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June 1964

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TECHNICAL PUBLICATION

PHOTOGRAPHIC EVALUATION REPORT
MISSION 1004-2
19-22 FEBRUARY 1964

This document contains information referring to

Project Corona

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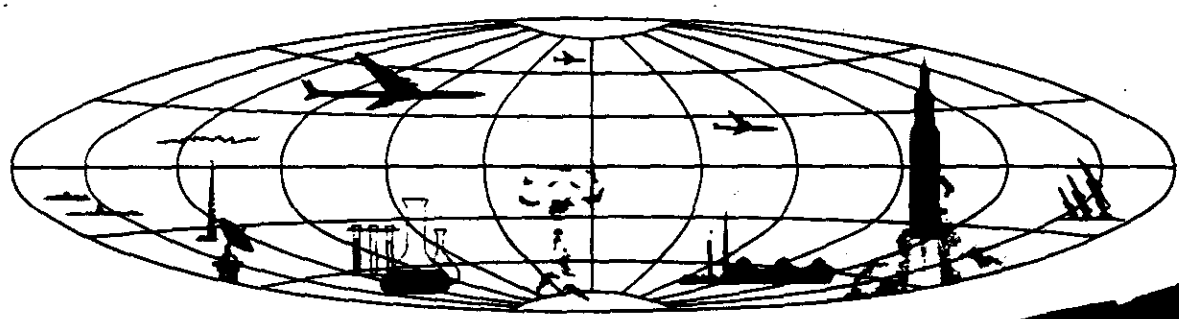

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SYNOPSIS

Mission 1004-2 (system J-5) was the second payload recovered from vehicle No 1174. The first photography exposed on this mission was on pass D49 after ejection of the "A Bucket" (Mission 1004-1). Mission 1004-2 accomplished 64 revolutions of which 32 were operational (photography was accomplished). The payload consisted of 5,858 panoramic frames (2,909 FWD, 2,949 AFT). Seventy-five feet of stellar index film and 135' of film exposed in the terrain index camera was recovered. The characteristics of the photographic take in regard to the panoramic cameras is very similar to that of Mission 1004-1, which is considered to be a good mission.

The panoramic cameras used on this mission operated well with the exception of softspots on the master take and a few other minor degradations.

Due to the large difference in densities recorded within a pass, portions of 19 passes of the master and 25 passes of the slave panoramic camera positives were reprinted at a special density for the PI's.

The weather was exceptionally good during this mission, with only 32.5% cloud cover. Another factor that lends to the favorable overall average of the mission is that exposures were generally made while the solar elevation was favorable.

The stellar index camera operated poorly throughout the mission. When functioning correctly, stars to the fifth magnitude could be discerned.

The terrain index camera functioned well.

The horizon cameras generally operated well but the port horizon appeared to be consistently underexposed.

GENERAL FLIGHT DATA

Date of Launch: 15 February 1964

Orbital Parameters:

	Planned	Actual (Revolution 92)
Period:	90.07 min	90.78 min
Perigee:	100.0 nm	102.38 nm
Perigee Latitude:	(Not Available)	43.25° north
Apogee:	236.0 nm	245.51 nm
Eccentricity:	0.019	0.0198
Inclination Angle:	75°	75.06°

PART I. CAMERA OPERATION

1. Master (FWD) Panoramic Camera No 124: This is the same camera used in Mission 1004-1. Therefore, as would be expected, the characteristics of the photographic take are very similar. The photography is highly degraded, due to image softness, in an area approximately 1.0" wide along the camera number edge in the first 3 to 15 frames of nearly every pass. This soft imagery extends from 3.0" to 8.0" from the take-up end of the affected frames. There are three small emulsion digs just inside the format adjacent to the camera number on every frame. A minor emulsion abrasion extends edge to edge in line with each dig.

Minor corona static discharges and occasional minor associated equipment shadow-

graphs appear intermittently near the center of the format.

A group of short, fine emulsion scratches parallel to the major axis of the film begins approximately 1.5" from the take-up end of each frame and extends approximately 3.0" toward the supply end. Thin, random, longitudinal emulsion scratches are frequent throughout the mission. Rail scratches are severe from head to tail.

A diagonal streak of fog extends into the format from the untitled edge on the third frame of most passes. The existence and density of the fog is dependent on the duration of the camera-off period.

The camera speed had a tendency to be slow on the first frame of some passes near the end of the mission, resulting in image smear as well as gross overexposure.

2. Slave (AFT) Panoramic Camera No 125: This camera was operational throughout the mission and, like the master camera, is the same unit used in Mission 1004-1.

Frames 29 thru 38, pass D49 of Mission 1004-1, which were recovered in this payload capsule, were severely damaged at the processing site.

Random longitudinal emulsion scratches are intermittent throughout the mission. Rail scratches are continuous from head to tail.

There is corona fog at the take-up end of the third or fourth frame of nearly every pass. The resulting degradation is minor.

A light leak resulting in a diagonal streak of fog emitted from the titled edge affects the fifth frame of nearly every pass. The existence and density of this fog is associated with the duration of the camera-off period.

Beginning at pass D86 there are from 1 to 3 random minus density spots approximately 0.1" in diameter on nearly all subsequent frames. Some of these spots are apparently the result of a roller-induced film crimp. The reason for others has not been determined.

3. Master (FWD) Horizon Cameras:

a. The port (supply) horizon camera operated normally through pass A71E. Horizon images, fiducials, binary words and end-of-pass markers do not appear on passes D72, frame 54; D85, frame 75; D87, frame 136; D103, frames 57 and 133. Underexposure prevails at the beginning of most passes but improves on passes which occur over areas of high solar elevations. All horizon images are slightly vignetted in two corners. Where the exposure is sufficient to permit analysis, acuity is very good.

b. The starboard (take-up) horizon camera operated normally through pass A71E. Horizon images, fiducials, the binary words and end-of-pass markers do not appear on pass D72, frame 54; D85, frame 75; D87, frame 136; D103, frames 57 and 133. When operational, the exposure was adequate and the acuity is very good. As in the port cameras all horizon images are slightly vignetted. There is a small plus density area at the edge of the format opposite the horizon image which is believed to be a reflection.

4. Slave (AFT) Horizon Camera:

a. The starboard (supply) horizon camera functioned normally throughout the mission. Some imagery is slightly vignetted on every format. The exposure was adequate and the acuity is very good.

b. The port (take-up) horizon camera functioned normally throughout the mission. The first few frames of most passes were underexposed but as the solar elevation improved the exposure became adequate.

The two west-looking (starboard) horizon cameras were set at f/8.0, 1/100 second with Wratten 25 filters and the east-looking (port) cameras were set at f/6.8, 1/100 second and equipped with Wratten 25 filters. The east horizon, photographed with the port camera, was

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often underexposed due to the unfavorable solar elevations. Horizon imagery in all four cameras is slightly vignetted but the vignetting does not hinder the useability of the horizon arcs for vehicle attitude determination. The design of the horizon cameras now employed is such that slight imagery vignetting will always be present.

5. Stellar Index Camera No D42/42/37: The camera operated erratically throughout the mission. There were eight double exposures during the course of the mission and 57 frames were grossly overexposed and unusable due to the shutter hanging open. The shutter also remained open while the film was being advanced on 53 occasions. Due to the shutter not opening or not opening long enough to form an image, 25 frames are clear in the first 350 programmed. There were no stellar images after frame 350. The program called for 407 frames. The correlation fiducial lamps did not function during the mission. Edge static is continuous on both edges throughout. A diagonal plus density band, attributed to a light leak, is apparent on nearly every frame. The moon is imaged on frames 298-355.

6. Terrain Index Camera No D42/42/37: The camera operated normally throughout the mission with the exception of a double exposure on frame 5. The imagery recorded is of good quality except for 8 frames affected by a minor light leak.

7. Collateral Equipment:

a. The 200 cycles per second (cps) frequency marks are present on all frames throughout the mission. On the Master (FWD) cameras, the marks are imaged in the format and, being superimposed on the terrain imagery, are not readable except on engineering passes and passes where the imagery is of low density. The frequency marks are printed outside of the terrain format on the slave panoramic camera but are reflected into the format edge. However, they are readable throughout and the reflection does not seriously degrade the pan camera imagery.

b. Light number 11 of the binary data block on the slave camera did not function during the mission. Light number 14 failed on frame 92 of pass D85 and on all subsequent frames. The binary data block of the slave camera tracks into the panoramic format on most frames. The binary data block of the master camera was operational and readable throughout except on pass D72, frame 54; D85, frame 75; D87, frame 136; D103, frames 57 and 103. The images of the data block on both cameras is slightly bloomed.

c. The terrain and stellar index camera correlation fiducial marks failed to operate during the entire mission.

d. The camera-off marker of the slave camera recorded satisfactorily through pass D56. On passes A56E, A71E and A72E it is superimposed on the binary word. The camera-off marker of the master camera recorded satisfactorily throughout pass D55. The mark is superimposed on the binary word in passes A55E, A56E and A71E. On all passes after A71E, the end-of-pass marker is misplaced and usually appears over the first frame of the following pass.

e. The camera numbers, although bloomed, are recorded and readable throughout.

PART II. FILM

1. Film Processing: This section provides a descriptive evaluation of the exposure and the processing, and comments on the exposure, the density, the processing and the physical condi-

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tion of the original negative.

Pertinent data was collected during various phases of the processing and more thoroughly during the evaluation of the negatives. This is a standard procedure. The community is informed by cable of any extensive defects in the photography which may affect the PI suitability of any mission.

Support organizations provided the processing center with pre-launch samples of the actual film used on this mission. These samples, along with fresh process control stock, were sensitometrically exposed and processed at controlled levels of development. A characteristic curve was prepared from these sensitometric strips and is defined as the "Mission Material Processing Curve."

While the film was being prepared for processing, it was inspected for physical damage which could cause processing difficulties. During processing, data was recorded giving the processing conditions and film footage locations where processing changes occur. Changes in the normal course of processing which may affect the film quality were recorded and, after processing, the original negatives were examined frame by frame for defects and damage.

Most of the film on this mission received adequate exposure. The solar elevation varied from a low of -55° on engineering passes A103E and A104E and -5° on operational pass D66 to a high of 68° on pass D103. Acceptable photography was accomplished with a minimum solar elevation of approximately 4°47' in pass D67, at a latitude of 71°30' north. The local time at which the exposure was made was 0942. The photographs taken at the lower latitudes, where the sun was relatively high (30° - 40°), tend to be slightly overexposed. The greatest variation of density that is directly attributed to exposure is in the horizon images. On the majority of frames from both FWD and AFT panoramic cameras the port horizons did not have optimum exposure. The starboard horizons were properly exposed rendering adequate density throughout most of the mission.

The exposure of the stellar index camera appears to be near optimum where not degraded by the various shutter problems. The exposure of the terrain index camera also appears to have been near optimum.

Approximately 50% of the film exposed in the pan cameras received intermediate development, 13% full, and 37% primary. Because of exposure changes due to variations in sun elevation and terrain, approximately 50 changes in the development level were made during the processing of the slave film and approximately 65 changes during the processing of the master film. The gross fog density readings range from a minimum of 0.07 to a maximum of 0.21.

The film from both the stellar and terrain index cameras was processed normally.

The density of the pan camera photography is near optimum considering the latitude of terrain reflectivities encountered on the mission.

