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PHOTOGRAPHIC EVALUATION REPORT
MISSION 1004-1
15-18 FEBRUARY 1964

This document contains information referring to

Project Corona

WARNING

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NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

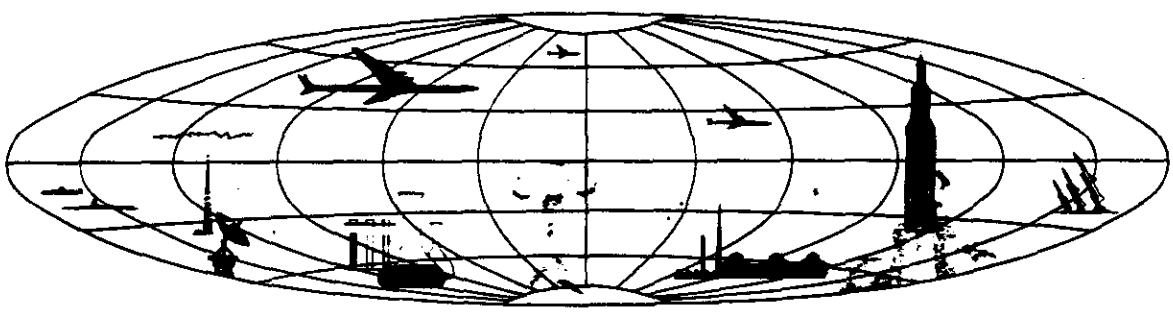

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TABLE OF CONTENTS

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SYNOPSIS

Mission 1004 (J-5), the third in the J series reconnaissance system, was launched 15 February 1964. The first phase (designated 1004-1) encompassed twenty-six operational photographic passes (of which three were programmed over the North American continent) and seven engineering passes. The first phase payload was air-recovered on 18 February 1964 and included 7,618 feet of master (FWD) camera film, 7,512 feet of slave (AFT) camera film, 40 feet of stellar index camera film, and 82 feet of terrain index camera film. The processed footage contains 2,889 master panoramic frames, 2,850 slave panoramic frames, 405 stellar index frames and 413 terrain index frames.

All cameras operated satisfactorily throughout the mission. The photographic quality and interpretation suitability of the panoramic material are good and compare favorably with the results achieved in Mission 9062 (M-26). The film is comparatively free of degradation, with the exception of small out-of-focus areas on most frames of the forward camera. Terrain index photography is also good and the stellar index take contains numerous stellar images. However, as in previous missions, approximately 40 percent of each stellar format is degraded by flare.

The horizon images are good despite slight vignetting of the format corners. They are usable for determination of vehicle attitude in most operational passes. Underexposure was encountered on the port horizon cameras causing difficulty in determining vehicle attitude on most passes. Vehicle attitude appears to have been normal throughout the mission.

Clouds and/or haze obscured or degraded approximately 31 percent of the panoramic photography, which is exceptionally low in view of the adverse weather that normally prevails in the northern latitudes during the winter months.

GENERAL FLIGHT DATA

Date of Launch: 15 February 1964, 2138Z

Launch Vehicle: Thor W/TAT Booster and Agena No 1174

The first phase payload capsule (1004-1) was recovered dry via air catch on Revolution 49, 18 February 1964.

Orbital Parameters:

Planned	Actual (Revolution 26)
Period: 90.67 Min	90.92 Min
Perigee: 100.5 NM	99.9 NM
Apogee: 234.65 NM	249.7 NM
Eccentricity: 0.0186	0.0207
Inclination Angle: 75.0°	74.97°

PART I. CAMERA OPERATION

1. Master (FWD) Panoramic Camera No 124: The camera was operational throughout the mission and the photography is comparatively free of degradation from light leaks and static discharges. Diagonal light leak traces are present in the second or third frames of a few passes and corona static discharges occurred in the third frame of most passes from pass D21 to the end of mission. However, degradation is relatively minor.

The photography obtained from the master camera is slightly inferior to that from the slave

[redacted]

unit, primarily due to the existence of areas where the imagery is soft. These areas are found adjacent to the camera number edges of most frames in the supply and take-up corners of the formats. This condition should not be confused with the out-of-focus or soft photography normally present in the bonus areas of the formats.

Numerous fine emulsion scratches are present in the take-up ends of all frames, and four small emulsion digs are consistently positioned on the frequency mark edge of each frame almost directly opposite the camera number. Three edge-to-edge abrasions, which appear to be cinch marks, are also found opposite the camera number.

2. Slave (AFT) Panoramic Camera No 125: The camera was operational throughout the mission and the photography is slightly superior to that obtained from the master unit. The fourth or fifth frames in most passes contain diagonal light leak traces across the frequency mark edge of the film and equipment shadow images are present in the third from last frames. Numerous fine emulsion scratches are present near the take-up ends of all frames.

3. Master (FWD) Horizon Cameras:

a. The port (supply) horizon camera was operational throughout the mission. Exposure varied from underexposed to adequate. Image quality is good and the horizon arcs are unaffected by the vignetting which is present in all of the images. Difficulty was encountered in determining vehicle attitude, due to underexposure occurring at the beginning of most passes. Example: pass D03, frame 1.

b. The starboard (take-up) horizon camera was operational throughout the mission and the exposure was adequate in most passes. Image quality is good and the horizon curves are unaffected by the vignetted image corners.

4. Slave (AFT) Horizon Cameras:

a. The starboard (supply) horizon camera was operational throughout the mission. Exposure was adequate and image quality is good. The horizon arcs are unaffected by vignetting of the image corners.

b. The port (take-up) horizon camera was operational throughout the mission. Exposures vary from underexposed to adequate, but underexposures predominate and present difficulties in determining vehicle attitude. Example: pass D03, frame 6. Image quality is good. Although the image corners are vignetted, the horizon arcs are unaffected and are usable for determination of vehicle attitude.

5. Stellar Index Camera No D29/29/29: The stellar index camera was operational throughout the mission. However, 40 percent of each format is degraded by flare, as has been the case in previous missions. Despite the degradation, more than 40 stellar images including some at the 7th magnitude are detectable on most frames. The reseau is visible in the flared areas only.

Sharply defined, extremely dense linear streaks are present intermittently within the formats. These are tentatively identified as images of crystallized formations of jettisoned fuel.

The fiducial marks and correlation lamps were grossly underexposed and failed to record in the latter two-thirds of the stellar take.

Edge static appears intermittently on the edge opposite the frame correlation fiducial mark. Occasional dendritic static discharges intrude into the formats. A gross fog level of 0.23 is present in several sections of the film. The fog density is not sufficient to obliterate the formats, but detection of faint stellar images in the affected sections is rendered more difficult. Opaque flaking from titling occasionally interfered with automatic stellar identification.

6. Terrain Index Camera No D29: The terrain index camera operated satisfactorily and pro-

vided good quality photography. Except for a slight fall-off in the format corners, the resolution is good. Exposure ranges from slightly underexposed to adequate. Low to medium contrast prevails, with a few examples of high contrast imagery.

The reseau is well defined in all frames. The correlation lamps are underexposed and are not usable for the last two-thirds of the mission. Edge static is present on both edges throughout the film but is more severe on the edge opposite the data chamber.

7. Collateral Equipment:

a. The frequency marks on the master (FWD) and slave (AFT) materials are flared with reflected images. This has been the case, with few exceptions, in previous KH missions. Despite this condition, the marks are recorded outside the formats in the slave material and are readable. However, in the master film they are imaged inside the formats and are not readable, making the panoramic-index frame correlations troublesome to accomplish.

b. The binary data blocks are good, although slightly bloomed. This caused occasional blossoming into the formats in the slave material. Lamp number 11 did not function on the slave panoramic camera after pass D19, frame 3. Lamp number 14 on the slave film was very dim but legible throughout the mission. Single binary records are recorded at pass ends and at camera-off positions within the passes in the material from both panoramic cameras.

c. The camera numbers are slightly flared but readable.

d. The panoramic fiducials are slightly ragged.

e. The horizon fiducials are well defined with little or no flare present.

f. The stellar and terrain index fiducial frame correlation marks were considerably underexposed and failed to record in the last two-thirds of the stellar/terrain index footage.

g. The end-of-pass markers functioned properly in the master (FWD) and slave (AFT) cameras but were occasionally overprinted on the binary data block. Single markers were recorded at all camera-off positions.

PART II. FILM

1. Film Processing: This section provides evaluations of processing, exposure, density, and the physical condition of the original negatives. Processing data is abstracted from records maintained by the processing contractor. Evaluation of exposure and determination of the material's physical condition are accomplished by on-site inspection of the negatives as they are made available for titling breakdown. Densitometric readouts and a final, more thorough examination of the negative material are conducted by photographic analysts at a later date.

The majority of the film in Mission 1004-1 received adequate exposure. However, low sun angles and/or the terrain reflectivity in snow-covered areas caused abrupt changes at times.

Approximately 79 percent of the material was processed at the intermediate level, 17 percent at full, and 4 percent in the primary condition. Exposure changes in the panoramic film necessitated approximately 35 changes in development level while processing the take from each of the panoramic cameras. Since the density changes from light to heavy, or vice versa, occurred abruptly, the interrupted processing could not compensate for many of the exposure differences inherent in winter photography of this nature. In view of the extensive footage involved, frame-by-frame compensation in processing is impractical at this time.

The stellar and terrain index film received

[redacted]

normal processing. Examination of the terrain index negatives indicates this was slightly less than optimal. However, the density of the stellar/terrain index negatives is considered adequate.

2. Film Degradations:

Although relatively free of degradations, the film did contain examples of static discharges, fog, light leak traces, etc.

Detailed descriptions and pertinent examples follow:

a. Master (FWD) Panoramic Camera:

Light Leaks	Intermittent and few. Examples are pass A11E, frame 2; pass D30, frame 3. Film transport indications are present at the beginning and/or end of a number of passes. Edge-to-edge fog degrades pass D49, frames 23, 25, 27, 29, 30.
Corona Static	Discharges are first noted in pass D21, frame 3, and are present in the third frame of most of the following passes: such as passes D23, D24, D33, D38, D47, D49.
Emulsion Digs	Four small emulsion digs appear consistently on the frequency mark edge of each frame opposite the camera number.
Scratches and Abrasions	Three edge-to-edge abrasions resembling cinch marks appear to be associated with the above-mentioned digs. Rail scratches are also present throughout the film.
Pinholes and Blisters	Intermittent and few.
±Density Streaks	Present in some passes. Example is pass D04, frames 2-30, where the minus density streaks are most numerous and persistent.
+Density fogging from heavy density areas	Present on some passes. Example is pass D17, frame 47.

b. Slave (AFT) Panoramic Camera:

Light Leaks	Present on the frequency mark edges of the fourth or fifth frames in the majority of passes. Film transport indications are found in the first and last frames of most passes. Equipment image shadowgraphs are generally present in the second or third frame preceding a camera-off position.
Corona Static	Infrequent and toward the end of the mission. Example is pass D35 frame 3.
Emulsion Digs	Few noted.
Scratches and Abrasions	Numerous fine short scratches are present in the take-up ends of all frames. These appear to have been camera-induced.
Pinholes and Blisters	Intermittent and few.
±Density Streaks	Minus density streaks are present in some passes. Example is pass D04 frame 12.
+Density fogging from heavy density areas	Present on some passes. Example is pass D17 frame 52.

c. Stellar Index Camera:

Flare	Forty percent of every format is flared by reflections from the baffle and lens elements, and a small flare of unknown origin appears at the lower center of the format.
Vignetting	Approximately 10 percent of every format is vignetted by the vehicle.
Fog	A high gross fog level appears eight different times and may be associated with a very small light leak that affected the film when it was at rest for a long period of time.
Static Discharges	Intermittent dendritic discharges and edge static traces are present on the edge opposite the frame correlation fiducial mark.
Scratches and Abrasions	Fine scratches are noted throughout the film.

d. Terrain Index Camera:

Static Discharges	Dendritic discharges occur intermittently on both edges and intrude into the formats in a number of cases. Examples are frames 149, 150, 175, 409. Edge static is also present on both edges but is more severe on the edge opposite the data chamber (titled edge).
Scratches and Abrasions	Numerous fine parallel scratches run continuously through the film.
Desensitized Spots	Two desensitized spots, apparently derived from particles of foreign matter on a roller, are present in each frame.

