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April 1965

TECHNICAL PUBLICATION

PHOTOGRAPHIC EVALUATION REPORT

MISSION 1012-1 17-20 OCTOBER 1964
MISSION 1012-2 21-23 OCTOBER 1964

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Project Corona

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NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

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PHOTOGRAPHIC EVALUATION REPORT
MISSION 1012-1 17-20 OCTOBER 1964
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NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

Notice of Missing Page(s)

Pages 6, 24, and 38 of the original document were blank and unnumbered.

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SYNOPSIS

Mission 1012 (System No J-13), the twelfth of the "J" reconnaisance series, was launched 17 October 1964 and consisted of 2 operational phases, designated Missions 1012-1 and 1012-2, respectively. Mission 1012-1 accomplished 36 photographic revolutions, including 3 domestic and 3 engineering (dark side) passes. The first-phase payload was recovered by air catch on 20 October and second-phase operations were initiated on the following day. Mission 1012-2 accomplished 17 photographic revolutions, including 1 domestic and 1 engineering pass. Recovery of the second payload on 23 October terminated the mission. The capsule was retrieved from water but subsequent inspection of the contents revealed no immersion damage.

All cameras functioned satisfactorily except in Mission 1012-1, where the stellar/index unit was not operational due to a command system anomaly or program malfunction.

The quality of the panoramic photography is good and is considered comparable with the results achieved in Mission 1008. The next-to-last frames of most passes following 9AE contain light-struck areas. These traces resemble corona static discharges, but investigation has firmly established them to be light leak patterns. In any case, the resultant degradation is relatively slight. The horizon cameras associated with the panoramic instruments produced comparatively good images. Slight vignetting of the format corners does not hamper use of the horizon images for determination of vehicle attitude, which was normal until the terminal revolution, 73D, where an extreme departure from normal occurred.

The stellar/index unit operated satisfactorily in Mission 1012-2 and produced good-quality stellar and terrestrial photography. However, the vehicle attitude abnormality in the last photographic pass was responsible for gross overexposure of the last 5 stellar frames and distortion (off-axis photography) of the last 4 index frames, which contain images of the horizons.

Cloud cover obscured approximately 55 percent of the panoramic photography in Mission 1012-1 and 45 percent of Mission 1012-2. Solar elevations ranged from 3 degrees to 42 degrees.

[redacted]

GENERAL FLIGHT DATA

Launch Date, Mission 1012-1	17 October 1964
Recovery Date, Mission 1012-1	20 October 1964
Activation Date, Mission 1012-2	21 October 1964
Recovery Date, Mission 1012-2	23 October 1964

Orbital Parameters

	Mission 1012-1		Mission 1012-2	
	Planned	Actual (Rev 10)	Planned	Actual (Rev 72)
Period	91.00 min	90.55 min	90.51 min	90.44 min
Perigee	96.28 nm	96.30 nm	98.78 nm	98.90 nm
Apogee	237.68 nm	237.60 nm	234.02 nm	235.79 nm
Eccentricity	0.0196	0.0196	0.0187	0.0188
Inclination Angle	75.05 deg	75.07 deg	74.99 deg	74.99 deg

Photographic Operations

	1012-1	1012-2
Operational Passes	30	15
Domestic Passes	3	1
Engineering Passes	3	1
Recovery Revolutions	49M	73D

[redacted]

PART I. CAMERA OPERATION

1. <u>Master (FWD) Panoramic Camera No 156</u>

The instrument was operational throughout the mission and the film is comparatively free of camera-induced degradations. No static discharges were noted. Brief descriptions of recurrent light leaks follow:

A light-struck area is present at the take-up end of the next-to-last frame in most passes. The trace resembles a corona static discharge. The fifth-from-last frame in each pass contains a bar-type light trace, extending from edge to edge in the vicinity of frame-center. A narrow light trace strikes diagonally across the frequency mark edge of the second or third frame of each pass. Film transport indications, including equipment shadowgraphs, are present in the final frames of a few passes.

Both film edges contain fine, continuous rail scratches. Random minus-density streaks are minor and few but a faint streak runs continuously through the format centers at a slight pitch from the long axis of the film. Although not readily detectable in all frames it is evident that this streak is present from head to tail of the material.

2. <u>Slave (AFT) Panoramic Camera No 157</u>

The camera operated without malfunction throughout the mission and film quality is comparable with the master material. The second- or third-from-last frames of most passes contain light-struck areas similar to those noted in the master record. The second-from-last frames also contain equipment shadowgraphs. A small light trace, resembling a flare, is present in the first frame of each pass but is not always readily detectable. Both film edges contain fine, continuous rail scratches. Minus-density streaks occur at random throughout the film but their number is not excessive and degradation is minor.

3. <u>Master (FWD) Horizon Cameras</u>

The port (supply) and starboard (take-up) horizon cameras were operational throughout the mission. The format corners are vignetted but the horizon curves are unaffected and remain usable for determination of vehicle attitude. Exposure was adequate except where low solar elevations precluded effective horizon photography.

4. <u>Slave (AFT) Horizon Cameras</u>

The port (take-up) and starboard (supply) horizon cameras were operational throughout the mission. The format corners are vignetted but the usefulness of the horizon curves is not impaired. Exposure was

[redacted]

adequate except where it was insufficient to compensate for the low solar elevations that prevailed in a number of passes.

5. Stellar Camera No D51/47 (Mission 1012-1)

A command system anomaly or program malfunction was responsible for failure of the stellar camera in Mission 1012-1. No photography was obtained from this instrument. The recovered film is totally unexposed, except for a few feet at the head of the material, which contain various fogged areas and light traces.

6. Stellar Camera No D46/53 (Mission 1012-2)

The instrument was operational and the film is free of major degradations except for a continuous, fine emulsion scratch which runs parallel to and midway between the film edges. The last 5 frames are grossly overexposed, due to the vehicle attitude abnormality which occurred in pass 73D, the terminal photographic revolution of Mission 1012. Numerous stellar images were recorded and are readily detectable in the majority of exposures.

7. Index Camera No D51/51 (Mission 1012-1)

No photography was obtained from this instrument, which failed to operate due to the system anomaly mentioned in Item 5. The recovered film is unexposed except for a few feet at the head of the material which contain various fog patterns and light traces.

8. Index Camera No D46/52 (Mission 1012-2)

The camera was operational and the film is free of camera-induced degradations. Horizons are imaged in the last 4 frames as a result of the vehicle attitude abnormality which occurred in pass 73D.

9. Associated Equipment

Numerous data block lamp failures occurred in Missions 1012-1 and 1012-2. Consequently, considerable time was lost in the determination of frame times for reduction of stellar data and production of the final frame ephemeris.

The lamp failures are the largest number encountered to date. A total of 6 Master (FWD) Camera lamps and 2 Slave (AFT) Camera lamps failed after launch, as follows:

[redacted]

Camera	Pass	Frame	Lamp No	Millisecond Value
FWD	4D	060	12	2048
FWD	6D	026	19	262144
AFT	6D	080	12	2048
AFT	23D	020	23	4194304
FWD	24D	006	1	1
FWD	39D	139	17	65536
FWD	52D	034	16	32768
FWD	53D	038	2	2

It is impossible to correct the numbers 1 and 2 lamps and the multiple failures in the larger binaries caused considerable difficulty in determination of accurate times.

In view of the possibility that power surges had overloaded the lamps and caused burn-outs, an attempt was made to correlate lamp densities with the failure pattern. However, detailed study of the lamp densities preceding each failure established no acceptable correlation. This does not eliminate power surges as the causative factor. It can only be stated that the lamp density study was inconclusive and further invetigation is required.

The master (FWD) camera frequency marks were recorded outside the formats and are readable throughout the mission. The slave (AFT) camera frequency marks registered within the formats and are readable only in thin-density areas. All camera-off positions are identified by single end-of-pass markers. The panoramic format shrinkage markers are slightly ragged but usable.

Special Note

Despite the good-quality horizon images reported in Items 3 and 4 of this part, considerable difficulty was encountered in reduction of horizon data. The absence of stellar photography in Mission 1012-1 precluded correlation of stellar-horizon data, which is standard procedure in technical analysis of the mission record. In addition, the Technical Intelligence (TI) copy of Mission 1012-2 material was not printed to the required TI standards. Heavy densities degraded the horizon images to the extent that their usefulness was seriously impaired.

[redacted]

PART II. FILM

1. Film Footage

The film footage/frame totals for Mission 1012 are as follows:

	1012-1	1012-2
Master (FWD) Camera:	6,948 ft/2,436 frames	3,871 ft/1,458 frames
Slave (AFT) Camera:	6,946 ft/2,464 frames	3,872 ft/1,461 frames
Stellar Camera:	13 ft/ 0 frames	73 ft/ 208 frames
Index Camera:	28 ft/ 0 frames	53 ft/ 207 frames

Total Footage/Frames, Master (FWD) Camera: 10,819 ft/3,894 frames
Total Footage/Frames, Slave (AFT) Camera: 10,818 ft/3,925 frames

Total Footage/Frames, FWD & AFT Panoramic Cameras: 21,637 ft/7,819 frames

The last 5 master panoramic frames and the last 7 slave panoramic frames of the terminal pass in Mission 1012-1 (49M) were recovered with the second payload. In every mission employing the two-phase concept, the last few frames of first-phase photography will be contained at the head of the second payload. Attention is also called to the fact that monoscopic coverage, employing either panoramic camera, may be programmed into any part of a mission.