2. Film Degradations: This section lists some of the more notable film degradations and a few frames on which examples of each can be found.

a. Master (FWD) Panoramic Camera:

Corona	Small corona discharges are evident in the horizon format of several frames after pass D49. (Examples: pass D50, frames 1, 2, 20.) Minor corona bursts are also common on the third frame after a camera-on position. Examples of this may be found on pass D52, A71E, and D78. On pass D64 and on all subsequent passes corona discharges become more frequent and appear at intervals of approximately 6.3''. (Example: D64, frame 35 Fwd.)
Light Leaks	A diagonal band of plus density resulting from a light leak appears on the fourth frame of each pass. The

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	film suspended in the camera during a camera-off position often is slightly fogged, depending on the duration of the camera-off period and the solar elevation during the period. (Example: pass D94, frame 1.)
Emulsion Digs	Four small emulsion digs are present adjacent to the camera number just inside the format at each edge.
Minus Density Streaks	Faint minus density streaks appear on frames 2-22 of pass D67.
Dendritic Static	Small, minor discharges are present occasionally in the third frame following a camera-on position. (Example: A72E, frame 3.)
Manufacturing Splices	Pass D49, frame 15; pass D68, frame 167; pass D102, frame 87.
Minus Density Comets	Excessive and pronounced throughout the mission. (Examples: D71, frame 36.)
Emulsion Scratches	Rail scratches are severe and continuous. Several short, longitudinal emulsion scratches appear within a 3.0" band edge to edge beginning approximately 3.0" from the take-up end of each frame. (Example: D62, frame 15.) Pass D111, frames 26-28 were severely scratched as loose film was drawn through the camera.
Blisters and Pinholes	Minor and Intermittent.
Image Smearing	This is common on the first 6 frames of most passes on frames exposed before the system overcame inertia. (Example: D62, frames 1-6.)

b. Slave (AFT) Panoramic Camera:

Corona Static	There is usually a small discharge on the third frame after a camera-on position. (Example: D64, frame 3.) Pass D66 contains random discharges throughout.
Light Leaks	There is a plus density band caused by a light leak on the fourth frame after each camera-on position. Several patterns of fog are present on pass D49 (Mission 1004-1). This apparently is associated with the cut and wrap operation. The first and last few frames of most passes contain fogging and equipment images due to light leaks within the system. (Example: pass A104E.)
Manufacturing Splices	Pass D55, frame 33; pass D71, frame 110.
Minus Density Comets	Appear at random throughout the mission. (Example: D71, frame 36.)
Emulsion Scratches	Rail scratches are continuous and severe. Longitudinal emulsion scratches appear intermittently throughout the mission, and on pass D49, Mission 1004-1.
Creases and Tears	Severe creasing, tearing, etc., occurred on Pass D49, Mission 1004-1 at the processing site to such an extent that small pieces of film were completely destroyed. A series of crimps and creases appear on pass D103, frames 96-98. Severe film damage occurred on the last 3 frames of pass D112 as the loose end of film was drawn through the camera.
Blisters	Some of the aforementioned minus density comets were definitely the result of blisters. They are moderate in number but serious in nature.
Pinholes	Minor and intermittent except on pass D71 where they are numerous and associated with the manufacturing splice on frame 110.
Minus Density Spots	A minus density spot approximately 0.15" in diameter appears intermittently 0.8" from the frequency mark edge on pass D86, frame 7 and on most subsequent frames. Another minus density pattern, in the shape of a half-moon with a tail projected from its concave surface, also begins on pass D86, frame 7 and appears intermittently throughout the remainder of the mission. The spot is approximately 0.1" by 0.1" at the extremes and a small plus density is often noted in the center of the half-moon area. The pattern is suggestive of a crimp.

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c. Stellar Index Camera:

Edge Static	Corona and dendritic static discharges along both edges are continuous. There are random static discharges within the format.
Light Leak	A diagonal band of fog appears on nearly every frame and is very distinct on 22 frames.

d. Terrain Index Camera:

Edge Static	Static discharges are continuous along both edges.
Corona	Frame 16 only.
Light Leaks	A band of fog projects into the format from the camera number edge of frames 19, 21, 29, 45, 49, 67, 74 and 81.

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 fundamental 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 are well-defined. No unusual distortions are present. Detection and accurate mensuration of small objects are 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 are not crisply defined and there is loss of detail in shadow and/or highlight areas. Detection and identification of small objects are possible but accuracy of mensuration is reduced by the fall-off in image quality and the less-than-optimal contrast that prevails.

Poor: Camera-induced degradations and/or weather limitations severely reduce the effectiveness 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 photography completely precludes detection, identification and mensuration of cultural details.

2. PI Suitability for Mission 1004-2: The PI

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suitability for this mission is considered to be good in that fine detail is readily discernible through most of the mission. Photo interpreters reported on 140 targets in the preliminary target read-out of which 9% were given quality ratings of poor and the remainder a rating of good. Snow was the degrading factor on 6% of the targets receiving poor ratings while haze was to blame for the remaining 3%. Highlights of the mission coverage are as follows:

a. Discovery of construction and activity observed at a missile test center.

b. Discovery of construction at a nuclear weapons proving ground.

c. Clear count of aircraft at a military airfield.

d. Identification of a radar array.

e. Discovery of a large area of new construction.

Mission 1004-2 produced imagery only slightly inferior to the best ever attained by the KH-4 system. The degradations that are present and the problems encountered that have a direct bearing on PI suitability are as follows:

Corona Static - The degradation of imagery due to the effects of corona discharge is minor on both panoramic cameras.

Light Leaks - Diagonal patterns and equipment shadowgraphs are usually present on one or more of the first five frames and on the last three frames of each pass on both the master and slave panoramic cameras. The fog caused by the light leaks is minor but it does have a degrading effect. A good example of the various fog patterns may be observed on pass D64, frames 4 and 5. These light leaks are a result of the camera design and are not an anomaly.

Scratches and Abrasions - Four small emulsion digs at each edge of the format, adjacent to the camera number, appear on most frames of the master camera. Although these digs are small, had a target fallen in this area, it would have been degraded or lost.

Atmospherics - 32.6% of the photographic take of this mission is obscured by clouds. Eighty-two known targets were not reported due to atmospherics. Haze degraded 5 targets to such an extent as to be rated poor for photographic interpretation.

Solar Elevation - Most photography was accomplished while the solar elevation was favorable and little imagery was lost.

Image Motion - The first few frames after each camera-on position display this condition. The slow camera speed at the beginning of pass becomes more pronounced as the mission progresses. The PI suitability is highly degraded on the affected frames.

Minus Density Comets - While each comet is very small, the large number of them encountered on this mission makes them a degrading factor.

Minus Density Spots - The small minus density spots on the take of the slave camera suspected to be roller-induced crimps would obscure any imagery within their path.

Soft Spots - The imagery within the area described as being of "soft focus" on the master camera is highly degraded and of little use to the PI.

The image distortions inherent in the KH-4 camera are common throughout the mission. Pass D62, frames 17 FWD and 22 AFT are good examples.

Plus and minus density streaks associated with areas of heavy density (clouds) are noted intermittently throughout the mission.

3. Mission Information Potential (MIP): The MIP is an arbitrary number, not limited by terminal values, which is subjectively assigned to the panoramic photography of a mission and which compares it to the other KH missions. It is meant to be a measure of the camera's maximum capability for recording information, dis-

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counting adverse atmospheric conditions, minimal solar elevations, camera malfunctions or other factors which reduce the quality of the photography. The MIP is based on the best photography found in a mission, even though the photography may be limited to a few frames. Since these frames are considered the best in the mission, they do not indicate the overall success, average quality, or general interpretability of the photography.

Criteria for selection of an MIP frame:

a. Eliminate all portions of the mission affected by system malfunctions.

b. Select frames which are free of clouds and atmospheric attenuation.

c. Eliminate the first ten frames and last frame of a pass as these may be affected by incorrect scan speed.

d. Select frames that are in a continuous strip of approximately ten cloud-free frames, as cloud shadows from distant weather fronts are cast for great distances.

e. Determine from the horizon cameras that the panoramic photography is not affected by apparent vehicle perturbations.

f. Select targets that are near the center of format and on frames as close as possible to perigee for scale purposes and to eliminate obliquity.

g. Select frames having near optimum solar elevation, thus eliminating frames having either overexposure or underexposure.

h. Select a high contrast target (preferably an airfield) and compare the target to a previous mission which has been given an MIP rating.

4. MIP For Mission 1004-2: Utilizing the criteria set forth in the preceding items, pass D62, frame 23 AFT was selected as the MIP frame for this mission. The mission was given an MIP rating of 85 and is comparable to Mission 1004-1 (also MIP 85).

The photographic scene covers a city and airfield which are located near the center of the format. Image quality is such that runway markings, aircraft engine nacelles (on larger aircraft), and vehicles in parking lots and on highways are discernible.

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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	609.60 mm	609.60 mm
Film Type	4404	4404
Film Length	7800'	7800'
Emulsion	45-73-12-3	45-73-12-3
Static Bench Test		
High Contrast	290 L/mm	238 L/mm
Low Contrast	160 L/mm	155 L/mm
Dynamic Test		
I. High Contrast	170 L/mm	178 L/mm
I. Low Contrast	131 L/mm	135 L/mm
P. High Contrast	183 L/mm	215 L/mm
P. Low Contrast	107 L/mm	108 L/mm

Stellar and Terrain Index Cameras

	Stellar	Terrain
Camera No	D42/42/37	D42/42/37
Lens Serial No	10510	813050
Reseau Serial No	37	42
Filter	None	Wratten 21
Aperture	f/1.6	f/4.5
Exposure Time	2 sec	1/500 sec
Operational Focal Length	NA	NA
Film Type	4401	4400
Film Length	75'	135'
Splices	None	None
Emulsion	7-3-1-4	16-4-11-3
Perpendicularity of Reseau	0.00''-0.93''	0.00''-2.25''
Location of Principal Point	NA	NA
Awar	NA	70 L/mm

Horizon Cameras

	Starboard (Take-up)	Port (Supply)	Starboard (Supply)	Port (Take-up)
Panoramic 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/6.0	f/6.8	f/6.0	f/6.8
Filter	Wratten 25	Wratten 25	Wratten 25	Wratten 25
Operational Focal Length	54.45 mm	54.33 mm	58.48 mm	58.48 mm
Average Lines/mm	162 L/mm	167 L/mm	111 L/mm	178 L/mm
Radial Resolution (L/mm)				
10° off axis	.009 mm	-.015 mm	.004 mm	.002 mm
20° off axis	.012 mm	-.015 mm	.002 mm	.009 mm
Tangential Distortion	.004 mm	Not Available	.005 mm	.003 mm

Camera No 124

Resolution	Take-up			Supply		
Angle Off Axis	0°	10°	20°	0°	10°	20°
Radial Resolution (L/mm)	157	141	100	157	141	106
Tangential Resolution (L/mm)	168	141	76	177	141	88

Camera No 125

Resolution	Take-up							Supply						
Angle Off Axis	0°	5°	10°	15°	20°	25°	27.5°	0°	5°	10°	15°	20°	25°	27.5°
Radial Resolution (L/mm)	164	164	144	112	103	105	58	164	164	162	134	109	99	41
Tangential Resolution (L/mm)	164	145	142	115	86	60	44	164	162	151	121	91	60	41

Camera No D42/42/37

Resolution	Stellar					Index				
Angle Off Axis	NA	NA	NA	NA	NA	0°	10°	20°	30°	35°
High Contrast	NA	NA	NA	NA	NA	73	92	108	89	77
Low Contrast	NA	NA	NA	NA	NA	73	83	91	35	18

NA denotes Not Available.

