contiguously. Highest pitch rate observed was 90 degrees per hour. It is possible that these pitch errors may be induced by the [illegible] cam drive, since

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

observed rates occurring before pitch jet actuations are approximately those calculated before flight. Further analysis will be conducted to determine effects of long burst operations.

7. Due to the loss of the index camera, yaw attitude analysis will not be as readily attained as hoped. NPIC has agreed to undertake analysis from the main panoramic film and stellar film but progress will be slower due to the need for developing new techniques and computer programs. Preliminary crude analysis of yaw data has been made from the geoplot prepared by ACIC and these indicate that the yaw programming functioned as planned. This is further corroborated by the fact that the observers report no cross-track smear.

8. The effects of vehicle attitude on "look points" was also analyzed and was found to contribute errors ranging from 0.00 nautical miles to 1.5 nautical miles across-track and 0.2 nautical miles to 3.2 nautical miles along-track. The ACIC plotting team regarded these errors to be of minor significance.

9. An examination of the vehicle attitude before roll joint separation and after separation shows that this event had no effect on the vehicle stability or pointing accuracy.

10. The high flying aircraft with resolution targets on its wings was detected for the first time. The experiment was not completely successful due to the fact that the airplane was in a cloud at the time the photographs were taken. This and the low photo resolution make any measurements very difficult.

PERFORMANCE EVALUATION TEAM
REPORT NO [redacted]

D. Geopositioning

1. The ACIC team performed the following tasks in the performance evaluation of Mission 8003:

a. Plotted principal points of individual photographs on series 200 USAF target charts by image match.

b. Determined actual center of photographic block from principal points.

c. Plotted position of block center on charts from Look Point data.

d. Plotted position of block center on charts from performance estimate data.

e. Scaled position of actual center of photographic block, and assigned an accuracy value in reference to the World Geodetic System.

f. Scaled error along-track and across-track for the Look Point Position and performance estimate position.

g. Provided graphical data for the final compilation of illustrations used to show the various modes of operation.

h. Assisted in the collection of source materials used in the compilation of draft copy of complete mission coverage index.

i. Provided team with:

(1) Work index of plots.

(2) Tabulation of scaled coordinates and errors.

2. Explanation of Geoposition Tabulation

Graphical techniques were used to develop basic information needed to draw comparisons between actual locations of the center of each photographic block and the look point positions as well as the performance estimate position. The principal point of each photo is defined by the center fiducial mark of the film and the center line between the leading and trailing edge of the exposure. These were located on USAF 200 Series Target Charts, scale 1/200,000 or USAF Operational Navigation Charts (ONC), scale 1/1,000,000 by photo image to chart detail match. An accuracy of ± 400 feet in determining the photo to chart match can be expected in areas of good chart coverage and cloud free photography. This accuracy will decrease as the percentage of cloud cover increases, chart detail becomes sparse or chart compilation source was inadequate.

3. The results of this comparison is tabulated with the following explanation of each major topic heading.

a. Operation - Furnished by PET Manager.

b. Photographic Position - This is a point equal distance between the 4th and 5th principal point on forward burst in stereo mode, 1[illegible] and 13th principal point on AFT burst in stereo mode or 8th and 9th principal point in mono mode and defines the center of each photographic block. The position was scaled from the maps on which principal points were plotted. A coordinate shift was applied in instances where a datum shift had been determined after the chart was compiled. In areas of undetermined datums, an estimated shift has been applied to place the chart on World Geodetic System (WGS). The coordinates recorded are on the World Geodetic System which is a uniform system and all points are directly relatable to each other. The WGS accuracy figure, in feet, represents the amount of uncertainty of the coordinate value of the photographic position. It is based on such things as inadequate source material, datum relationships, datum conversions requiring new spherical parameters, ability to locate [illegible] points due to either cloud cover or lack of chart detail or scale of chart source. It is an educated estimation using a [illegible] of facts, experience and general knowledge of the [illegible] point in question.

c. Look Point error is a comparison of required target locations vs actual locations as determined by the [illegible] block centers. The track, as used in this tabulation, is a line connecting the principal points of the exposures of the block. It does not necessarily represent vehicle track as attitude errors are not accounted for. The in-track error is the distance in NM along the track from the actual to look point location. The sign is + if the camera turned on too late, - if turned on too soon. The + track error is the distance in NM perpendicular from the track to look point location. The sign is + if the look point is to the right of the track when facing in the direction of travel. The accuracy values in feet are influenced by chart and positional accuracy, method of locating track, whether extended from located principal points on the end of block or connected through the area, actual or prorated center of block location, etc. They will vary for the + track and in-track evaluations.

d. The performance estimate error is a comparison of reprogrammed target locations as determined by the plotted block centers. The comments made in the paragraph above regarding track sign convention and error statement also apply to this section of the tabulation.

4. The mission geo-plots and Look Point Error plots are shown in Illustrations 1 through 6, pages 26 through 31.

TABLE III

Geoposition Tabulation

	Photographic Position			Look Point Error: Actual Look Point Compared to Pre-Launch Designated Look Point				Performance Estimate Error: Actual Look Point Compared to Last Computed Look Point			
Oprn	Lat.	Long.	WGS ACC	In Track N.M.	ACC Ft.	Across Track N.M.	ACC Ft.	In Track N.M.	ACC Ft.	Across Track N.M.	ACC Ft.
0001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0001	[illegible]	Water	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0002	[illegible]51 N	[illegible] E	+15,000	[illegible]7.8	[illegible],000	[illegible]	[illegible]5,000	+42.1	17,500	[illegible]4.0	15,000
0002	69°19 N	160 22 E	±12,000	[illegible].9	14,000	[illegible]	12,000	-0.5	14,500	+0.5	12,000
0002	69°22 N	160 00 E	±12,000	[illegible]	14,000	[illegible]	12,000	-0.2	14,500	-0.5	12,000
0002	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0002	[illegible]	Water	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,000	[illegible]	[illegible],000	[illegible].6	6,000	[illegible]0.2	8,000
[illegible]	[illegible]	Cloud	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,000	[illegible]	[illegible]	26.0	26,000	[illegible]	[illegible]
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[illegible]	[illegible]	Cloud	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	600	[illegible]	600	[illegible]	600	[illegible]	600	[illegible]	600

Oprn.	Photographic Position			Designated Look Point				Computed Look Point			
	Lat.	Long	WGS ACC	In Track N.M.	ACC Ft.	Across Track N.M.	ACC Ft.	In Track N.M.	ACC Ft.	Across Track N.M.	ACC Ft.
0009	55°14'	72°34' E	± 800'	None	±	Recorded	±	- 3.3	± 1,000	- 0.2	± 1,000
0009	55°15	72°31' E	± 800	None	±	Recorded	±	- 4.8	± 1,000	- 0.7	± 1,000
0009	53°47'	73°4[illegible] E	± 600'	None		Recorded		- 6.6	± 800	+ 0.5	± 800
0009	53°48	73°39 E	± 600'	None		Recorded		- 8.2	± 800	- 0.5	± 800
0009	49°12	26[illegible] E	± 600'	7.6	± 600	+ 0.8	± 500	+ 3.0	± 500	0.0	± 500
0013											
0014		Cloud									
0014											
0014	40°[illegible]	[illegible] W	± 400					- 4.8	± 500	- 0.[illegible]	± 500
0014	40°06	[illegible] W	± 400'					- 4.1	± 500	1.[illegible]	± 500
0014	38°34	87°[illegible] W	± 400					- 4.5	± 5	0.6	± 500
0014	38°34	87°[illegible] W	± 400					- 5.3	±	1.8	± 500
0014	37°03'	8[illegible]°55' W	± 500		±		±	- 7.6	± 700	- 0.6	± 500
0014	37°06	8[illegible]°56 W	± 500					- 9.0	± 700	1.2	± 500
0014	35°28'	81°[illegible] W	± 600					6.6	± 800	0.0	± 600
0014	35°29'	81°23 W	± 600					7.0	± 800	0.3	± 600
0014	34°00'	80°46 W	± 600					-15.3	± 1,000	0.2	± 600
0014	34°02'	80°53 W	± 600					-17.2	± 1,200	- 0.8	± 700
0014	22°03'	77°28' W	± 400	-15	± 800	+ 9.0	± 500	5.8	± 500	- 0.3	± 400
0014	20°23'	77°05' W	± 500					7.2	± 700	- 0.7	± 500
0014		Water									
0015	45°53'	108°37' W	± 1,400	- 8.0	± 600	+ 3.5	± 500	+ 3.5	± 1,500	- 2.0	1,500
0015	44°31'	107°55 W	± 1,400					- 0.2	± 1,500	- 0.3	1,500
0015	43°10'	107°17' W	± 1,400					- 3.5	± 1,600	- 2.2	1,600
0015	41°47'	106°39' W	± 1,400					6.8	± 1,700	0.0	± 1,400
0015	40°25'	106°04' W	± 1,400					10.2	± 1,800	0.0	± 1,400
0016											
0016											
0016		Water									
0016											
0018											
0018		Clouds									
0018											
0018											
0018		Water									

Oprn.	Photographic Position Lat.	Long.	WGS ACC	Designated Look Point In Track N.M.	ACC Ft.	Across Track N.M.	ACC Ft.	Computed Look Point In Track N.M.	ACC Ft.	Across Track N.M.	ACC Ft.
0019	55°34'	23°31'E	± 400'	-13.8	± 900	-11.6	± 1,200	+ 4.8	± 600	- 1.5	± 500
0019	55°33'	23°27'E	± 400'	-15.4	± 900	-10.3	± 1,200	+ 2.2	± 600	- 0.3	± 500
0019	59°52	29°03'E	± 400'	-15.5	± 900	- 8.7	± 700	+ 1.5	± 600	0.0	± 400
0019	59°50	28°57'E	± 400'	-20.8	± 1,000	- 8.1	± 700	- 4.0	± 600	+ 0.6	± 500
0019		Clouds									
0019											
0019	71°43	12[illegible]°45 E	±15,000'	-15.5	±15,000	-15.2	±15,000	+10.4	±15,000	-13.8	±15,000
0019	71°40'	127°42 E	±15,000'	-16.7	±15,000	-15.6	±15,000	+ 9.2	±15,000	+14.3	±15,000
0020		Clouds									
0020	48°54'	135°26 E	± 5,000'	-26.0	± 5,000	+ 4.5	± 5,000	+ 5.3	± 5,000	- 3.6	± 5,000
0020	48°50	135°2[illegible] E	± 5,000'	-28.8	± 5,000	+ 3.0	± 5,000	+ 3.2	± 5,000	- 4.4	± 5,000
0021	69°42	87°40 E	±13,000'	-18.0	±13,000	+ 0.2	±13,000	+ 5.0	±13,000	+ 2.0	±13,000
0021		Clouds									
0021											
0021	40°10'	116°22'E	± 1,500'	-14.[illegible]	± 8,000	+11.2	± 8,000	+10.2	± 8,000	+ 2.6	± 6,000
0021	40°12'	116°21'E	± 1,500'	-16.5	± 8,000	+10.7	± 8,000	+ 8.2	± 8,000	+ 2.2	± 6,000
0022											
0022											
0022		Clouds									
0022											
0022	43°12'	93°16'E	± 1,000'	-11.5	± 1,200	+ 9.8	± 1,200	+ 2.6	± 1,000	- 2.0	± 1,000

PET REPORT NO. [redacted]

ILLUSTRATION 1

PET REPORT NO. [redacted]

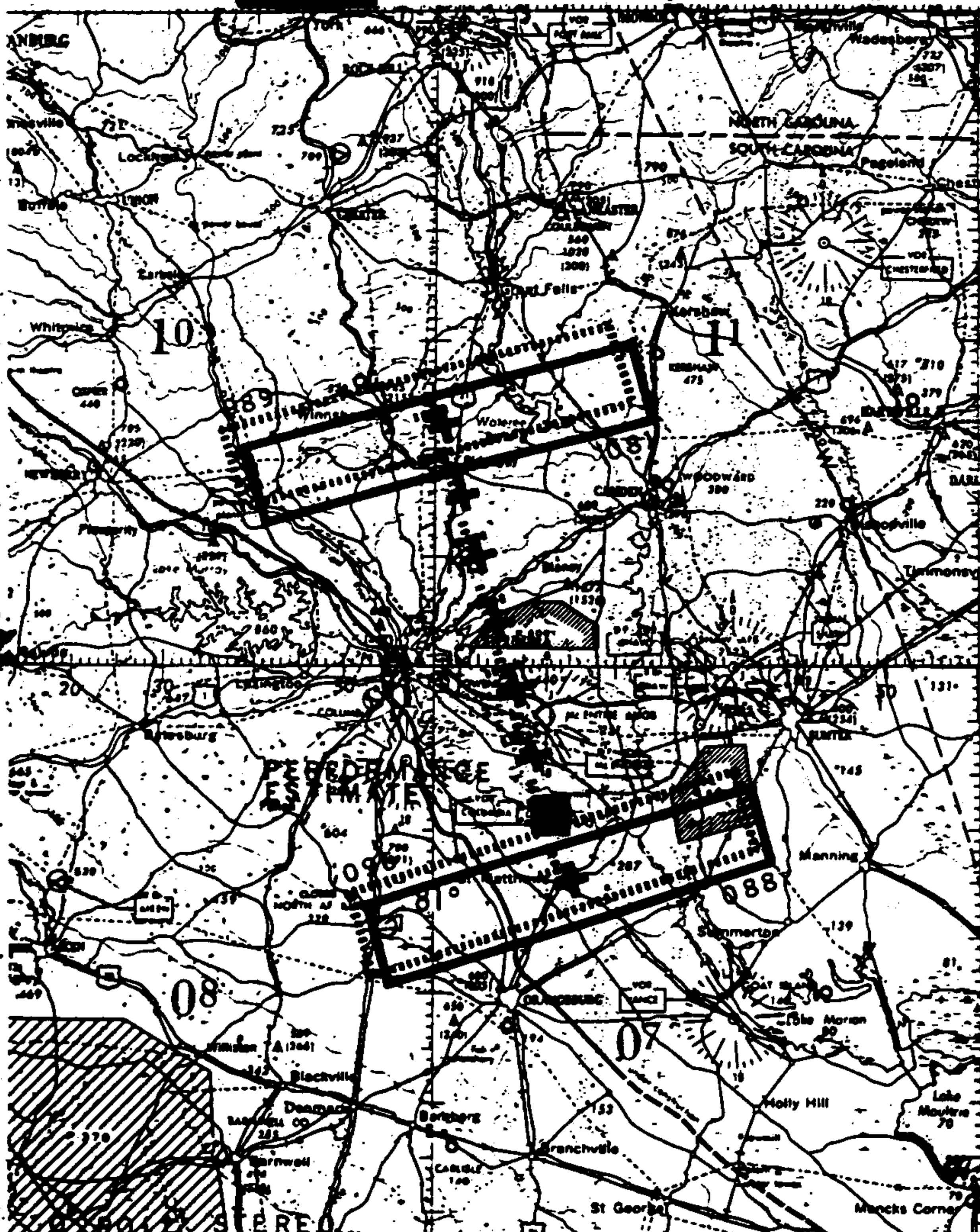


ILLUSTRATION 2

PET REPORT NO. [redacted]