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PART III. IMAGE QUALITY

1. Photographic Interpretation (PI) Suitability: This is an assessment of the information content of photographic reconnaissance material and its interpretability. A number of interrelated factors are involved, such as the quality of the photography, the extent of target coverage, scale, weather limitations, and similar considerations. However, the criteria for assigning a PI suitability rating may be reduced to (a) the scope of the photographic coverage and (b) the degree to which a photo interpreter may extract useful and reliable information from the material.

PI suitability ratings are categorized as Excellent, Good, Fair, Poor, and Unusable. These ratings refer to the overall interpretive value of the photography obtained from a particular reconnaissance mission. Individual targets may also be assigned PI suitability ratings if that is necessary or desirable. The standards that determine assignment of the various ratings are as follows:

Excellent: The photography is free of degradation by camera malfunctions or processing faults and weather conditions are favorable throughout. The imagery contains sharp, well-defined edges and corners, with no unusual distortions. Contrast is optimal and shadow details, as well as details in the highlight areas, are readily detectable. Observation of small objects and a high order of mensuration are made possible by the consistently good quality of the photography.

Good: The photography is relatively free of degradation or limiting atmospheric conditions. Edges and corners of objects are well-defined. No unusual distortions are present. Detection and accurate mensuration of small objects is feasible, but to a lesser degree than in material rated as "Excellent".

Fair: Degradation is minimal but the acuity of the photography is less than optimum. Edges and corners of objects are not crisply defined and there is loss of detail in shadow and/or highlight areas. Detection and identification of small objects is possible but accuracy of mensuration is reduced by the fall-off in image quality and the less-than-optimum contrast that prevails.

Poor: Camera-induced degradations and/or weather limitations severely reduce the quality of the photography. Definition of edges and corners is not sharp. Only gross terrain features and culture may be detected or identified and distortion of form may exist. Accurate mensuration of even large objects is doubtful.

Unusable: Degradation of the photography completely precludes detection, identification, and mensuration of cultural details.

2. PI Suitability of Mission 1004-1: The PI suitability of the photography obtained in Mission 1004-1 is good. A total of 149 targets was observed and reported in the preliminary PI reports. Of these, 14 targets are classified poor quality photographs because of snow cover or combined snow and haze effects, and six targets are rated poor quality because of cloud cover and/or haze. Highlights of the initial scan performed by the photo interpreters are reported as follows:

(1) New identifications, including various missile sites, complexes, missile storage sites and support area construction at suspect missile sites.

(2) Detection of unidentified new-type suspect missile sites.

(3) Corrected identification of a possible nuclear weapons installation, previously classified as an industrial installation.

It should be noted that the preliminary re-

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port represents the initial-scan results only, accomplished in a short time and without the aid of the precise analytical and mensural instruments normally employed in photographic analysis. More detailed study of the photography may develop additional information or may necessitate alteration of portions of the preliminary report.

Although the PI suitability of Mission 1004-1 is good, the film contains a variety of degradations, many of which are potentially capable of seriously affecting image quality. Examples follow:

Corona Static: This can be a major source of film degradation. Fortunately, in Mission 1004-1 the discharges were not severe and affected only the third frames of passes D21-D49, FWD. Example: pass D47, frame 3. A single corona discharge is present in pass D35, frame 3 (AFT).

Light Leaks: The master (FWD) panoramic material contained a few intermittent light leak traces, as in pass D47, frame 2. Evidence of light leaks is more consistent in the slave (AFT) panoramic film, where the majority of passes contain traces on the frequency mark edges of the fourth or fifth frames. Examples: pass D47, frame 4 and pass D31, frame 5. In addition, random light leak traces are exemplified in pass D31, frames 43 and 44. Equipment images (shadowgraphs) are present in the material from both cameras and usually occur in the second or third frame preceding a camera-off position. Example: pass D47, frame 38.

Scratches and Abrasions: The effect of scratches and abrasions on imagery in any photographic reconnaissance system cannot be ignored. The potential degradation is intensified in this system where the scale is such that even a small scratch or abrasion may obliterate or degrade a target of significance. Mission 1004-1 contains a repetitive scratch/abrasion pattern in the material from both panoramic cameras. Numerous fine short scratches appear in the take-up ends of all frames in the slave (AFT) panoramic film. The master (FWD) material contains emulsion digs with associated cinch marks on the frequency mark edge of each frame, positioned almost directly opposite the camera number. Examples: pass D06, frame 1 (FWD and AFT) and pass D31, frame 26 (AFT).

Image Motion: Characteristically, this is evident in the first and last frames of each pass in both cameras. Smeared imagery may also be detected in the second and third frames but only if the film is viewed under considerable magnification. Examples: pass D30, frame 1 and pass D31, frame 45 (FWD and AFT).

Image Softness: The master (FWD) panoramic material contains areas of soft imagery adjacent to the camera number edge of the film. These areas are confined to the supply and take-up corners of the formats. The soft condition of the imagery is severe in the supply end of the frames. Example: pass D17, frame 24.

Plus/Minus Density Streaks: The material from both cameras contains random minus-density streaks. Examples: pass D04, frame 16 (FWD) and pass D04, frame 12 (AFT). Pass D17 exhibits plus-to-minus density streaks of unknown origin. Extensive streaking of this nature could seriously affect PI suitability. Examples are found in frames 47 (FWD) and 52 (AFT) of pass D17.

Frequency Marks: The marks are invariably flared with reflected images, and may be recorded inside the formats as in the master panoramic material. When this is the case they are unreadable. Their image-degrading potential is slight since the marks are seldom intense enough to mask out images and barely intrude on the formats. However, this is obviously an undesirable condition. Example: pass D17,

frame 47. A double elongated frequency mark is present in pass D36, frame 105. This is an unusual occurrence, not previously observed. Operation of the Stellar/Index unit is normally signified by a single elongated marker on every seventh panoramic frame.

Data Block Record: This record holds little significance with regard to PI suitability even when the binary record blooms into the format. However, it is conceivable that the binary lamps may be overprinted on a target of value in the peripheral imagery along the titled edge of the formats. Therefore, this is an undesirable condition. Example: pass D31, frame 42 (AFT). In pass A11E, frame 4 (AFT) the end-of-pass (EP) marker is overprinted on the binary record. This displacement of the EP marker has been observed to occur intermittently in previous KH missions.

Manufacturer's Splices: These opaque splices obviously degrade PI suitability when they are positioned within a format. Example: pass D17, frame 47 (AFT).

Several additional factors affect PI suitability. These are not related to photographic and/or processing procedures and equipment and are therefore listed separately, as follows.

Atmospherics: Thirty-one percent of Mission 1004-1 is degraded by clouds and/or haze conditions, including industrial haze in dense cultural areas. Examples of the latter condition are found in pass D22, frames 95 (FWD) and 99 (AFT).

In addition to the above, seasonal climatic conditions may degrade PI suitability or enhance it. The effects of snow, for example, may be advantageous or injurious. Snow, as an asset to the photo interpreter, is exemplified by frame 46 of pass D09 FWD. The injurious or degrading effects of wind-blown snow are exhibited in pass D08, frames 49 (FWD) and 54 (AFT).

Low Solar Elevation: This affects PI suitability to various degrees, depending on terrain reflectivity and sun azimuth with regard to the vehicle as well as the angular position of the sun over the horizon. Example: pass D39, frames 5 (FWD) and 11 (AFT).

Image Distortion: Some distortion of imagery is inherent in the photography. However, the image distortion, while noticeable, is seldom severe. Example: pass D21, frame 113 (FWD).

3. Mission Information Potential: The MIP rating is an arbitrary figure intended to indicate the quality of the best photography obtained in a particular mission. It is representative of the camera system's maximum capability for recording information. Therefore, photography containing adverse factors such as atmospherics, low solar elevation, and similar degradations is eliminated in the selection of the MIP example. The MIP rating assigned to a mission is indicative solely of the camera system's photographic capability, exclusive of degradations which are not camera-derived. The MIP selection may constitute a portion of a frame, one frame, or several frames. In any case, the selected examples of best photography are not indicative of the success, quality, or PI suitability of the mission as a whole. The selections represent only the camera system's maximum capabilities. The criteria which govern selection of suitable MIP examples are as follows:

a. The photography must be comparatively free of cloud cover and/or atmospheric interference.

b. The selected targets should be at or near frame-center in order to minimize obliquity and similar distortive factors.

c. No photography affected by system malfunctions can be considered for MIP selection. This eliminates the first few frames and the last frames of the passes since these may contain smeared images as a result of incorrect

[redacted]

scan arm speed. In addition, the selected photography must be free of effects induced by vehicle pitch, roll or yaw deviations.

d. Sun angle must be near optimum. Overexposed or underexposed photography is not suitable for MIP selections.

e. Preferably, high contrast targets such as airfields are chosen for comparison with similar targets covered in previous missions which have been assigned MIP ratings.

4. MIP For Mission 1004-1: Based on the foregoing, frame 18 (AFT) of pass D47 is the MIP selection for Mission 1004-1. The mission is assigned an MIP rating of 85 and is considered comparable to Mission 9062.

The MIP frame contains a large seaport and an airfield near frame-center. The photography is cloud-free and haze is minimal.

Additional examples of good photography were selected. These are pass D31, frames 24 (FWD) and 29 (AFT); pass D40, frames 112 (FWD) and 117 (AFT). Resolution targets are present in pass D31, frames 24 (FWD) and 29 (AFT) and pass D47, frames 19 (FWD) and 25 (AFT).

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APPENDIX A. SYSTEM SPECIFICATIONS

Panoramic Cameras

	Master (Fwd)	Slave (Aft)
Camera No	124	125
Lens Serial No	0642435	1022435
Slit Width	0.250"	0.250"
Aperture	f/3.5	f/3.5
Filter	Wratten 21	Wratten 21
Operational Focal Length	609.602 mm	609.602 mm
Film Type	4404 (SO 132)	4404 (SO 132)
Film Length	7,618'	7,512'
Splices	2	2
Emulsion	45-73-75-12-3	45-73-75-12-3
Static Bench Test		
High Contrast	290 L/mm	238 L/mm
Low Contrast	160 L/mm	155 L/mm
Dynamic Test		
Itek High Contrast	170 L/mm	176 L/mm
Itek Low Contrast	131 L/mm	135 L/mm
AP High Contrast	183 L/mm	215 L/mm
AP Low Contrast	107 L/mm	108 L/mm

Stellar and Terrain Index Cameras

	Stellar	Index
Camera No	D29/29/29	D/29/29/29
Lens Serial No	10494	811906
Reseau Serial No	29	29
Filter	None	Wratten 21
Aperture	f/1.8	f/4.5
Exposure Time	2 secs	1/500 sec
Operational Focal Length	Not Reported	Not Reported
Film Type	4401	4400
Film Length	40'	82'
Splices	None	None
Emulsion	7-3-1-4	16-4-11-3
Perpendicularity of Reseau to optical axis	0.0013" 0.937"	0.009" 2.25"
Location of Principal Point	Not Reported	Not Reported

Horizon Cameras

	Starboard (Take-up)	Port (Supply)	Starboard (Supply)	Port (Take-up)
Camera No	124	124	125	125
Lens Serial No	812265	812271	812270	812272
Exposure Time	1/100 sec	1/100 sec	1/100 sec	1/100 sec
Aperture	f/8.0	f/6.8	f/8.0	f/6.8
Filter	Wratten 25	Wratten 25	Wratten 25	Wratten 25
Operational Focal Length	54.452	54.33	58.4645	58.464
Average Lines/mm	162 L/mm	167 L/mm	111 L/mm	178 L/mm
Radial Distortion				
10° off axis	.009 mm	-.015mm	.004 mm	.002 mm
20° off axis	.012 mm	-.015mm	.002 mm	.009 mm
Tangential Distortion	.004 mm	NA	.005 mm	.003 mm