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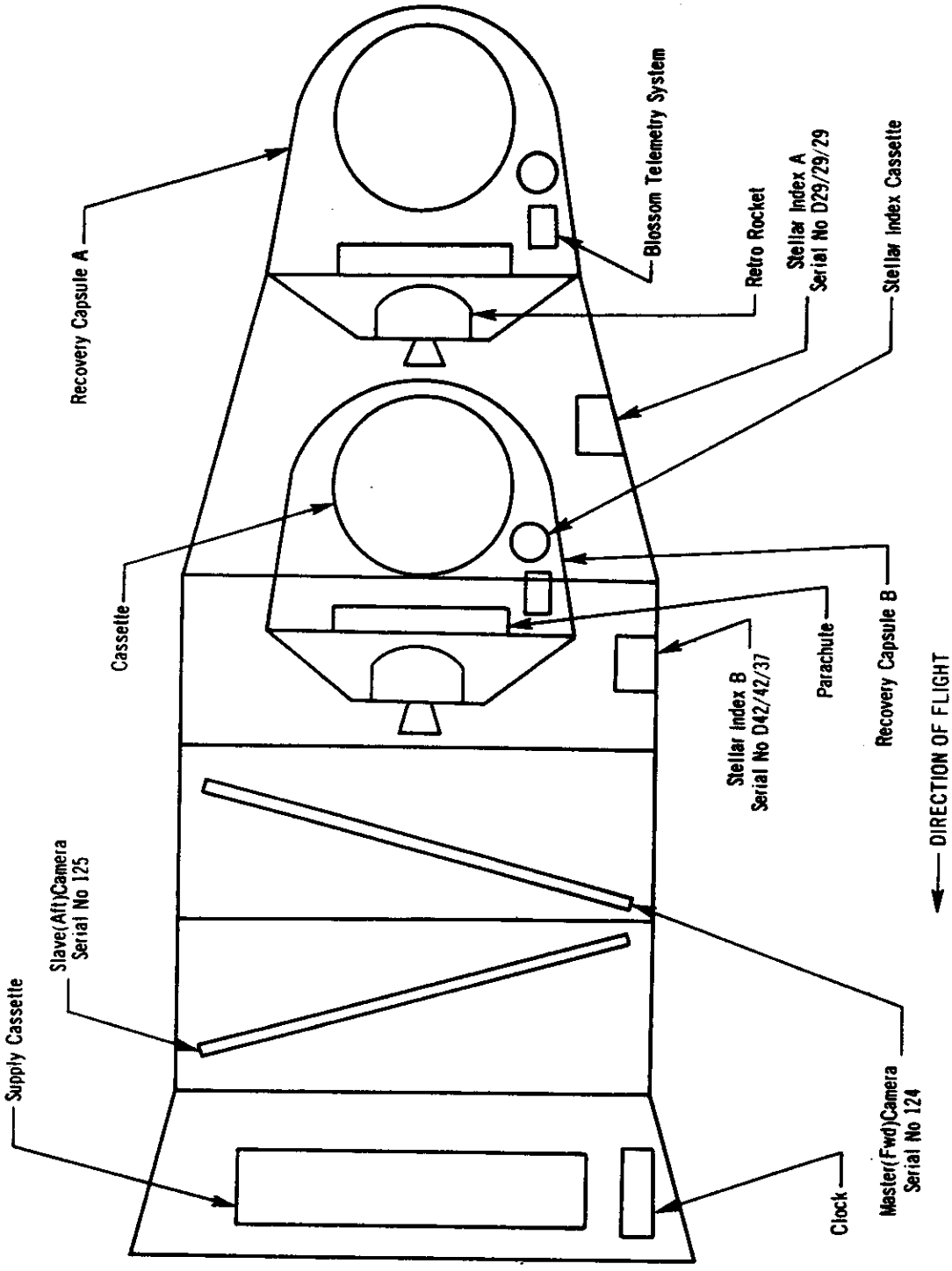
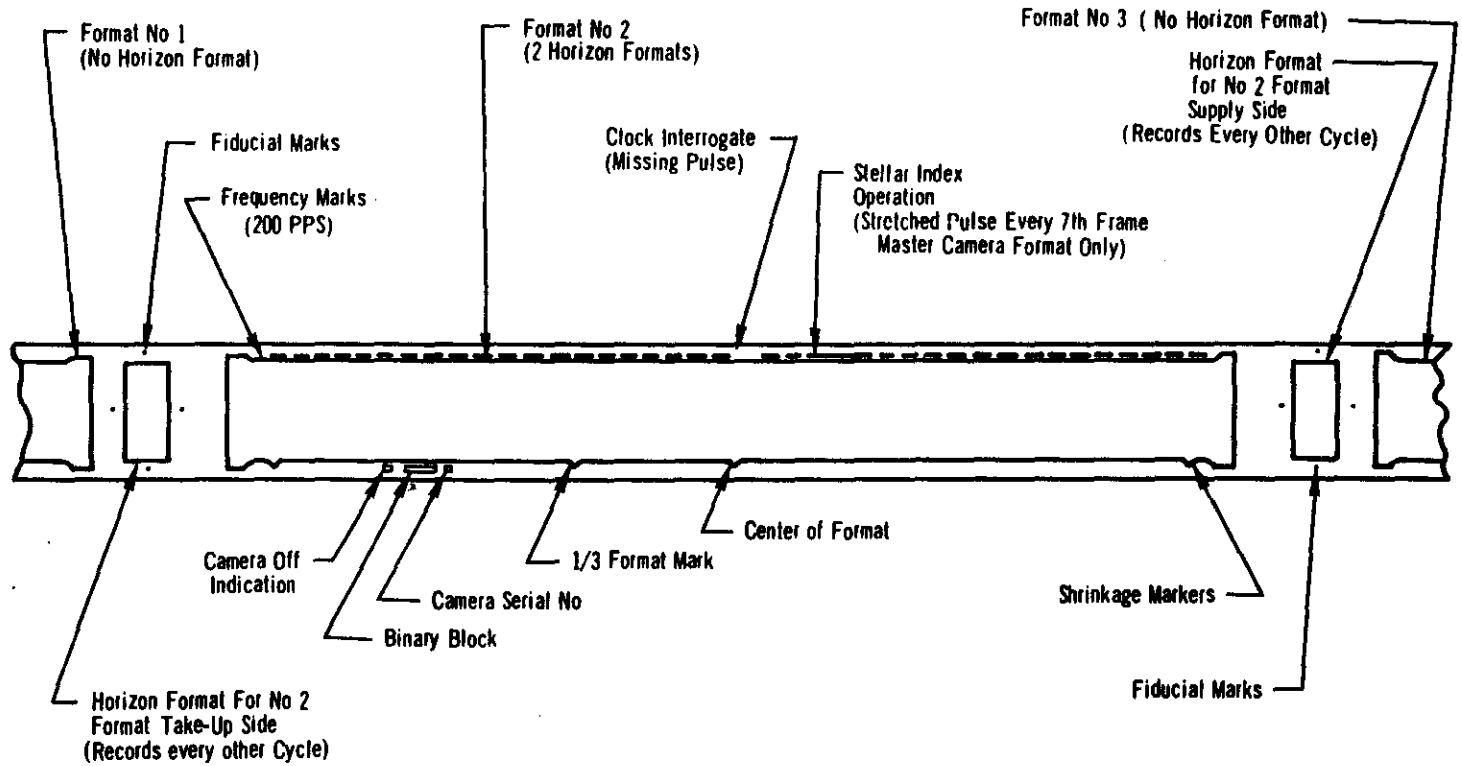
VEHICLE LAYOUT



NPIC J-0950 (6/64)

FILM SPECIFICATIONS
FORMAT LAYOUT

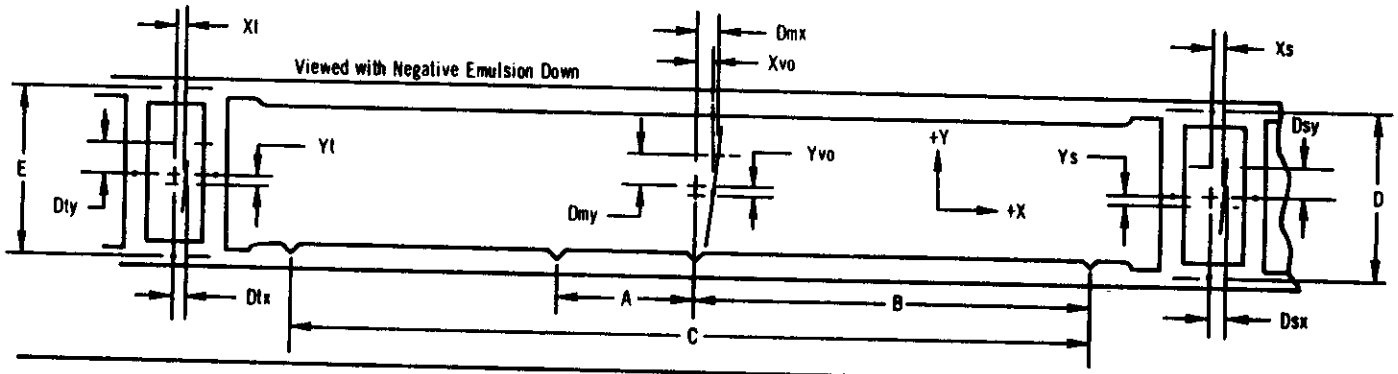


Master(Fwd)Panoramic Camera No 124
Viewed With Negative Emulsion Down
Direction of Film Transport ←
Direction of Scan →
Direction of Vehicle Motion ↓

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

FILM SPECIFICATIONS

FORMAT SPECIFICATIONS



Master (Fwd) Camera		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		Vehicle Motion		Scan Direction	
A	76.1	Xl	-0.045	Dtx	-0.047
B	355.3	Yl	+0.348	Dty	-2.000
C	710.3	Xs	-0.721	Dsx	-0.737
D	56.488	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

TOP SECRET CORONA
NO FOREIGN DISSEM

[redacted]