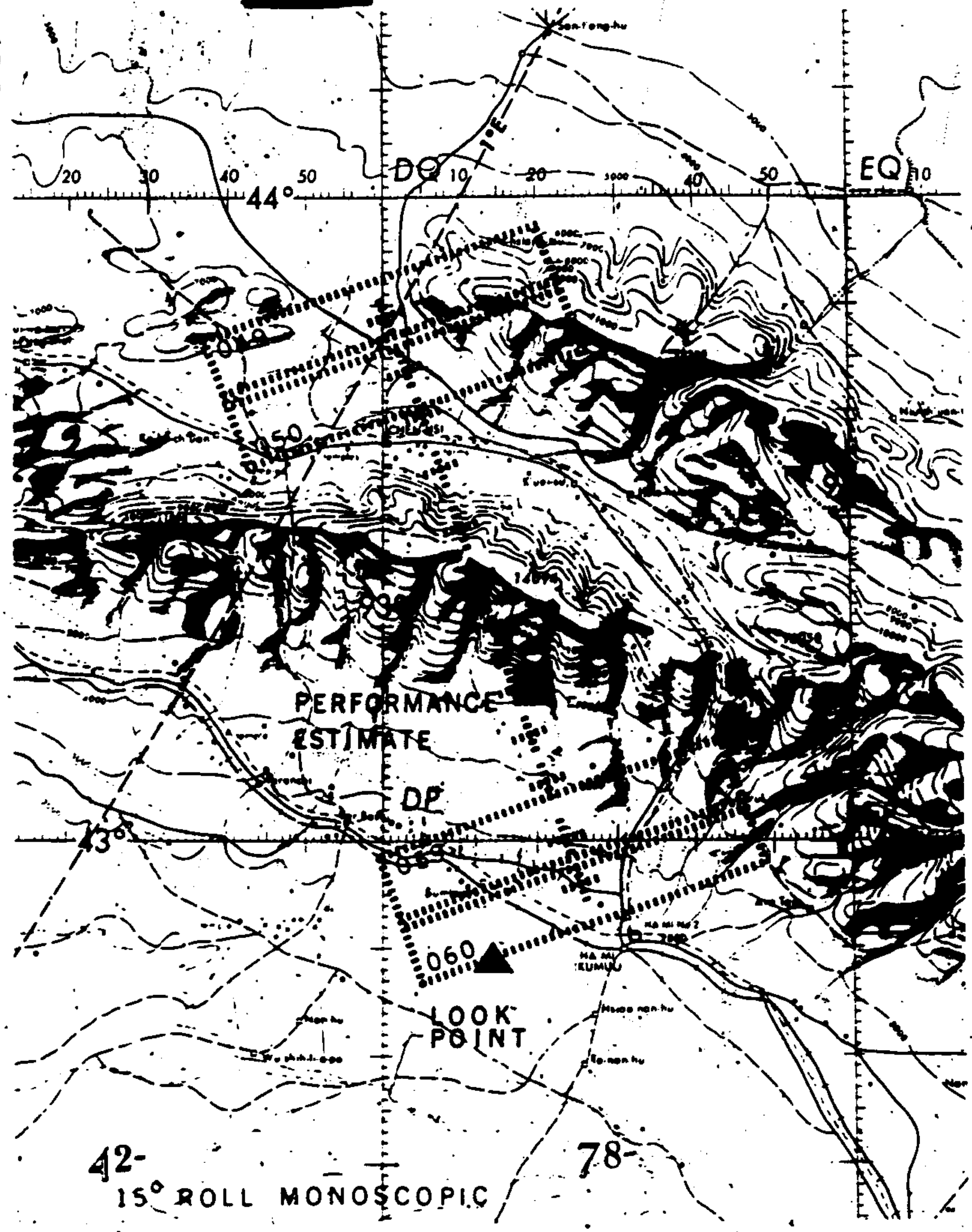


ILLUSTRATION 3

PET REPORT NO. [redacted]

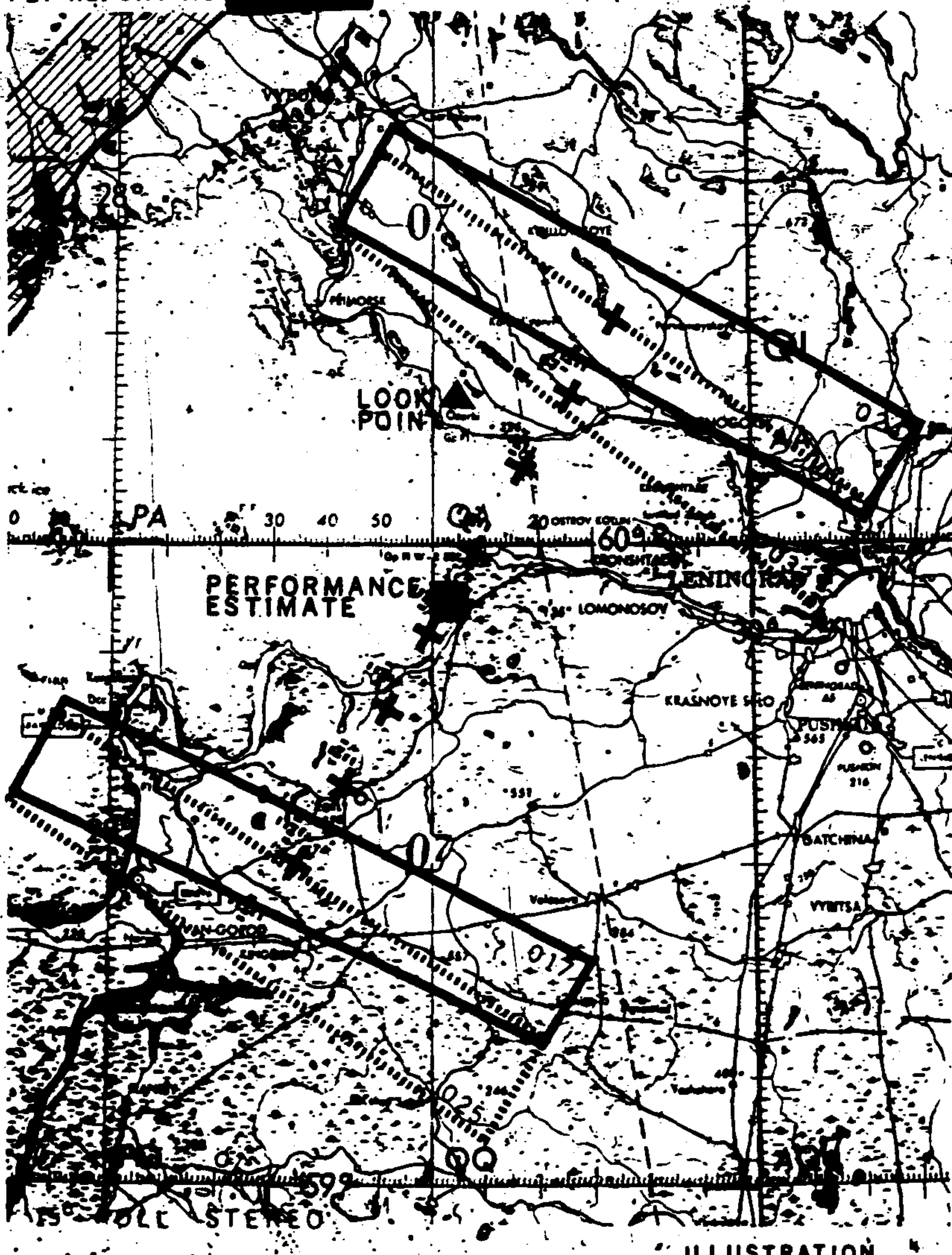
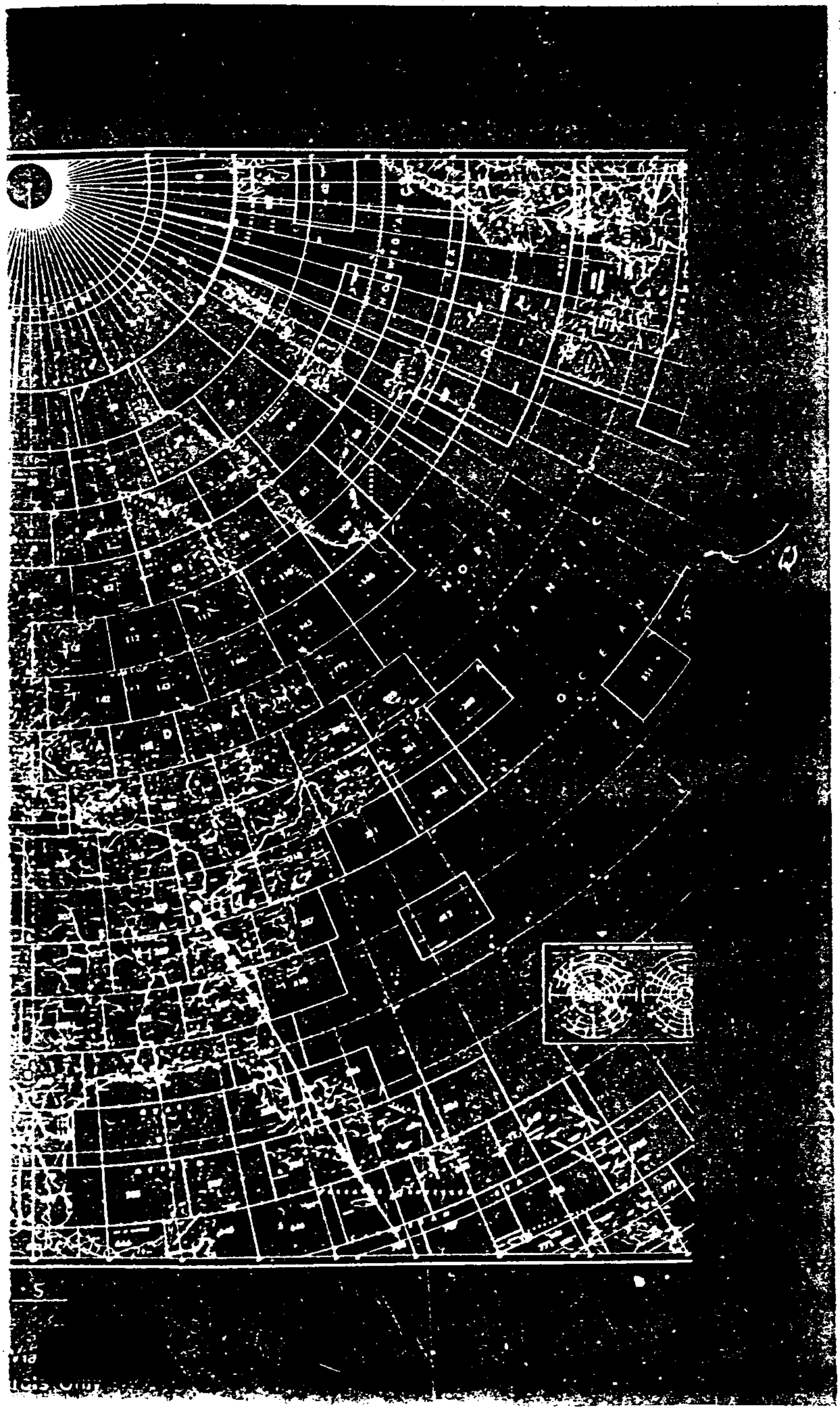
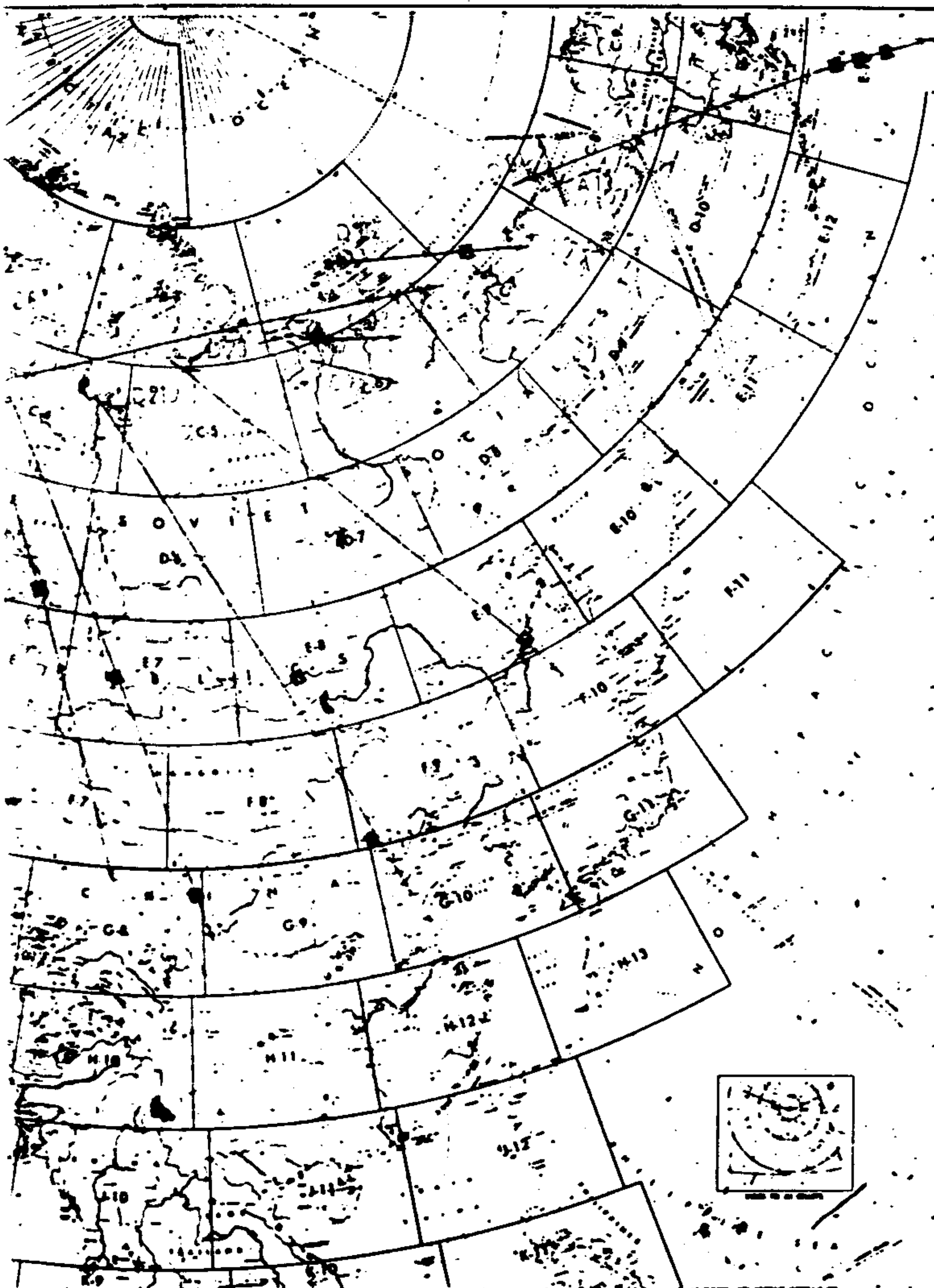


ILLUSTRATION 4

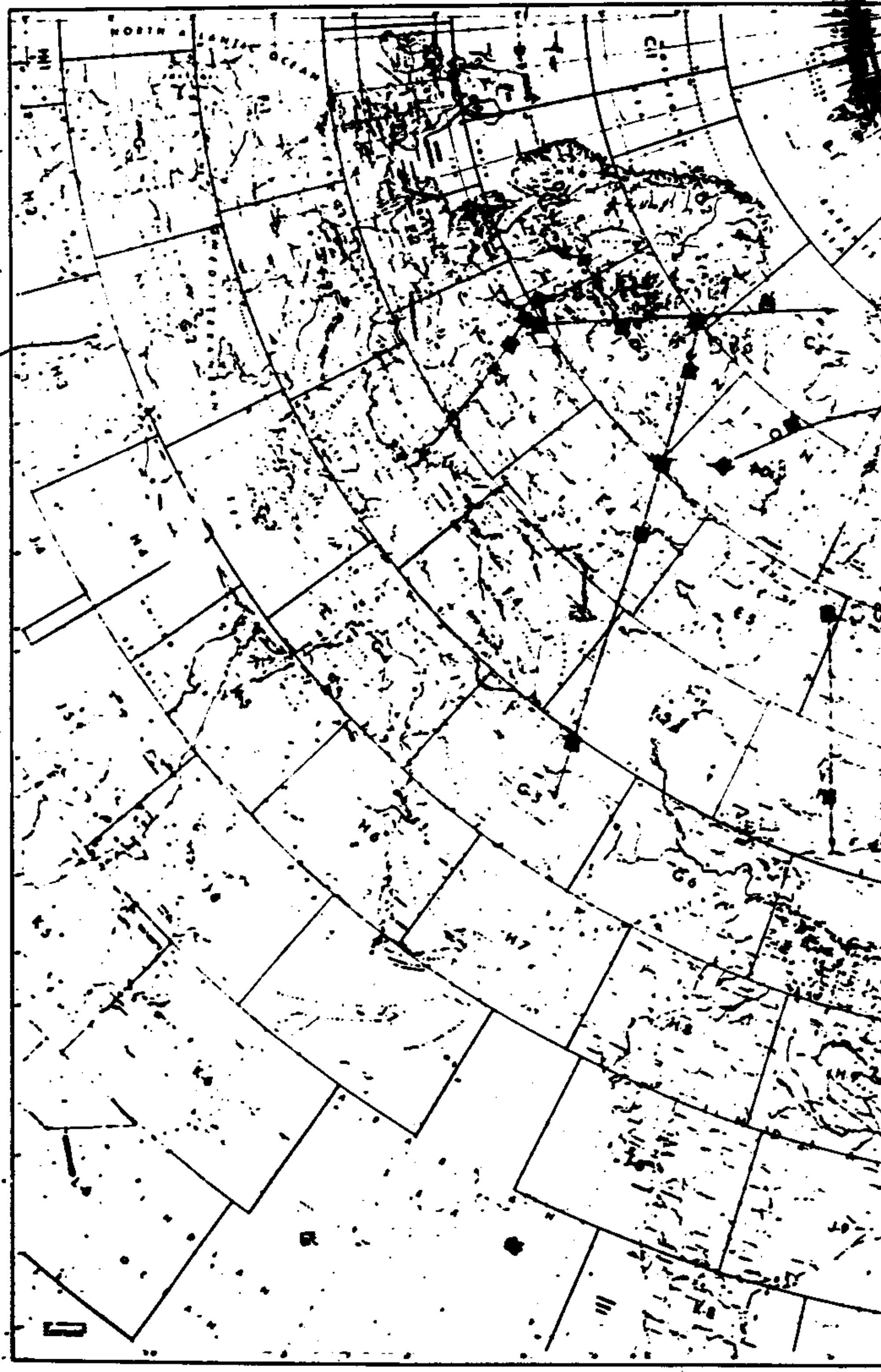


PET REPORT NO [redacted]

[redacted]



[redacted]
is Only


NORTH ATLANTIC OCEAN

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

SECTION IV

SPPL TECHNICAL EVALUATION REPORT NO. [redacted]

(Photographic Physical Characteristics Evaluation)

This section bound separately and must accompany this volume for the complete system evaluation.