Camera No 124

Resolution	Take-up						Supply					
Angle Off Axis	0	10	20	—	—	—	0	10	20	—	—	—
Radial Distortion	157	141	100	—	—	—	157	141	106	—	—	—
Tangential Distortion	168	141	78	—	—	—	177	141	86	—	—	—

Camera No 125

Resolution	Take-up						Supply					
Angle Off Axis	0	5	10	15	20	25	0	5	10	15	20	25
Radial Distortion	164	164	162	134	109	99	184	164	144	112	103	105
Tangential Distortion	164	162	151	121	91	60	164	145	142	115	86	60

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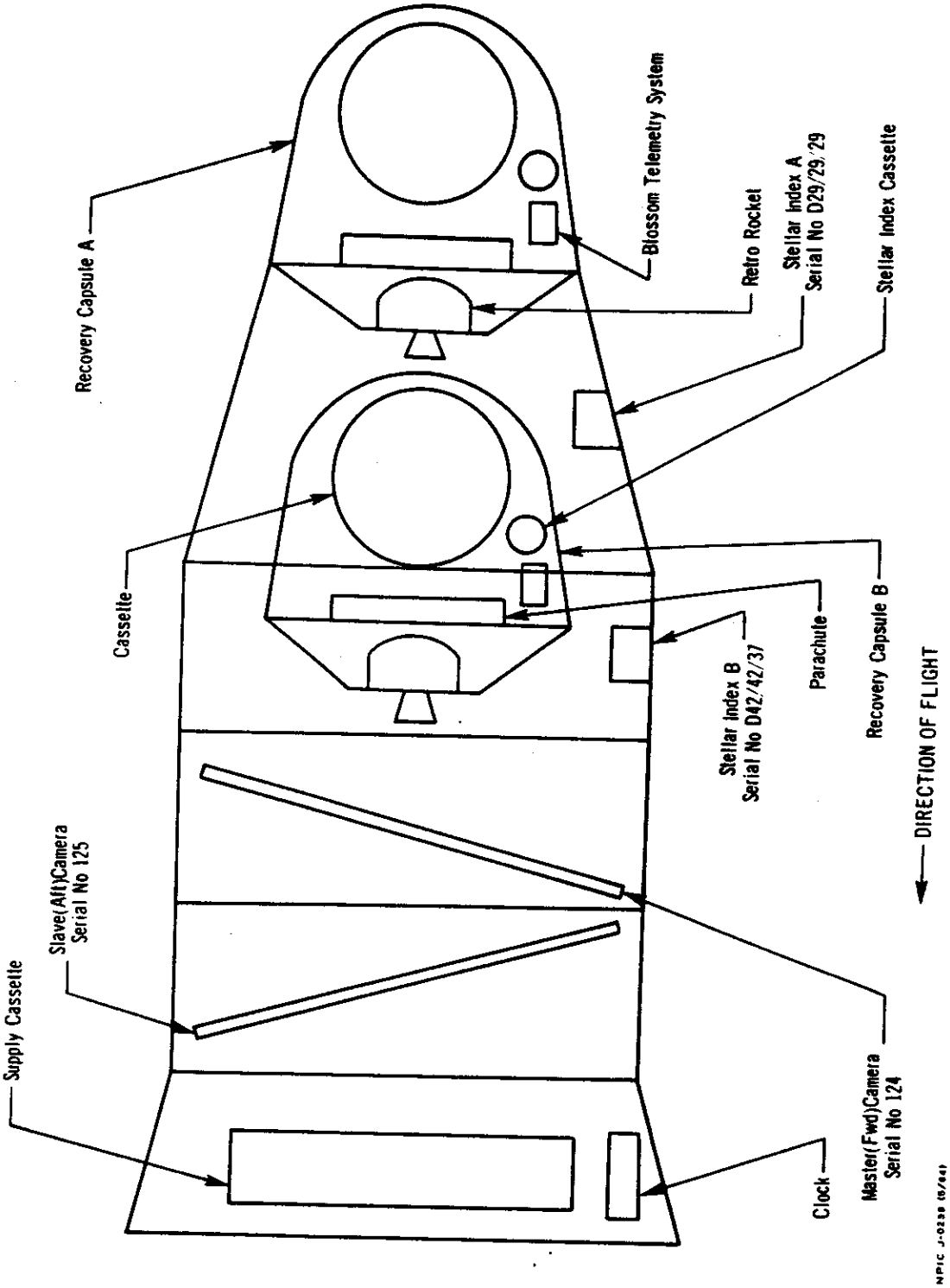
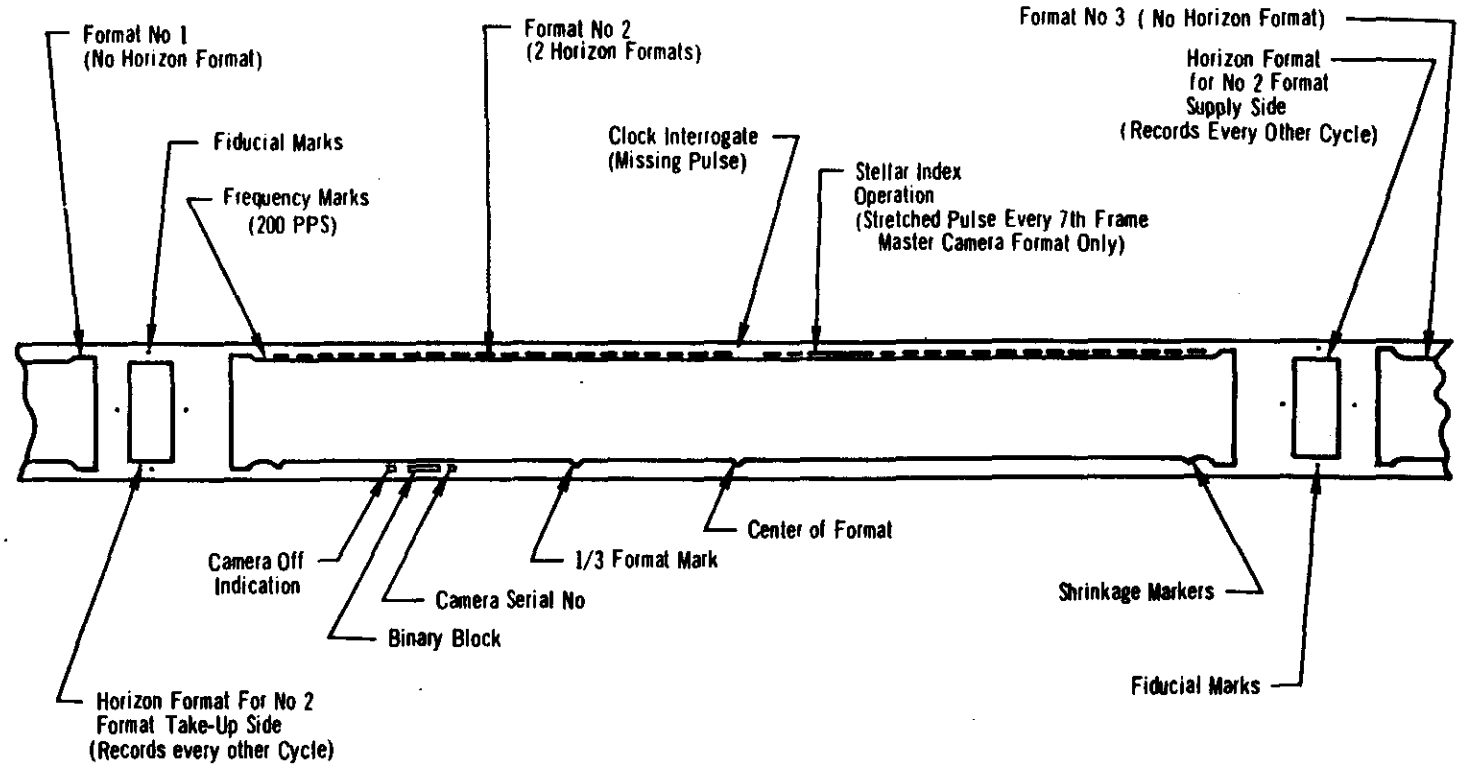
VEHICLE LAYOUT



FILM SPECIFICATIONS
FORMAT LAYOUT



Master(Fwd)Panoramic Camera No 124
Viewed With Negative Emulsion Down
Direction of Film Transport ←
Direction of Scan →
Direction of Vehicle Motion ↓

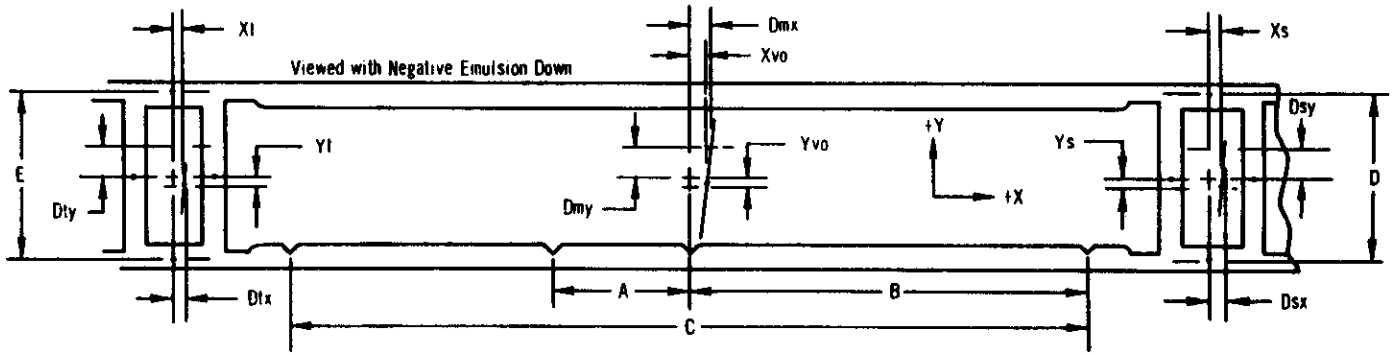
Slave(Aft)Panoramic Camera No 125
Viewed With Negative Emulsion Down
Direction of Film Transport ←
Direction of Scan →
Direction of Vehicle Motion ↑

NPIC J-0240 (8/84)

TOP SECRET CORONA

FILM SPECIFICATIONS

FORMAT SPECIFICATIONS



Master (Fwd) Camera 124		Vehicle Motion		Scan Direction	
A	76.1	Xl	-0.225	Dtx	+0.226
B	355.3	Yl	0.089	Dty	+2.000
C	710.3	Xs	0.393	Dsx	-0.394
D	56.496	Ys	+0.036	Dsy	-2.000
E	56.435	Xvo	+0.757	Dmx	+0.773
		Yvo	+1.104	Dmy	-2.000

Format dimensions:

	Panoramic	Take-Up	Supply
Height	55.9		
Width	756.4		

Slave (Aft) Camera 125		Vehicle Motion		Scan Direction	
A	76.1	Xl	-0.045	Dtx	-0.047
B	355.3	Yl	+0.348	Dty	-2.000
C	710.6	Xs	-0.721	Dsx	-0.737
D	54.488	Ys	+0.045	Dsy	+2.000
E	56.459	Xvo	-0.737	Dmx	-0.749
		Yvo	+0.306	Dmy	-2.000

Format dimensions:

	Panoramic	Take-Up	Supply
Height	56.2		
Width	755.3		

NOTE: 1. All dimensions are in millimeters and are average dimensions of three formats
2. Height of main format is taken at center of format
3. Dt, Dm, Ds, X and Y dimensions are taken 10 MM above point defining target center
4. Format Sign Convention