APPENDIX B. TECHNICAL COMPENDIUM

1. Master (FWD) Panoramic Camera

											Terrain			Limiting				
Pass	Frame	% Over-lap	Cloud	Univ. Time	Sun Time	Solar Elev.	Pitch	Roll	Yaw (All Minus)*	Alt. (yds)	D Min	D Max	Δ	D Min	D Max	Δ	Fog	Exp
D49	01	NR	3321	2359	1307	51°43'	NA	NA	NA	NA	NR	NR	NR	0.37	2.25	1.65	0.11	NA
D50	05	06	4212	0116	1027	08 21	14°54'	-00°07'	01°05'	244719	0.74	1.69	0.95	0.74	2.05	1.31	0.21	1/211
D50	44	07	4311	0116	1116	14 36	15 02	00 12	01 04	233726	0.51	1.34	0.83	0.51	1.92	1.41	0.11	1/229
D52	58	06	1111	0424	1220	31 51	15 10	00 25	01 42	211782	0.62	1.21	0.59	0.42	2.05	1.63	0.11	1/256
D52	86	07	1111	0425	1229	35 39	14 08	00 35	01 25	206772	1.25	1.98	0.73	0.85	2.13	1.28	0.11	1/257
D53	06	07	1111	0552	1147	21 25	15 39	00 07	01 00	223759	0.89	1.95	1.06	0.87	2.06	1.19	0.21	1/236
D53	57	09	1111	0556	1232	36 46	15 04	00 26	NA	207146	0.98	1.99	1.01	0.98	1.99	1.01	0.11	1/257
D54	03	00	2234	0719	1027	08 36	14 47	00 23	01 07	247956	0.27	0.44	0.17	0.27	2.07	1.80	0.06	1/194
D54	75	06	1111	0723	1147	21 50	15 26	00 53	01 53	222733	1.07	1.67	0.60	0.80	1.74	1.14	0.08	1/241
D54	87	06	1111	0724	1155	23 44	15 26	00 51	01 39	219022	0.83	1.51	0.68	0.66	1.65	0.99	0.08	1/245
D54	102	NR	1111	0725	1204	25 49	15 15	00 45	NA	217022	1.35	1.59	0.24	0.60	1.71	1.11	0.08	1/247
D55	02	NR	5555	0849	1000	05 36	14 52	-00 17	00 16	253602	NR	NR	NR	0.34	1.63	1.29	0.16	1/156
D55	05	01	3445	0850	1005	06 02	14 58	-00 19	00 18	246516	NR	NR	NR	0.33	1.85	1.52	0.20	1/206
D55	84	NR	5555	0853	1136	18 23	14 26	00 10	01 02	227902	NR	NR	NR	0.75	1.30	0.52	0.07	1/237
D55	124	06	1111	0856	1159	24 27	15 12	00 10	01 14	219146	0.75	1.55	0.80	0.75	1.63	0.88	0.07	1/245
D55	160	08	1111	0856	1215	30 01	15 54	00 15	01 09	214201	1.36	1.80	0.42	0.83	1.80	0.97	0.06	1/253
D55	258	06	1211	0900	1244	42 36	14 34	00 06	00 57	205000	0.57	0.94	0.37	0.41	2.30	1.89	0.06	1/261
D56	56	08	2111	1027	1214	29 52	15 08	00 07	01 11	213492	1.00	1.55	0.55	1.00	1.55	0.55	0.06	1/255
D61	35	NR	4455	1604	1310	NA	15 30	-00 17	00 53	205561	NR	NR	NR	0.60	2.14	1.34	0.09	1/256
D62	01	00	1111	1936	1314	42 54	15 25	00 08	NA	205000	1.30	1.82	0.52	1.30	2.08	0.78	0.09	NA
D62	02	00	1111	1936	1315	43 06	15 25	00 08	NA	205000	0.62	1.38	0.76	0.62	1.68	1.06	0.09	1/181
D62	03	00	1111	1936	1317	43 19	15 24	00 07	NA	204650	0.40	1.68	1.28	0.40	1.68	1.28	0.09	1/224
D62	04	02	1111	1936	1318	43 32	15 24	00 07	NA	204500	0.46	1.42	0.94	0.46	1.72	1.24	0.11	1/240
D62	05	04	1111	1936	1319	43 40	15 23	00 05	NA	204500	0.66	1.56	0.90	0.66	1.82	1.14	0.11	1/246
D62	06	04	1111	1936	1319	43 40	15 23	00 05	NA	204500	0.72	1.48	0.76	0.72	1.92	1.20	0.10	1/250
D62	17	03	1111	1937	1321	45 05	15 21	00 02	00 46	204550	0.62	1.70	1.08	0.40	1.76	1.36	0.10	1/258
D62	18	03	1111	1937	1321	45 08	15 22	00 03	00 46	204550	0.68	1.90	1.22	0.68	1.90	1.22	0.11	1/256
D64	35	06	1111	2226	1125	10 06	14 34	-00 07	NA	239425	0.60	1.62	1.02	0.50	1.82	1.32	0.11	1/224
D64	60	07	2222	2252	1450	60 26	14 40	00 20	00 36	275757	NR	NR	NR	0.48	2.21	1.73	0.11	1/192
D65	16	06	1111	2359	1049	11 32	15 26	00 12	NA	239038	0.61	1.58	0.97	0.60	1.84	1.24	0.11	1/229
D65	49	09	1111	0001	1121	16 47	15 23	00 06	NA	227365	0.55	1.66	1.11	0.27	1.91	1.64	0.09	1/238
D66	32	07	1111	0132	1126	19 20	14 38	00 03	NA	225229	0.62	1.73	1.09	0.27	2.03	1.76	0.11	1/232
D66	64	08	4313	0134	1145	24 11	15 37	00 00	00 31	216000	1.01	2.13	1.12	0.53	2.14	1.61	0.11	1/246
D66	74	10	4313	0134	1151	25 21	15 30	00 13	NA	217000	0.82	1.92	1.10	0.66	2.22	1.56	0.08	1/248
D67	21	10	1111	0259	0942	04 47	14 56	00 31	01 16	248400	0.68	0.90	0.22	0.46	1.32	0.86	0.20	1/214
D67	44	09	1111	0305	1203	26 01	15 06	00 23	00 45	215152	0.72	2.00	0.28	0.61	2.06	1.45	0.20	1/244
D68	48	09	1121	0435	1144	24 36	14 53	00 03	NA	216375	0.60	1.91	1.31	0.60	2.08	1.48	0.11	1/238
D68	63	10	1111	0436	1152	26 56	14 40	-00 03	00 22	215339	0.58	1.68	1.10	0.58	1.94	1.36	0.12	1/249
D68	132	10	1112	0439	1217	36 39	14 57	00 10	01 19	207000	0.96	1.78	0.82	0.84	1.92	1.08	0.10	1/256
D68	161	08	2213	0440	1226	40 45	14 54	00 15	01 03	205500	NR	NR	NR	0.39	2.03	1.64	0.11	1/260
D69	07	10	1111	0604	1120	18 11	15 57	00 45	NA	227049	0.54	1.66	1.12	0.54	1.96	1.42	0.11	NA
D69	41	09	1111	0606	1122	23 29	15 52	00 06	NA	217449	1.04	2.00	0.96	1.04	2.16	1.12	0.21	NA
D70	09	09	1111	0736	1126	19 59	14 48	00 31	01 23	222921	0.76	1.82	1.06	0.76	2.02	1.26	0.21	1/238
D70	97	08	1211	0740	1215	35 54	14 34	00 25	01 02	207338	1.36	1.90	0.54	1.20	1.98	0.78	0.09	1/256
D71	08	07	1114	0906	1121	18 55	14 56	00 01	NA	224730	0.94	1.42	0.48	0.80	1.68	0.88	0.11	1/237
D72	23	12	3121	1039	1142	24 21	15 18	-00 10	00 32	216000	NR	NR	-	0.26	2.04	1.78	0.11	1/247
D72	46	11	1111	1040	1155	27 55	15 24	-00 05	NA	213000	1.00	1.93	0.93	0.72	2.07	1.35	0.09	1/251
D72	74	10	1112	1045	1235	46 39	16 04	00 08	NA	205250	0.69	1.92	1.23	0.65	2.19	1.54	0.21	1/259
D72	84	11	1111	1046	1241	48 18	16 01	00 19	01 08	205000	1.10	1.70	0.60	1.10	2.00	0.90	0.18	1/259
D78	05	10	1111	1947	1210	37 05	15 14	00 01	00 43	206500	NR	NR	NR	1.16	1.96	0.80	0.10	1/248
D78	25	11	1111	1946	1217	40 02	15 17	-00 06	NA	203500	1.16	1.44	0.26	0.52	1.90	1.38	0.09	1/258
D83	10	09	1111	0318	1133	25 33	15 11	00 12	00 31	215000	0.96	1.96	1.00	0.70	1.98	1.28	0.11	1/247
D83	43	11	2111	0319	1151	31 32	14 50	00 19	NA	211000	1.16	1.66	0.66	1.16	2.02	0.84	0.06	1/254
D83	76	10	1211	0320	1257	36 16	14 51	00 23	00 46	207702	0.74	1.92	1.18	0.36	2.02	1.64	0.11	1/257
D85	11	06	1111	0615	1120	21 44	15 35	-00 01	NA	216962	0.94	1.97	1.03	0.69	2.06	1.37	0.19	1/242

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1. Master (FWD) Panoramic Camera (Continued)

											Terrain			Limiting				
Pass	Frame	% Overlap	Cloud	Univ. Time	Sun Time	Solar Elev.	Pitch	Roll	Yaw (All Minus)*	Alt. (yds)	D Min	D Max	Δ	D Min	D Max	Fog	Δ	Exp
D85	51	10	1111	0620	1141	27 47	15 26	00 24	NA	211596	0.42	1.74	1.32	0.41	1.88	1.47	0.11	1/251
D85	83	10	4313	0622	1206	37 37	14 53	00 09	NA	206882	0.85	1.91	1.06	0.69	2.00	1.31	0.09	1/253
D86	26	11	4312	0749	1121	22 32	15 45	00 22	01 02	216000	0.86	1.67	0.99	0.86	2.03	1.17	0.09	1/246
D86	75	09	1111	0752	1153	32 17	14 59	00 32	NA	209000	1.49	1.75	0.26	1.01	1.87	0.86	0.09	1/255
D86	93	09	4412	0753	1200	34 46	15 17	00 27	00 36	207000	0.88	1.72	0.84	0.88	1.72	0.84	0.07	1/254
D87	45	11	1111	0920	1128	24 00	15 04	-00 04	NA	216976	1.16	1.96	0.78	1.16	1.96	0.80	0.11	1/247
D87	84	09	4434	0923	1156	34 39	15 15	00 09	01 01	207880	1.48	1.84	0.36	1.48	2.06	0.60	0.06	1/256
D94	01	00	1111	2001	1209	44 05	14 56	00 07	NA	205835	0.72	1.72	1.00	0.64	1.92	1.28	0.11	NA
D94	02	00	1111	2001	1209	44 05	14 57	00 07	NA	205335	0.76	1.64	0.88	0.76	1.76	0.96	0.10	1/193
D94	16	08	1111	2001	1212	46 03	15 05	-00 02	NA	206000	0.80	1.70	0.90	0.70	1.50	0.80	0.10	1/249
D94	38	08	1111	2003	1216	49 11	15 11	-00 02	NA	206000	0.80	1.64	0.84	0.40	1.80	1.40	0.10	1/254
D101	10	08	1111	0632	1124	26 08	15 26	-00 02	NA	212250	0.95	1.50	0.55	0.95	1.70	0.85	0.07	1/247
D101	42	10	1112	0633	1137	30 32	15 17	00 20	NA	209336	1.09	1.59	0.50	1.09	1.82	0.73	0.07	1/254
D102	92	09	1121	0804	1159	31 36	15 27	00 06	NA	208685	0.87	1.49	0.62	0.56	1.77	1.21	0.09	1/259
D103	11	11	5334	0932	1059	19 29	15 16	-00 04	NA	218000	0.44	1.75	1.31	0.37	1.95	1.58	0.09	1/249
D103	36	11	3111	0933	1115	23 44	15 32	00 05	NA	214500	0.53	1.85	1.32	0.51	2.03	1.52	0.09	1/255
D103	87	11	1111	0935	1137	31 02	15 18	00 23	NA	209180	1.03	1.68	0.65	0.81	1.80	0.99	0.07	1/260
D103	137	06	2111	0942	1227	60 49	14 19	-00 04	NA	214500	0.81	1.33	0.52	0.34	1.82	1.48	0.07	1/236
D103	150	10	1111	0943	1228	61 34	14 26	-00 06	NA	216000	0.80	1.51	0.71	0.35	1.94	1.59	0.07	1/248
D103	169	10	1111	0944	1232	63 46	14 36	00 07	NA	223000	0.47	1.44	0.97	0.20	1.85	1.65	0.07	1/246
D111	18	11	3111	2135	0940	07 11	14 53	-00 17	NA	230500	0.85	0.95	0.10	0.77	1.44	0.67	0.19	1/236

*All yaw values are determined from stellar readings.

Note NR denotes no reading made
NA denotes not available

Terrain

D Max Range	0.44-2.13
D Min Range	0.27-1.49
Average D Max	1.66
Average D Min	0.83

Limiting

D Max Range	1.30-2.30
D Min Range	0.20-1.46
Average D Max	1.90
Average D Min	0.67

Gross Fog Range	0.07-0.21
Average Gross Fog	0.11

2. Slave (AFT) Panoramic Camera

											Terrain			Limiting				
Pass	Frame	% Overlap	Cloud	Univ. Time	Sun Time	Solar Elev.	Pitch (All Minus)	Roll	Yaw (All Minus)*	Alt. (yds)	D Min	D Max	Δ	D Min	D Max	Δ	Fog	Exp
D49	02	NR	3311	2359	1307	NA	13°56'	-00°10'	NA	NA	0.67	2.24	1.57	0.30	2.35	2.05	0.11	1/248
D49	06	NR	3311	2359	1307	51°43'	14 05	-00 07	NA	206360	NR	NR	NR	0.21	2.25	2.04	0.11	1/248
D50	10	05	4114	0116	1029	08 21	15 00	00 12	01°05'	244719	0.64	1.23	0.59	0.64	2.06	1.42	0.21	1/214
D50	49	07	1114	0116	1116	14 36	14 52	00 12	01 04	233726	0.75	1.61	0.86	0.58	1.79	1.21	0.11	1/227
D52	63	06	1111	0424	1220	31 51	14 44	00 25	01 42	211782	1.11	1.74	0.63	0.95	2.17	1.22	0.21	1/251
D52	90	04	1111	0425	1229	35 39	15 06	00 35	01 25	208772	1.41	2.21	0.80	1.27	2.25	0.98	0.21	1/254
D53	12	04	1111	0552	1147	21 25	14 08	00 16	01 00	223758	0.79	1.92	1.13	0.67	2.04	1.37	0.21	1/238
D53	62	04	1111	0556	1232	36 46	14 50	00 26	NA	207146	1.23	1.97	0.74	1.23	1.97	0.74	0.21	1/255
D54	09	00	2244	0719	1027	06 36	15 07	00 23	01 07	247956	0.49	0.75	0.26	0.38	0.83	0.45	0.10	1/215
D54	80	06	1111	0723	1147	21 50	14 26	00 53	01 53	222733	1.24	1.87	0.63	1.24	1.93	0.69	0.10	1/239
D54	91	06	1111	0724	1155	23 44	14 26	00 51	01 39	219022	0.75	1.52	0.77	0.75	1.52	0.77	0.07	1/242
D54	107	06	1111	0725	1204	25 49	14 39	00 45	NA	217022	0.60	1.60	1.00	0.49	1.83	1.34	0.06	1/246