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

SECTION V

TECHNICAL DATA

A. Scope of Data

1. The reduced and plotted quantitative data accumulated by AFSSD personnel and PET members is contained within this section.

2. The conclusions reached by PET members are, for the most part, based on this data; however, additional information and calculations are required prior to the completion of the evaluation effort.

B. Data Presentation

Illustrations 7 through 19, pages 34 through 46.

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

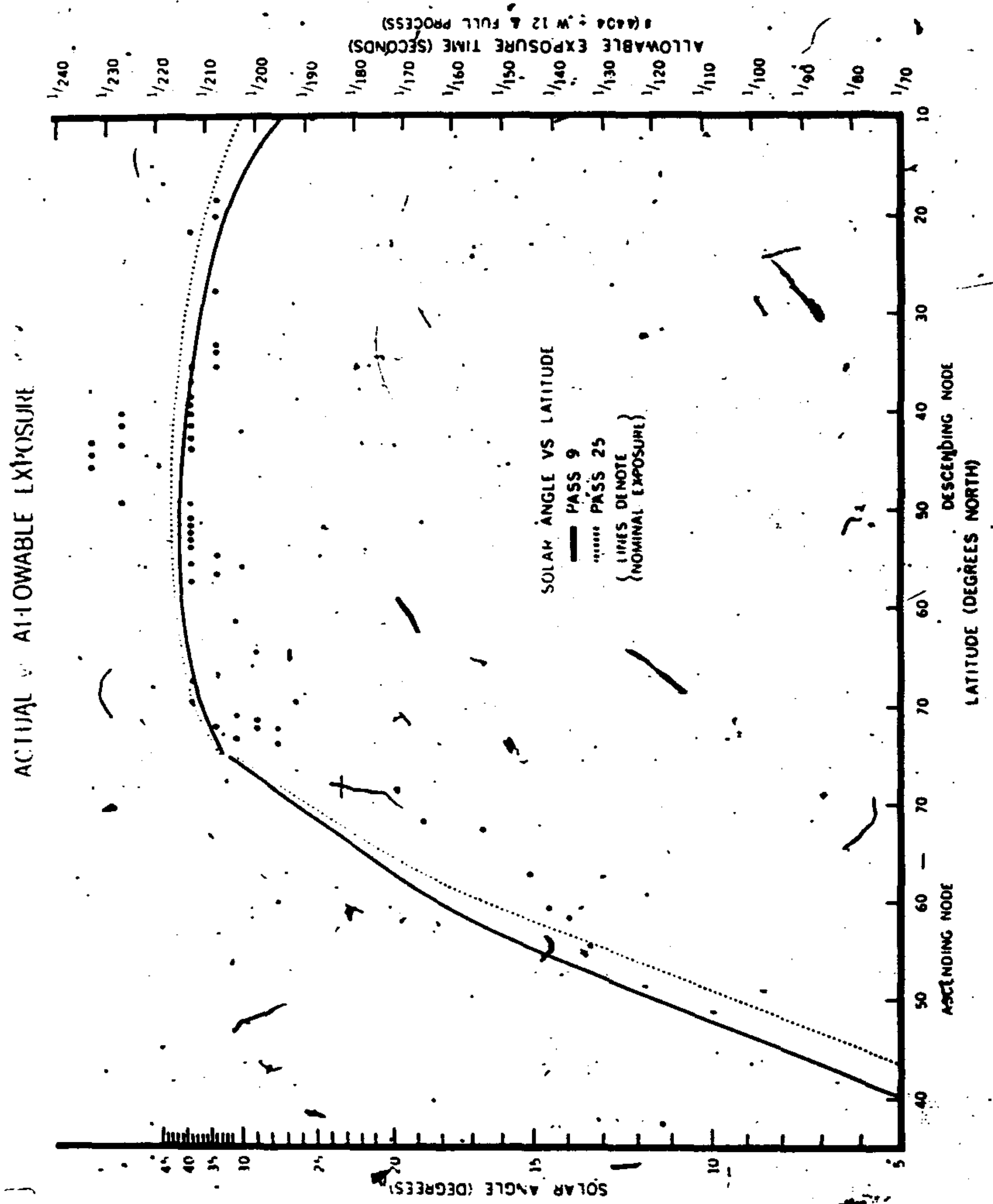


ILLUSTRATION 7

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

FREQUENCY DISTRIBUTION – BRIGHTNESS RATIO

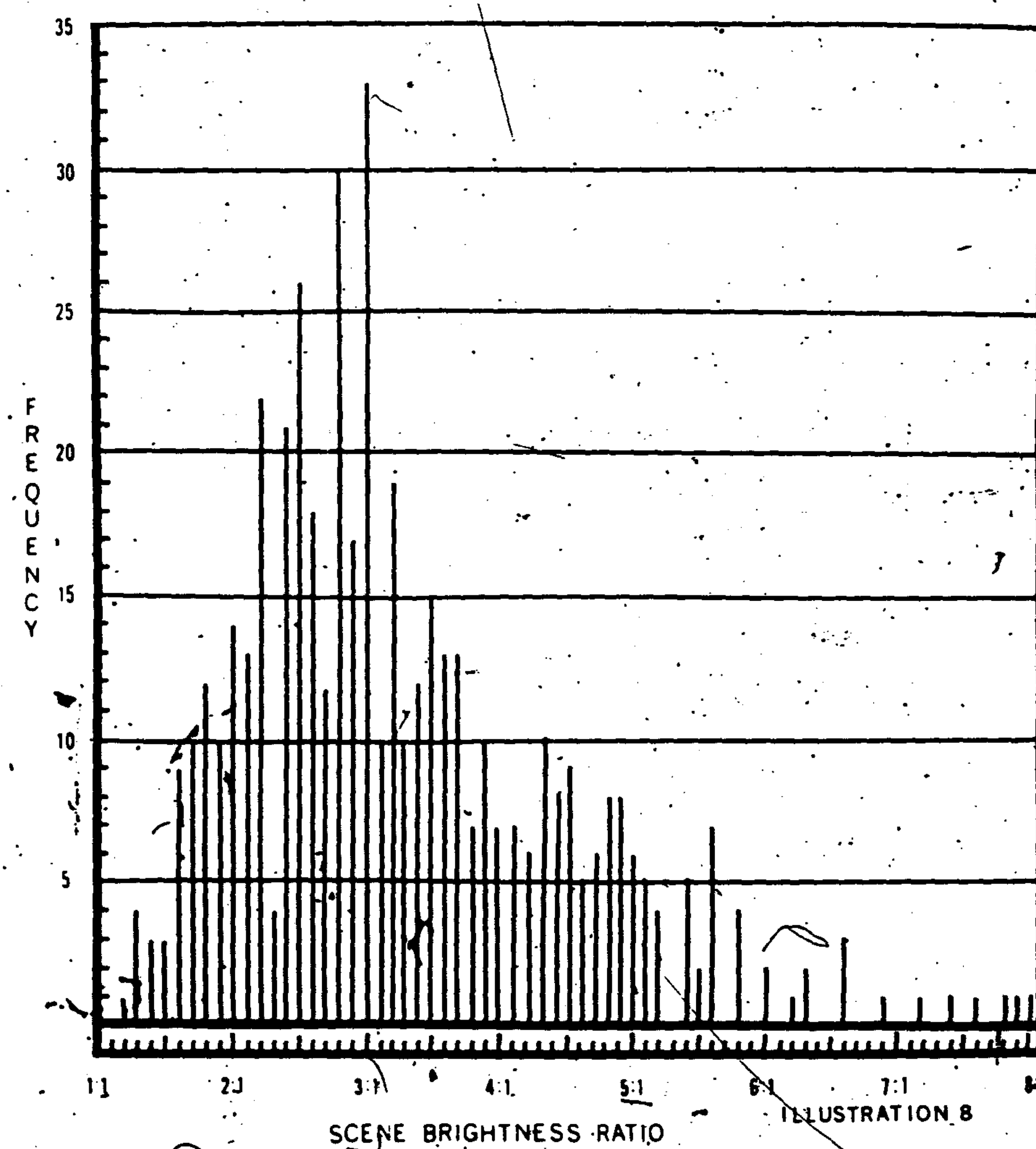
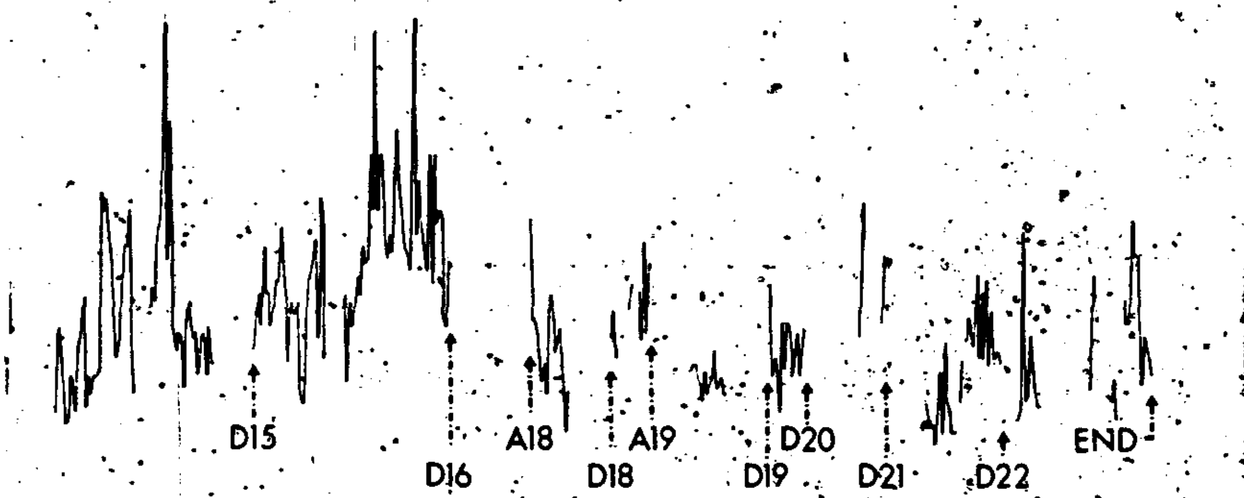


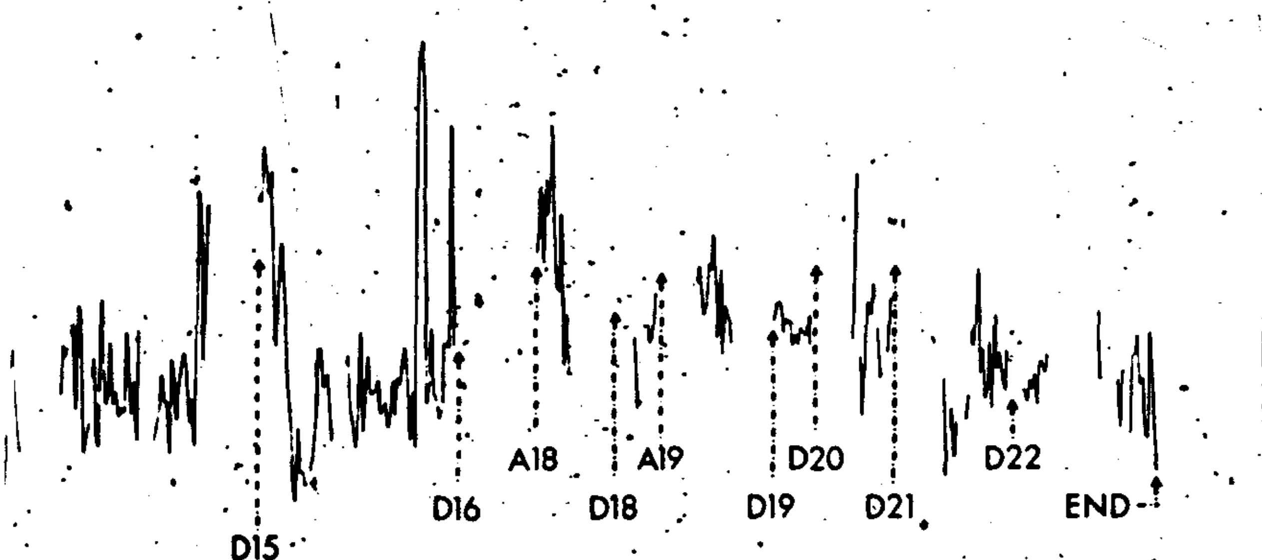
ILLUSTRATION 8

[redacted]

; RATIO PER FRAME



R.E.S. PER FRAME



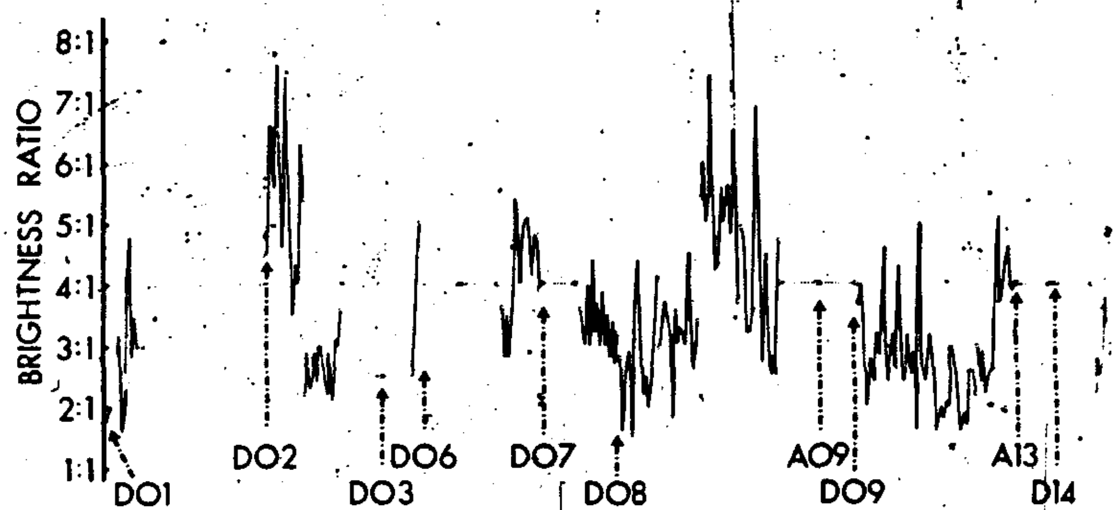
TION 9

[redacted]