-X+Y	+X+Y
-X-Y	+X-Y

NPIC J-0241 (8/64)

APPENDIX B. TECHNICAL COMPENDIUM

1. Master (Fwd) Panoramic Camera

												Terrain			Limiting			
Pass	Frame	% Overlap	Cloud Cat.	Univ. Time	Sun Time	Solar Elev.	Pitch	Roll	Yaw	Alt. (yds)	Exp	D Min	D Max	Δ	D Min	D Max	Δ	Gross Fog
D03	01	00	1111	0205	1114	08°55'	14°34'	-00°09'	02°53'	264,431	1/149	1.14	1.91	0.77	1.14	1.91	0.77	0.11
D03	09	10	1111	0206	1120	20 00	14 39	-00 15	02 49	256,411	1/202	0.55	1.86	1.31	0.55	1.98	1.43	0.10
D03	76	09	2112	0210	1228	22 01	15 06	00 10	02 15	228,649	1/225	0.92	2.05	1.13	0.92	2.10	1.18	0.12
D04	71	10	1111	0339	1214	15 48	14 56	00 13	02 28	240,546	1/159	0.59	1.79	1.20	0.59	1.84	1.25	0.11
D04	129	06	2113	0342	1254	26 45	15 11	00 05	02 10	222,295	1/243	0.68	2.02	1.34	0.52	2.18	1.66	0.10
D05	13	07	1111	0512	1155	23 55	15 03	00 04	02 53	226,960	1/212	0.40	1.45	1.05	0.40	1.65	1.25	0.06
D06	26	09	1134	0639	1140	12 07	14 42	-00 07	02 35	252,901	1/206	0.80	1.42	0.62	0.66	1.80	1.14	0.07
D06	65	09	1111	0641	1204	17 36	15 14	00 11	02 26	238,505	1/221	0.78	1.74	0.96	0.70	1.83	1.13	0.08
D06	131	06	3111	0646	1343	34 40	14 51	00 12	02 15	212,176	1/254	0.50	1.88	1.38	0.50	2.07	1.57	0.08
D07	13	09	1111	0611	1224	14 32	15 03	-00 15	02 11	244,376	1/225	0.65	1.85	1.20	0.65	2.20	1.55	0.09
D07	62	09	1111	0615	1307	29 17	15 04	00 04	02 01	220,066	1/243	0.67	1.65	0.78	0.67	1.92	1.05	0.07
D08	20	11	1134	0944	1235	20 47	15 05	00 00	02 35	230,175	1/229	0.96	1.75	0.77	0.96	2.01	1.03	0.11
D09	19	08	1111	1115	1232	21 28	14 54	-00 04	02 47	229,252	1/229	0.73	1.83	1.10	0.47	1.94	1.47	0.10
D09	74	09	1111	1117	1255	26 33	15 09	00 25	02 14	218,618	1/243	0.41	1.95	1.54	0.41	2.14	1.73	0.10
D17	04	08	2223	2340	1436	55 02	14 36	00 05	03 12	246,120	1/217	1.10	1.70	0.60	0.50	2.24	1.74	0.10
D17	47	14	2222	2342	1421	52 46	15 09	00 20	02 37	266,063	1/217	NR	NR	NR	0.50	2.26	1.76	0.12
D19	10	05	1111	0219	1042	06 57	14 46	-00 01	03 27	259,123	1/199	1.06	2.08	1.02	1.06	2.08	1.02	0.22
D19	36	08	1211	0220	1125	11 52	15 31	00 04	02 39	251,415	1/212	0.99	2.18	1.19	0.99	2.18	1.19	0.21
D19	76	06	4234	0222	1200	17 10	14 39	00 20	02 47	237,239	1/225	1.11	1.93	0.82	1.11	1.93	0.82	0.11
D20	17	08	2112	0352	1138	14 12	15 11	00 19	02 32	242,907	1/217	0.57	1.62	1.05	0.57	1.78	1.21	0.09
D20	70	08	1121	0355	1220	21 52	14 52	00 22	02 30	224,132	1/234	0.54	1.92	1.38	0.54	1.92	1.38	0.06
D20	99	09	1134	0357	1248	31 30	15 14	00 04	03 06	214,562	1/248	0.55	2.01	1.46	0.23	2.01	1.78	0.08
D21	10	08	1111	0524	1209	19 40	15 17	00 24	02 43	235,032	1/229	0.78	1.73	0.95	0.78	2.03	1.25	0.19
D21	63	10	1111	0527	1237	26 51	15 15	00 20	02 23	216,241	1/243	0.53	2.07	1.54	0.53	2.07	1.54	0.09
D21	113	11	1111	0529	1258	35 12	15 09	00 09	03 05	210,245	1/254	0.45	2.12	1.67	0.45	2.12	1.67	0.08
D22	01	00	3221	0651	1020	05 21	14 16	NR	02 40	262,947	1/147	0.81	1.89	1.08	0.81	1.89	1.08	1.17
D22	29	04	1111	0653	1126	12 37	14 55	00 20	02 42	247,604	1/202	0.52	1.69	1.17	0.52	1.77	1.25	0.11
D22	94	10	1111	0656	1218	22 09	15 22	00 01	03 01	227,867	1/235	0.61	1.93	1.32	0.61	2.02	1.41	0.11
D23	36	08	2111	0824	1317	11 01	15 10	00 14	02 47	246,347	1/210	1.20	1.82	0.62	1.20	1.82	0.62	0.21
D23	114	09	1111	0830	1223	33 22	14 42	00 23	02 38	212,607	1/236	1.04	2.14	1.10	1.00	2.14	1.14	0.11
D24	12	08	2221	0957	1200	18 45	15 14	00 10	03 22	231,797	1/224	0.77	1.75	0.98	0.77	1.75	0.98	0.09
D24	90	08	4412	1000	1253	29 57	15 16	00 17	02 35	215,974	1/248	0.51	1.59	1.08	0.51	2.04	1.53	0.10
D30	14	08	4214	1909	1333	43 27	14 52	00 15	02 42	204,546	1/258	0.48	1.34	0.86	0.48	2.12	1.64	0.08
D31	24	07	1111	2040	1403	42 17	15 15	-00 03	03 11	204,352	1/258	0.39	1.52	1.13	0.39	1.52	1.13	0.08
D33	43	06	1111	2332	1203	10 07	15 16	00 11	02 50	247,813	1/216	0.62	1.71	1.09	0.62	1.71	1.09	0.10
D33	99	06	2223	2354	0923	46 54	14 26	00 10	03 36	254,103	1/206	0.65	1.87	1.22	0.65	2.16	1.51	0.10
D34	10	07	1111	0102	1011	05 30	14 51	00 01	02 46	253,806	1/204	0.91	0.98	0.07	0.68	1.54	0.86	0.20
D34	95	11	4311	0106	1152	18 58	14 58	-00 11	02 26	227,206	1/234	NR	NR	NR	0.68	2.40	1.72	
D35	09	05	3232	0233	1010	05 28	14 48	00 02	03 30	252,404	1/204	NR	NR	NR	0.75	1.28	0.53	0.21
D35	67	09	1111	0235	1128	14 29	15 11	00 11	02 51	236,343	1/226	0.74	1.81	1.07	0.56	1.88	1.32	0.10
D36	04	02	1111	0406	1209	22 54	15 16	00 34	02 27	225,173	1/225	0.54	1.66	1.12	0.54	1.91	1.37	0.10
D36	27	07	1123	0409	1221	26 23	15 08	00 19	02 16	220,942	1/245	0.83	1.91	1.08	0.47	1.97	1.50	0.10
D36	86	09	1111	0411	1242	34 06	15 00	00 25	02 46	211,694	1/256	0.74	2.02	1.28	0.51	2.07	1.56	0.11
D37	129	07	5421	0547	1255	50 01	15 36	00 13	03 06	203,919	1/261	NR	0.98	NR	0.47	2.07	1.60	0.09
D38	08	07	1111	0707	1120	13 53	15 10	00 23	02 26	241,256	1/222	0.42	1.42	1.00	0.42	2.05	1.63	0.11
D38	101	09	1111	0711	1222	27 16	14 56	00 16	02 35	216,311	1/248	0.96	1.94	0.98	0.74	2.08	1.34	0.09
D39	05	05	1124	0837	1032	09 25	14 57	00 08	02 56	246,671	1/204	0.52	1.01	0.49	0.24	1.40	1.16	0.10
D39	104	10	1111	0841	1207	22 41	15 03	00 26	02 31	222,245	1/242	0.72	1.92	1.20	0.62	1.95	1.23	0.09
D40	08	08	1111	1010	1145	18 09	15 02	00 14	02 54	232,377	1/231	0.80	1.57	0.77	0.80	1.62	0.82	0.11
D40	112	07	1111	1014	1227	32 46	15 31	00 10	02 31	212,663	1/254	1.10	2.02	0.96	0.24	2.12	1.88	0.09
D47	13	08	1111	2054	1331	38 13	15 27	-00 04	02 49	203,987	1/257	0.48	1.97	1.49	0.48	2.03	1.55	0.17
D49	19	10	1111	2346	1105	12 25	15 02	00 01	NR	240,167	1/225	0.63	1.68	1.05	0.52	2.04	1.52	0.08

Terrain
D Max Range 0.96-2.18
D Min Range 0.39-1.14
Average D Max 1.77
Average D Min 0.72

Gross Fog Range 0.07-0.21
Average Gross Fog 0.11

Limiting
D Max Range 1.28-2.40
D Min Range 0.24-1.14
Average D Max 1.95
Average D Min 0.63

[redacted]