2. Film Processing

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

Most of the footage in the mission received adequate exposure. However, some variations in terrain reflectivity and/or low solar elevations caused occasional departures from normal exposure results. The following development levels were employed in processing the film:

	1012-1		1012-2	
	Master	Slave	Master	Slave
Primary:	7%	0%	6%	3%
Intermediate:	56%	33%	44%	15%
Full:	37%	67%	50%	82%

[redacted]

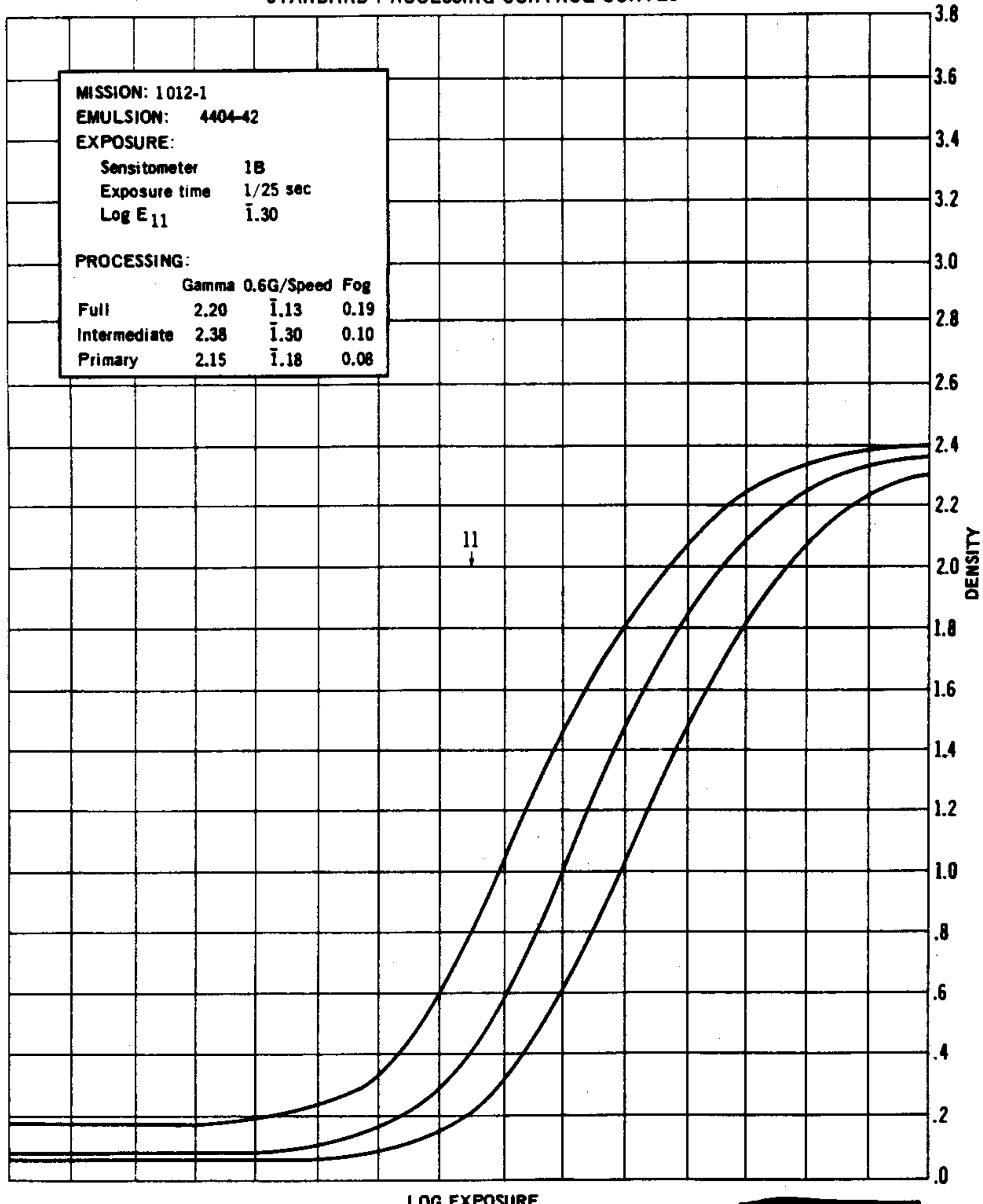
Fifty process level changes (Master record) and 47 process level changes (Slave record) were required in Mission 1012-1. Twenty-seven changes (Master record) and 20 process level changes (Slave record) were required in processing Mission 1012-2. The density of the mission record, as a whole, is considered to be good.

3. Film Processing Curves

The following pages contain reproductions of the film processing curves plotted by the processing contractor for Missions 1012-1 and 1012-2.

[redacted]

STANDARD PROCESSING CONTROL CURVES



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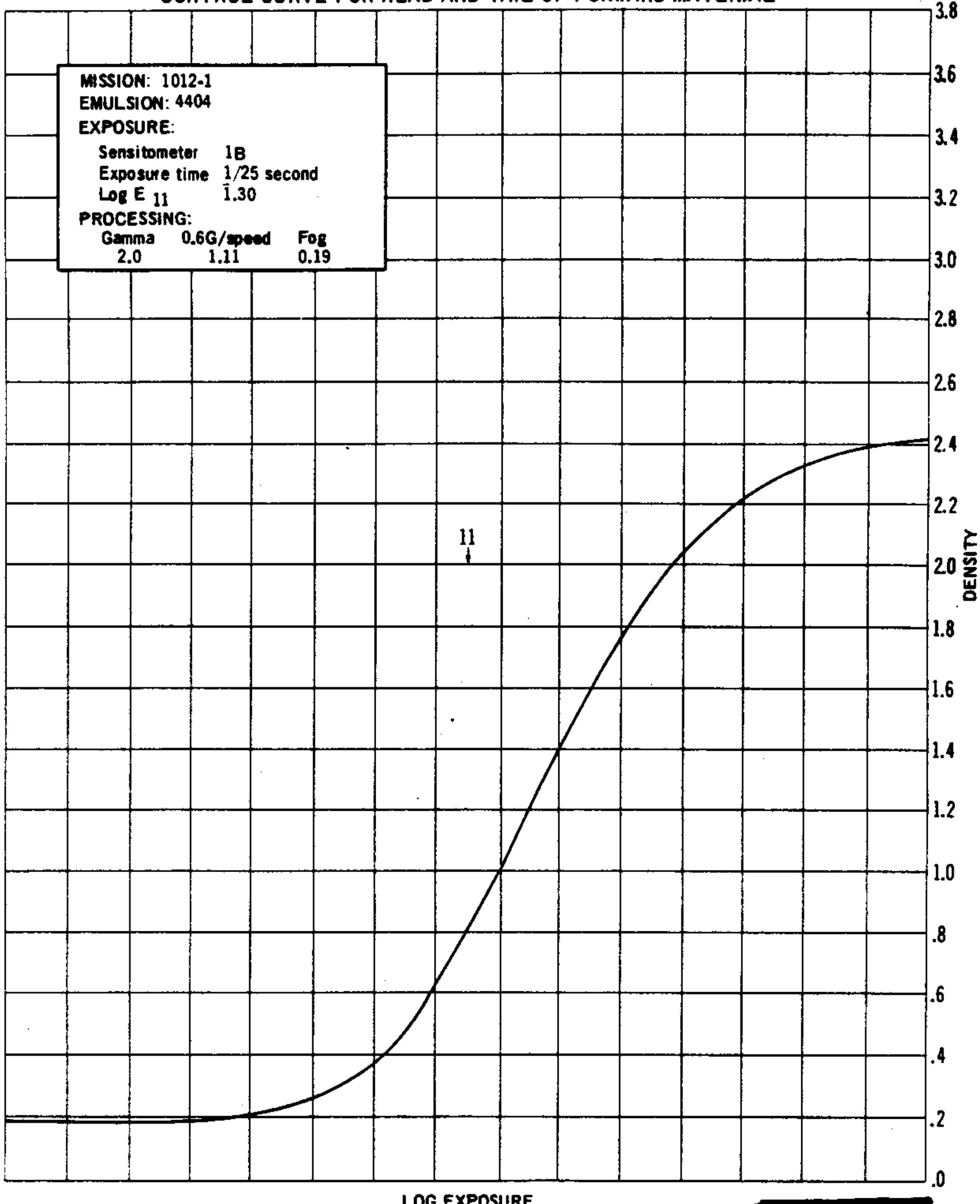
CONTROL CURVE FOR HEAD AND TAIL OF FORWARD MATERIAL



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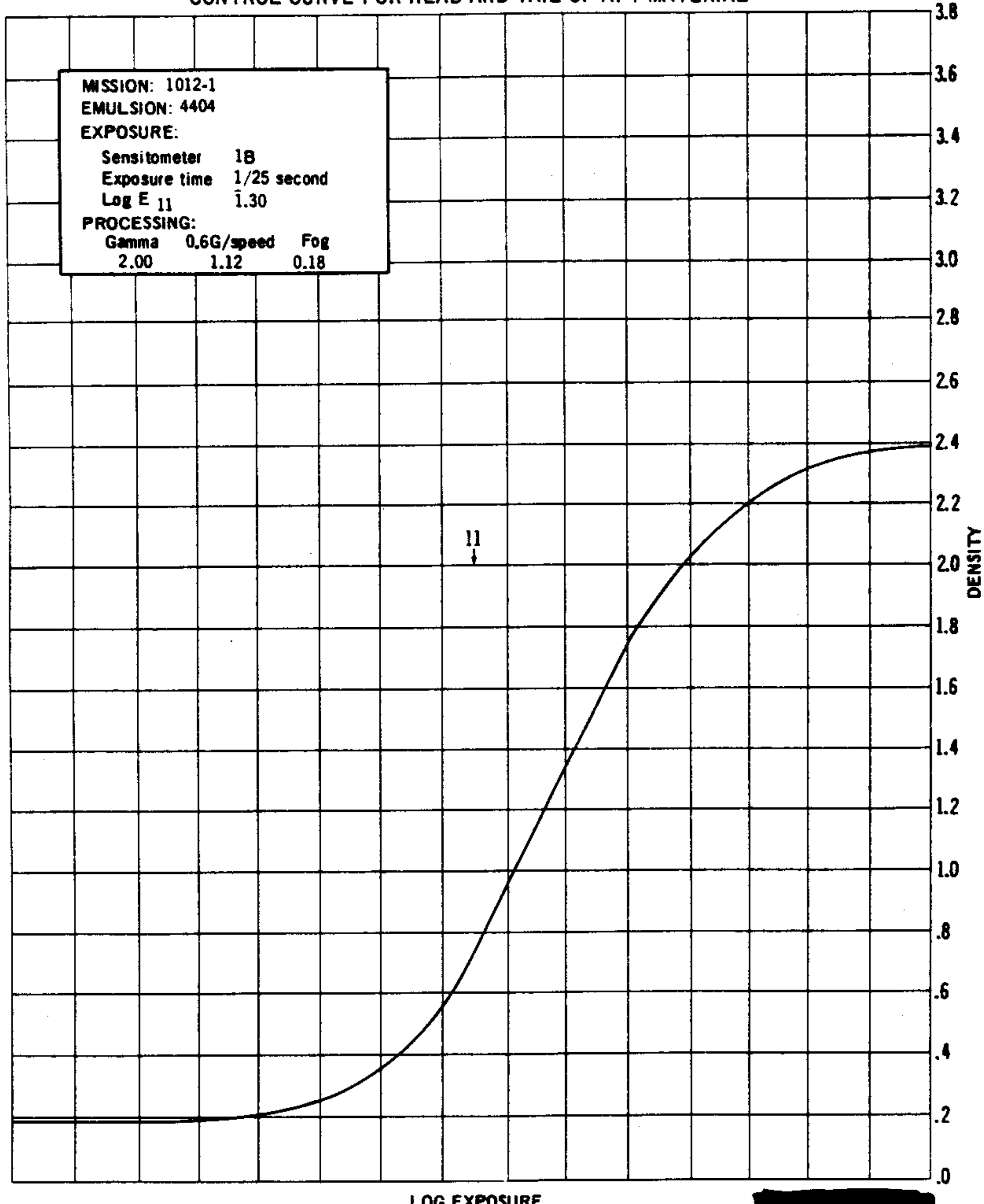
CONTROL CURVE FOR HEAD AND TAIL OF AFT MATERIAL