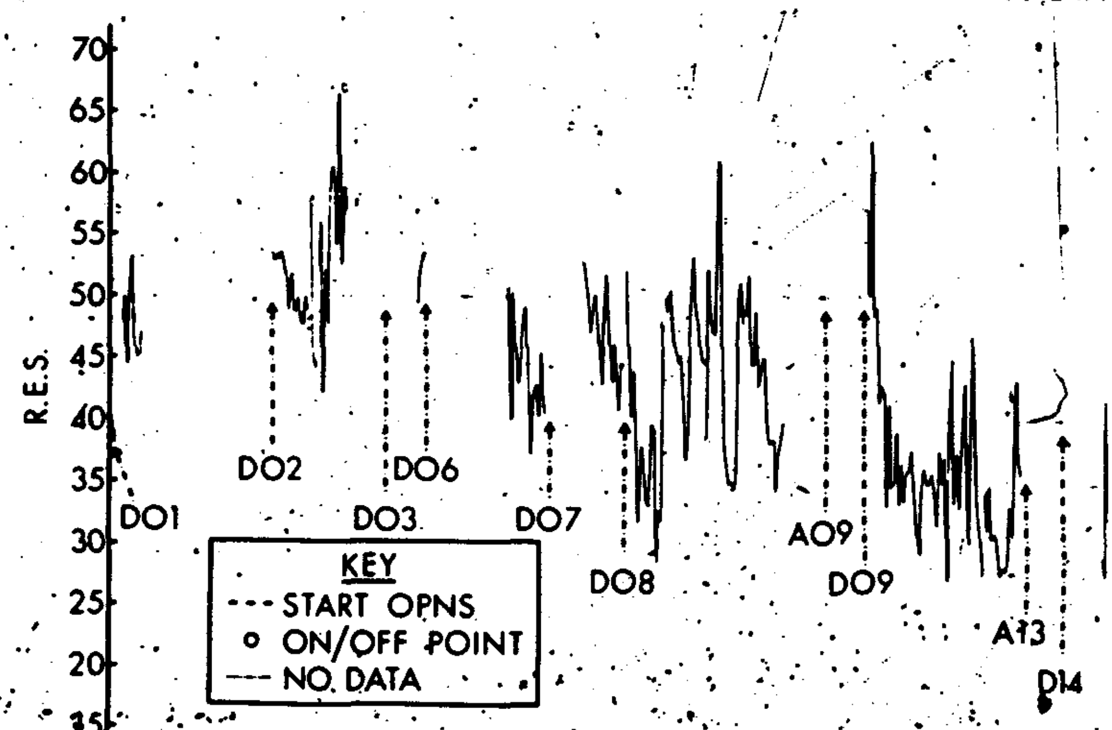
ply Only /

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

BRIGHTN



AVERA(



ILLUST

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

AVERAGE RES VARIATION

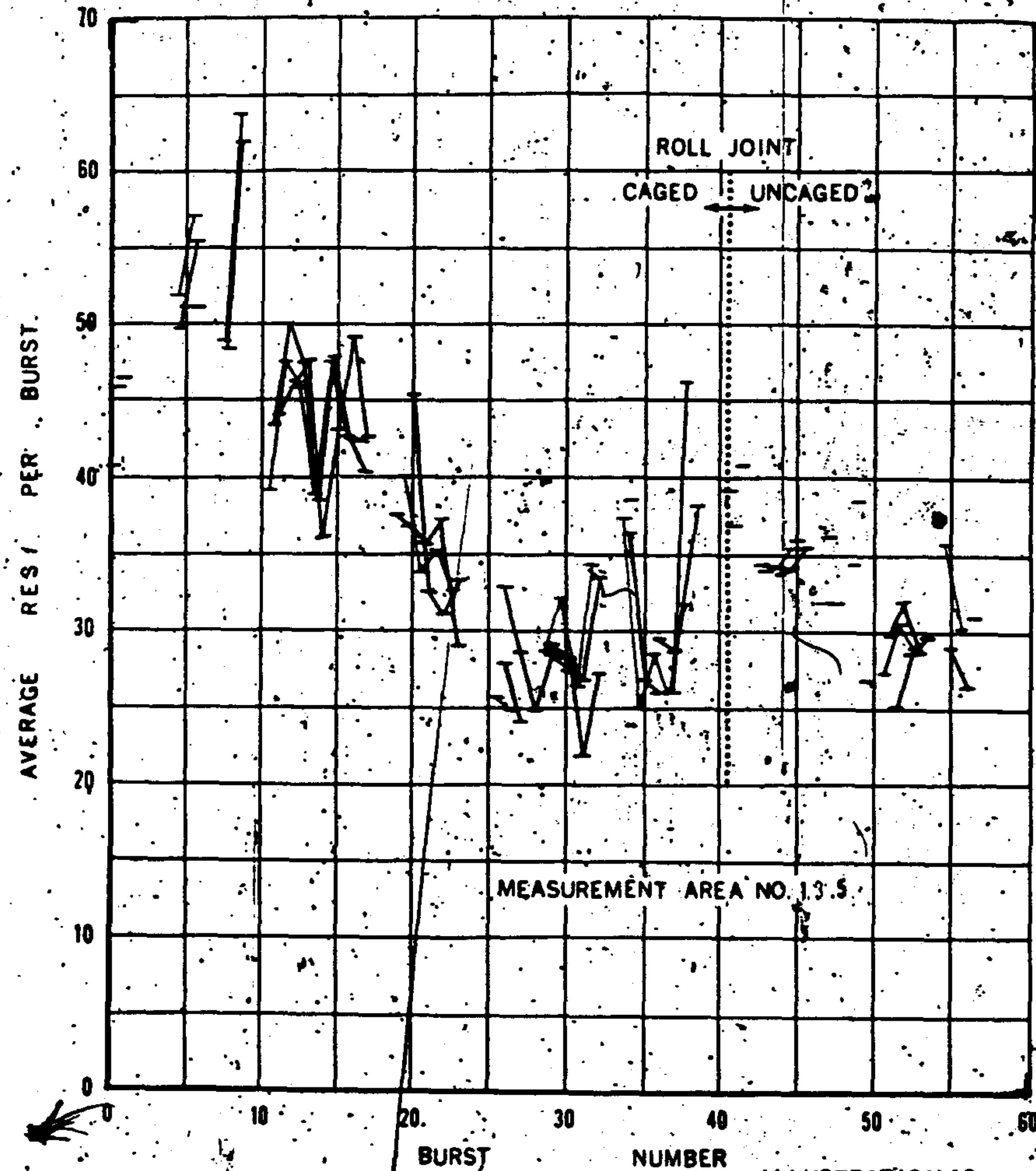


ILLUSTRATION 10

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

TEMPERATURE PROFILE - ORBIT 8

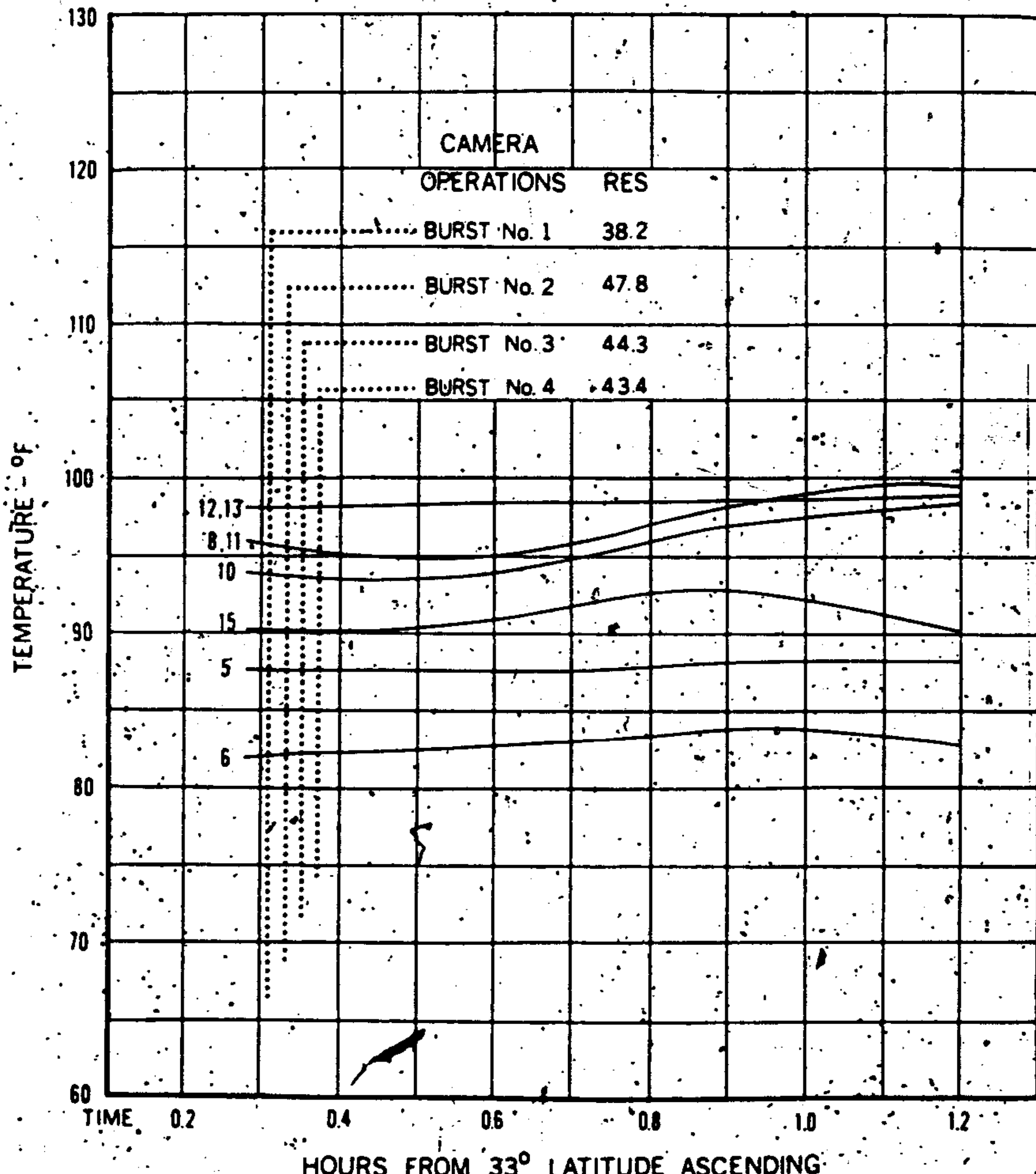
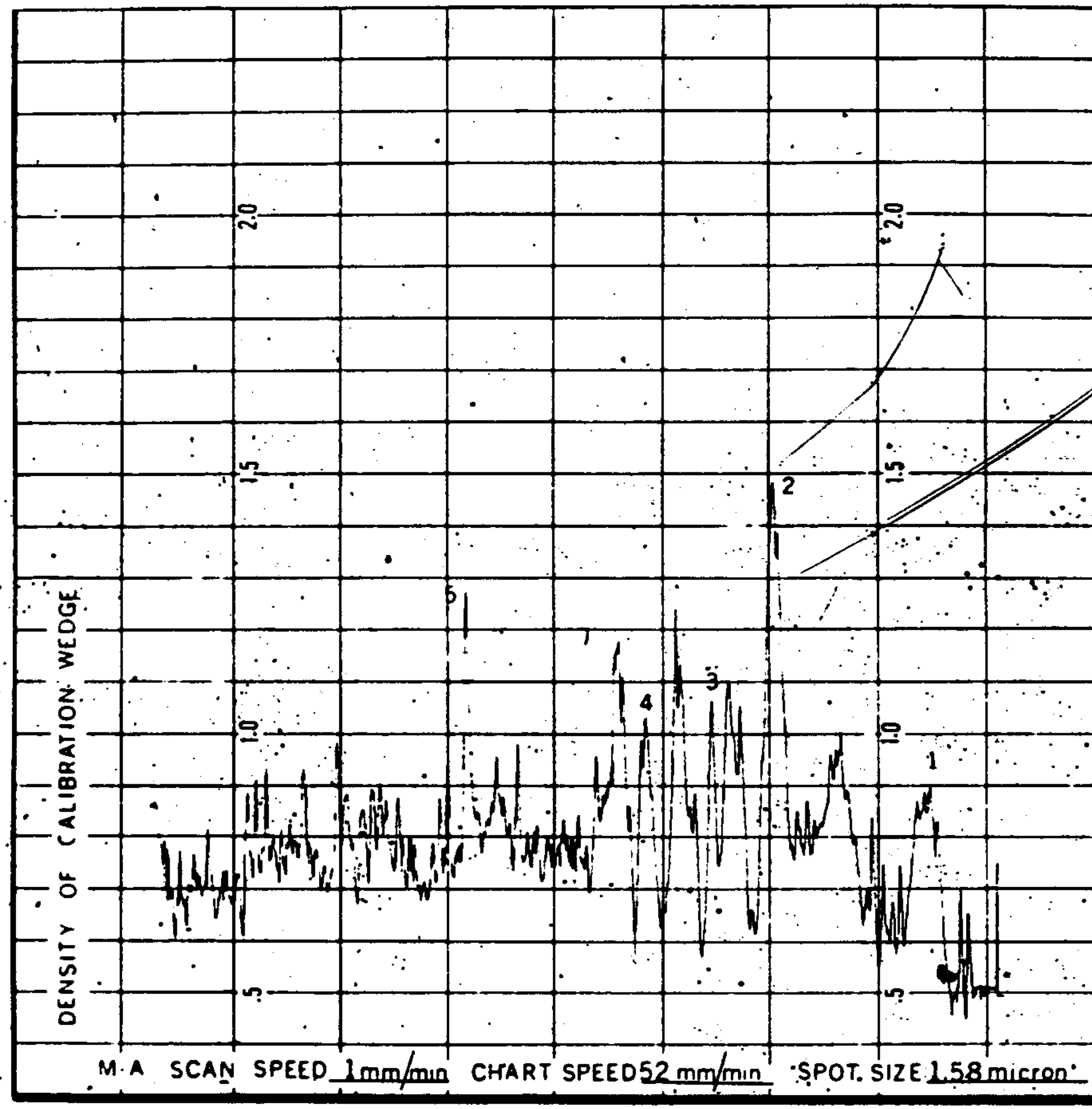