2. Slave (Aft) Panoramic Camera

Pass	Frame	% Overlap	Cloud Cat.	Univ. Time	Sun Time	Solar Elev.	Pitch (All Minus)	Roll	Yaw	Alt. (yds)	Exp.	Terrain D Min	Terrain D Max	Terrain Δ	Limiting D Min	Limiting D Max	Limiting Δ	Gross Fog
D03	006	04	1111	0205	1114	08°35'	15°17'	-00°13'	02°49'	264,441	1/195	0.56	1.75	1.19	0.52	2.07	1.55	0.12
D03	015	10	1111	0206	1120	10 00	15 14	-00 15	NR	256,411	1/200	0.52	1.90	1.38	0.47	2.04	1.57	0.11
D03	061	09	2112	0210	1225	22 01	14 17	00 10	02 21	228,649	1/226	1.12	2.21	1.09	0.94	2.15	1.21	0.06
D04	076	10	1111	0339	1214	15 46	14 56	00 13	02 24	240,546	1/217	0.52	1.56	1.04	0.42	1.62	1.20	0.07
D04	133	09	2113	0342	1254	26 45	14 44	00 05	02 08	222,295	1/236	0.53	1.62	1.11	0.34	2.04	1.70	0.08
D05	018	05	1111	0512	1155	23 55	14 54	00 04	02 48	226,960	1/212	0.46	1.34	0.88	0.37	1.80	1.43	0.10
D06	032	07	1134	0639	1140	12 07	15 04	-00 07	02 27	252,901	1/205	0.67	1.45	0.78	0.54	1.91	1.37	0.11
D06	070	08	1111	0641	1204	17 36	14 36	00 11	02 22	238,505	1/221	0.78	1.74	0.96	0.55	1.90	1.35	0.12
D06	135	08	3211	0646	1343	34 40	15 04	00 02	02 15	212,176	1/254	0.57	1.64	1.07	0.37	1.75	1.38	0.08
D07	018	06	1111	0611	1224	14 32	14 45	-00 15	02 06	244,376	1/225	0.78	1.91	1.13	0.41	2.00	1.59	0.10
D07	067	06	1111	0615	1307	29 17	14 46	00 04	01 54	220,068	1/243	1.07	2.07	1.00	1.07	2.15	1.08	0.10
D08	025	08	1134	0944	1235	20 47	14 42	00 00	02 22	230,175	1/226	0.80	1.94	1.14	0.60	1.99	1.19	0.10
D09	025	05	1111	1115	1232	21 26	14 56	-00 04	02 38	229,252	1/226	0.78	1.84	1.06	0.32	1.95	1.63	0.10
D09	079	08	1111	1117	1255	26 33	14 47	00 25	02 15	218,618	1/242	1.09	2.05	0.96	0.30	2.09	1.79	0.09
D17	010	11	2234	2340	1436	55 02	15 01	00 05	03 05	248,120	1/223	1.00	2.14	NR	0.42	2.33	1.91	0.13
D17	052	14	2222	2342	1421	52 46	14 44	00 20	02 35	266,063	1/211	0.54	1.71	1.17	0.49	2.35	1.86	0.13
D19	015	05	1111	0219	1042	06 57	14 56	-00 01	03 06	259,123	1/200	0.89	1.47	0.58	0.89	1.55	0.66	0.21
D19	041	07	1211	0220	1125	11 52	14 25	00 04	02 36	251,415	1/211	1.18	2.07	0.89	0.92	2.16	1.24	0.20
D19	081	07	3234	0222	1200	17 10	15 15	00 20	03 00	237,239	1/225	NR	NR	NR	0.91	1.87	0.96	0.11
D20	022	06	2112	0352	1138	14 12	14 46	00 19	02 36	242,907	1/215	0.54	1.35	0.81	0.54	1.68	1.14	0.11
D20	075	06	1131	0355	1220	21 52	15 00	00 22	02 45	224,132	1/233	0.71	1.84	1.13	0.41	1.99	1.58	0.10
D20	103	06	1134	0357	1248	31 30	14 40	00 04	03 06	214,562	1/247	0.22	1.74	1.52	0.22	2.08	1.86	0.11
D21	016	06	1111	0524	1209	19 40	14 35	00 24	02 37	235,032	1/226	0.39	1.51	1.12	0.37	1.88	1.51	0.10
D21	068	08	1111	0527	1237	26 51	14 46	00 20	02 33	218,241	1/242	0.47	2.00	1.53	0.47	2.16	1.69	0.10
D21	117	08	1111	0529	1258	35 12	14 44	00 09	03 04	210,245	1/253	0.38	2.06	1.68	0.39	2.15	1.76	0.09
D22	07	01	3211	0651	1020	05 21	15 34	NR	02 59	262,947	1/194	0.97	1.12	0.15	0.31	1.58	1.27	0.19
D22	034	03	1111	0653	1126	12 37	14 52	00 20	02 44	247,604	1/212	0.51	1.50	1.01	0.51	1.62	1.11	0.10
D22	098	08	1111	0656	1218	22 09	14 33	00 01	02 54	207,867	1/234	0.66	1.94	1.28	0.57	2.01	1.44	0.08
D23	041	05	2111	0824	1317	11 01	14 59	00 14	02 53	246,347	1/210	1.15	1.69	0.54	1.03	1.73	0.70	0.16
D23	118	08	1111	0830	1223	33 22	15 12	00 23	02 35	212,607	1/235	0.65	1.99	1.14	0.72	2.18	1.46	0.14
D24	018	06	1121	0957	1200	18 45	14 51	00 10	03 27	231,799	1/224	0.55	1.41	0.96	0.55	1.72	1.17	0.10
D24	094	06	4412	1000	1253	29 57	14 35	00 17	02 28	215,974	1/245	0.56	0.77	0.21	0.55	2.05	1.50	0.09
D30	020	06	3112	1909	1333	43 27	14 56	00 15	02 46	204,546	1/256	0.46	1.48	1.02	0.38	2.09	1.71	0.11
D31	029	05	1111	2040	1403	42 17	15 00	-00 03	02 59	204,352	1/256	0.43	1.30	0.87	0.43	1.78	1.35	0.11
D33	049	07	1111	2332	1203	10 07	14 55	00 11	02 48	247,818	1/215	0.84	1.85	1.01	0.84	1.95	1.11	0.18
D33	105	05	2223	2354	0923	46 54	15 26	00 10	03 35	254,103	1/211	0.97	1.75	0.78	0.49	2.21	1.72	0.07
D34	016	06	1111	0102	1011	05 30	15 04	00 01	02 47	253,808	1/204	0.64	1.01	0.37	0.56	1.04	0.46	0.20
D34	089	10	4311	0106	1152	18 58	14 52	-00 11	02 27	227,206	1/233	NR	NR	NR	0.94	2.05	1.11	0.16
D35	015	04	2231	0233	1010	05 28	14 52	00 02	03 30	252,404	1/204	NR	NR	NR	0.62	1.08	0.46	0.20
D35	072	08	1111	0235	1128	14 29	14 46	00 11	02 53	236,343	1/225	0.60	2.04	1.44	0.60	2.04	1.44	0.10
D36	09	05	1111	0406	1209	22 54	14 36	00 34	02 23	225,173	1/236	0.99	1.77	0.78	0.62	1.93	1.31	0.09
D36	033	06	1123	0409	1221	26 23	14 49	00 19	02 15	220,942	1/243	0.66	1.78	1.12	0.56	1.97	1.41	0.09
D36	091	06	1111	0411	1242	34 06	14 55	00 25	02 57	211,694	1/254	0.52	2.02	1.50	0.46	2.10	1.64	0.10
D37	134	05	4321	0547	1255	50 01	14 16	00 13	03 20	203,919	1/258	NR	NR	NR	0.38	2.06	1.68	0.08
D38	014	06	1111	0707	1120	13 53	14 49	00 23	02 27	241,256	1/215	0.26	1.30	1.02	0.26	1.67	1.39	0.08
D38	105	06	1111	0711	1222	27 16	14 54	00 16	02 27	218,311	1/245	0.80	1.86	1.06	0.80	2.00	1.20	0.10
D39	011	04	1124	0837	1032	09 25	14 54	00 08	02 56	246,871	1/209	0.44	1.70	1.26	0.40	1.80	1.40	0.21
D39	109	08	1111	0841	1207	22 41	14 50	00 26	02 31	222,245	1/240	1.20	1.92	1.72	0.66	1.98	1.32	0.12
D40	014	08	1111	1010	1145	18 09	14 51	00 14	03 00	232,377	1/231	0.63	1.48	0.85	0.58	1.65	1.07	0.11
D40	117	05	1111	1014	1227	32 46	14 19	00 10	02 43	212,663	1/253	0.21	1.62	1.41	0.10	1.74	1.64	0.07
D47	018	08	1111	2054	1331	38 13	14 25	-00 04	NR	203,987	1/256	0.66	2.02	1.36	0.48	2.02	1.54	0.21
D49	024	08	1111	2346	1105	12 25	14 53	00 01	NR	240,187	1/224	0.78	1.63	0.85	0.71	2.09	1.38	0.10

Note: NR denotes no reading made

Terrain	
D Max Range	1.12-2.21
D Min Range	0.21-1.20
Average D Max	1.70
Average D Min	0.68

Limiting	
D Max Range	1.04-2.35
D Min Range	0.10-1.07
Average D Max	1.92
Average D Min	0.55

Gross Fog Range	0.07-0.21
Average Gross Fog	0.12

APPENDIX C. DENSITY READINGS

1. Stellar Index Camera.

Density readings were taken on each pass, using a Macbeth QuantaLog Densitometer, Model EP 1000, with an ET-20 attachment and a 0.5 mm aperture. The values are correlated below.

Frame	Pass	Pan Frame	D-Max	D-Min	Δ D	Gross Fog	Frame	Pass	Pan Frame	D-Max	D-Min	Δ D	Gross Fog
1	D01	7	2.23	0.25	1.98	0.24	195	D23	5	1.14	0.21	0.93	0.21
2	D01	14	2.37	0.25	2.12	0.25	211	D23	117	2.62	0.23	2.39	0.22
3	D03	3	1.29	0.24	1.05	0.24	212	D24	2	2.37	0.21	2.16	0.19
17	D03	101	2.18	0.28	1.90	0.24	229	D24	121	2.90	0.24	2.66	0.22
18	D04	5	0.72	0.26	0.44	0.25	230	A25	4	NR	NR	NR	0.22
40	D04	159	2.43	0.20	2.23	0.18	231	D30	3	2.51	0.25	2.26	0.23
41	D05	7	1.76	0.20	1.56	0.18	236	D31	2	2.70	0.22	2.48	0.19
56	D05	112	2.38	0.21	2.17	0.17	242	D31	44	2.53	0.23	2.30	0.20
57	D06	1	1.21	0.19	1.02	0.15	243	D33	6	NR	NR	NR	0.19
76	D06	134	2.43	0.23	2.20	0.19	263	D33	146	2.62	0.23	2.39	0.22
77	D07	1	1.96	0.22	1.74	0.19	264	D34	1	0.79	0.22	0.57	0.20
90	D07	92	2.68	0.26	2.42	0.22	276	D34	99	2.68	0.37	2.31	0.33
91	D08	5	2.20	0.22	1.98	0.20	280	D35	4	1.28	0.42	0.86	0.42
100	D08	68	2.64	0.23	2.41	0.21	295	D35	116	2.75	0.28	2.47	0.24
101	A09	3	NR	NR	NR	0.23	296	D36	7	2.66	0.28	2.38	0.25
102	D09	2	2.23	0.22	2.01	0.22	311	D36	112	2.61	0.27	2.34	0.21
115	D09	93	2.64	0.30	2.34	0.27	312	D37	3	2.70	0.25	2.50	0.21
116	A11	2	NR	NR	NR	0.27	332	D37	143	3.08	0.22	2.86	0.16
117	D17	5	2.24	0.31	1.93	0.28	333	D38	6	2.34	0.21	2.13	0.19
124	D17	54	2.18	0.49	1.69	0.49	349	D38	118	2.91	0.21	2.70	0.19
125	D19	2	1.28	0.50	0.78	0.50	350	D39	1	1.32	0.20	1.12	0.20
137	D19	86	2.52	0.40	2.12	0.38	377	D39	190	3.06	0.22	2.84	0.19
138	D20	6	1.95	0.40	1.55	0.39	378	A39	3	NR	NR	NR	0.19
154	D20	116	2.74	0.25	2.49	0.20	379	D40	6	2.54	0.22	2.32	0.19
155	D21	4	2.27	0.25	2.02	0.21	401	D40	160	3.08	0.28	2.80	0.24
174	D21	137	2.80	0.22	2.58	0.19	402	A41	1	NR	NR	NR	0.22
175	D22	7	1.16	0.23	0.93	0.22	403	A41	8	NR	NR	NR	0.21
194	D22	140	2.75	0.20	2.55	0.19	404	D47	7	2.59	0.52	2.07	0.41

Note NR denotes no reading made

Gross Fog Range	0.18-0.50
Average Gross Fog	0.24

Limiting	
D Max Range	0.72-3.08
D Min Range	0.19-0.52
Average D Max	2.26
Average D Min	0.27

[redacted]

2. Terrain Index Camera.

Density readings were taken on each pass, using a Macbeth QuantaLog Densitometer, Model EP 1000, with an ET-20 attachment and a 0.5 mm aperture. The values are correlated below.