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2. Slave (AFT) Panoramic Camera (Continued)

Pass	Frame	% Over-lap	Cloud	Univ. Time	Sun Time	Solar Elev.	Pitch (All Minus)	Roll	Yaw (All Minus)*	Alt. (yds)	Terrain D Min	Terrain D Max	Terrain Δ	Limiting D Min	Limiting D Max	Limiting Δ	Fog	Exp
D53	06	NR	5555	0849	1000	05°38'	15 02	-00 17	00 18	253602	NR	NR	NR	0.33	1.34	1.01	0.19	1/206
D55	10	02	3445	0850	1005	06 02	14 56	-00 19	00 18	246516	NR	NR	NR	0.29	1.84	1.55	0.19	1/210
D55	90	NR	5555	0853	1136	18 23	15 26	00 10	01 02	227902	NR	NR	NR	0.86	1.38	0.52	0.09	1/236
D55	126	04	1111	0855	1159	24 27	14 42	00 10	01 14	219148	1.40	1.96	0.56	1.04	2.06	1.02	0.09	1/234
D55	164	08	1111	0856	1215	30 01	14 00	00 15	01 09	214201	1.20	1.79	0.59	0.73	1.95	1.22	0.06	1/249
D55	260	07	1211	0900	1244	42 36	15 20	00 06	00 57	205000	0.55	1.90	1.35	0.32	2.06	1.74	0.09	1/256
D56	03	02	1111	1025	1149	22 00	15 04	-00 06	00 42	221748	0.27	1.43	1.16	0.27	1.52	1.25	0.06	1/240
D56	61	06	2111	1027	1214	29 52	14 46	00 07	01 11	213492	1.09	1.57	0.48	0.99	1.87	0.88	0.07	1/251
D61	40	NR	4455	1804	1310	NA	14 24	-00 17	00 53	205581	NR	NR	NR	0.62	1.62	1.00	0.09	1/256
D62	06	03	1111	1936	1314	42 54	14 29	00 08	NA	205000	0.70	1.31	0.61	0.70	1.96	1.26	0.07	1/247
D62	07	03	1111	1936	1315	43 06	14 29	00 08	NA	205000	0.71	1.24	0.53	0.51	1.71	1.20	0.09	1/250
D62	08	04	1111	1936	1317	43 19	14 30	00 07	NA	204650	0.56	1.24	0.68	0.56	1.81	1.25	0.08	1/251
D62	09	04	1111	1936	1318	43 32	14 30	00 07	NA	204500	0.52	1.42	0.90	0.30	1.67	1.37	0.08	1/254
D62	11	03	1111	1936	1319	43 40	14 31	00 05	NA	204500	0.72	1.45	0.73	0.44	1.82	1.38	0.09	1/255
D62	22	02	1111	1937	1321	45 05	14 23	00 02	00 46	204550	0.88	1.71	0.83	0.70	1.76	1.06	0.09	1/256
D62	23	03	1111	1937	1321	45 06	14 22	00 03	00 46	204550	1.01	1.85	0.84	0.40	1.85	1.45	0.09	1/256
D62	37	05	1111	1937	1325	46 45	14 16	00 06	NA	204600	1.12	1.78	0.66	1.12	2.00	0.88	0.19	1/256
D64	41	07	1111	2226	1125	10 08	15 20	-00 07	01 28	239425	0.50	1.76	1.26	0.50	1.76	1.26	0.11	1/224
D64	65	08	2222	2252	1450	60 25	15 14	00 20	00 36	275757	0.56	1.84	1.26	0.30	1.84	1.54	0.06	1/187
D65	24	06	1111	2359	1029	11 32	14 25	00 03	NA	239036	0.41	1.99	1.58	0.41	1.99	1.51	0.11	1/226
D65	54	08	1111	0001	1121	16 47	14 31	00 06	NA	227365	1.49	2.16	0.57	0.89	2.16	1.27	0.19	1/236
D66	69	04	4313	0134	1145	24 11	14 32	00 04	00 31	218000	1.41	1.94	0.53	0.28	1.94	1.66	0.11	1/245
D66	79	08	4313	0134	1151	25 21	14 31	00 19	NA	217000	1.23	2.00	0.77	1.23	2.12	0.89	0.11	1/246
D67	26	06	1111	0259	0942	04 47	14 47	00 25	01 16	246400	0.37	1.03	0.66	0.37	1.39	1.02	0.17	1/214
D67	50	09	1111	0305	1203	26 01	14 41	00 42	00 45	215152	0.38	1.98	1.60	0.38	2.06	1.68	0.07	1/245
D68	54	06	1121	0435	1144	24 36	15 11	-00 02	NA	218378	0.80	1.92	1.12	0.62	2.08	1.46	0.11	1/243
D68	69	09	1111	0436	1152	26 56	15 13	-00 04	00 22	215339	0.68	1.72	1.04	0.68	2.00	1.32	0.07	1/247
D68	138	06	1112	0439	1217	36 39	14 55	00 14	01 19	207000	0.49	1.94	1.45	0.45	1.95	1.50	0.11	1/255
D68	167	07	2213	0440	1226	40 45	15 01	00 12	01 03	205550	0.80	2.02	1.22	0.37	2.08	1.71	0.11	1/257
D69	12	06	1111	0604	1120	16 11	14 03	00 45	NA	227049	0.52	1.78	1.26	0.40	1.85	1.45	0.11	1/251
D69	46	09	1111	0606	1122	23 29	14 08	00 06	NA	217449	0.50	1.71	1.21	0.50	1.79	1.29	0.11	1/254
D70	14	10	1111	0736	1126	19 59	15 01	00 31	01 23	222921	0.55	1.94	1.39	0.55	2.04	1.49	0.21	1/239
D70	101	07	1211	0740	1215	35 54	15 23	00 24	01 02	207338	0.90	1.89	0.99	0.90	1.94	1.04	0.09	1/255
D71	14	07	1111	0906	1121	16 55	14 58	00 01	NA	224730	0.63	1.55	0.92	0.52	1.75	1.23	0.11	1/237
D72	26	11	3121	1039	1142	24 21	14 33	-00 10	00 32	216000	0.33	1.63	1.30	0.27	1.99	1.72	0.11	1/255
D72	51	10	1111	1040	1155	27 55	14 30	-00 03	NA	213000	0.93	2.00	1.07	0.65	2.16	1.31	0.18	1/256
D72	79	10	1112	1045	1235	46 39	13 50	00 11	NA	205250	0.97	1.88	0.91	0.84	2.25	1.41	0.21	1/256
D72	89	10	1111	1046	1241	48 18	13 59	00 28	01 08	205000	1.21	2.07	0.86	1.11	2.18	1.07	0.21	1/256
D78	09	06	1111	1947	1210	37 05	14 46	00 01	00 43	206500	1.70	2.17	0.47	1.25	2.17	0.92	0.11	1/251
D78	30	08	1211	1948	1217	40 02	14 43	-00 08	NA	205500	0.37	1.47	1.10	0.37	2.23	1.86	0.11	1/255
D83	15	09	1111	0316	1133	25 33	14 48	00 05	00 31	216000	1.33	2.03	1.70	0.88	2.07	1.19	0.15	1/246
D83	48	10	2111	0319	1151	31 32	15 08	00 21	NA	211000	0.98	1.79	0.81	0.89	2.10	1.21	0.09	1/251
D83	80	09	1211	0320	1257	36 16	15 03	00 21	00 48	207702	0.49	1.89	1.40	0.24	1.94	1.70	0.11	1/254
D85	16	07	1111	0618	1120	21 44	14 12	-00 03	NA	218962	0.80	1.73	0.93	0.80	2.06	1.26	0.21	1/241
D85	36	09	1111	0620	1141	27 47	14 34	00 24	NA	211596	0.50	1.67	1.17	0.38	1.89	1.51	0.11	1/249
D85	88	11	4312	0622	1206	37 37	14 57	-00 01	NA	206852	0.91	1.67	0.76	0.91	1.67	0.76	0.11	1/254
D86	33	08	4312	0749	1121	22 32	14 18	00 23	01 02	216000	0.45	1.48	1.03	0.45	1.52	1.17	0.07	1/244
D86	80	07	1111	0752	1153	32 17	14 49	00 31	NA	209000	1.71	1.77	0.06	0.90	1.77	0.87	0.07	1/254
D86	98	08	4412	0753	1200	34 48	14 35	00 25	00 38	207000	1.02	1.61	0.59	0.90	1.76	0.86	0.07	1/254
D87	50	09	1111	0920	1128	24 00	14 52	00 00	NA	216976	0.75	1.85	1.10	0.75	1.94	1.19	0.11	1/245
D87	89	08	4434	0923	1158	34 39	14 34	00 06	01 01	207580	1.09	1.87	0.78	1.09	2.11	1.02	0.09	1/254
D94	07	06	1111	2001	1209	44 05	14 53	00 07	NA	205335	0.72	1.62	0.90	0.40	1.69	1.29	0.11	1/248
D94	22	07	1111	2001	1212	46 03	14 45	-00 01	NA	206000	0.55	1.68	1.13	0.50	1.94	1.44	0.11	1/253
D94	43	07	1111	2003	1216	49 11	14 43	-00 01	NA	206000	0.77	1.61	0.84	0.29	1.85	1.56	0.11	1/253
D101	15	08	1111	0632	1124	26 08	14 31	-00 04	NA	212250	1.05	1.46	0.43	1.05	1.62	0.57	0.07	1/246
D101	47	07	1112	0633	1137	30 32	14 37	00 27	NA	209236	0.98	1.68	0.70	0.98	1.82	0.84	0.07	1/251
D102	97	NR	1121	0804	1159	31 36	14 25	00 04	NA	208685	0.82	1.05	0.23	0.46	1.44	0.98	0.07	1/258
D103	16	10	5334	0932	1059	19 29	14 31	-00 03	NA	216000	0.45	1.64	1.19	0.22	1.67	1.45	0.11	1/247
D103	43	10	3111	0933	1115	23 44	14 21	00 07	NA	214500	0.56	1.67	1.29	0.22	1.98	1.76	0.09	1/253
D103	91	10	1111	0935	1137	31 02	14 39	00 24	NA	209160	0.75	1.56	0.83	0.75	1.60	1.05	0.07	1/258

*All yaw values are determined from stellar readings.

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											Terrain			Limiting				
Pass	Frame	% Over-lap	Cloud	Univ. Time	Sun Time	Solar Elev.	Pitch (All Minus)	Roll	Yaw (All Minus)°	Alt. (yds)	D Min	D Max	Δ	D Min	D Max	Δ	Fog	Exp
D103	141	06	2111	0942	1227	60 49	15 35	-00 06	NA	214500	0.72	1.41	0.69	0.26	1.93	1.65	0.07	1/247
D103	154	10	1111	0943	1226	61 34	15 26	-00 04	NA	216000	0.87	1.42	0.55	0.35	1.99	1.64	0.07	1/247
D103	173	09	1111	0944	1232	63 48	15 15	00 11	NA	223000	1.06	1.93	0.87	0.62	2.10	1.48	0.17	1/247
D111	23	10	3111	2135	0940	07 11	15 04	-00 02	NA	230500	0.65	0.91	0.26	0.65	1.25	0.60	0.19	1/235

Note NR denotes no reading made
NA denotes not available

Terrain

D Max Range	0.75-2.24
D Min Range	0.27-1.71
Average D Max	1.71
Average D Min	0.81

Limiting

D Max Range	0.83-2.35
D Min Range	0.21-1.27
Average D Max	1.85
Average D Min	0.63

Gross Fog Range	0.06-0.21
Average Gross Fog	0.12

[redacted]

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 attachment and a 0.5 mm aperture. The values are correlated below.