ILLUSTRATION 11

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

MANN-DATA MICRO-ANALYZER TRACE

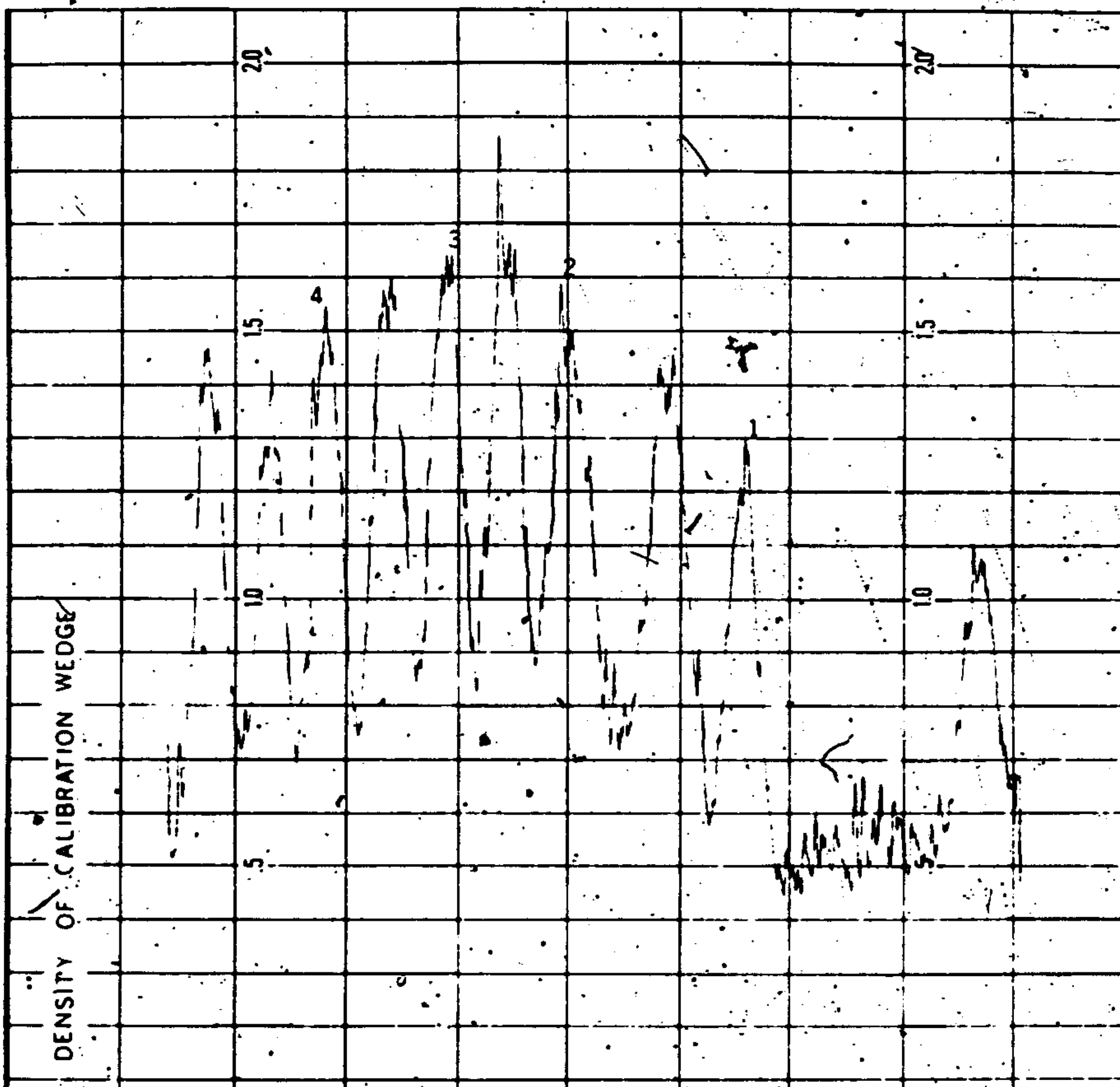


MISSION 8003 PASS D02 CAMERA POSITION ______ FRAME 030

ILLUSTRATION 12

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

MANN-DATA MICRO-ANALYZER TRACE



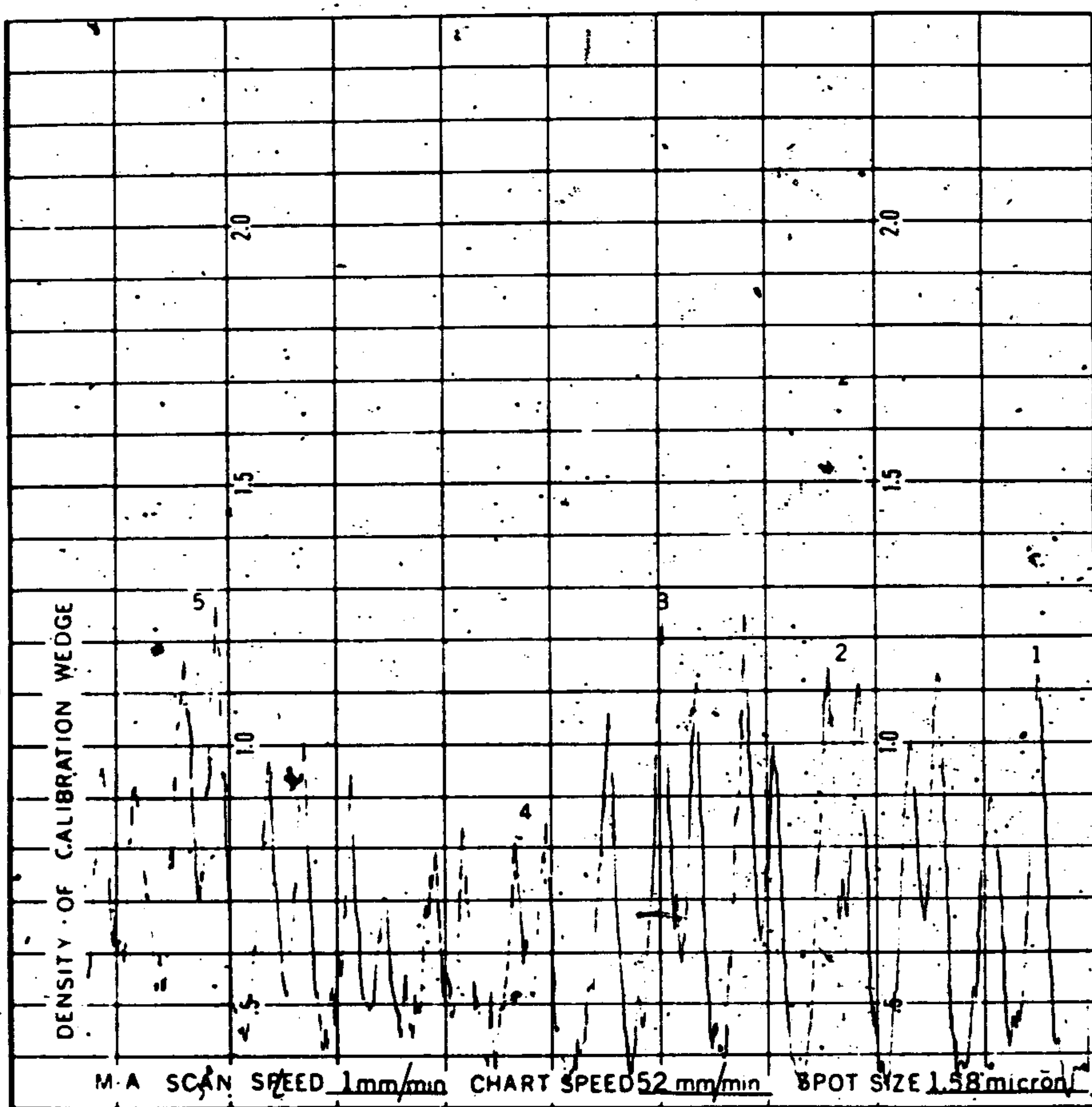
M A SCAN SPEED 1mm/min CHART SPEED 52 mm/min SPOT SIZE 1.58 micron

MISSION 8003 PASS D14 CAMERA POSITION ______ FRAME 123

ILLUSTRATION 13

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

MANN-DATA MICRO-ANALYZER TRACE



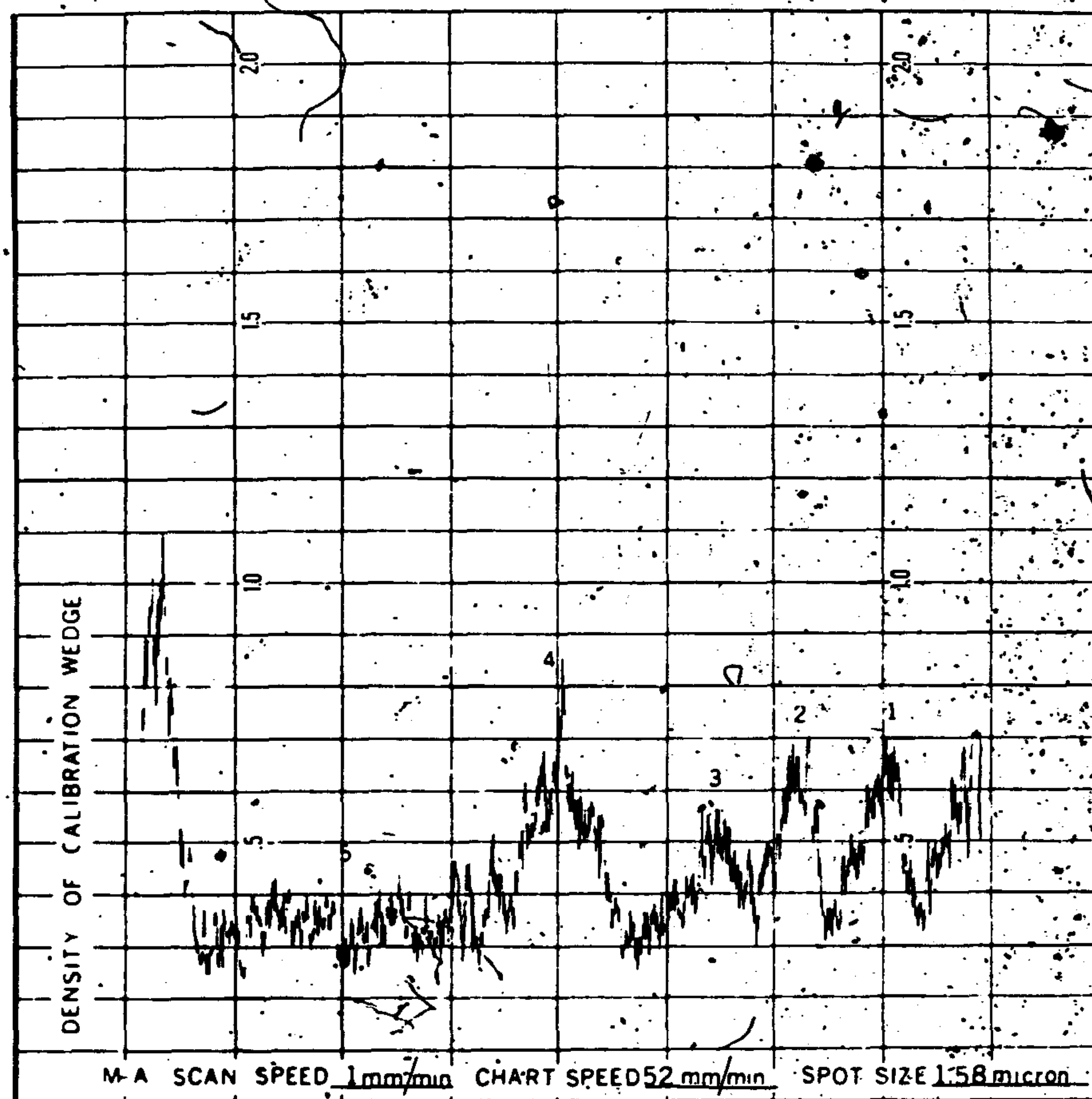
MISSION 8003 PASS A18 CAMERA POSITION ______ FRAME 012

ILLUSTRATION 14

[redacted] TOP SECRET CORONA/LANYARD [redacted]

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

MANN-DATA MICRO-ANALYZER TRACE



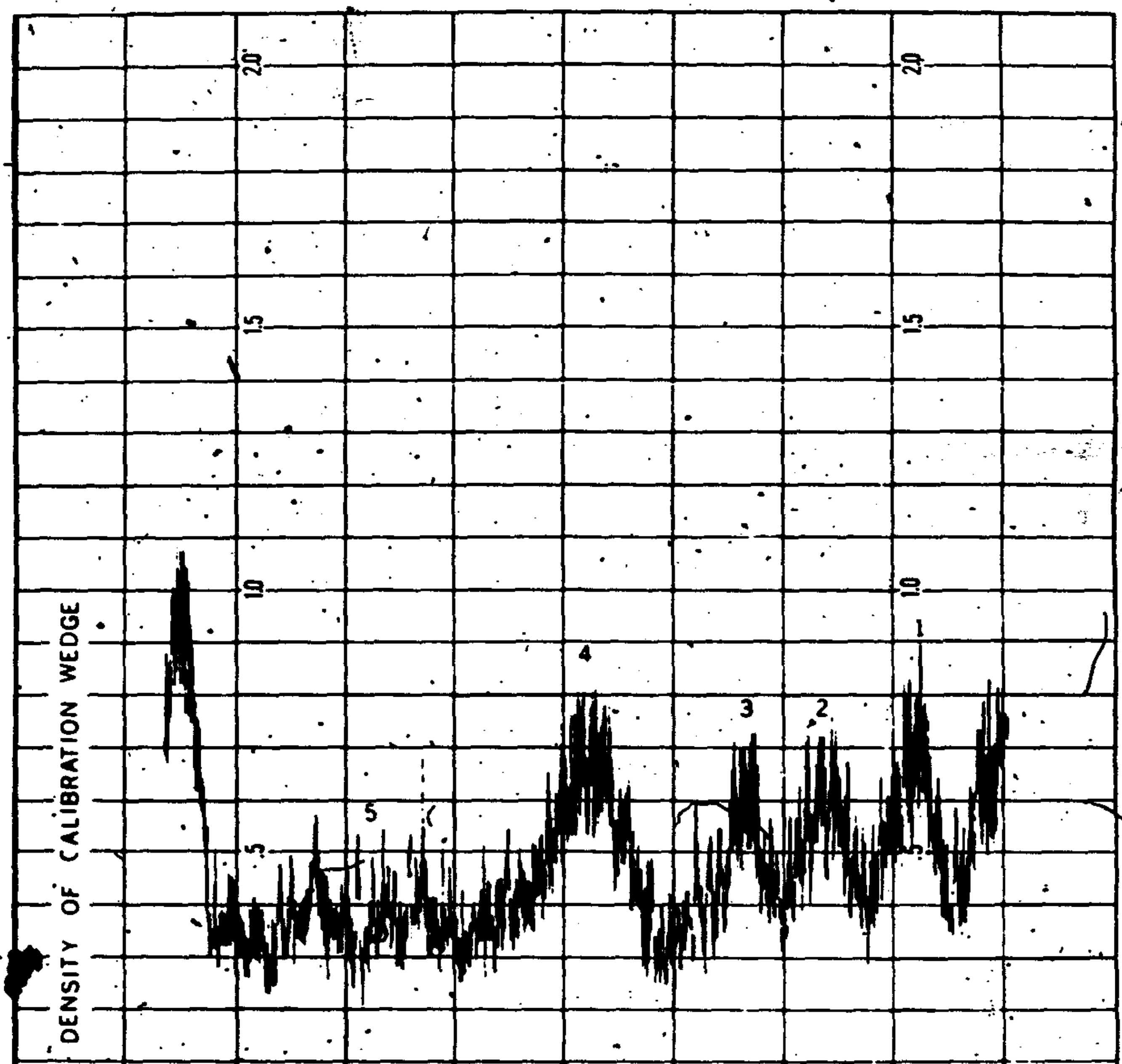
MISSION 8003 PASS D20 CAMERA POSITION ______ FRAME 024

ILLUSTRATION 15

TOP SECRET CORONA/LANYARD [redacted]