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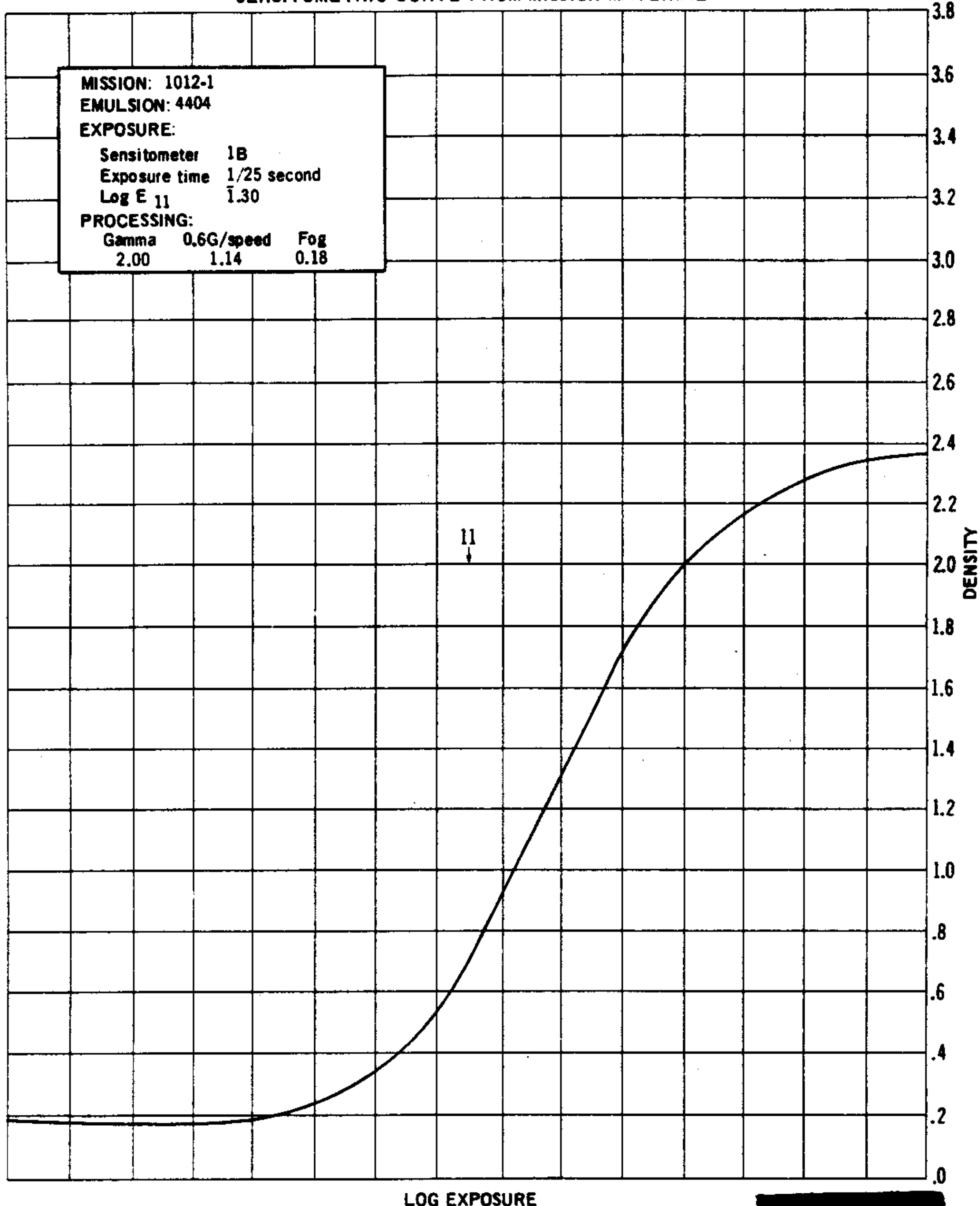
SENSITOMETRIC CURVE FROM MISSION MATERIAL



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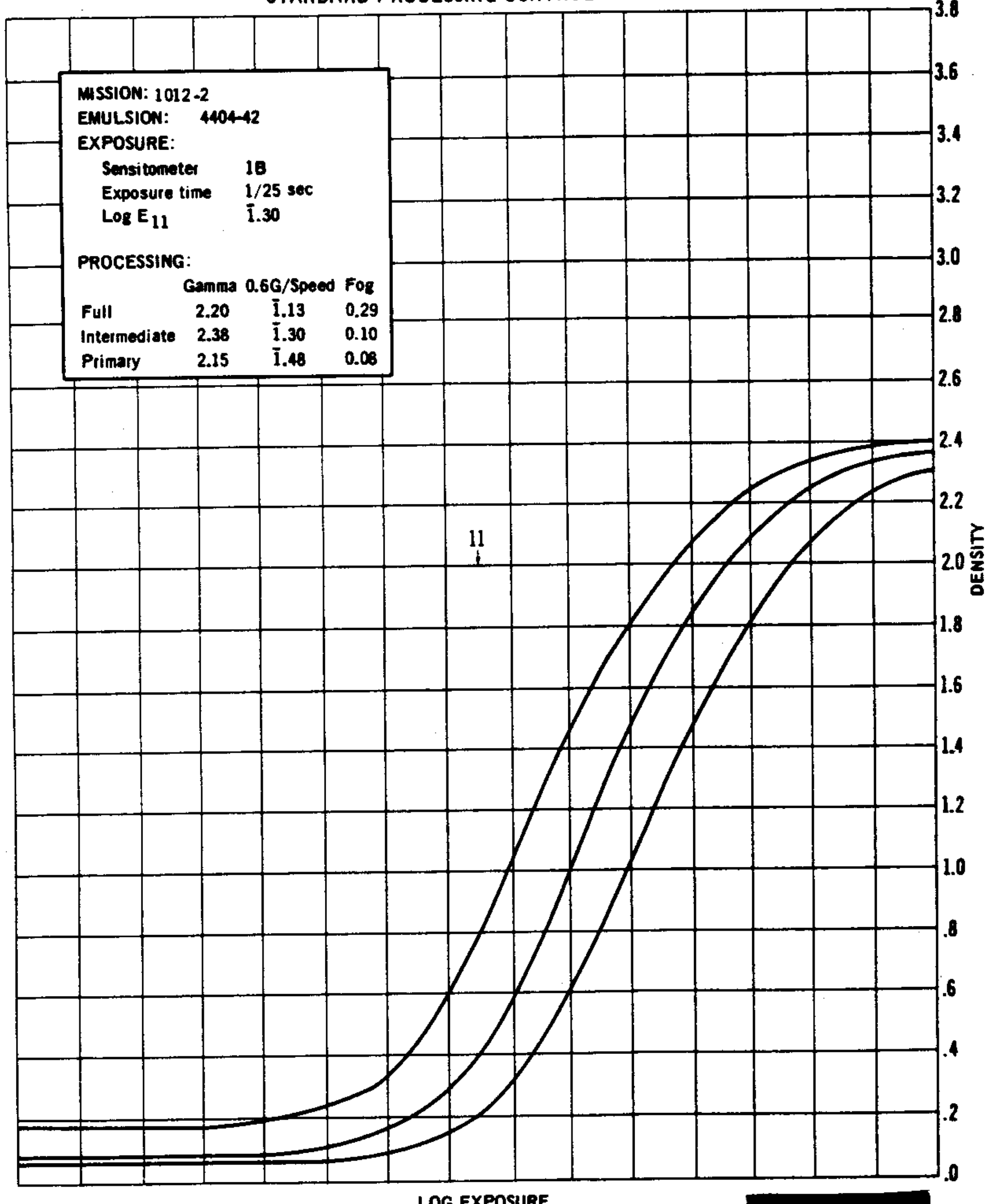