Reading	Pass	Frame	Terrain		Limiting		Gross Fog		
			D-Min	D-Max	D-Min	D-Max	Titled	Center	Untitled or (Camera No. Edge)
1	D01	1	NR	NR	0.26	1.34	0.06	0.06	0.06
2		2	NR	NR	0.29	1.35	0.06	0.06	0.06
3	D03	3	0.14	0.72	0.14	0.72	0.05	0.05	0.05
4		17	NR	NR	0.20	1.28	0.05	0.05	0.05
5	D04	18	NR	NR	0.07	0.82	0.05	0.05	0.05
6		40	NR	NR	0.20	1.55	0.05	0.05	0.05
7	D05	41	0.17	0.67	0.17	1.07	0.05	0.05	0.05
8		56	0.27	1.37	0.27	1.37	0.05	0.05	0.05
9	D06	57	0.21	0.50	0.11	0.68	0.05	0.05	0.05
10		76	0.33	1.45	0.33	1.45	0.05	0.05	0.05
11	D07	77	0.13	1.04	0.13	1.07	0.05	0.05	0.05
12		90	0.30	1.60	0.19	1.60	0.05	0.05	0.05
13	D08	91	NR	NR	0.29	1.38	0.06	0.06	0.06
14		100	0.55	1.38	0.55	1.47	0.06	0.06	0.06
15	A09E	101	NR	NR	NR	NR	0.07	0.07	0.07
16	D09	102	NR	NR	0.22	1.25	0.07	0.07	0.07
17		115	NR	NR	0.10	1.30	0.07	0.07	0.07
18	A11E	116	NR	NR	NR	NR	0.07	0.07	0.07
19	D17	117	NR	NR	0.31	1.82	0.07	0.07	0.07
20		124	NR	NR	0.25	1.47	0.07	0.07	0.07
21	D19	125	NR	NR	0.11	0.72	0.07	0.07	0.07
22		137	NR	NR	0.52	1.20	0.07	0.07	0.07
23	D20	138	0.22	0.82	0.20	0.87	0.07	0.07	0.07
24		145	0.25	1.18	0.25	1.18	0.07	0.07	0.07
25	D21	155	0.15	0.76	0.15	1.04	0.07	0.07	0.07
26		174	NR	NR	0.55	1.51	0.07	0.07	0.07
27	D22	175	NR	NR	0.08	0.62	0.07	0.07	0.07
28		194	0.47	1.53	0.47	1.53	0.07	0.07	0.07
29	D23	195	NR	NR	0.10	0.32	0.07	0.07	0.07
30		211	0.17	1.28	0.17	1.28	0.07	0.07	0.07
31	D24	212	0.38	0.65	0.27	0.99	0.07	0.07	0.07
32		229	0.29	1.58	0.29	1.58	0.07	0.07	0.07
33	A25E	230	NR	NR	NR	NR	0.07	0.07	0.07
34	D30	231	0.23	0.67	0.23	1.52	0.07	0.07	0.07
35		235	NR	NR	0.17	1.70	0.07	0.07	0.07
36	D31	236	0.20	1.02	0.20	1.55	0.07	0.07	0.07
37		242	0.22	0.82	0.22	1.34	0.07	0.07	0.07
38	D33	243	NR	NR	NR	NR	0.07	0.07	0.07
39		263	NR	NR	0.12	1.79	0.07	0.07	0.07
40	D34	264	NR	NR	0.08	0.44	0.07	0.07	0.07
41		278	0.30	0.93	0.17	1.13	0.07	0.07	0.07
42	D35	279	NR	NR	0.08	0.45	0.07	0.07	0.07
43		295	0.27	1.22	0.27	1.22	0.07	0.07	0.07
44	D36	296	0.26	1.28	0.26	1.28	0.07	0.07	0.07
45		311	NR	NR	0.17	1.39	0.07	0.07	0.07
46	D37	312	NR	NR	0.41	1.16	0.07	0.07	0.07
47		332	NR	NR	0.25	1.53	0.07	0.07	0.07
48	D38	333	0.17	0.64	0.17	0.92	0.07	0.07	0.07
49		349	0.66	1.39	0.66	1.39	0.07	0.07	0.07
50	D39	350	NR	NR	0.08	0.82	0.07	0.07	0.07
51		377	NR	NR	0.40	1.28	0.07	0.07	0.07

[redacted]

[redacted]

Reading	Pass	Frame	Terrain		Limiting		Gross Fog		
			D-Min	D-Max	D-Min	D-Max	Titled	Center	Untitled or (Camera No. Edge)
52	A39E	376	NR	NR	NR	NR	0.07	0.07	0.07
53	D40	379	0.30	0.82	0.30	0.83	0.07	0.07	0.07
54		401	0.28	1.45	0.28	1.56	0.07	0.07	0.07
55	A41E	402	NR	NR	NR	NR	0.07	0.07	0.07
56		403	NR	NR	NR	NR	0.07	0.07	0.07
57	D47	404	0.16	1.29	0.16	1.29	0.07	0.07	0.07
58		408	0.15	0.74	0.15	0.74	0.07	0.07	0.07
59	D49	409	0.32	0.88	0.20	0.88	0.07	0.07	0.07
60		413	0.29	1.16	0.29	1.16	0.07	0.07	0.07

Note NR denotes no reading made

Terrain	
D-Max Range	0.67-1.60
D-Min Range	0.13-0.66
Average D Max	1.07
Average D Min	0.27

Limiting	
D-Max Range	0.32-1.79
D-Min Range	0.08-0.66
Average D Max	1.19
Average D Min	0.24

Gross Fog Range	0.05-0.07
Average Gross Fog	0.07

[redacted]

[redacted]

PANORAMIC CAMERA
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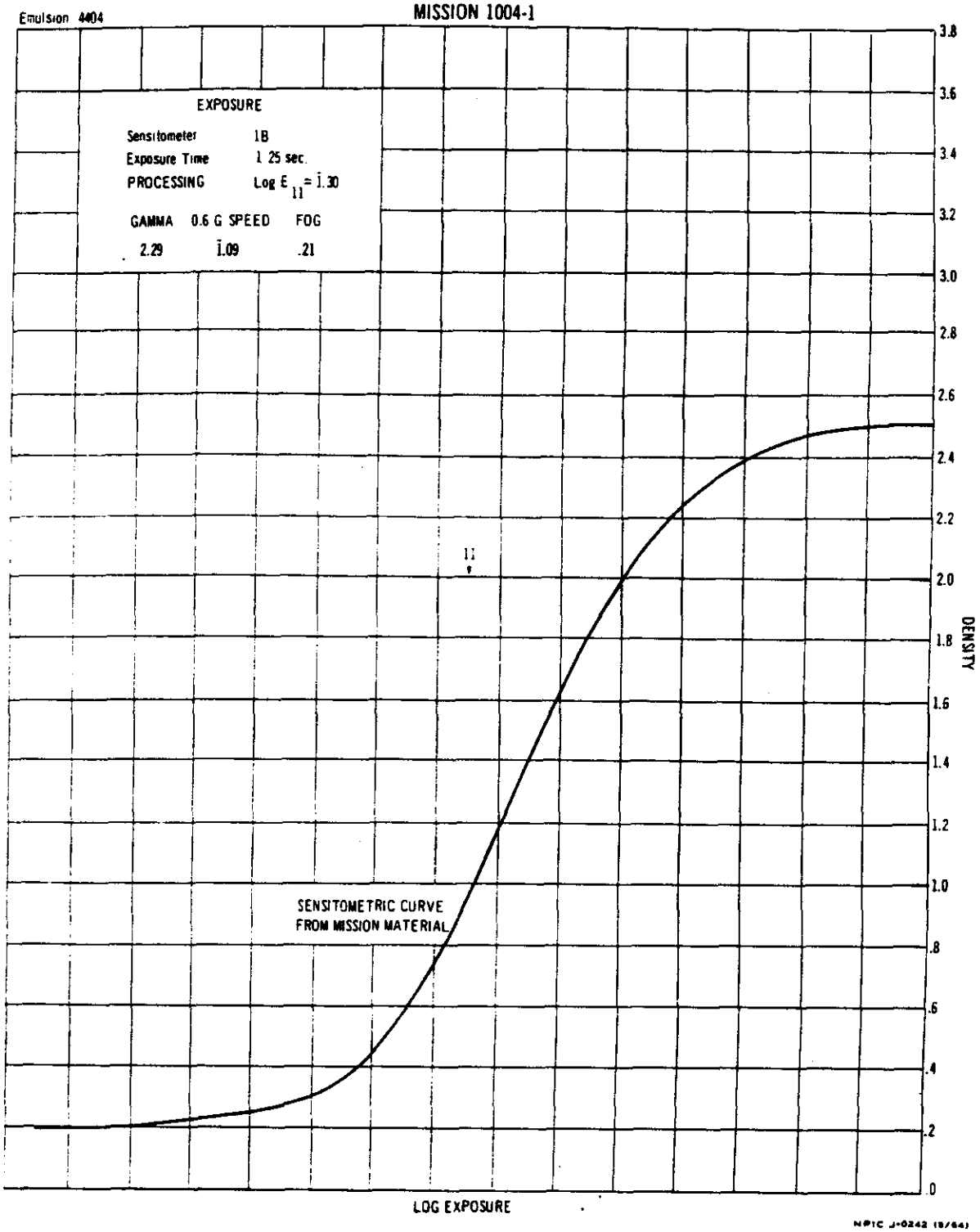

NPIC J-0242 (8/64)

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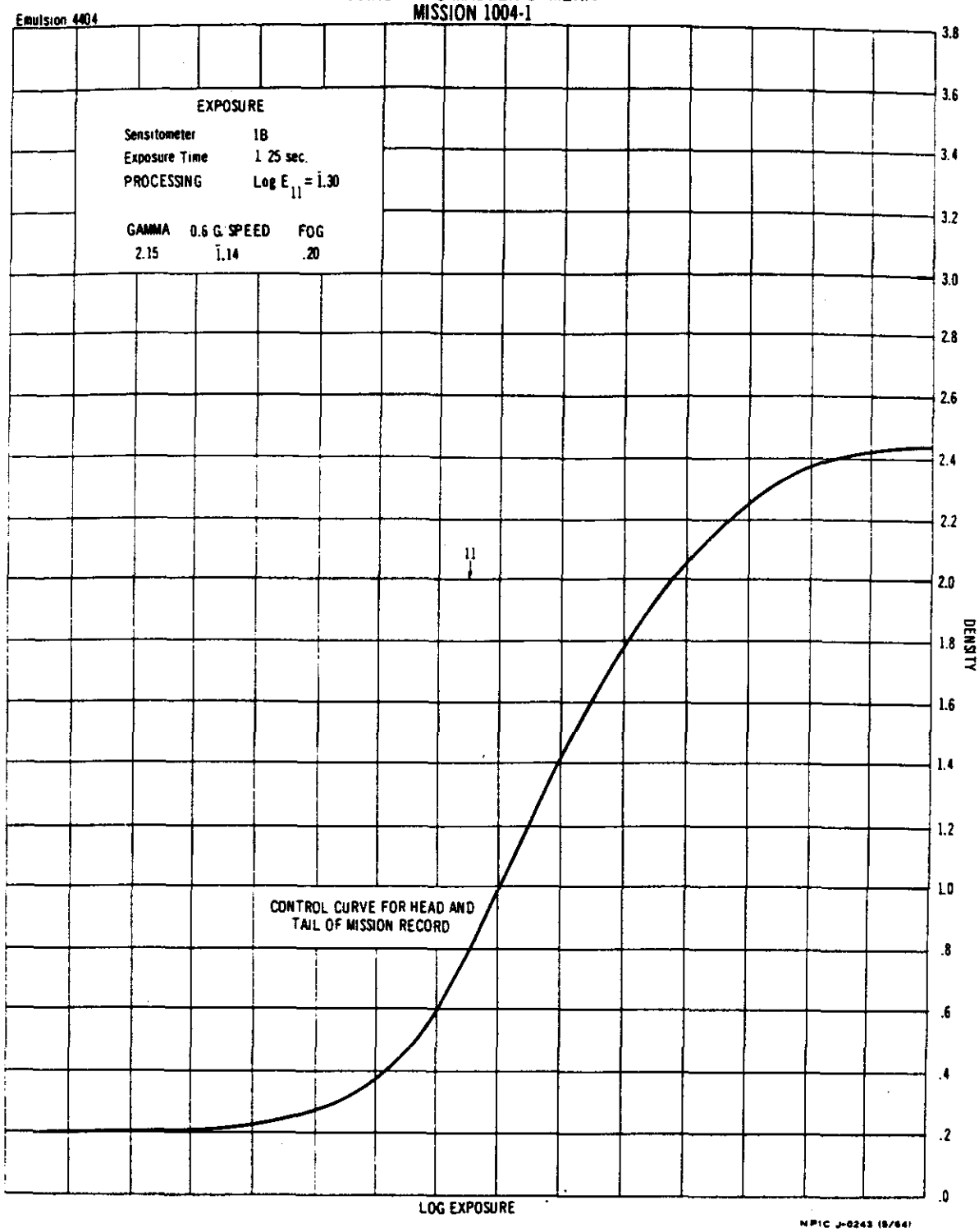
PANORAMIC MASTER CAMERA
MISSION 1004-1