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

MANN-DATA MICRO-ANALYZER TRACE



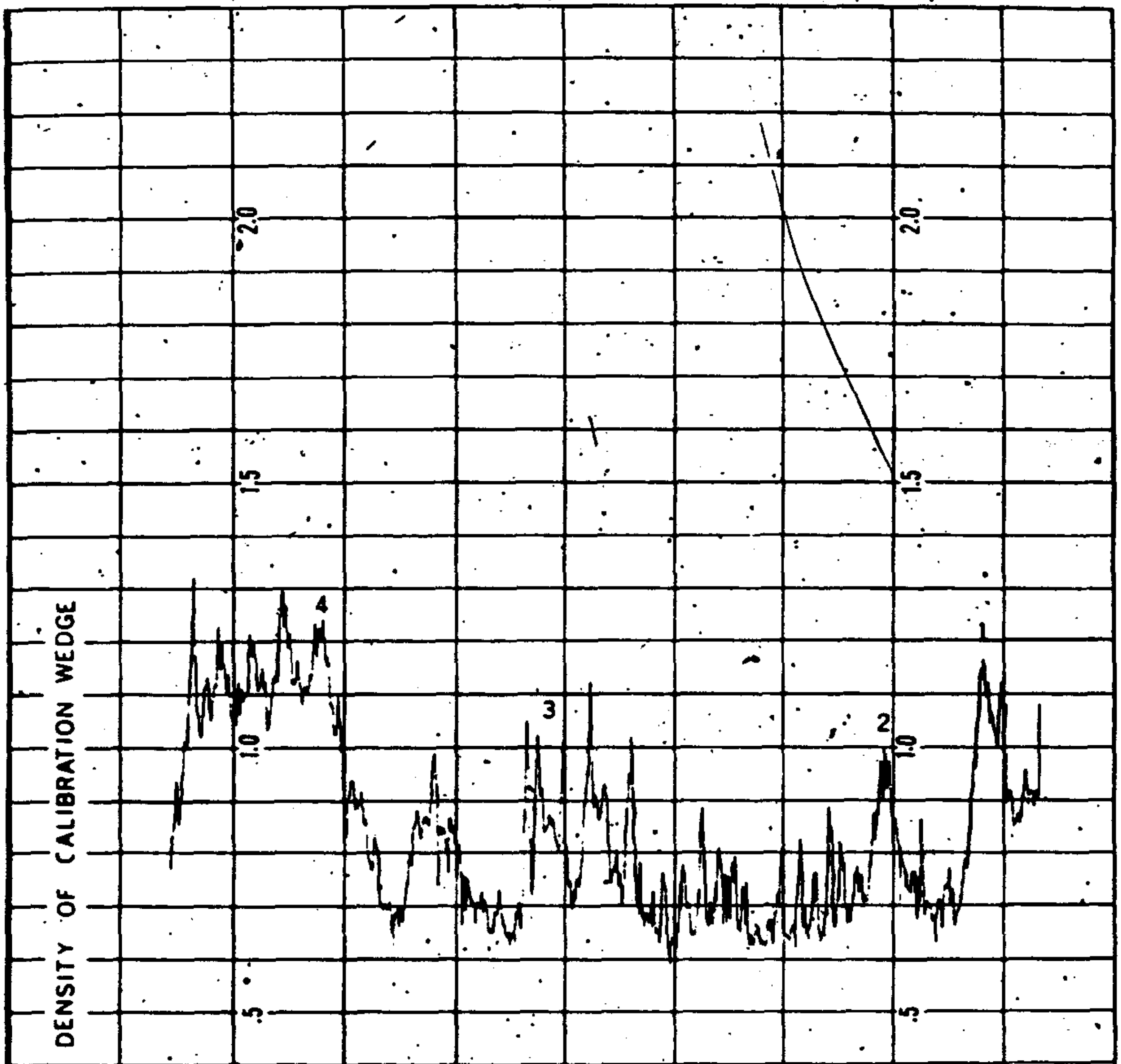
M-A SCAN SPEED 1mm/min CHART SPEED 52 mm/min SPOT SIZE 1.58 micron

MISSION 8003 PASS D20 CAMERA POSITION ______ FRAME 032

ILLUSTRATION 16

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

MANN-DATA MICRO-ANALYZER TRACE



M-A SCAN SPEED 1mm/min CHART SPEED 52 mm/min SPOT SIZE 1.58 micron

MISSION 8003 PASS D21 CAMERA POSITION ______ FRAME 045

ILLUSTRATION 17

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

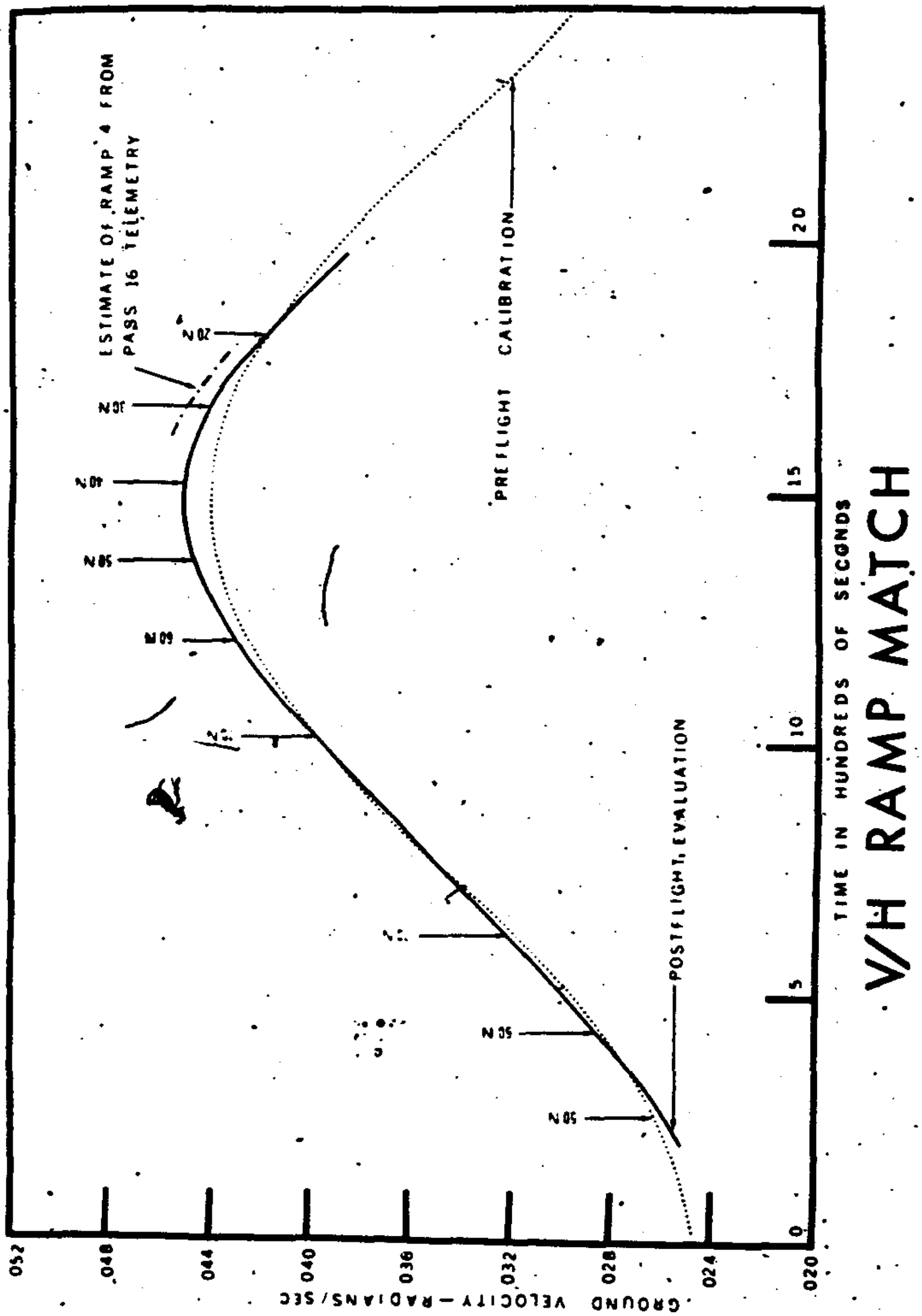
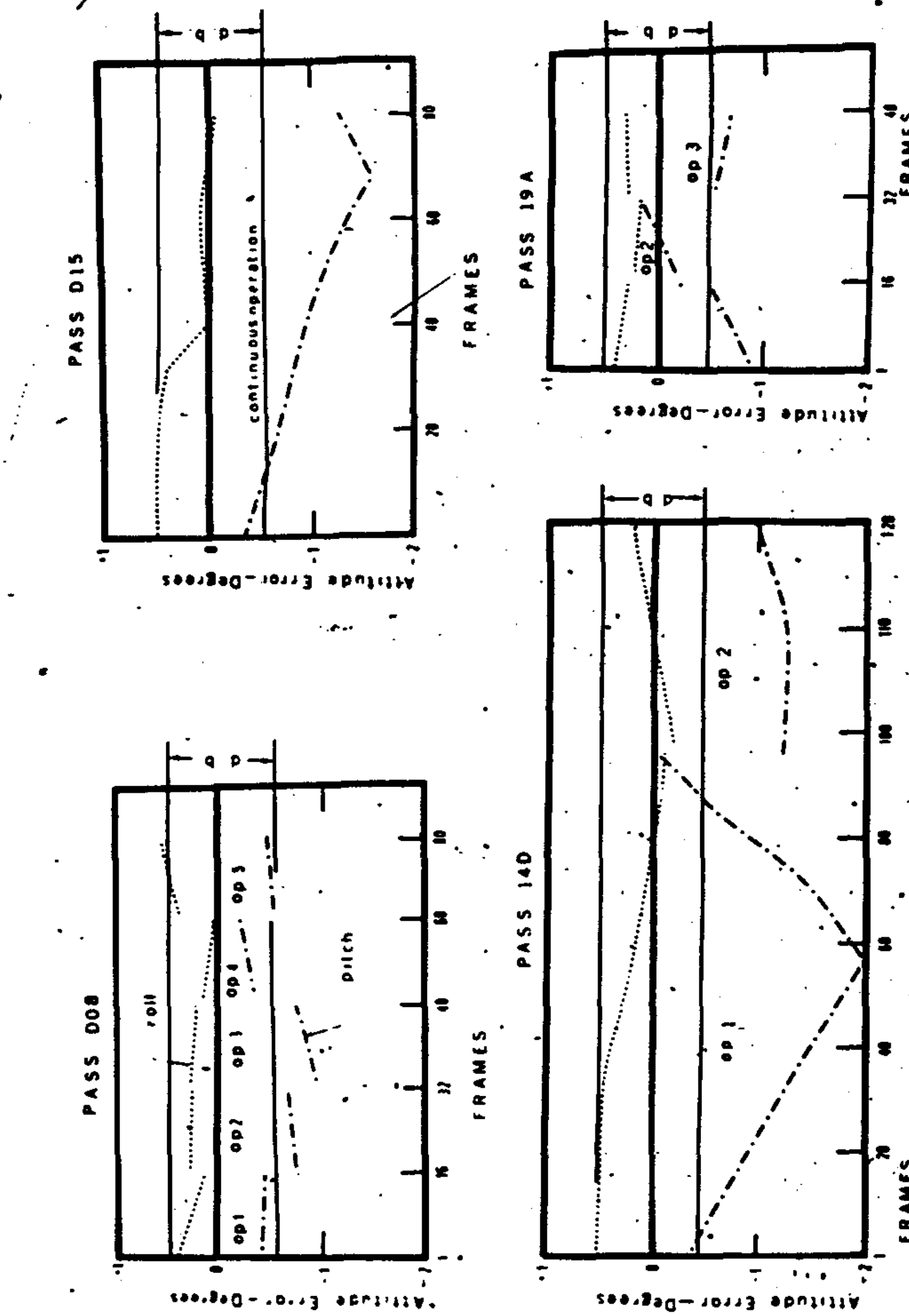


ILLUSTRATION 18

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]



TYPICAL VEHICLE ATTITUDES

ILLUSTRATION 19

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

SECTION VI

PERFORMANCE EVALUATION TEAM GROUP OBSERVATIONS

A. Camera Performance

1. Panoramic Camera

Functional T/M Data indicates that the instrument operated normally through Rev 22. T/M showed no operation after Rev 22 and the recovered photographic product confirmed this.

2. A frame-by-frame analysis of the film was accomplished by SPPL and is given in Section IV. However, the absence of edge wrinkles, tears, and scratches indicates normal instrument operation in film transporting. There was no evidence of Corona discharge. There was an indication of a light leak of minor significance which occurs on the first and next to last frame of each pass. This may have been a pinhole in the fairing or could possibly be associated with the "End of Pass" indicator lamp. Both possible causes require further investigation.

3. All of the auxiliary data block lamps appeared to be operating giving spots of adequate size and density uniformity to be easily machine read. The data block's position on the film relative to the format was consistent except when the camera was running at maximum speed. This effect did not occur at the slower speeds. This movement of the Data Block with respect to the Format has occurred in high speed ground tests when there is a worn clutch in the metering transmission. Corrective action

may involve replacing the clutch after a specified life time which the camera contractor will be asked to establish.

4. All functions and circuits whose output was recorded in the Data Block appeared to operate normally with the exception of the indication of roll steering position. There were seven cases where the binary indicated 0° roll when a roll actually was accomplished as verified by T/M and recovered photography. The decoder command circuit is the suspected component and is being investigated.

5. On Orbit 0 there was indication of severe image motion and banding. This occurred when the camera IMC was not synchronized with ground motion and during the yaw around the Agena. This was expected since the burst was solely for verification of launch survival. On orbit A19, there was also evidence of banding when the camera was running at a low scan velocity corresponding to 1/133 sec. exposure. Banding was less obvious at the lowest scan speed used, however, which was 1/118 second exposure.

6. Analysis of the photographic material for image quality shows that focus was never optimum and that it varied throughout the mission. Quality was generally better early in the mission. RES measurements were made in seven areas of each frame (see SPPL Technical Report [redacted], Illustration 30, page 81). RES measurements were averaged for each frame and are

presented in Illustration 9, page 36. Except for isolated instances, RES values drop after Rev 9 and stay lower throughout the remaining orbits.

7. It is possible to hypothesize a number of causes for a focus error. Some of these have been examined and discarded:

a. Change of Focal Distance with Altitude

The shift in focus between the two extremes in altitude has been calculated. Considering minimum and maximum altitudes of 90 and 164 nautical miles, the computed difference in focal distance is .000300 inches. This shift in focal distance is well within the depth of focus for this lens so we can rule out altitude change alone as a cause of defocusing.

b. Variation of the Film During Exposure

This possibility was considered and checked. The best method of checking film position during exposure is the Dr. Aschenbrenner test. This consists of placing a row of slits at some distance in front of the film and two lights at off-axis positions so that each slit exposes two parallel lines as the exposure slit is passed across the format. The separation between these lines is a sensitive indicator of the distance between slit and film and yields an entirely independent check of film flatness. During the past week, this test was conducted on a flight unit at the contractor's plant. The tests results indicated a deviation of less than ± .002 inch on any portion of the format. This also is within the depth of focus of the lens.

8. Another possible source of defocusing is a shift due to unpredicted and high temperatures at critical points in the optical system. Analysis of temperature data from the "on board" tape recorder is continuing to establish the precise time history of the thermal conditions which existed during flight. When this is completed, a more complete correlation with image quality (from RES measurement) can be accomplished. Flight instrumentation indicates that the lens was not in optimum focus due to the on-orbit temperature conditions. The most probable cause of quality degradation after Rev 9 is a shift of the lens elements at the high temperatures experienced on orbit. Attempts were made to correlate the on-orbit measurement with laboratory results which indicate that a total shift of approximately eight thousandths of an inch is probable, which could reduce the peak resolution by one third. These facts support the conclusion that the thermal conditions were the cause of the overall "softness" in image quality.

9. There is an indication of possible double images occurring in a few cases in small localized areas of the format. There is not a definitive explanation of this phenomena at this time. It is conceivable that a reflection from the film to the back of the slit and then back to the film may have caused this effect; however, tests indicate that this is not probable. It is possible that this problem may be related to the focus problem since all cases observed involve aircraft or other objects with

bright reflections Analysis and tests are continuing to see if this phenomenon can be duplicated in the laboratory, or accounted for

10 The exposure ranged from 1/118 sec to 1/233 sec It is not evident that the image quality is better at the higher shutter speeds However, if the overall quality had been higher, a finer check on this point could have been made

11 Prior to flight, this instrument produced 83 l/mm performance with the flight slit when assembled in the flight configuration Although no direct correlation between RES and l/mm is possible, and therefore a precise relationship cannot be established, it is estimated that the overall system resolution was degraded by approximately a factor of two below the expected capability

12 The following comments pertain to the camera stoppage after orbit 22.

a A V/H ramp change was attempted on orbit 23 Command was sent to change ramp 5 to 4 Automatic command sequences at tracking station sent signal to step to position 4 but V/H ramp ended on position 6. Another signal was sent to correct this and stepper went to position 4.

b On orbit 25 two commands were sent to change from program 1 to program 3 No operation indicated. Increased power drain on the Agena batteries was noted by T/M.

c. On orbit 26 two real time commands were sent in an attempt to bypass the decoder and command the camera to operate. No response.

d. On orbit 31 recovery enable command was sent.

e. On orbit 33 air recovery accomplished.

f. On orbits 27 through 54 selected commands for failure analysis were sent. These commands caused the mirror to change position upon command. In addition, these commands indicate that the decoder was responding correctly and that the operate signal was getting to the decoder.

13. Possible Trouble Areas

a. Investigation of the L-3 failure has been concentrated principally in the intervalometer area. The intervalometer motor could have failed. The motor could have been stressed by the V/H commands being inserted while the motor was running. Failure of the metering amplifier would also have caused the instrument to cease operating. Other areas that could cause this failure are:

(1) A shorted capacitor in the intervalometer motor input.

(2) A failure in the T-1 transformer that supplies 26 volt AC to the intervalometer tachometer.

(3) A relay failure.