Pass	Frame	D Min	D Max	Gross Fog	Pass	Frame	D Min	D Max	Gross Fog
D49	01	1.56	2.99	0.34	D66	212	1.04	3.37	0.27
D49	02	0.91	2.66	0.34	D69	213	0.65	3.04	0.27
D49	03	0.93	3.12	0.34	D69	229	0.95	3.27	0.28
D50	04	0.50	2.54	0.31	D70	230	0.75	3.29	0.22
D50	17	0.92	2.67	0.39	D70	244	1.06	3.35	0.24
D52	18	1.64	3.45	0.26	D71	245	0.83	3.23	0.23
D52	34	0.99	3.17	0.26	D71	263	1.05	3.34	0.25
D53	35	0.66	2.67	0.25	D72	264	0.96	3.34	0.24
D53	55	1.42	3.39	0.32	D72	277	0.96	3.20	0.26
D54	56	0.46	2.90	0.26	A72E	278	NR	NR	0.27
D54	75	0.69	3.29	0.25	D78	277	1.24	3.45	0.29
D55	76	0.37	2.33	0.28	D78	284	NR	NR	0.24
D55	113	1.14	3.30	0.25	D83	285	1.13	3.40	0.26
D56	114	0.90	3.18	0.24	D83	296	1.61	3.61	0.24
D56	123	1.07	3.27	0.25	D85	297	NR	NR	0.24
A56E	124	NR	NR	0.25	D85	312	NR	NR	0.25
A57	125	NR	NR	0.31	D86	313	1.04	2.86	0.25
D61	126	1.24	3.29	0.27	D86	329	1.55	3.48	0.25
D61	131	1.29	3.30	0.24	D87	330	1.12	3.25	0.26
D62	132	1.02	3.21	0.26	D87	348	1.17	3.43	0.38
D62	137	0.69	3.10	0.26	D94	349	NR	NR	0.25
D64	138	0.39	2.96	0.27	D94	355	NR	NR	0.25
D64	148	0.56	2.97	0.30	D101	356	NR	NR	0.25
D65	149	0.56	3.21	0.27	D101	363	NR	NR	0.25
D66	158	0.63	3.23	0.25	D102	364	NR	NR	0.25
D66	159	0.26	1.44	0.27	D102	380	NR	NR	0.25
D66	171	1.00	3.29	0.28	A103E	381	NR	NR	0.25
D67	172	0.32	2.50	0.27	D103	382	NR	NR	0.25
D67	186	0.95	3.10	0.25	D103	409	NR	NR	0.27
D68	187	0.29	2.91	0.24					

Note NR denotes no reading made

D Max Range	1.44-3.61	Average D Max	3.11
D Min Range	0.26-1.61	Average D Min	0.91
Gross Fog Range	0.22-0.39		
Average Gross Fog	0.27		

2. Terrain Index Camera

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

		Terrain		Limiting		
Pass	Frame	D Min	D Max	D Min	D Max	Gross Fog
D49	01	NR	NR	0.34	1.73	0.05
D49	02	NR	NR	0.20	1.77	0.10
D49	03	NR	NR	0.13	1.74	0.11
D50	04	0.16	0.67	0.16	0.91	0.10
D50	17	0.18	1.12	0.15	1.12	0.07
D52	18	0.30	1.01	0.30	1.01	0.10
D52	34	0.40	1.47	0.16	1.47	0.07
D53	35	0.17	1.06	0.17	1.06	0.09

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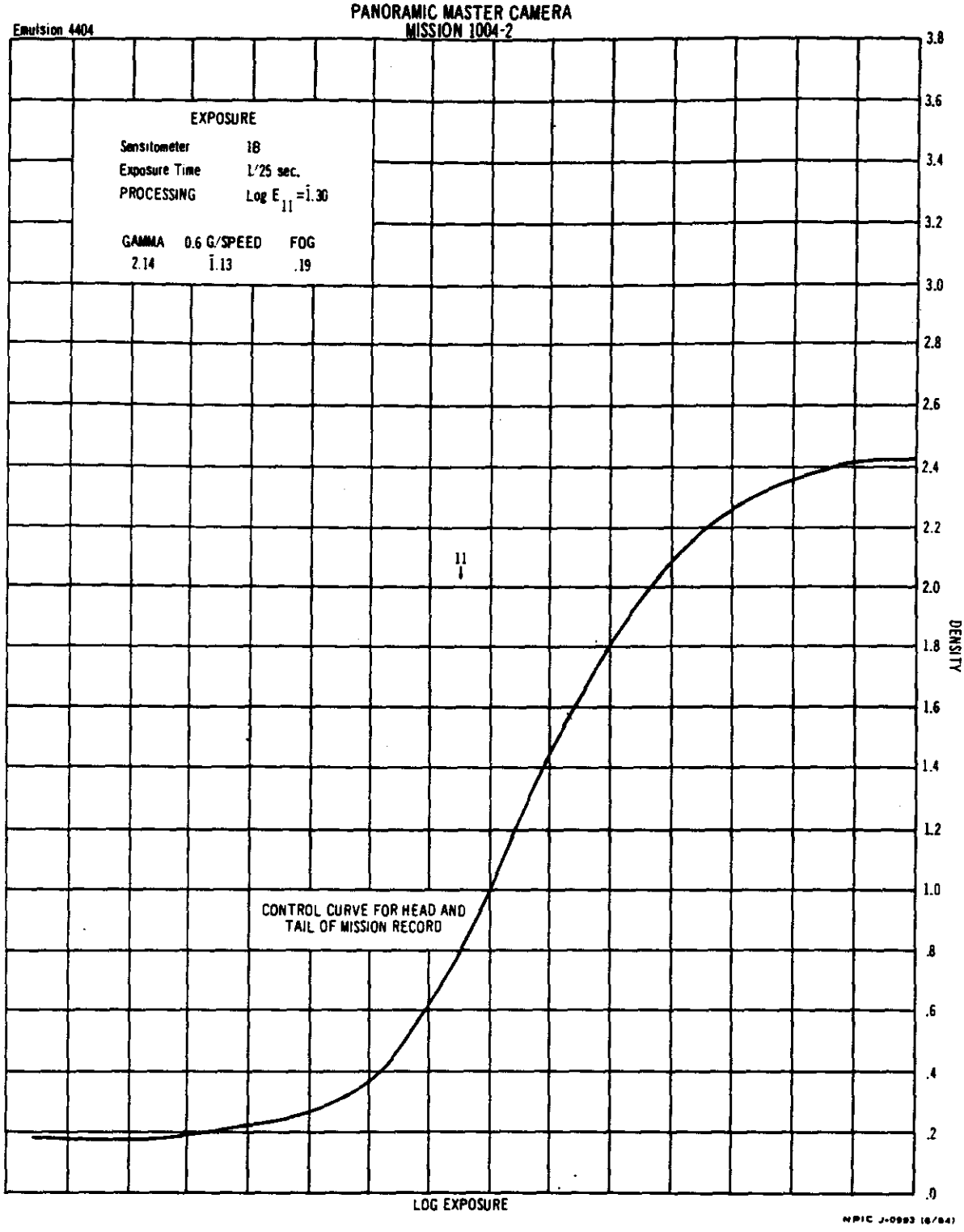
		Terrain		Limiting		
Pass	Frame	D Min	D Max	D Min	D Max	Gross Fog
D53	55	NR	NR	NR	1.58	0.07
D54	64	0.31	0.88	0.31	0.88	0.07
D54	75	0.47	1.35	0.47	1.35	0.07
D55	82	0.28	0.74	0.28	0.67	0.07
D55	113	0.31	0.95	0.31	1.58	0.07
D56	114	0.25	1.10	0.25	1.13	0.07
D56	123	0.26	1.00	0.26	1.10	0.07
A56E	124	NR	NR	NR	NR	0.07
A56	125	NR	NR	NR	NR	0.07
D61	126	NR	NR	0.66	1.29	0.08
D61	131	NR	NR	0.43	1.54	0.08
D62	132	0.25	0.98	0.25	0.98	0.10
D62	137	0.14	0.91	0.14	0.91	0.10
D64	142	0.16	0.70	0.16	0.85	0.12
D64	148	NR	NR	0.15	1.47	0.11
D65	149	0.34	0.67	0.20	0.70	0.11
D65	156	0.53	1.05	NR	NR	0.11
D66	163	0.33	1.15	0.22	1.15	0.07
D66	169	0.40	1.35	0.18	1.36	0.07
D67	177	0.23	1.21	0.23	1.21	0.07
D67	185	0.23	1.09	0.17	1.18	0.08
D68	193	0.25	1.29	0.25	1.29	0.07
D68	212	0.60	1.22	0.52	1.24	0.07
D69	213	0.20	1.02	0.20	1.06	0.07
D69	229	0.29	1.26	0.29	1.46	0.07
D70	230	0.16	1.31	0.16	1.31	0.07
D70	244	0.30	1.50	0.30	1.50	0.07
D71	245	0.33	0.87	0.33	1.14	0.07
D71	263	0.34	1.09	0.13	1.46	0.07
D72	264	0.23	1.12	0.14	1.12	0.07
D72	277	0.31	1.06	0.31	1.06	0.07
A72E	278	NR	NR	NR	NR	0.07
D76	279	0.44	1.49	0.44	1.49	0.07
D76	284	NR	NR	NR	NR	0.07
D83	285	0.17	1.17	0.17	1.17	0.07
D83	296	0.27	1.10	0.15	1.37	0.07
D85	297	0.22	1.17	0.22	1.17	0.07
D85	312	0.39	1.31	0.26	1.31	0.07
D86	319	0.27	1.17	0.27	1.17	0.07
D86	326	0.49	1.24	0.49	1.24	0.07
D87	330	0.24	0.90	0.24	0.90	0.07
D87	348	0.27	1.58	0.27	1.58	0.07
D94	349	0.17	1.08	0.17	1.08	0.07
D94	355	0.27	1.05	0.17	1.05	0.07
D101	356	0.26	1.22	0.26	1.22	0.07
D101	363	0.56	1.30	0.56	1.30	0.07
D102	372	0.31	0.65	0.31	1.07	0.07
D102	380	0.23	1.64	0.23	1.64	0.07
A103E	381	NR	NR	NR	NR	0.07
D103	409	0.56	1.17	0.22	1.17	0.07
A104E	410	NR	NR	NR	NR	0.07
D111	411	NR	NR	0.07	0.30	0.07
D111	425	0.39	0.82	0.39	0.82	0.07

Note NR denotes no reading made

Terrain	
D Max Range	0.65-1.58
D Min Range	0.14-0.60
Average D Max	1.11
Average D Min	0.30

Gross Fog Range	0.05-0.11
Average Gross Fog	0.08

Limiting	
D Max Range	0.30-1.77
D Min Range	0.07-0.66
Average D Max	1.22
Average D Min	0.26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MISSION 1004-2
Emulsion 4404
EXPOSURE
Sensitometer 18
Exposure Time 1/25 sec.
PROCESSING Log E11 = 1.30
GAMMA 0.6 G/SPEED FOG
2.14 1.13 .19
11
CONTROL CURVE FOR HEAD AND TAIL OF MISSION RECORD
DENSITY
LOG EXPOSURE
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
NPIC J-0993 (6/64)

[redacted]