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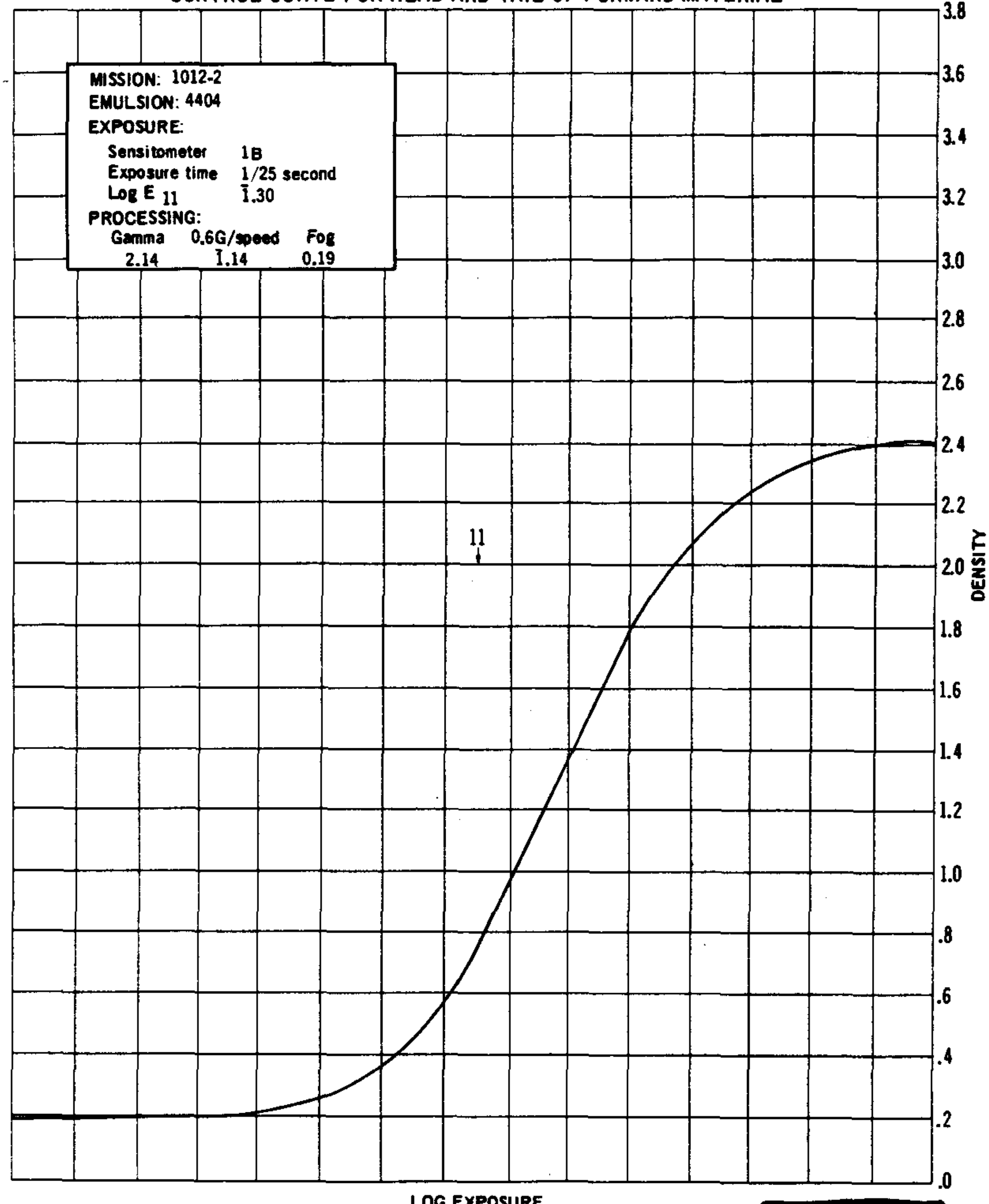

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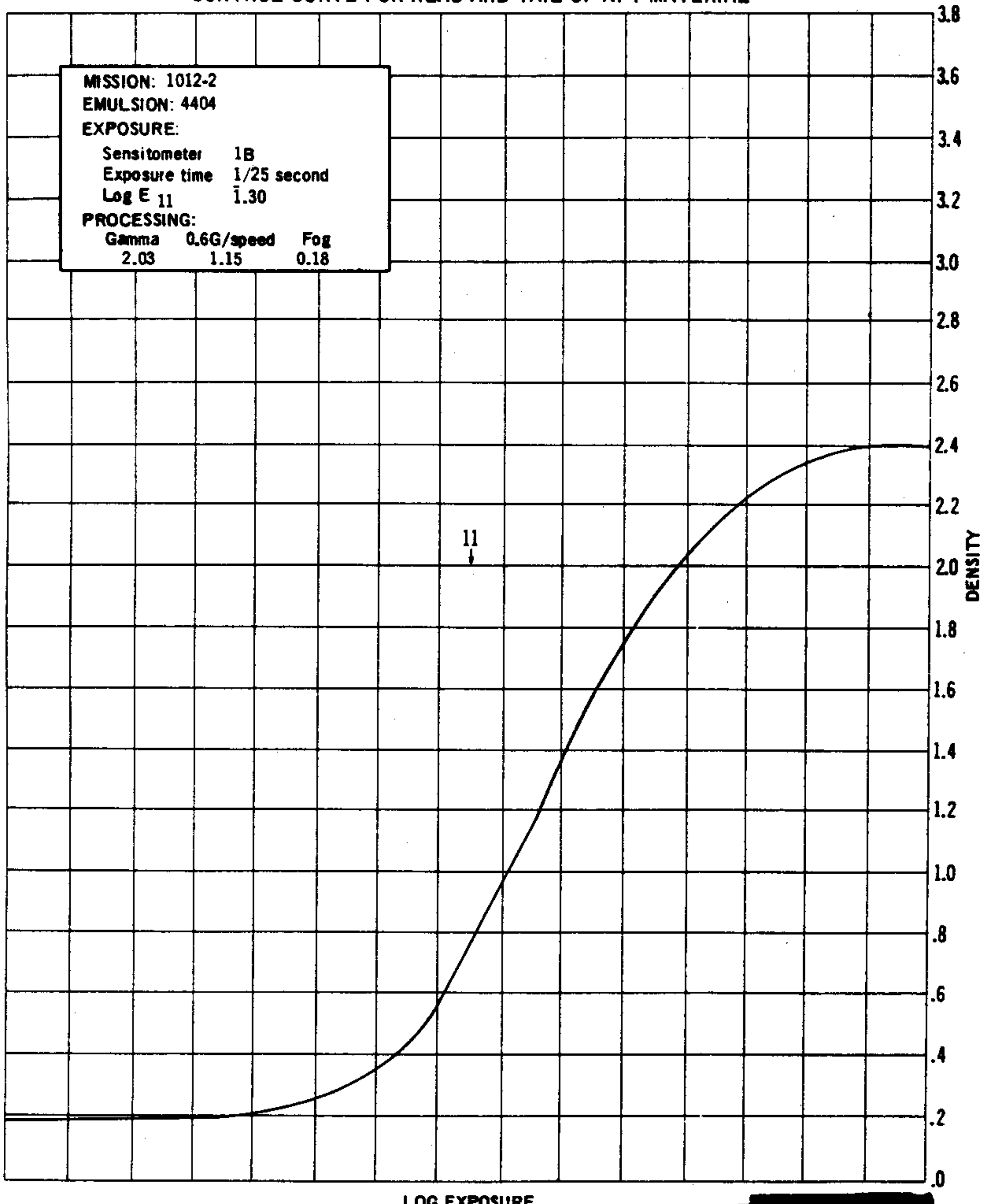

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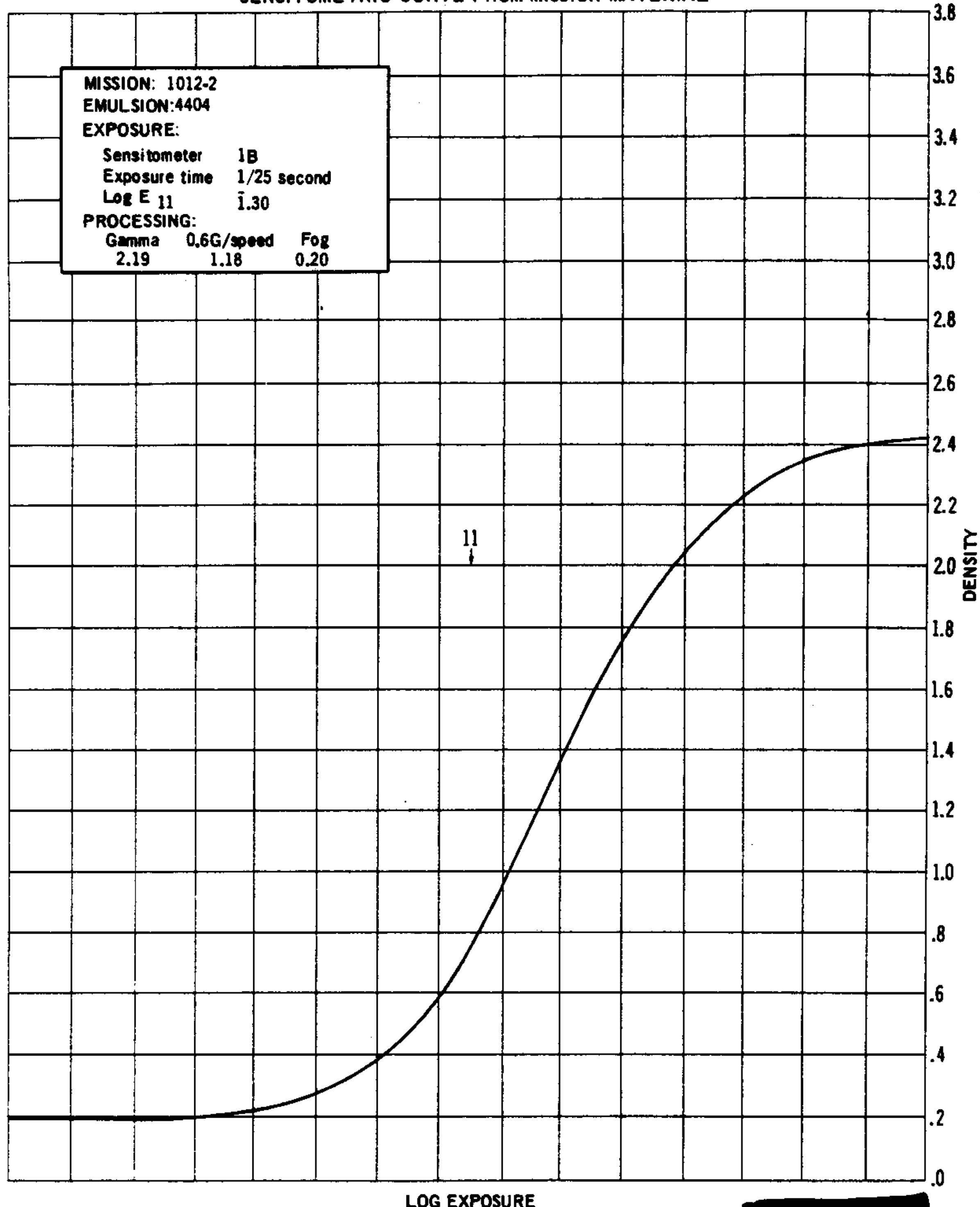
SENSITOMETRIC CURVE FROM MISSION MATERIAL