(4) A broken wire.

b. Power switching failure is not the likely cause since this could not explain the power increase observed after the failure in L-3.

c. Under aggravated environmental conditions, a metering servo was operated in the intervalometer mode for three days continuously. During this period, every fifteen minutes the V/h programmer switch was stepped through a series of positions giving the metering servo commands alternating between 60% V/h and 120% V/h. This test produced no malfunction.

d. In a later test, the stepper was cycled just at the instant of application of S/I command. This produced even milder transients than the previous test and did not produce a malfunction. The servo amplifier has been extensively tested under simulated environmental conditions, and except for the possibility of a component failure, is not expected to be the cause of the failure.

e. A test was conducted in which the tachometer feedback of the metering servo was removed. This caused the metering servo motor to run at 13,000 rpm, corresponding to a V/h rate of 270% of nominal. Near the end of this test, the motor stopped rotating and the current drawn by the unit increased by approximately 5 amperes.

f. Inspection of the metering drive servo showed that the motor pinion, mating gear, and the coupling to the flywheel were damaged to such a degree that they caused the motor to jam. On the chance that the transformer supplying the voltage to the tachometer was the cause of malfunction, the tachometer excitation transformer is now being tested under aggravated environmental conditions.

g. Examination of the type of tachometer used on this drive reveals a potential source of malfunction. The leads emerge from the tachometer through a hole having a sharp edge. Sleeving put on to protect at this point was found to have worked up out of the area to be protected. A short or open on the tachometer leads is considered to be the cause of the malfunction.

h. The following are the details of the analysis which concludes that the tachometer leads failed.

T/M on channel 10, S/I shutter and Stellar and Index Commutators showed that the S/I did not operate on the programmed S/I turn-on that occurred over the [redacted] station on pass 23. Tests run on the S/I unit show that at the high pulsing rate due to a run-away panoramic metering servo, the S/I unit does not meter film. Therefore, it is possible that the run-away condition existed at that time.

i. Corrective actions being taken are:

(1) Design of a nylon bushing or sleeve that can be anchored in a position that will protect the leads on existing units.

(2) Vendor (Kearfott) contacted and ordered to improve his design in this area. He pointed out that latest deliveries of these tachometers have a bushing for lead protection.

(3) Investigation started to see if this type tachometer is available from other vendors.

14. Stellar/Index Camera

Stellar photographs were obtained on approximately 1400 frames. All frames recorded had normal background fog resulting from earth shine reflected from the baffle and door. Approximately 1/4 of the format is vignetted by the baffle and door as predicted by pre-flight testing. Stars were recorded in all areas of the format except this vignetted area. Density measurements of the fogged area have not yet been made, but subjective opinion is that interference will be minimal.

15. Only three frames of Index photography were recorded; these were normal. Some very light corona was noted on the unexposed film.

16. Erratic metering produced approximately 1000 extra formats. The Stellar portion did not run out of film before recovery.

17. The cause of failure on the Stellar/Index unit cannot be identified at this writing although it is possible that the higher than normal temperature contributed to the failure.

B. Photographic Quality

1. Examination of the Panoramic camera film immediately shows that nominal system performance was not achieved during the mission. Extensive quantitative data has been acquired in an attempt to ascertain the causes of performance reduction.

2. The RES values show a significant downward shift during the initial operation of Pass D09 (Illustration 9, page 36). The cause of this change is presently unknown. A corresponding anomaly in system operation has not been located.

C. Exposure Time

1. The diffuse density measurements are nominal throughout the mission (see SPPL Technical Report [redacted] Illustrations 8 through 13, pages 18 through 23). Density values were measured in areas 1 through 5 in every frame (see SPPL Technical Report [redacted] Illustration 30, page 81). Area 3 was a combination of areas 3, 6, and 7 for density measurements only.

2. The majority (90%) of the panoramic photography was made at sun angles from 36° to 39°. No correlation was found to exist between the density data and:

a. Sun angle (see SPPL Technical Report [redacted] Illustration 14, page 24)

b. Pan angle

c. Stereo angle

d. Exposure time

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

3. The exposure time utilized during the mission followed the allowable curve for "full" processing according to pre-flight prediction (see Illustration 7, page 34). The PET members consider any further underexposure would have resulted in loss of information content as the original negative was slightly thin.

4. The brightness ratio for each frame was calculated based on the actual characteristic curve provided by the processing facility (see SPPL Technical Report [redacted] Illustration 2, page 7). The average mission brightness ratio was 3.25 which is significantly higher than anticipated (see Illustration 8, page 35). The average brightness ratio per frame is plotted in Illustration 9, page 36.

D. Performance Measurement

1. The level of performance of the panoramic camera was ascertained by the Reciprocal Edge Spread (RES) measurement technique. Details of this technique are contained in Section IV.

2. Extensive measurements (in excess of 4000) were made in the seven prescribed areas of each frame as shown in Illustration 30, page 81, of SPPL Technical Report [redacted] It was recognized that prescribing a large number of areas within the format would significantly reduce the average mission RES value; however, PET members considered the detailed evaluation of the system to be paramount.

3. The high degree of variation in RES measurements shown in Illustration 9, page 36, is not considered highly significant with the exception of the downward shift in Pass D09.

4. The validity of the RES technique in establishing a performance level is unquestioned when the spread measurement is made in areas of known contrast ratio since diffraction theory is based on contrast variations. In order to best utilize the RES measurement, it should be normalized with the contrast ratio and other factors at the point of measurement.

5. The best known method presently available to simultaneously measure the image spread function and the contrast ratio is the "Micro-Analyzer". For this reason, all of the Micro-Analyzer traces made during the mission evaluation are included in this report for further analysis by the participating contractors:

a. Illustrations 12 through 17, pages 39 through 44

b. SPPL Technical Report [redacted] Illustrations:

19, page 36

20, page 40

21, page 44

22, page 47

23, page 51

35, Appendix 3, page 5

37, Appendix 3, page 9

6. The RES data summaries are shown in SPPL Technical Report [redacted] Illustrations 15 through 17, pages 25 through 31. Various approaches were taken to achieve correlation of the RES data with other mission variables (see Illustrations 10 and 11, pages 37 and 38, and SPPL Technical Report [redacted] Illustration 18, page 32); however, no correlation or relationship could be found between RES values and:

a. Format areas

b. Sun angle

c. Temperature changes

d. Differential temperature measurements

e. Brightness ratio

f. Vehicle attitude errors and rates

g. Mono and stereo operation

h. Caged or uncaged roll joint

i. Roll angle

7. Further attempts at correlation will be conducted as soon as all of the mission data is available. Particular attention will be given to the thermal and attitude control areas.

8. The absence of complete attitude error data precluded the incorporation of the desired IMC error analysis in this report. This analysis will be conducted as soon as the complete data is available.

SECTION VII

NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

OBSERVATIONS

INTERIM SUBJECTIVE EVALUATION OF MISSION 8003 (L-3)

1. Suitability for photo interpretation varies greatly throughout the mission. The best image quality appears in the first portion of the mission, with Pass D08 having the greatest information potential. Image quality is not consistent within a frame. Areas of best quality appear along the edges and in the lower right hand corner (as viewed facing direction of flight) or end of scan area of the frames. Imagery in the degraded areas appears soft with no directional streaking observed at the magnifications used in photo interpretation. No degradation is observed that could be attributed to pass duration or mode change within a pass. There is no apparent quality distinction related to mono versus stereo or vertical versus roll operation. The smallest objects discerned by photo interpreters in the preliminary scan of the mission include:

a. Unidentified swept wing fighter aircraft (Pass D03).

b. Small buildings 15' X 15', storage tanks 15' in diameter, vehicles identified as sedan or bus type, parked trucks 8' X 25' (Pass D08).

c. Circular aperture 20' in diameter (Pass D09).

d. Railroad cars (Pass A18).

e. Small buildings (Pass A19).

f. Large trucks 30' X 9' (Pass D20).

2. Overall mission cloud cover was 53.7 per cent. The following table is based on five categories of cloud cover, namely:

Category	1	less than 10%
	2	10% - 25%
	3	25% - 50%
	4	51% - 99%
	5	100%

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

Percentage of Cloud Cover by Category and Pass:

PASS NUMBER	1	2	3	4	5	CLOUD COVER % PER PASS
1D	0.0	0.0	0.0	75.0	25.0	81.3
2D	8.3	58.3	29.2	4.2	0.0	24.9
3D	0.0	12.5	31.3	56.2	0.0	56.3
6D	0.0	0.0	6.2	59.4	34.4	81.4
7D	6.2	12.5	18.8	62.5	0.0	56.5
8D	45.0	7.5	27.5	20.0	0.0	29.1
9D	0.0	30.0	42.5	27.5	0.0	42.1
13A	0.0	0.0	0.0	50.0	50.0	87.5
14D	25.0	22.9	35.4	16.7	0.0	31.3
18A	0.0	6.3	6.3	87.4	0.0	69.1
18D	0.0	0.0	37.5	62.5	0.0	61.2
19A	4.2	29.1	0.0	66.7	0.0	55.3
19D	0.0	0.0	50.0	50.0	0.0	56.5
20D	8.3	8.3	12.5	70.9	0.0	59.9
21D	0.0	0.0	9.4	90.6	0.0	71.6
22D	12.5	0.0	0.0	87.5	0.0	66.2
	10.2*	13.8*	20.2*	51.0*	4.8*	53.7**

*Average percentage by Category for mission.

**Overall mission cloud cover percentage.

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

3. The deviation in nautical miles of the plotted center of "burst" from the predicted position is given in the table below.

PASS	BURST	MODE	DEVIATION OF PLOTTED POSITION
D-01	1	Mono	3 S 5 E
D-01	2	Stereo	No Plot Available
D-02	1	Mono	2 S 7 E
D-02	2	Stereo	2 S 0 E
D-03	1	Mono	1 N 7 W
D-06	1	Mono	No Accurate Plot Available
D-06	2	Stereo	21 N 9 W
D-06	3	Stereo	No Accurate Plot Available
D-07	1	Stereo	1 N 0 E
D-07	2	Stereo	0 N 1 W
D-08	1	Stereo	0 N 2 W
D-08	2	Stereo	1 N 3 W
D-08	3	Stereo	3 S 0 E
D-08	4	Stereo	0 N 3 E
D-08	5	Stereo	5 N 4 W
D-09	1	Stereo	1 S 1 W
D-09	2	Stereo	5 N 2 W
D-09	3	Stereo	3 N 3 W
D-09	4	Mono	3 S 1 E
A-18	1	Stereo	5 S 1 W
A-18	2	Stereo	0 N 2 W
D-18	1	Mono	3 N 1 E
A-19	1	Stereo	2 N 3 E
A-19	2	Stereo	2 N 1 E
A-19	3	Stereo	No Plot Available
D-19	1	Stereo	9 S 7 W
D-20	1	Mono	No Accurate Plot Available
D-20	2	Stereo	5 S 2 W
D-21	1	Mono	4 S 8 E
D-21	2	Stereo	2 S 0 E
D-21	3	Stereo	7 S 5 E
D-22	1	Mono	No Accurate Plot Available
D-22	2	Mono	No Plot Available
D-22	3	Stereo	2 S 1 W
D-22	4	Mono	5 N 2 W

4. The data block was clear throughout the mission with a density difference of approximately 1.60. There were no apparent light failures. While well within the requirements for machine reading, the Data Block Reader was unable to read because titling and fiducial marks on the edge of the film caused false scanning, thus the data block was hand read. All of the data agreed with programmed data except for the roll position values when in a roll position. This is still being studied. Binary time was correct throughout the mission. Attitude will be compared with that obtained from stellar reduction. The scan rate light did not light indicating less than 10 per cent error, which has not yet been completely checked. In summary the data block functioned well.

5. While only three frames with imagery were obtained from the index camera, the data block functioned throughout the mission. Lights for positions 26 and 27 remained on for the entire time causing several gross errors in the time values. A spare was used for position 15 because of light failure. An automatic reader was not available for data block read-out. There was considerable light leaking into unlit binary positions which would have caused a serious problem for automatic reading. A thorough correlation of time has not been completed to determine any clock failure.

6. A comparison test was made of photo measurements versus reliable ground distances. Unfortunately, the photography over the area of known ground distances was of poor quality. The "softness" of the photo images made accurate pointing difficult.

The per cent of error for various size measurements is presented in graph form. While these results are not conclusive, it is indicated from the graph that measurements of objects under about 60 feet are in error by 10 per cent or more, the error increasing as size of objects decreases (see Illustration 20, page 66).

7. Pitch and roll as recorded in the data blocks have been plotted. Four samples are included in this report. They represent the best (D06-1), normal (D06-2), worst pitch (D14-2), and worst roll (D21-2) conditions (see Illustrations 21 through 24, pages 67 through 70).