PANORAMIC SLAVE CAMERA
MISSION 1004-2

Emulsion 4404

EXPOSURE

Sensitometer 1B
Exposure Time 1/25 sec.
PROCESSING Log E_{11}=1.30

GAMMA	0.6 G/SPEED	FOG
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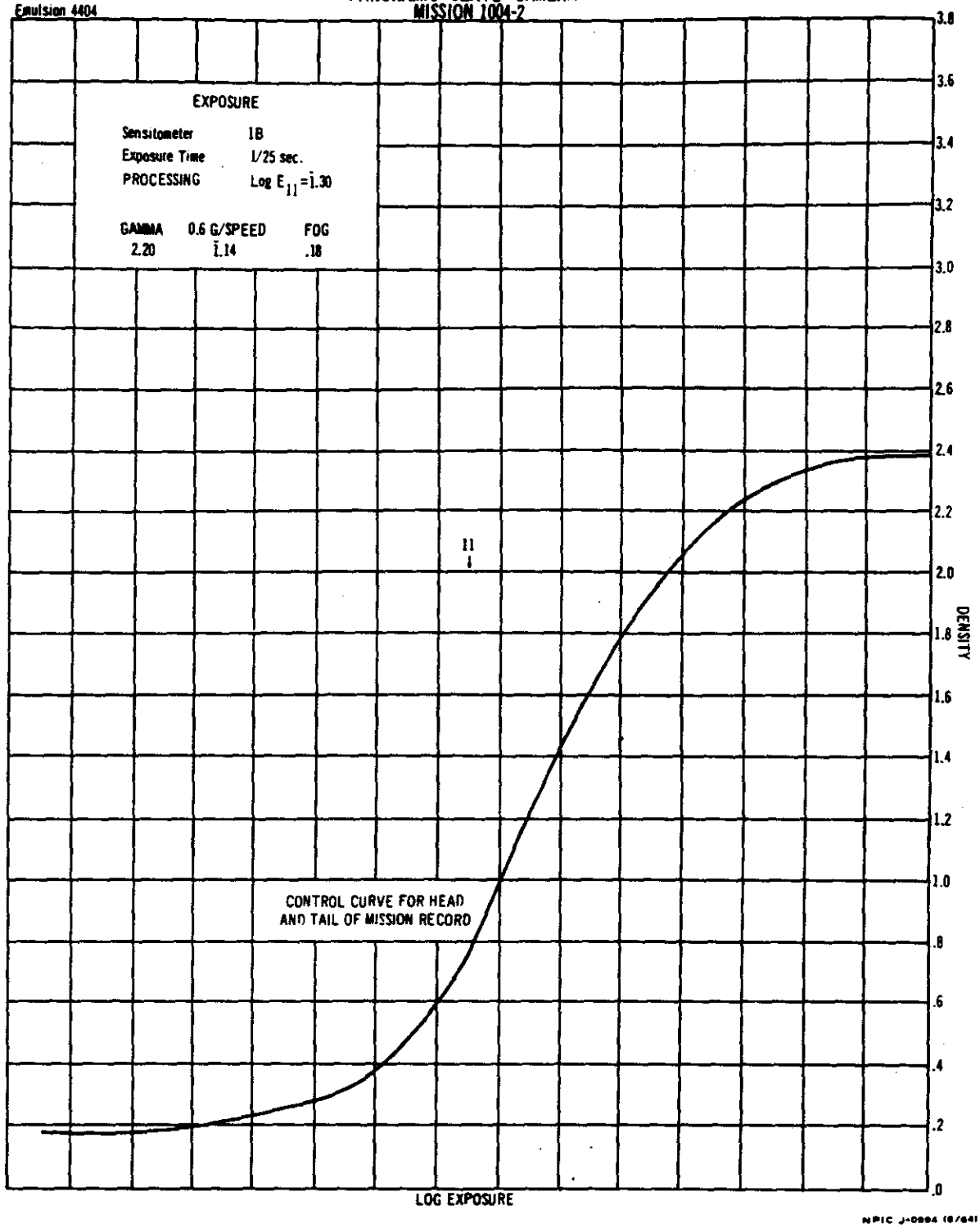

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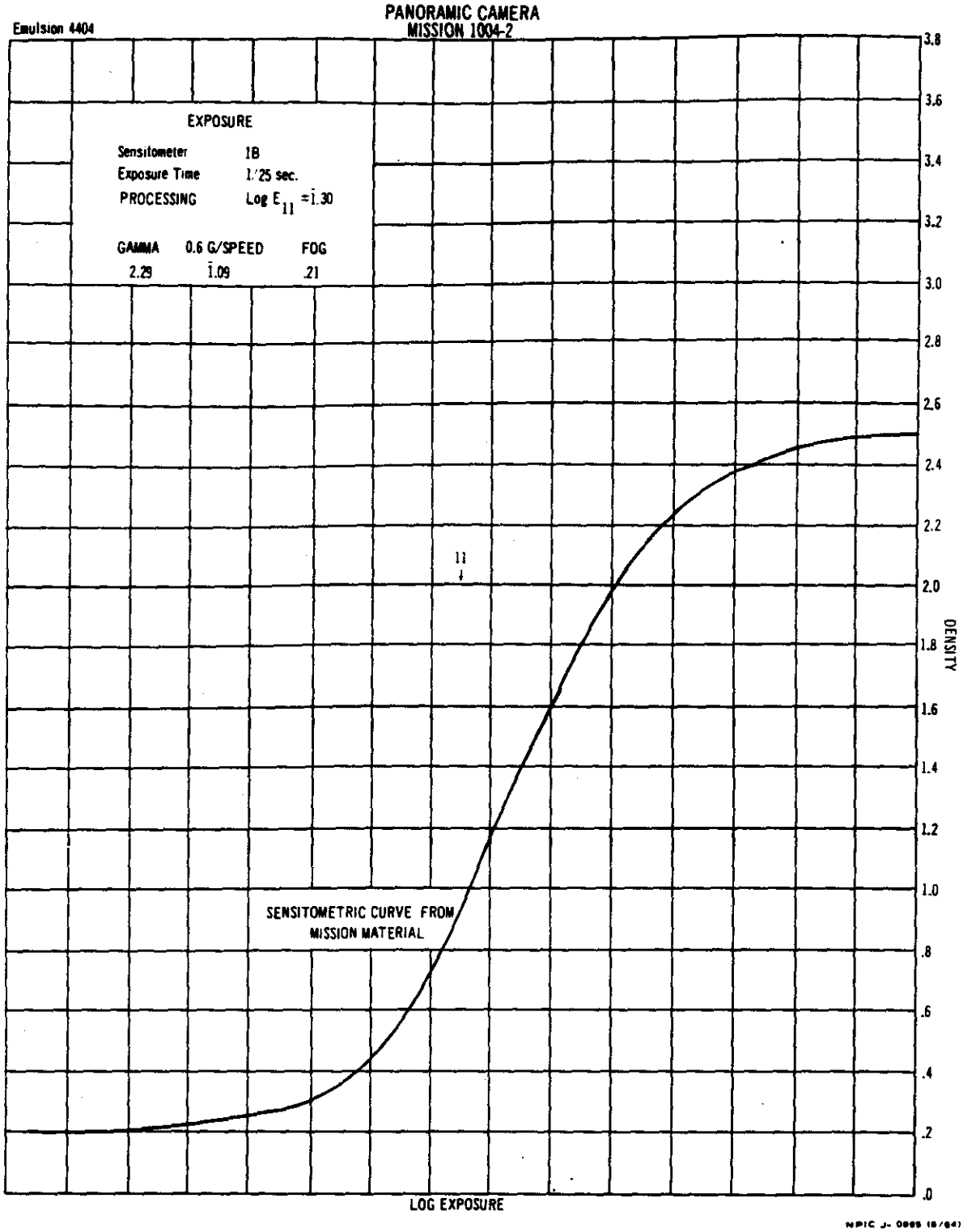

NPIC J- 0865 (8/64)

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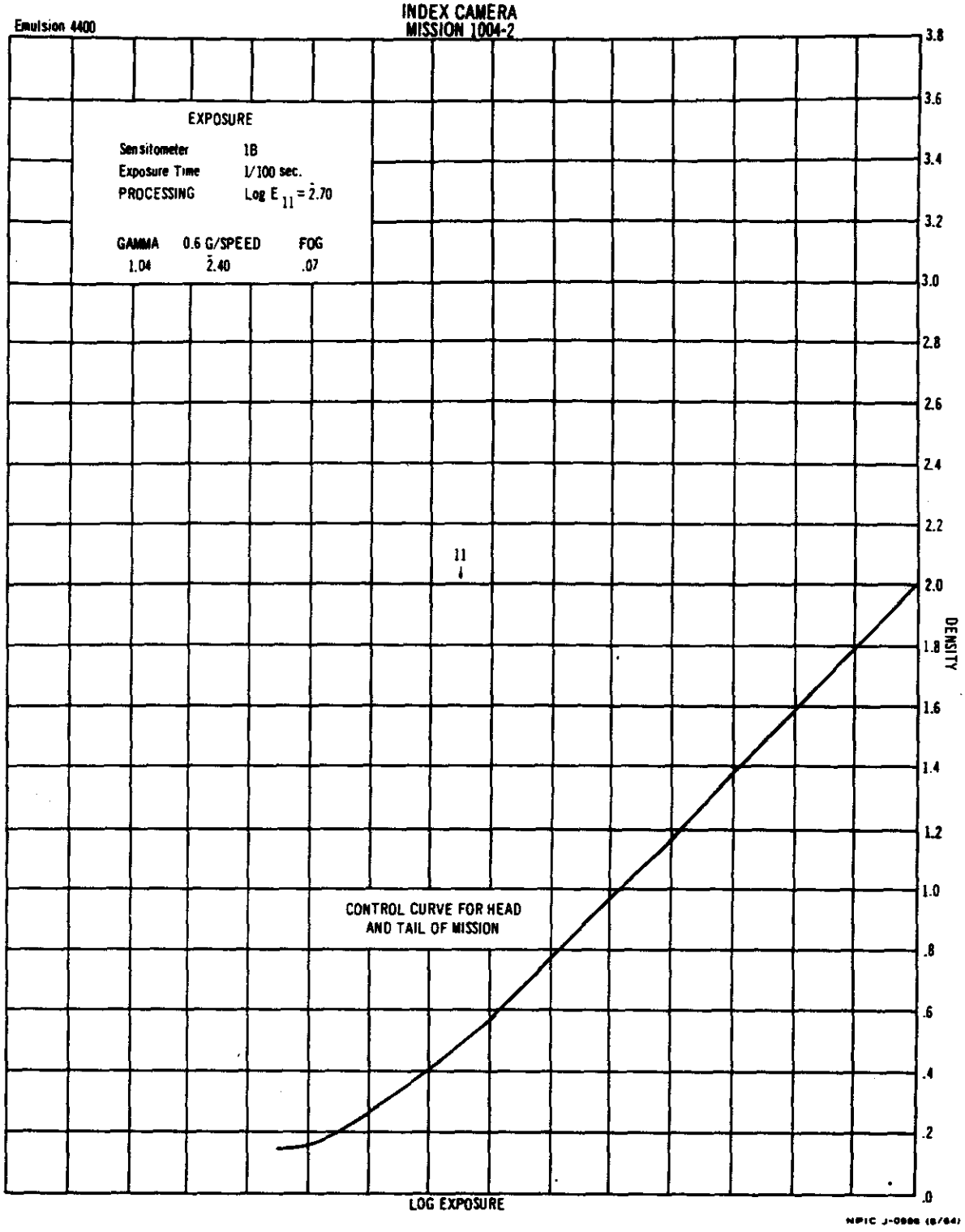
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MISSION 1004-2
EXPOSURE
Sensitometer 1B
Exposure Time 1/100 sec.
PROCESSING Log E 11 = 2.70
GAMMA 0.6 G/SPEED FOG
1.04 2.40 .07
11
CONTROL CURVE FOR HEAD
AND TAIL OF MISSION
DENSITY
LOG EXPOSURE
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
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1.0
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.2
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NPIC J-0006 (8/64)