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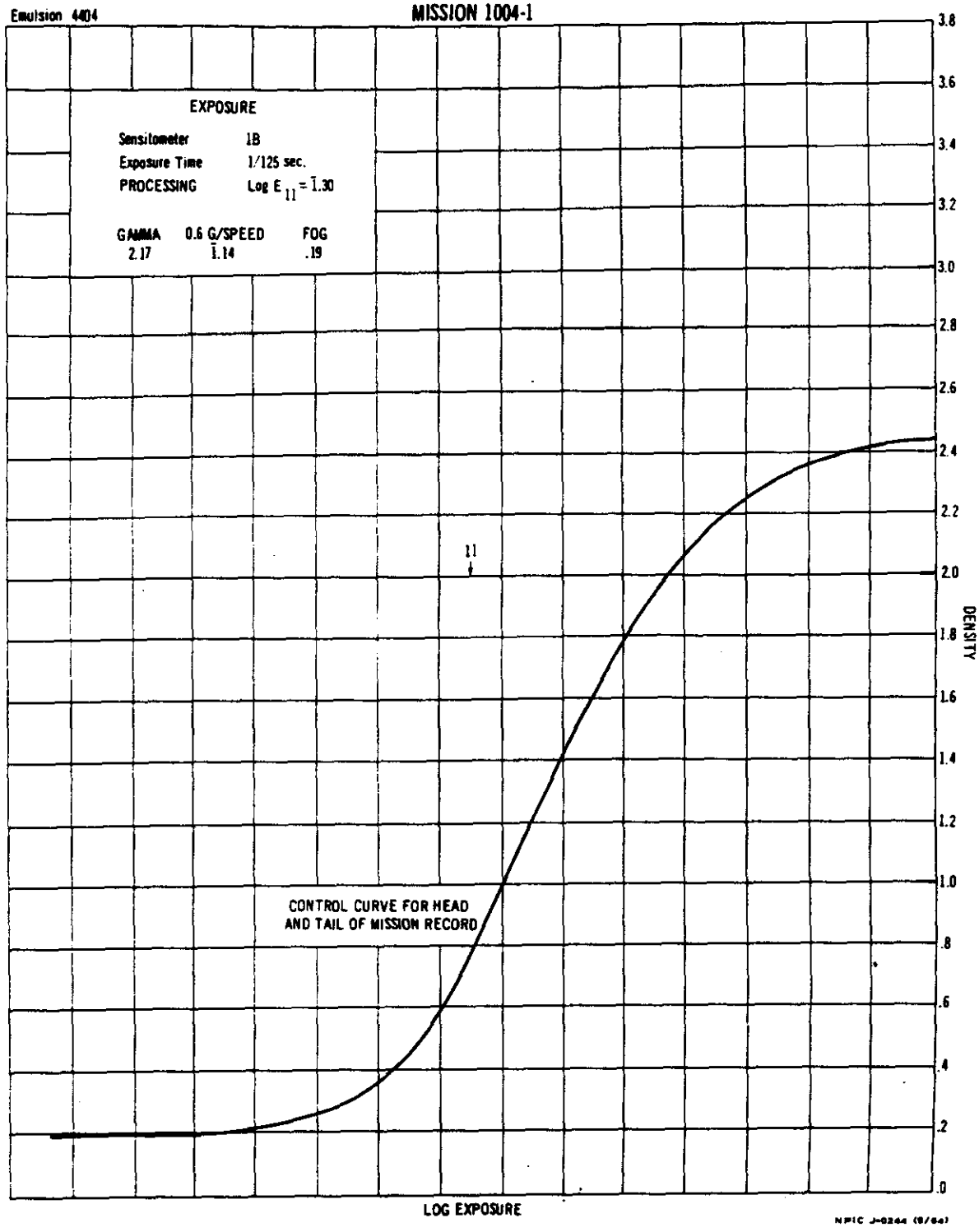
PANORAMIC SLAVE CAMERA
MISSION 1004-1



NPIC J-0244 (9/64)

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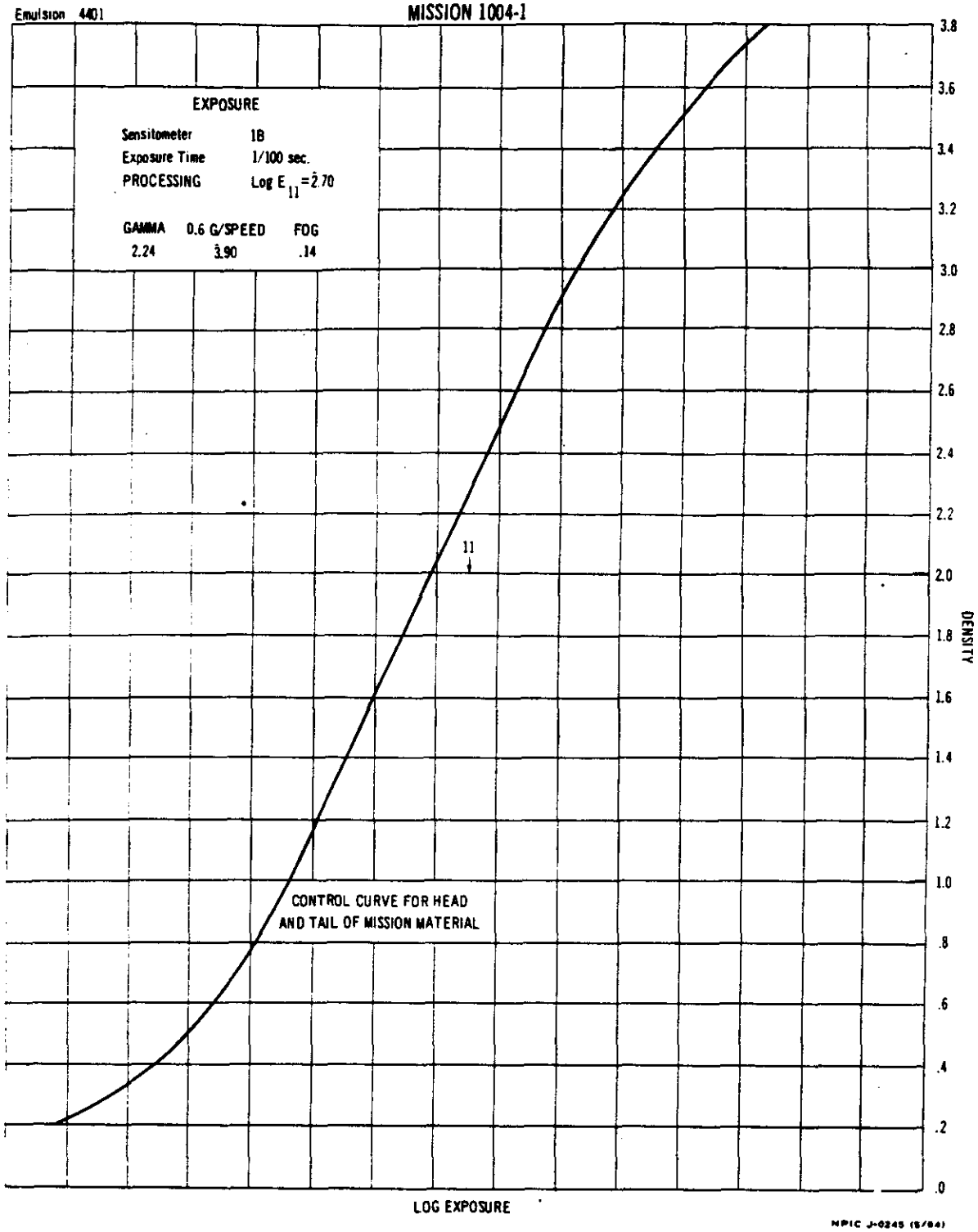
[redacted]

STELLAR CAMERA
MISSION 1004-1



NPIC J-0245 (5/64)

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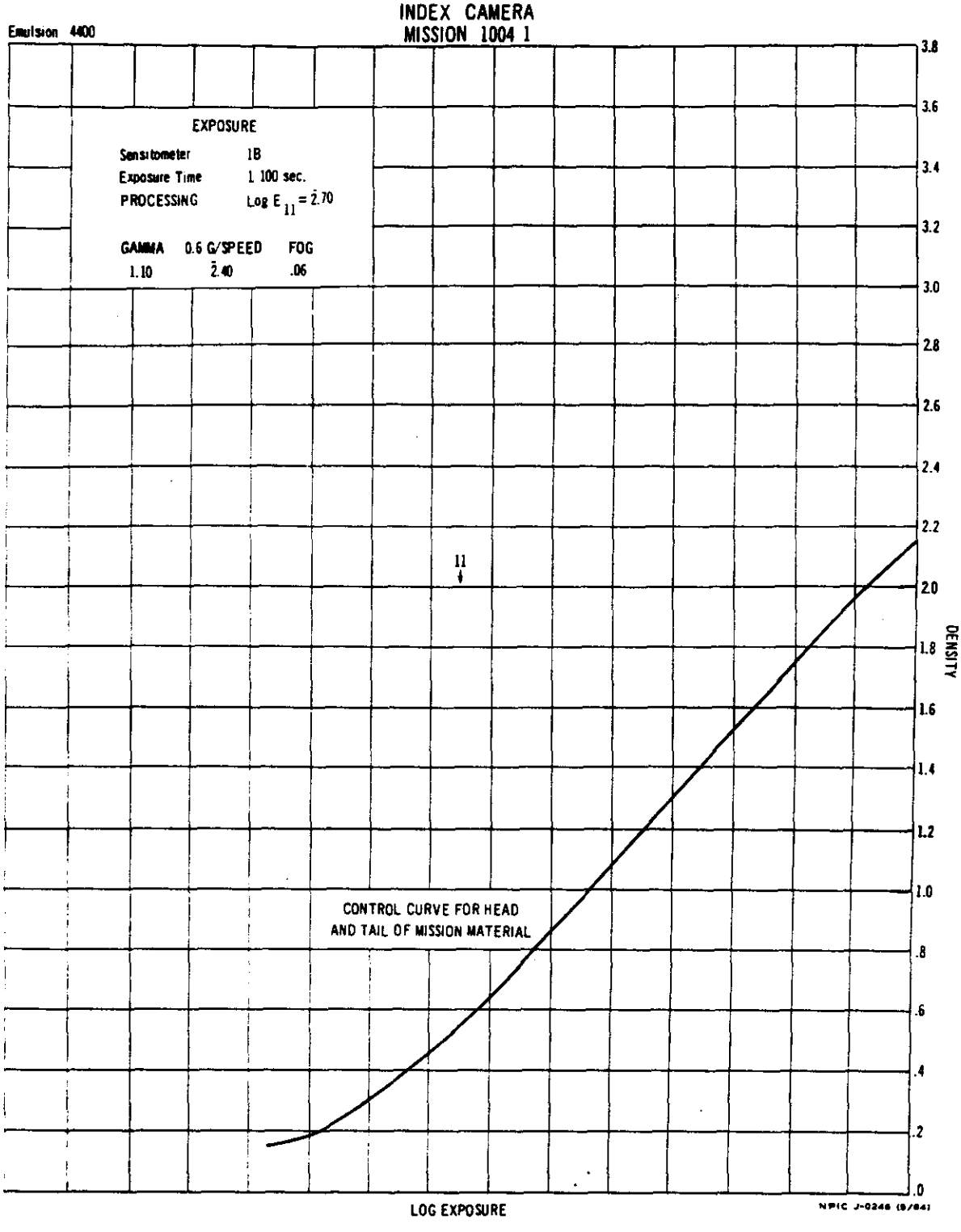

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APPENDIX D. EDGE SPREAD FUNCTION

In an attempt to establish an objective measurement of image quality in photography, the technique of obtaining the spread function from microdensitometric edge traces is being investigated. The spread function curve represents the whole photographic system, and is a summation of the separate elements: lens, film, and uncompensated image motion due to vibration, velocity, roll, pitch, yaw, and aerial turbulence.