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

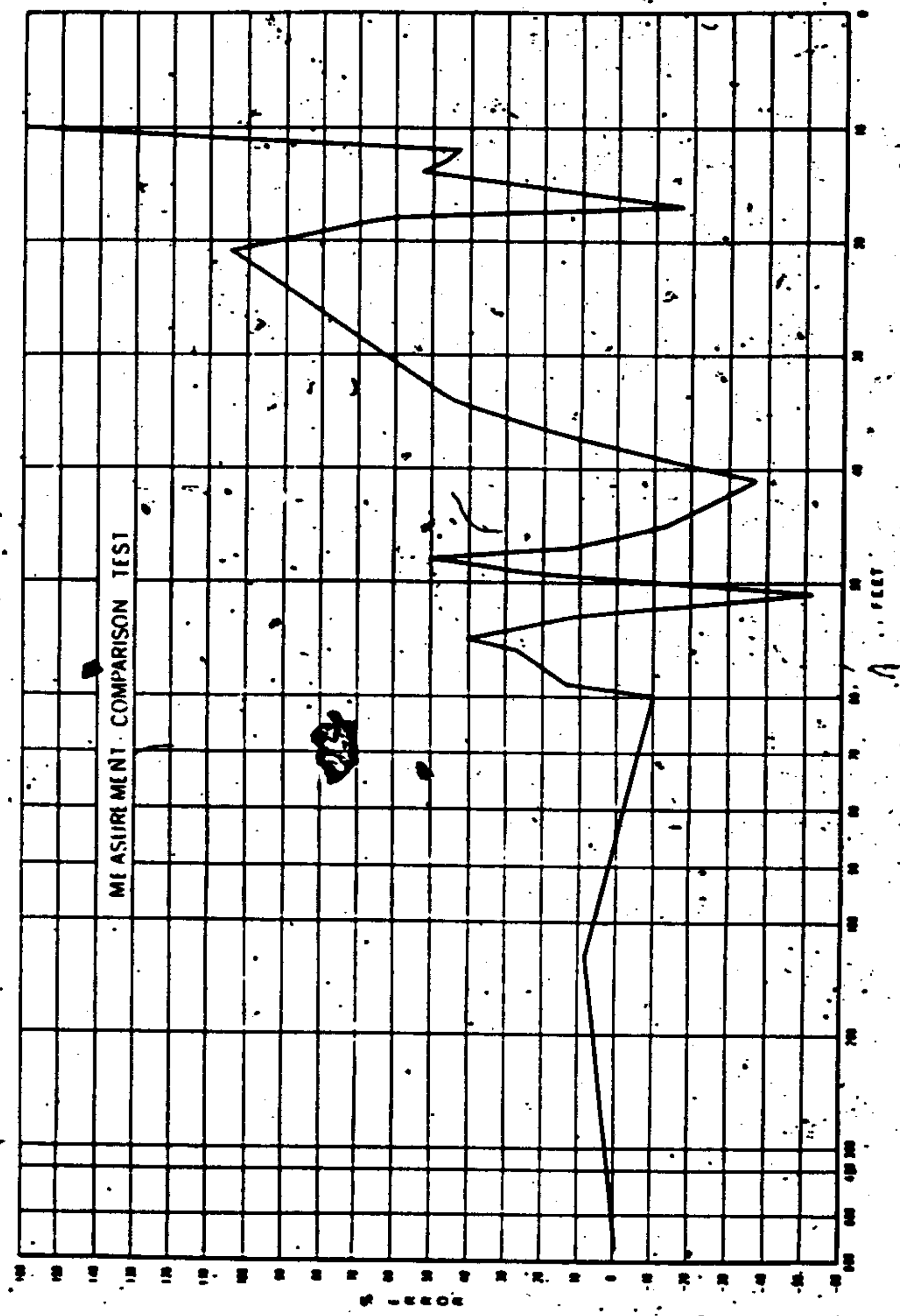
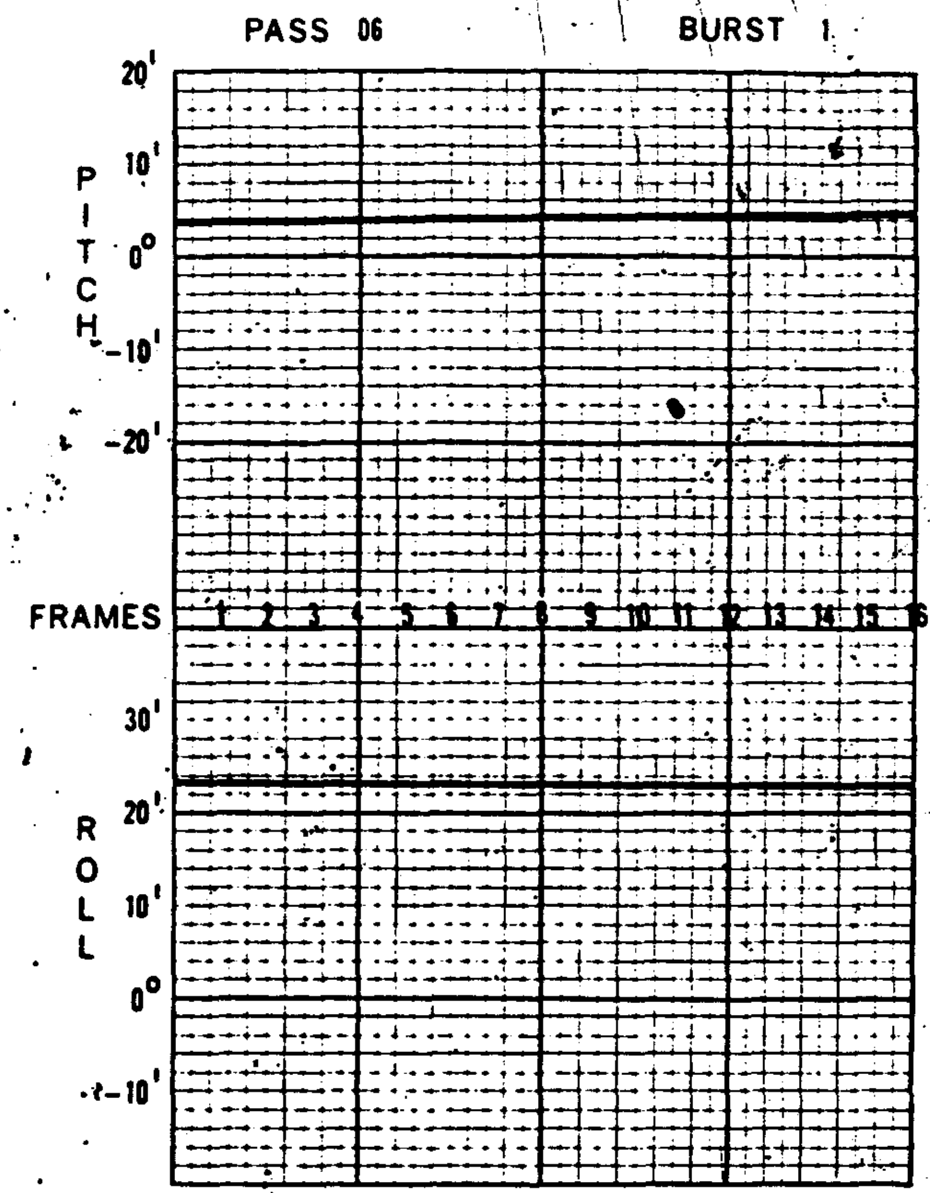


ILLUSTRATION 20

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

ATTITUDE ERRORS AND RATE

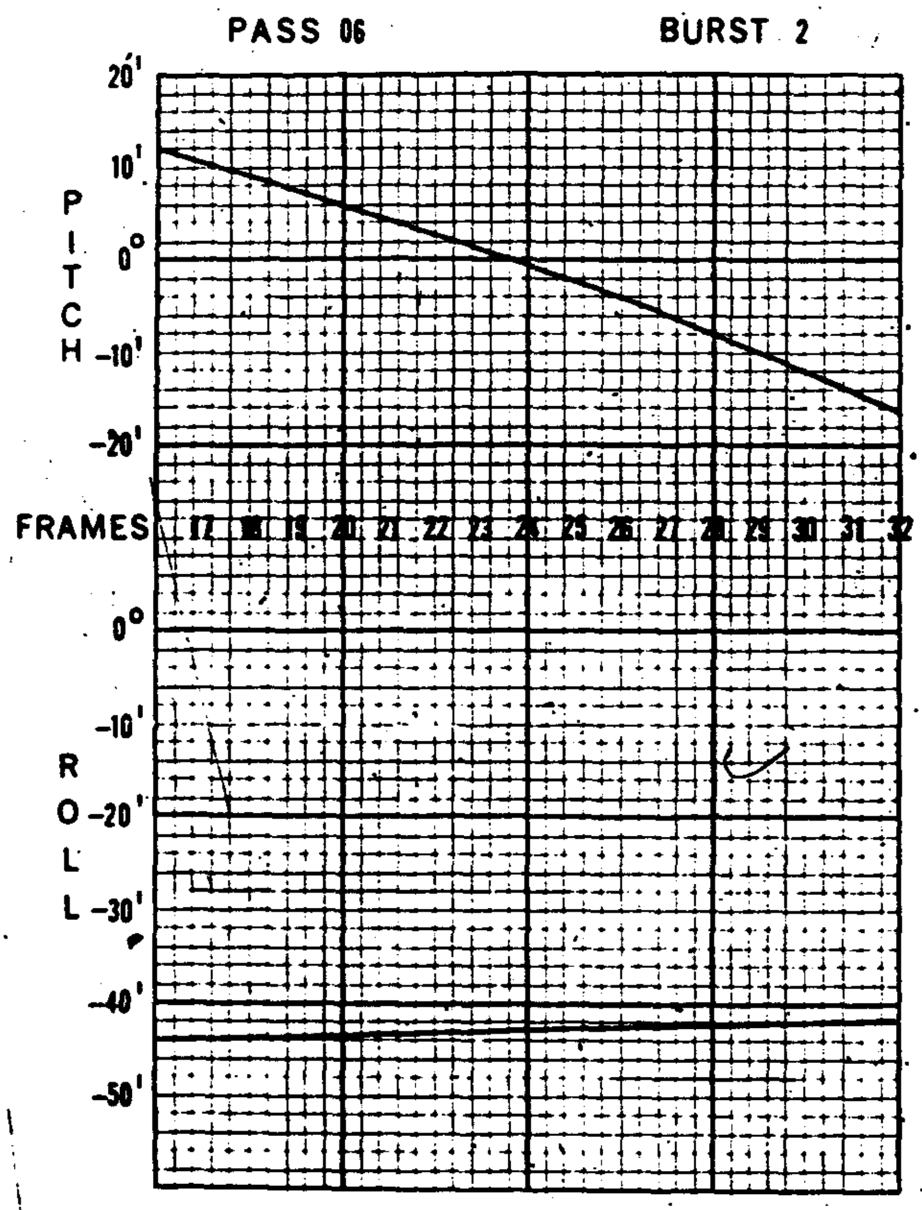


PITCH RATE: 0° hr.
ROLL RATE: 0° hr.

ILLUSTRATION 21

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

ATTITUDE ERRORS AND RATE



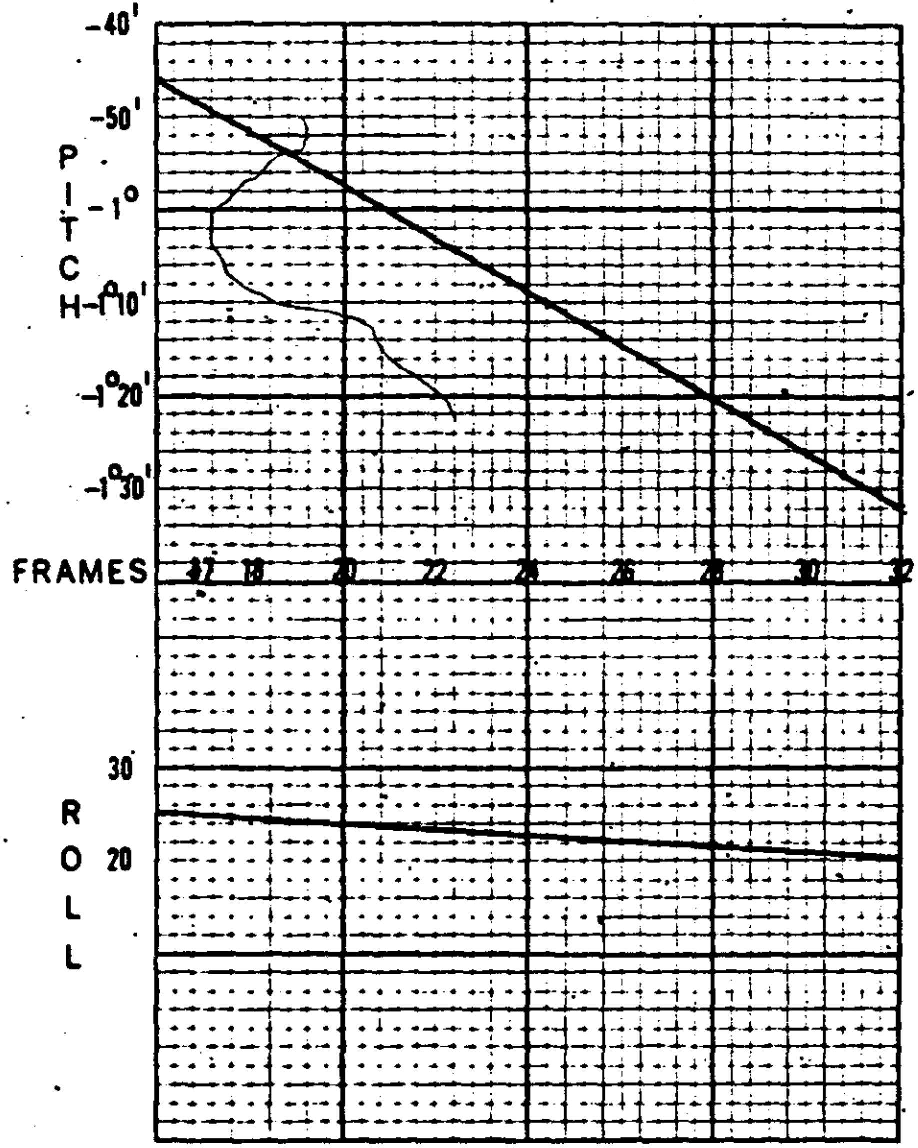
PITCH RATE: 64 hr.
ROLL RATE: 3 hr.

ILLUSTRATION 22

PERFORMANCE EVALUATION TEAM
REPORT [redacted]

ATTITUDE ERRORS AND RATE

PASS D14 BURST 2

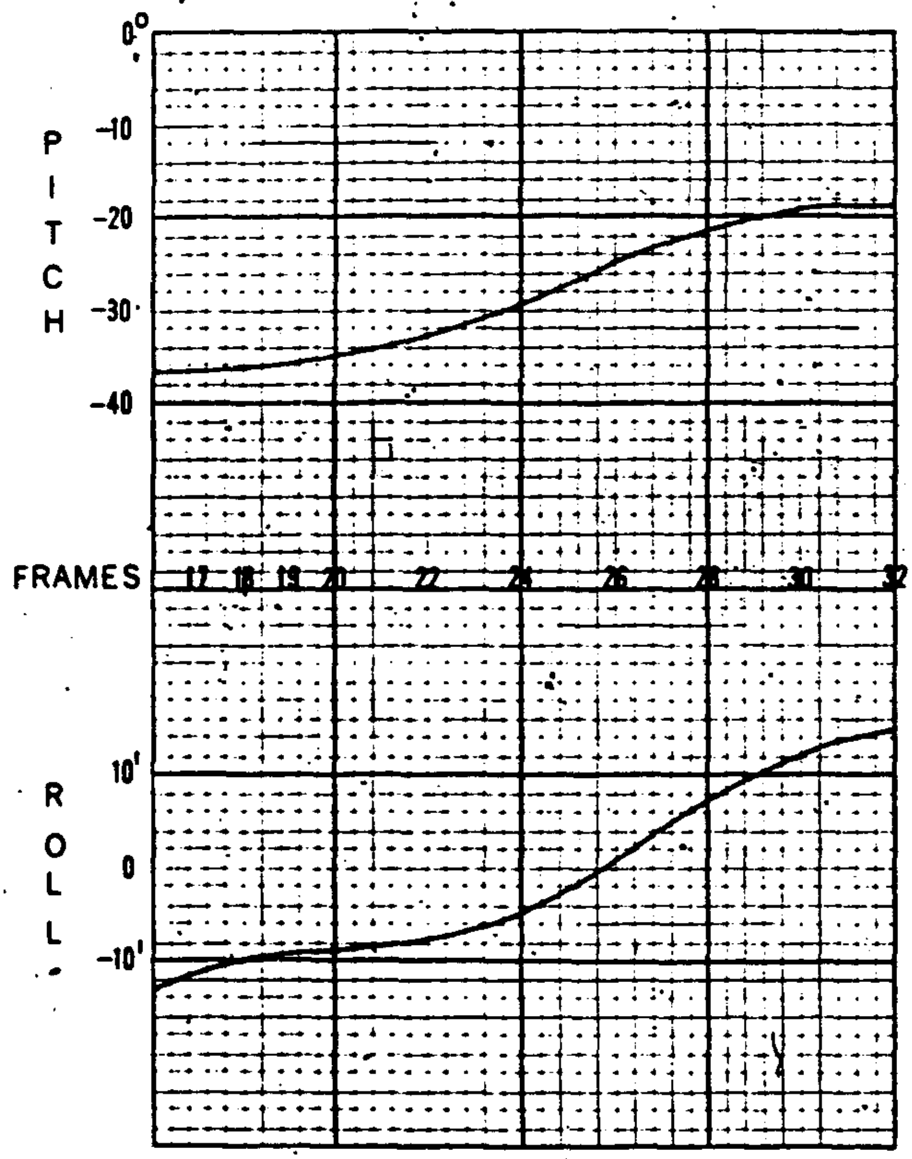


PITCH RATE: 129° hr.
ROLL RATE: 15° hr.

ILLUSTRATION 23

ATTITUDE ERRORS AND RATE

PASS D 21 BURST 2



PITCH RATE: 60° hr.
ROLL RATE: 6.° hr.

ILLUSTRATION 24

PERFORMANCE EVALUATION TEAM
REPORT NO. [redacted]

SECTION VIII

SUMMARY

A. It should first be recognized that this performance evaluation effort is just a first-time-through the first available data, and that analysis efforts are continuing which can significantly affect the team's conclusions.

B. It should be noted that in the NPIC report the word "discerned" means "identified", and the smallest detectable object is smaller than the objects listed by NPIC.

C. The targeting accuracy can be summarized as follows:

1. The difference between the actual Look Point and the pre-launch designated Look Point averaged approximately 5 n.m. across track and 16 n.m. in track. The worst case was Rev 6 where timer error built up to 57 n.m. The difference between the actual Look Point and the last computed Look Point averaged approximately 2 n.m across track and 6 n.m. in track.

2. Pointing dispersions due to vehicle attitude variations were generally less than the map errors and were negligible. There were no errors due to the roll joint.

D. The system performance can be summarized as follows:

1. The system resolution is estimated to be degraded by approximately a factor of 2 from pre-flight predicted values probably due to an out of focus condition.

2. There appears to be a significant downward shift in RES values after Rev 9 (reason unknown at present).

3. RES values were not significantly different from position to position within the frame.

4. No correlation was observed from plots of RES values as a function of sun angle, brightness ratio, temperature, vehicle attitude rates, mono and stereo operation, and the caged or uncaged roll joint. Additional correlation efforts must be made in the temperature and vehicle attitude rate areas.