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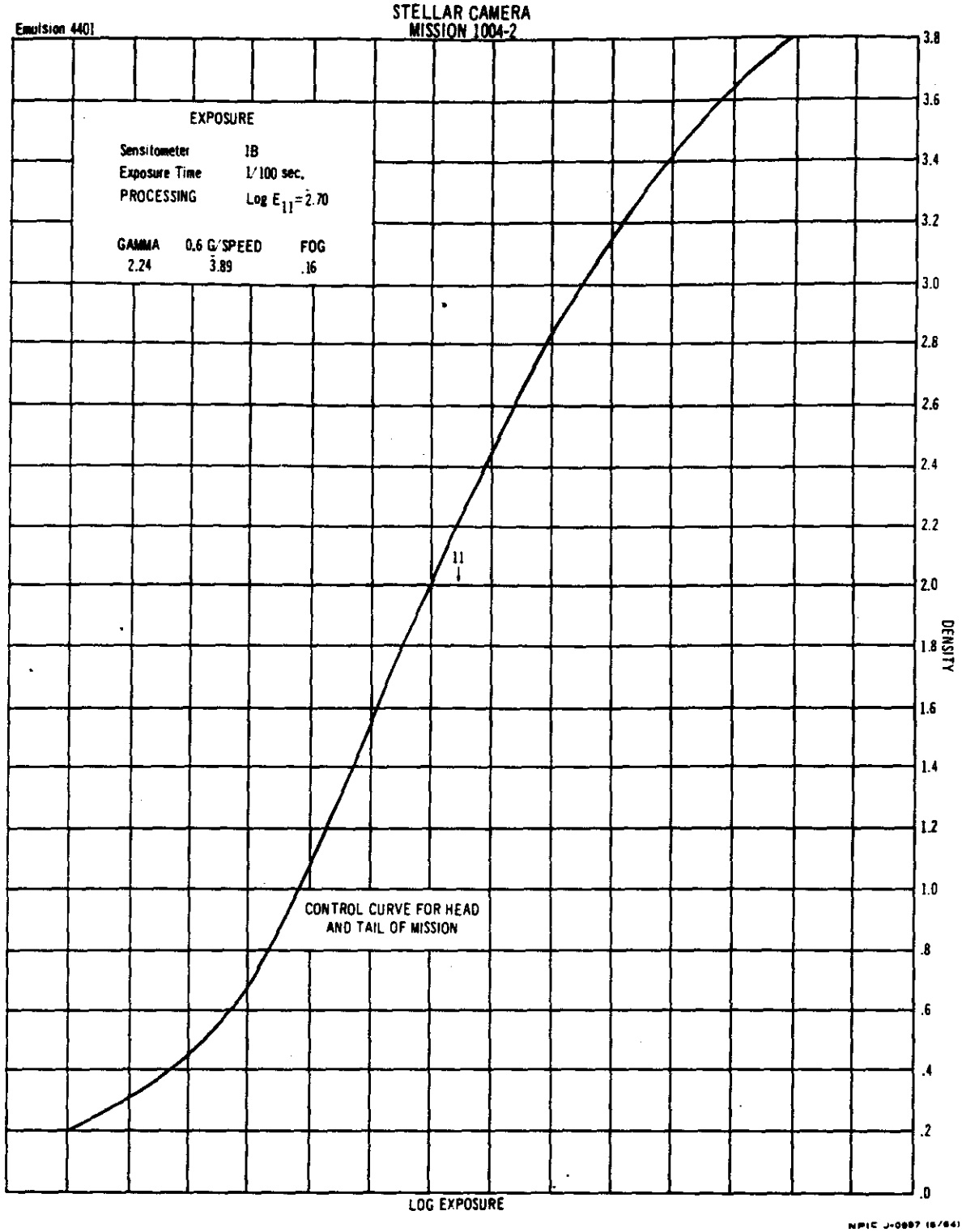

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APPENDIX D. EDGE SPREAD FUNCTION

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 percent 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 aircraft runways in small-scale photographs.

The microdensitometer used is a Joyce-Lobel Double Beam Model III C. It is used with an effective slit of one 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.

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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 D Log E curve for the material (density to log exposure) is used to determine the Log E and therefore the exposure 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 spread function for the whole photographic system.

The width of the spread function curve is measured at 50 percent of maximum amplitude and is indicated on the enclosed traces.

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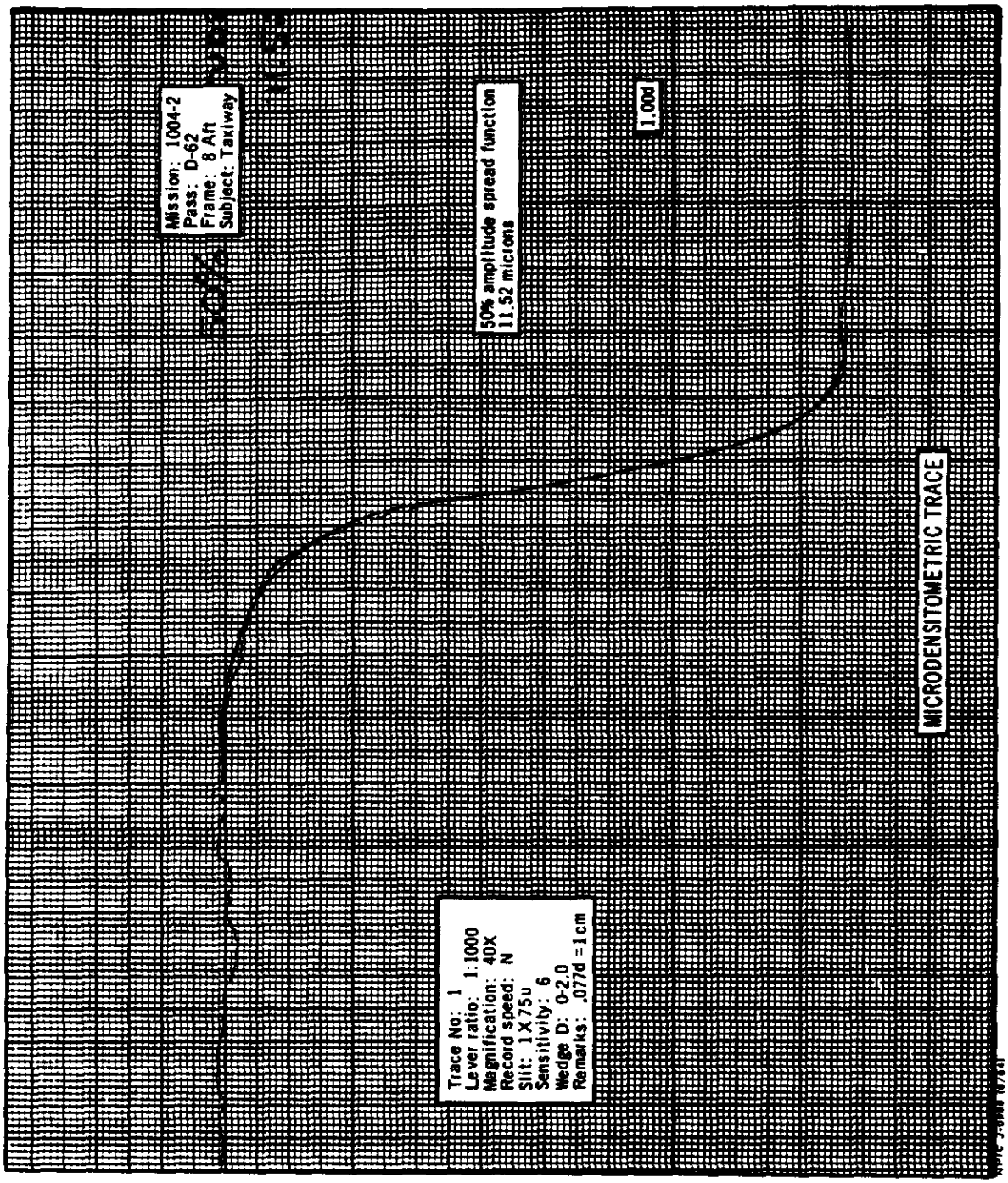
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11.52 microns
1.00d
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Lever ratio: 1:1000
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Record speed: N
Slit: 1X75u
Sensitivity: 6
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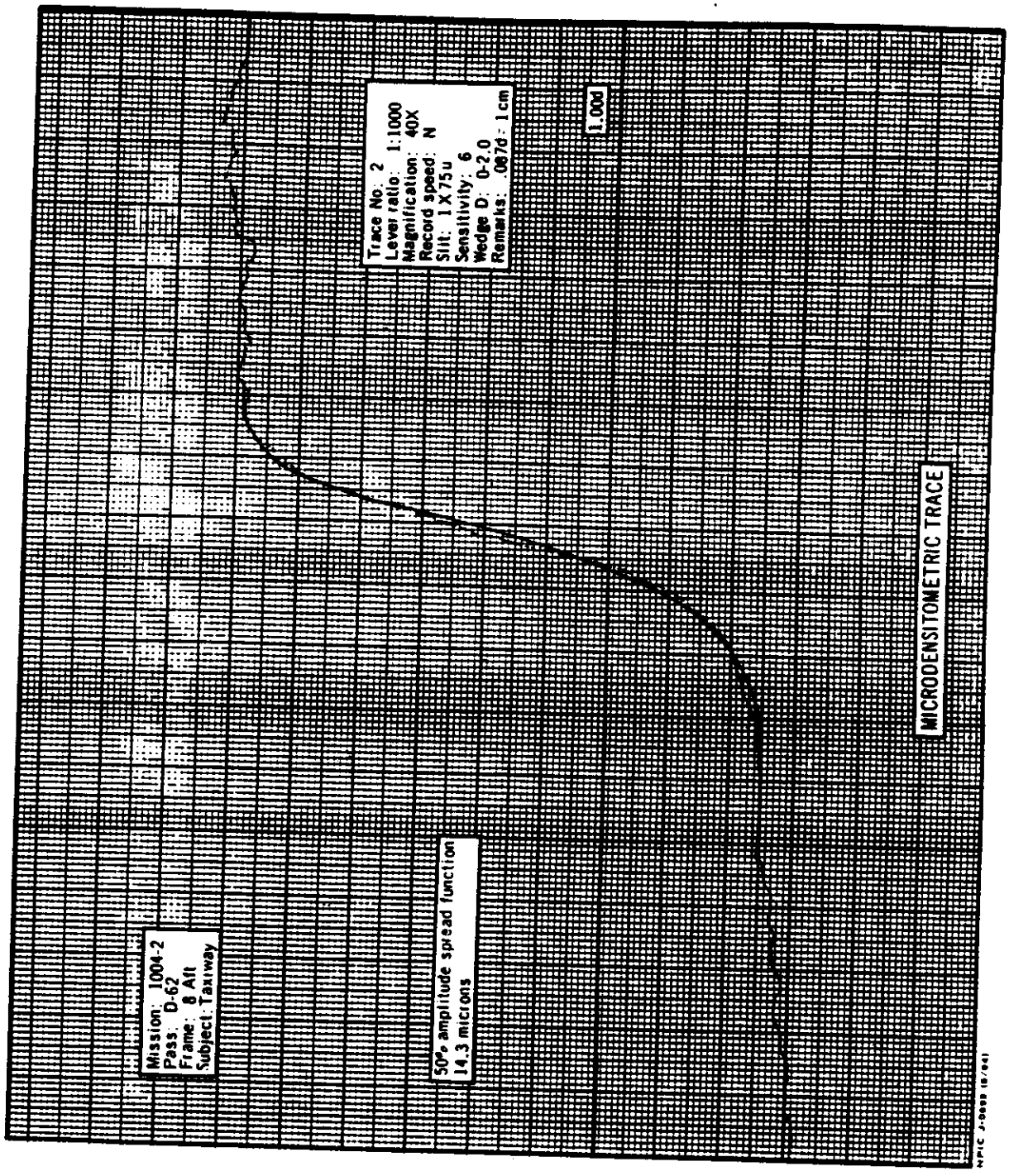
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Slit: 1X75u
Sensitivity: 6
Wedge D: 0-2.0
Remarks: .067d = 1cm
1.00d
MICRODENSITOMETRIC TRACE
50% amplitude spread function
14.3 microns
Mission: 1004-2
Pass: D-62
Frame: 8 Aft
Subject: Taxiway