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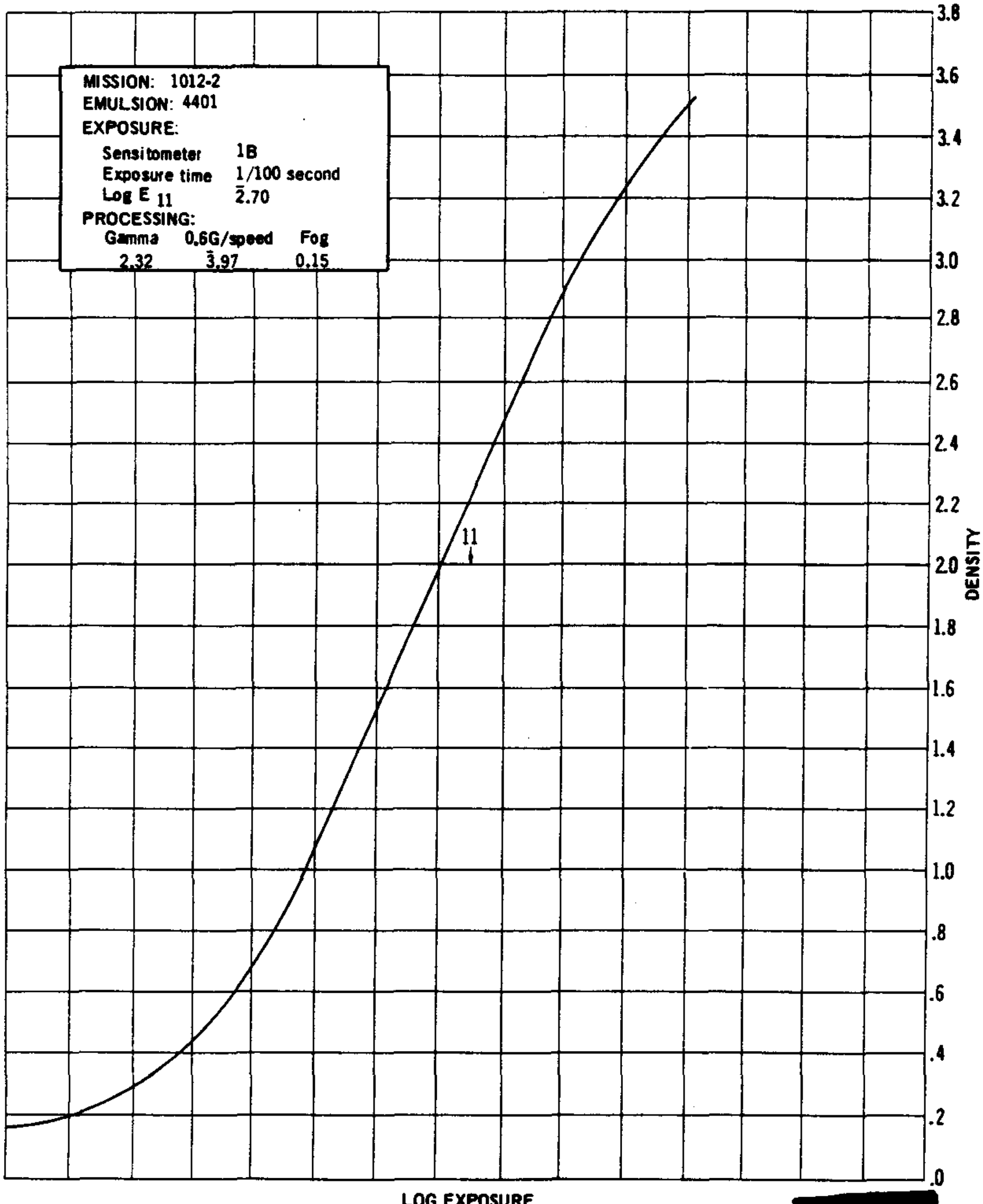
CONTROL CURVE FOR HEAD AND TAIL OF STELLAR MATERIAL



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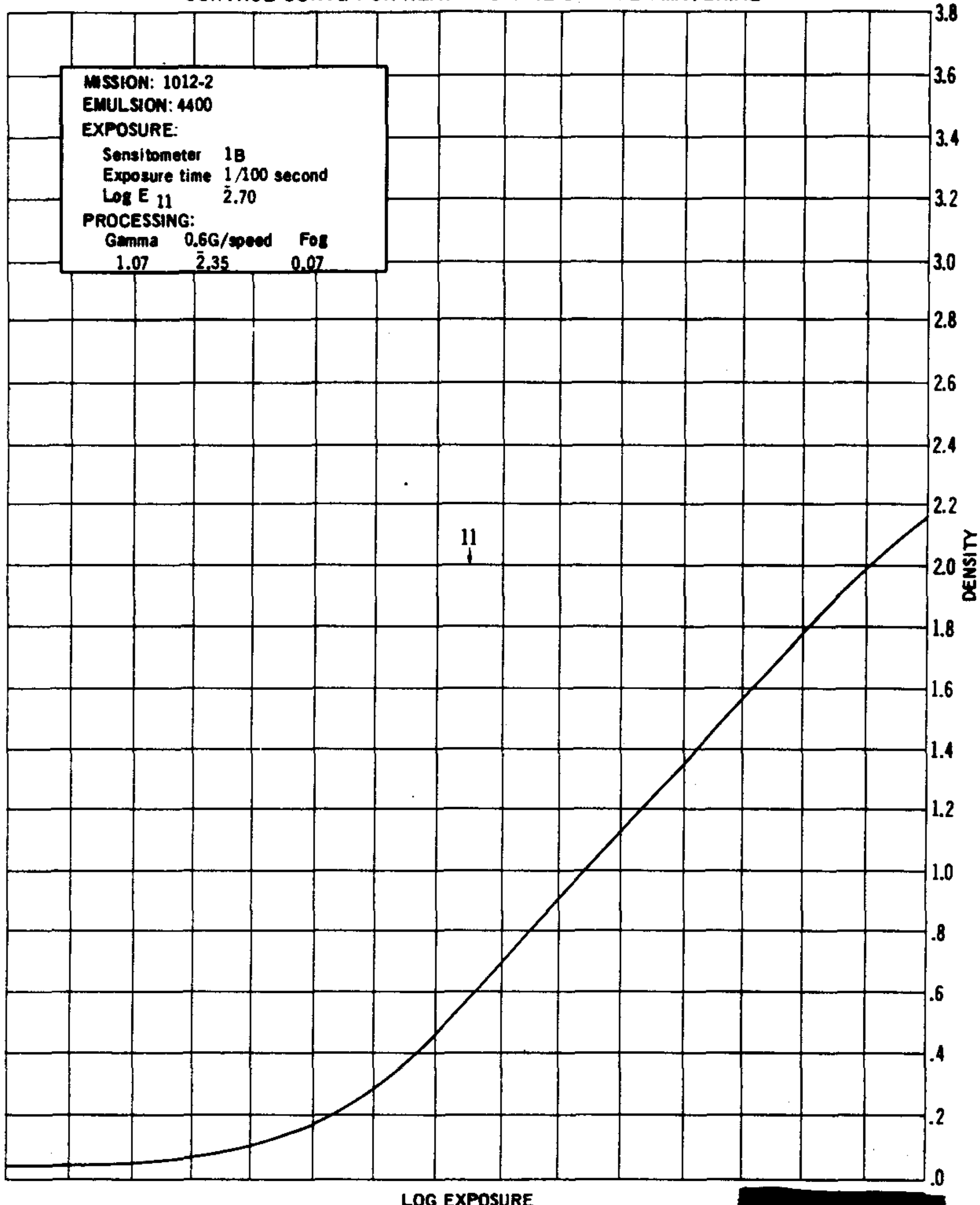
CONTROL CURVE FOR HEAD AND TAIL OF INDEX MATERIAL



[redacted]

[redacted]

4. Physical Film Degradations

There are no major physical degradations present on the panoramic film. Intermittent emulsion scratches, base scratches, pinholes, digs, etc., occurred but not in profuse numbers or repetitive patterns. Unless film damage is severe and/or recurrent, little benefit derives from detailed enumeration of common, minor degradations.

Similarly, the stellar/index records are free of all but minor defects, except for the stellar film, Mission 1012-2, which contains a fine, continuous emulsion scratch parallel to and midway between the film edges. The origin of the scratch has not been firmly established at this writing.

[redacted]

PART III. IMAGE QUALITY

1. Definition of 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, and weather limitations. 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 superior quality of the photography.

Good: The photography is relatively free of degradations and limiting weather 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 optimal. 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 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.

[redacted]

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

2. PI Suitability, Missions 1012-1 and 1012-2

The PI suitability of the photography obtained in Missions 1012-1 and 1012-2 ranges from fair to good. A total of 100 targets was observed and reported in the preliminary PI reports (60 targets in Mission 1012-1 and 40 targets in Mission 1012-2). Few new activities were uncovered. Approximately 25 percent of the reported targets were obscured or degraded by clouds and/or haze conditions to an extent that detailed readouts were difficult to execute.