To assign a single number to the spread function, the width is measured at 50% amplitude. This number, usually expressed in microns, may be converted by use of the scale factors to ground distance in feet.

Edges meeting the criteria described below have been found in domestic passes of missions in the same frame as resolution targets and have been scanned. The ground distance in feet, thus determined, has been close to that determined from the resolution target. Although the techniques used are not refined and are considered to be still in the development stage, the potential of this type of objective analysis should be realized. The two examples of edge scans and their respective spread functions are included as a preview of this type quality analysis.

Any optical image can be thought of as being composed of an infinite number of image points (or lines) of light, each being conjugate with points (or lines) in the object. While the object points can be infinitesimal light sources, the image points are always mounds or distributions of light having finite size. This blurring of light points in a photographic system comes from diffraction and aberration in the lens, light spreading and diffusion in the emulsion, and image motion caused by camera movement and atmospheric shimmering. The fundamental building block of the image then is the distribution of light in any of the image points. This distribution is called the spread function of the photographic system.

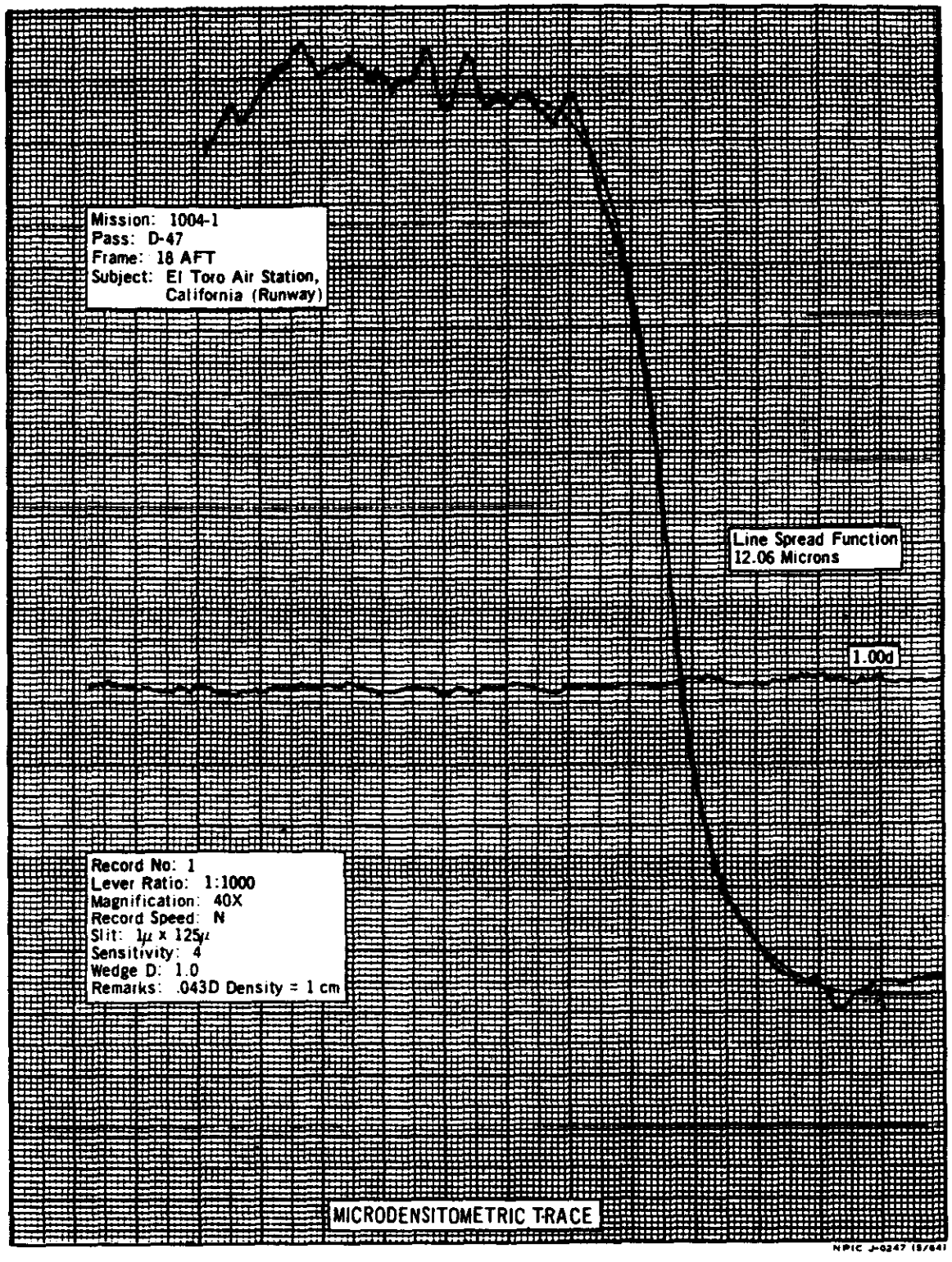
Lamberts and others have explained the mathematical and experimental correspondence of a sharp edge and its spread function. An analogy exists in the techniques of studying electrical system response. The analysis requires that the source or object fulfill the conditions of a unit step function, i.e. exist for an appreciable time or distance at a fixed signal level and instantaneously or abruptly change to a new level which is maintained for an appreciable time or distance. The spread function is obtained by differentiating the signal output curve point by point; i.e. measuring the rate of change or signal with time or distance, and plotting signal amplitude versus time or distance.

As a starting point the mission is examined to locate examples of best photography with edges long enough and straight enough for use in the microdensitometer, and having uniform density on each side of the edge to fulfill the conditions of a unit step function. This requirement is usually achieved by rooftops of buildings in large-scale photography, and only aircraft runways or taxiways in small-scale photographs.

The microdensitometer used is a Joyce-Lobel Double Beam Model IIIC. It is used with an effective slit of 1 micron by 125 microns. The recording table and sample table are directly linked with a ratio arm of 1000:1. The speed of the scan is variable and is determined by the amount of pen deflection (as the pen is deflected the speed decreases giving the pen time to reach its maximum response). The chart thus produced represents a plot of chart displacement versus distance. This plot is manually smoothed by the analyst and is a judgment of what the edge would be if grain and other anomalies were absent.

The data reduction is done manually at present, but the feasibility of using the UNIVAC 490 computer is being investigated. The microdensitometer calibration curve (chart displacement to density) is used to determine the densities at equal distance increments along the trace. The curve for the material density to log exposure (D Log E) is used to determine the Log E and therefore the exposure (E) required to produce the determined densities. The values of E are plotted against the distance across the edge to produce the original scene reflectance distribution as recorded in the negative. The final step is a determination and plotting of the slope of this curve (dE/dX) versus distance, point by point. This last plot is the line spread function for the whole photographic system.

The width of the spread function curve is measured at 50% of maximum amplitude and is noted on the enclosed graphs.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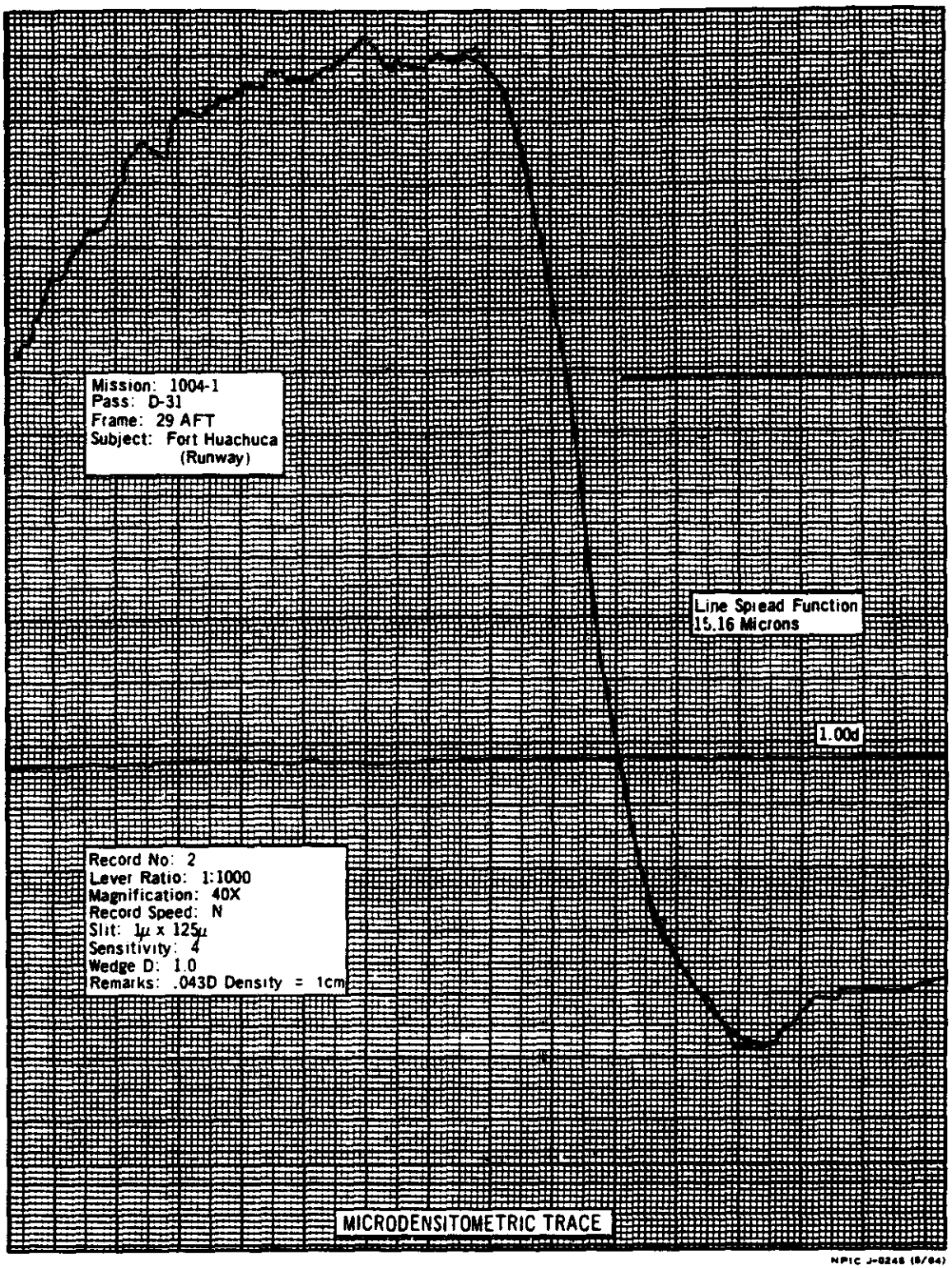
Pass: D-47
Frame: 18 AFT
Subject: El Toro Air Station, California (Runway)
Line Spread Function
12.06 Microns
1.00d
Record No: 1
Lever Ratio: 1:1000
Magnification: 40X
Record Speed: N
Slit: 1μ x 125μ
Sensitivity: 4
Wedge D: 1.0
Remarks: .043D Density = 1 cm
MICRODENSITOMETRIC TRACE
NPIC J-0247 (5/64)

[redacted]



NPIC J-0248 (8/84)