It should be noted that the preliminary reports represent the initial-scan results only, which were accomplished in a short time without the aid of the precise analytical and mensural instruments normally employed in photographic interpretation. More detailed study of the material may develop additional information or may require revision of information presented in the preliminary reports.

In view of the unfavorable atmospheric conditions that hampered interpretation of some of the photography (particularly in the material obtained from Mission 1012-1) a brief discussion of commonly-encountered atmospheric degradations is considered desirable. The effect of cloud cover on PI suitability is immediately apparent to even an unitiated observer. The effects of haze; however, are more subtle and often present a problem in evaluating the true quality of the photography. Atmospheric haze and/or industrial haze veil terrain imagery and may impart an out-of-focus appearance to the photography. Thermal variations may also be present, particularly over existensive industrial complexes or dense urban areas, with resultant image distortion. Under such conditions, identification of small objects is difficult and accurate mensuration of even relatively large images is not feasible.

Cloud shadows are often responsible for partial or near-complete loss of ground detail. In such cases special printing is required in order to retrieve details. Similar loss of imagery is encountered when low solar elevations prevail. Special printing may salvage only the more prominent targets.

A relatively unusual form of degradation derives from cloud-reflected light, particularly in the presence of alto-cumulus formations. It is observed as streaks, originating in the clouds and oriented to the direction of scan. The streaks appear to be induced by favorable combinations of incident light angle, maximum cloud reflectivity, and adjacency of the cloud formations to each other. They are readily detectable when background contrast and density facilitate observation. The cloud streaking

[redacted]

observed in Mission 1012 does not appear to be significantly excessive despite the larger slit width (0.200") that was employed in the panoramic cameras.

3. Definition of Mission Information Potential (MIP)

The MIP rating assigned to a mission is an arbitrary figure intended to indicate the quality of the best photography obtained in the mission. It is representative of the camera system's maximum capability for recording information as demonstrated by the instruments employed in each mission. In consideration of the information the MIP is intended to convey, photography containing adverse factors such as low solar elevation, poor atmospheric conditions, and similar degradations is eliminated in 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 selected photography may constitute a portion of a frame containing a particular target, an entire frame, or several frames. In any case the selections do not indicate the success, quality, or PI suitability of the mission as a whole but only the camera system's maximum effort. 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 the effects of obliquity and similar distortive factors.

c. No photography affected by system malfunctions or inherent degradations can be considered for MIP selection. This eliminates the first few and last few frames of a pass, since these may contain image motion. In addition, the photography must be free of effects induced by vehicle pitch, roll, or yaw deviations from normal.

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

e. Preferably, good-contrast targets such as airfields are chosen for comparison with similar targets covered in previous missions.

4. MIP, Mission 1012-1 and 1012-2

Based on the foregoing criteria, frame 008 of pass 47DE (FWD) and frame 011 of pass 63D (FWD) are selected as the MIP examples for Missions

[redacted]

1012-1 and 1012-2, respectively. The specific targets selected for study are airfields. Both missions are assigned MIP ratings of 85 and are held comparable to Mission 1008.

Special Note

Yaw steering experiments were conducted at various times in Missions 1012-1 and 1012-2 in an attempt to establish a valid comparison between photography acquired with and without yaw steering of the vehicle. The results were inconclusive and it is probable that yaw steering experimentation will continue until the comparison study produces sufficient negative or positive evidence to permit a firm conclusion.

[redacted]

APPENDIX A. SYSTEM SPECIFICATIONS

1. Cameras

Panoramic Cameras	Master (FWD)	Slave (AFT)
Camera Number	156	157
Lens Serial Number	1342435	1232435
Slit Width	0.200 x 2.278 inches	0.200 x 2.278 inches
Aperture	f/3.5	f/3.5
Filter	Wratten 21	Wratten 21
Operational Focal Length	609.628 mm	609.602 mm
Film Type	4404 (SO 132)	4404 (SO 132)
Film Length	16,000 ft	16,000 ft
Splices	4	5
Emulsion	62-7-7-4	62-7-7-4
Static Bench Test:		
High Contrast	264 L/mm	297 L/mm
Low Contrast	152 L/mm	157 L/mm
Dynamic Test:		
ITEK High Contrast	167 L/mm	174 L/mm
ITEK Low Contrast	131 L/mm	131 L/mm
AP High Contrast	173 L/mm	193 L/mm
AP Low Contrast	114 L/mm	119 L/mm

Stellar & Index Cameras	Stellar		Index	
	1012-1	1012-2	1012-1	1012-2
Camera Number	D51	D46	D51	D46
Lens Serial Number	11144	10771	813053	813064
Resau Serial Number	47	53	51	52
Filter	None	None	Wratten 21	Wratten 21
Aperture	f/1.8	f/1.8	f/4.5	f/4.5
Exposure Time	2.0 Sec	2.0 Sec	1/500 Sec	1/500 Sec
Operational Focal Length	Not Applicable	Not Applicable	38.50 mm	38.277 mm
Film Type	4401	4401	4400	4400
Film Length	NR	NR	NR	NR
Splices	None	None	None	None
Emulsion	44-30-7-4	44-30-7-4	31-4-7-4	31-4-7-4
Perpendicularity of Resau to Optical Axis Inches	0.0002/0.937	0.0005/0.937	0.0008/2.25	0.0001/2.25
Location of Principal Point	NR	NR	NR	NR

NOTE: NR denotes Not Reported

[redacted]

Horizon Cameras	Master		Slave	
	Stbd (Take-up)	Port (Supply)	Stbd (Supply)	Port (Take-up)
Camera Number	156	156	157	157
Lens Serial Number	812265	814019	814009	812292
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	54.45 mm	54.98 mm	55.21 mm	54.97 mm
Average L/mm	Not Reported	1.70	1.70	1.64
Radial Distortion:				
10° Off-Axis	0.009 mm	0.002 mm	0.001 mm	0.002 mm
20° Off-Axis	0.006 mm	0.007 mm	0.003 mm	0.005 mm
Tangential Distortion	0.004 mm	0.005 mm	0.004 mm	0.002 mm

Master (FWD) Horizon Cameras

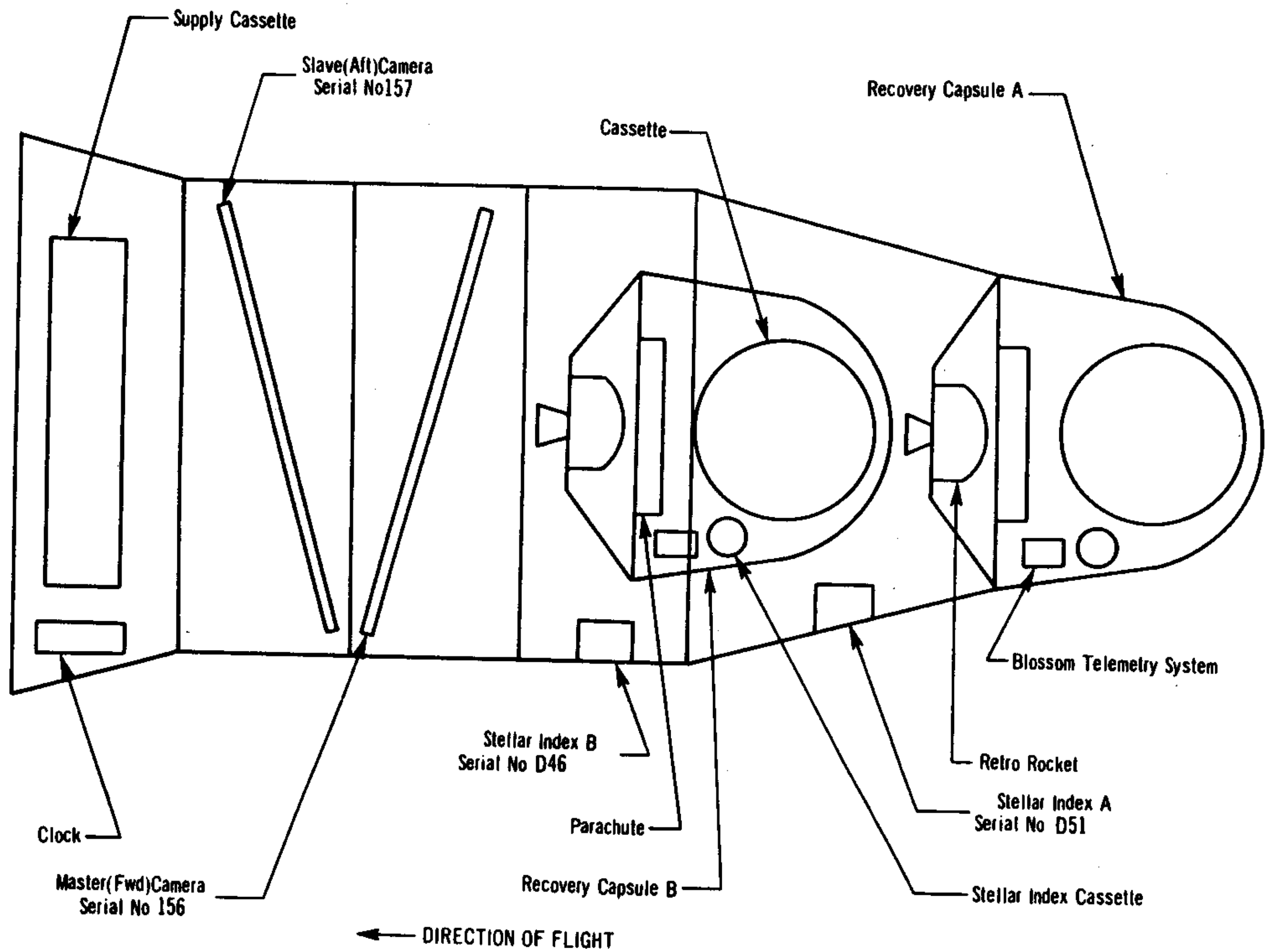
Resolution	Stbd (Take-up)	Port (Supply)					
Angle Off-Axis (Degrees)	Not Reported	0	10	15	20	25	27.50
Radial Resolution (L/mm)	Not Reported	170	125	77	75	68	59
Tangential Resolution	Not Reported	170	116	84	75	55	42

Slave (AFT) Horizon Cameras

Resolution	Stbd (Supply)						Port (Take-up)						
Angle Off-Axis (Degrees)	0	10	15	20	25	30	0	5	10	15	20	25	30
Radial Resolution (L/mm)	170	118	101	89	97	79	164	164	144	126	116	105	23
Tangential Resolution	170	116	94	79	58	42	164	145	134	115	102	60	29

[redacted]

2. VEHICLE CONFIGURATION AND EQUIPMENT LAYOUT



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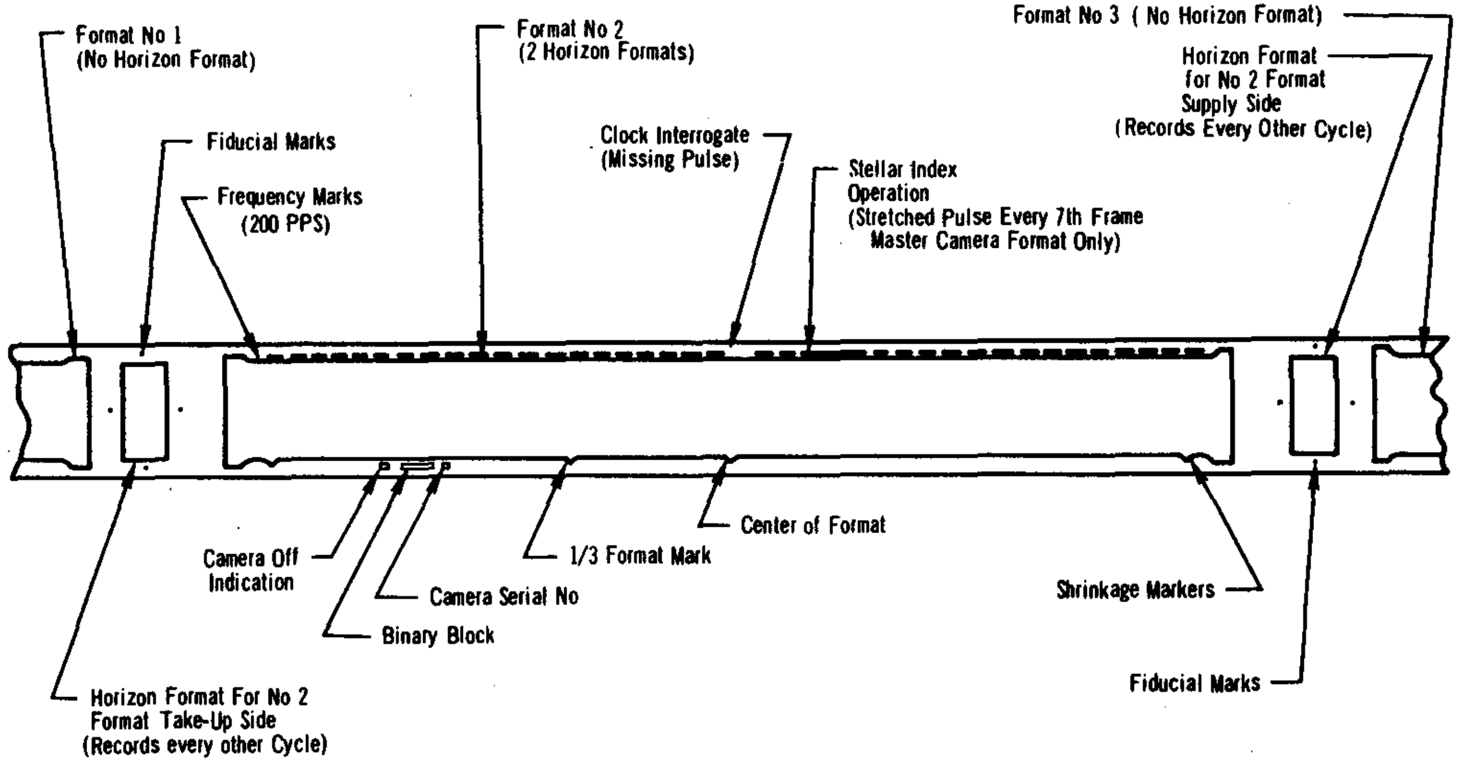
3. PANORAMIC FORMAT AND CONFIGURATION



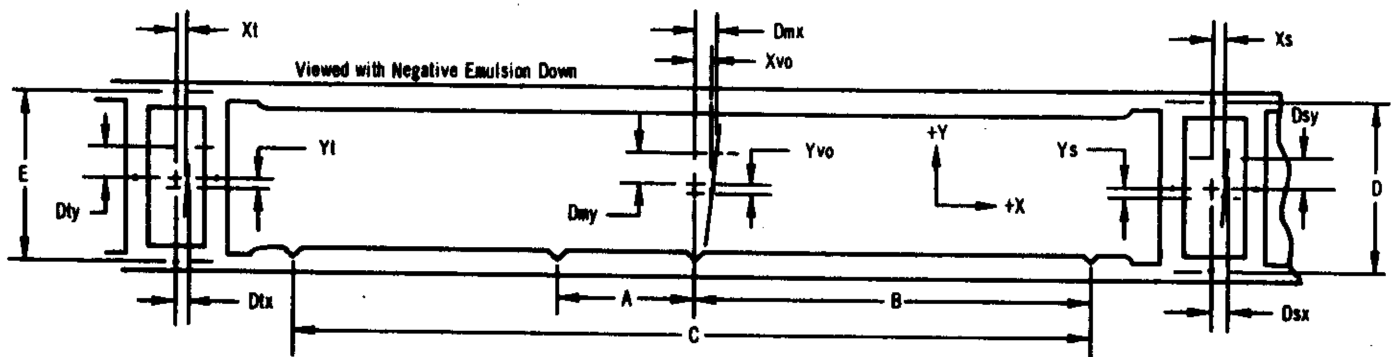
Master (Fwd) Panoramic Camera No 156
Viewed With Negative Emulsion Down
Direction of Film Transport ←
Direction of Scan →
Direction of Vehicle Motion ↓

Slave (Aft) Panoramic Camera No 157
Viewed With Negative Emulsion Down
Direction of Film Transport ←
Direction of Scan →
Direction of Vehicle Motion ↑

[redacted]

[redacted]

4. PANORAMIC FORMAT DIMENSIONS



Master (Fwd) Camera 156

		Vehicle Motion ↓		Scan Direction →	
A	76.1	Xt	+.241	Dtx	+.252
B	355.6	Yt	-.006	Dty	-2.857
C	710.8	Xs	-.411	Dsx	-.407
D	56.485	Ys	-.150	Dsy	+2.842
E	56.510	Xvo	+1.138	Dmx	+1.142
		Yvo	+1.024	Dmy	-1.976

Format dimensions:

	Panoramic
Height	55.544
Width	755.7

Slave (Aft) Camera 157

		Vehicle Motion ↑		Scan Direction →	
A	76.3	Xt	-.265	Dtx	-.260
B	355.3	Yt	-.041	Dty	+2.102
C	710.6	Xs	-.135	Dsx	-.140
D	56.550	Ys	+.003	Dsy	-2.261
E	56.579	Xvo	-.392	Dmx	-.407
		Yvo	+.259	Dmy	-2.741

Format dimensions:

	Panoramic
Height	56.217
Width	755.0

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 10mm above point defining target center
4. Format Sign Convention

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

[redacted]

[redacted]

DEFINITION OF PANORAMIC CAMERA FORMAT CALIBRATIONS

Measurements are made with respect to collimator targets fixed with respect to the mechanical interface between the total payload assembly and the orbital vehicle.

Two sets of three targets each are aligned to be coplanar within ± 5 seconds of arc so positioned to form an angle of -15.00° ± 5 seconds to the mechanical interface for master camera calibrations and an angle of +15.00° ± 5 seconds to the mechanical interface for slave camera calibrations.

> One target, Target 1 of each set is imaged on the Terrain Format.
>
> The second and third targets of each set are at angles of 75.00° ± 5 seconds from Target 1 and are imaged on the horizon formats.

The indicated center of format for the panoramic cameras is given by the intersection of a line through the center of mass of the central shrinkage marker drawn normal to the edge of format containing the shrinkage marker and a line parallel to the same edge located at a position half-way between the format edges.

The indicated principal points of the horizon cameras are the points of interesection of lines joining opposite fiducials.

Xvo and Yvo are the offsets of Target 1 from the indicated center of format of the panoramic cameras as defined in Paragraph 3.

Xs, Ys and Xt, Yt are the offsets of Targets 2 and 3 from the indicated principal points of the supply and take-up horizon cameras respectively.

The indicated flight direction is the direction of vehicle travel during orbit. The forward edge of format is the edge opposite the shrinkage markers for the master camera and is the edge containing the shrinkage markers for the slave camera.

Dimensions A, B and C are the spacings of the shrinkage markers and dimensions D and E are the spacing of the Y axis fiducials. Techniques for exact measurement of these dimensions have not been developed. The figures quoted are measurements made on hand processed film without control of shrinkage.

The format dimensions are measured to the best estimate of format edge.

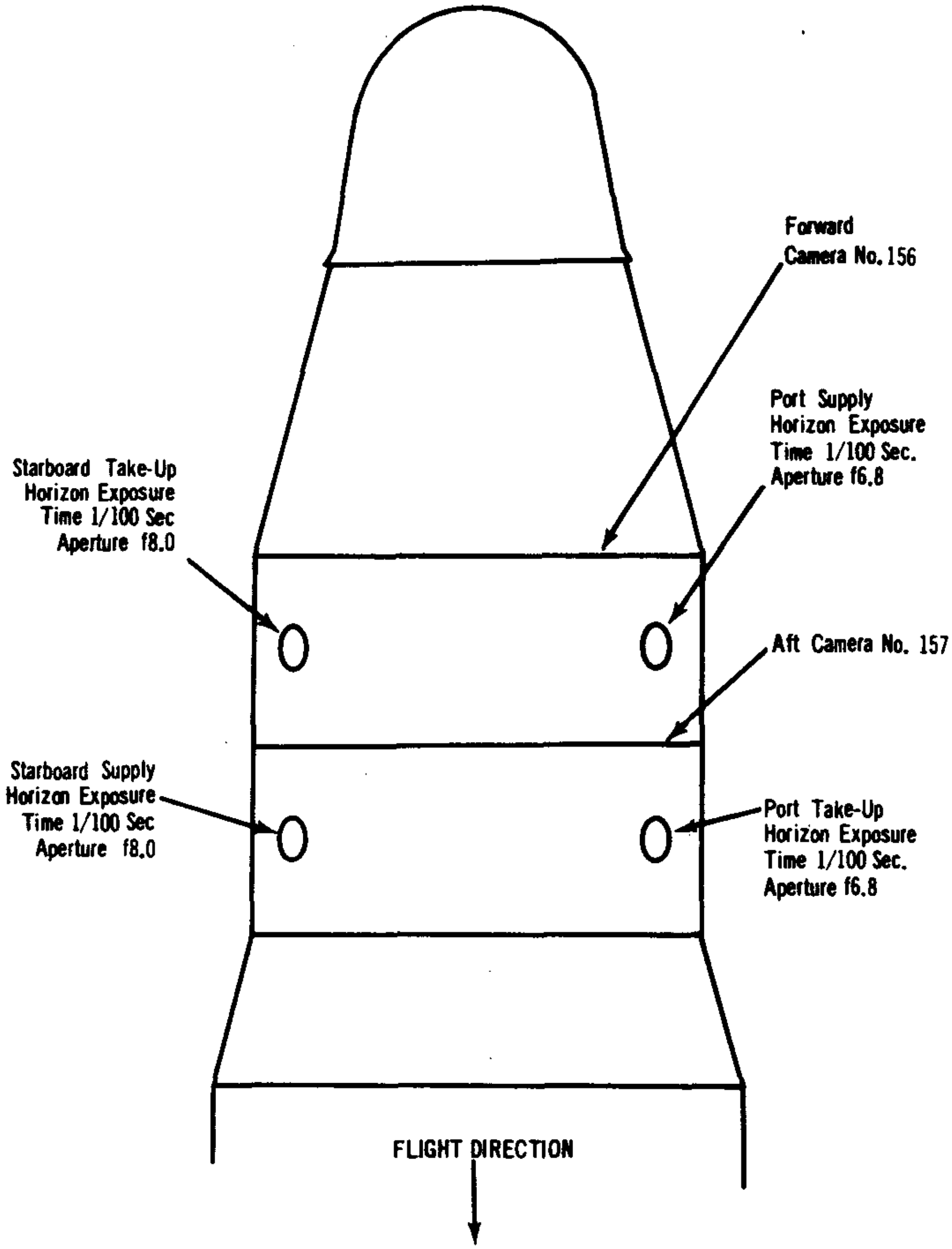
[redacted]

Measurements of the angle between the indicated axis of the panoramic cameras and the line of intersection of the plane defined in Paragraph 2 on the format is obtained from the offset dimensions Dmx and Dmy of Target 1 for each camera.

Measurement of the angle between the indicated axis of the horizon cameras and the line of intersection of the plane defined in Paragraph 2 of the format is made by measuring the scan direction offset of the targets defined in Paragraph 2B at a fixed distance from the target center in the Y direction. Dimensions Dtx, Dty, Dsx and Dsy are the offsets of these measurements.

[redacted]

5. HORIZON LENS SETTINGS
(Viewed from top of vehicle in flight)



[redacted]

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APPENDIX B. DENSITY READINGS

The following pages contain a compilation of the Stellar/Index density values obtained with a Macbeth QuantaLog Densitometer, Model EP 1000, fitted with an ET 20 attachment and an 0.5 mm aperture.

[redacted]

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		STELLAR CAMERA				INDEX CAMERA						
						LIMITING			Gross Fog	TERRAIN		
Pass	Frame	Dmax	Dmin	Delta	Gross Fog	Dmax	Dmin	Delta		Dmax	Dmin	Delta
50D	001	0.50	0.28	0.22	0.20	0.68	0.12	0.56	0.08	0.67	0.20	0.47
50D	011	1.60	0.28	1.32	0.22	1.32	0.21	1.11	0.08	1.32	0.21	1.11
51D	012	1.89	0.30	1.59	0.22	1.36	0.42	0.94	0.08	NR	NR	NR
51D	019	2.05	0.30	1.75	0.21	1.60	0.21	1.39	0.08	NR	NR	NR
52D	020	1.92	0.29	1.63	0.22	1.33	0.66	0.67	0.08	NR	NR	NR
52D	030	2.04	0.26	1.78	0.18	1.41	0.17	1.24	0.09	0.68	0.17	0.51
53D	031	1.65	0.26	1.39	0.19	1.30	0.14	1.16	0.08	1.30	0.14	1.16
53D	047	2.25	0.35	1.90	0.22	1.80	0.25	1.55	0.08	NR	NR	NR
54D	048	1.81	·0.29	1.52	0.21	1.42	0.48	0.94	0.08	NR	NR	NR
54D	070	2.04	0.36	1.68	0.21	1.96	0.18	1.78	0.08	1.96	0.18	1.78
56D	071	1.54	0.22	1.32	0.18	1.10	0.11	0.99	0.08	0.30	0.11	0.19
56D	089	1.89	0.28	1.61	0.18	1.37	0.14	1.23	0.08	0.49	0.21	0.28
57AE	090	0.18	0.18	0.00	0.18	0.08	0.08	0.00	0.08	NR	NR	NR
57AE	091	0.21	0.21	0.00	0.21	0.08	0.08	0.00	0.08	NR	NR	NR
57D	092	1.73	0.24	1.49	0.18	1.99	0.32	1.67	0.08	0.95	0.32	1.63
57D	095	1.58	0.23	1.35	0.20	1.95	0.25	1.70	0.08	0.92	0.25	0.67
58D	096	2.24	0.28	1.96	0.17	1.82	0.21	1.61	0.08	1.16	0.21	0.95
58D	099	2.21	0.28	1.93	0.18	1.62	0.35	1.27	0.08	1.28	0.35	0.93
63D	100	1.92	0.26	1.66	0.18	1.00	0.16	0.84	0.08	1.00	0.16	0.84
63D	105	1.95	0.25	1.70	0.18	1.60	0.11	1.49	0.08	0.88	0.33	0.55
66D	106	0.20	0.20	0.00	0.20	0.12	0.09	0.03	0.08	NR	NR	NR
66D	123	1.96	0.28	1.68	0.18	1.47	0.22	1.25	0.08	NR	NR	NR
67D	124	0.29	0.18	0.11	0.18	0.64	0.12	0.52	0.08	0.64	0.15	0.49
67D	138	2.14	0.28	1.86	0.17	1.66	0.19	1.47	0.08	0.53	0.24	0.29
68D	139	2.15	0.28	1.87	0.18	1.38	0.14	1.24	0.08	1.38	0.14	1.24
68D	153	2.02	0.30	1.72	0.18	1.48	0.27	1.21	0.08	0.57	0.27	0.30
69D	154	1.72	0.23	1.49	0.16	1.38	0.41	0.97	0.08	NR	NR	NR
69D	176	2.38	0.35	2.03	0.17	2.25	0.25	2.00	0.08	0.62	0.25	0.37
70D	177	2.05	0.26	1.79	0.16	1.45	0.21	1.24	0.08	0.47	0.21	0.26
70D	185	2.28	0.32	1.96	0.17	1.64	0.40	1.24	0.08	NR	NR	NR
71D	186	1.61	0.21	1.40	0.16	1.06	0.12	0.94	0.08	0.23	0.15	0.08
71D	203	2.34	0.80	1.54	0.32	1.09	0.21	0.88	0.08	1.02	0.27	0.75
73D	204	3.81	2.95	0.86	1.58	1.72	0.08	1.64	0.08	NR	NR	NR
73D	207	NR	NR	NR	NR	1.87	0.08	1.79	0.08	0.59	0.33	0.26
73D	208	3.86	3.71	0.15	1.52	NR	NR	NR	NR	NR	NR	NR
Average		1.82	0.46	1.36	0.27	1.35	0.18	1.13	0.08	0.55	0.22	0.66
Range		0.18 to 3.86	0.18 to 3.71	0.00 to 2.03	0.16 to 1.58	0.08 to 1.99	0.08 to 0.66	0.03 to 2.00	---	0.23 to 1.38	0.11 to 0.35	0.08 to 1.78

NR - Denotes No Reading Made

[redacted]

APPENDIX C. MICRODENSITOMETRY

1. Edge Spread Function

The technique of obtaining the spread function from microdensitometer edge traces is used as an objective measure of the image quality in mission photography. The spread function curve represents a summation of the separate elements of the photographic system. By taking the Fourier Transform of the spread function the modulation transfer function of the system may be obtained.

To satisfy the desire to express image quality in terms of a value, a single number is determined from the spread function curve by measuring its width at 50% amplitude. This width is expressed as a micron distance in image space and may be converted to a distance on the ground. On domestic passes, where 3-bar resolution targets have been available the ground distance determined from edge trace analysis and from the targets has been found to be comparable.

The microdensitometric analysis of edges in the image requires that the object edge fulfill the conditions of a unit step function, i.e., exist for an appreciable distance at a fixed brightness level and change abruptly to a new level which exists for an appreciable distance. This requirement is usually achieved by rooftops of buildings in large-scale photography, and aircraft runways or taxiways in small-scale photography.

The mission is examined to determine the MIP (Mission Information Potential) frame which is a subjective selection of the best photography. Straight edges in this imagery meeting the criteria of a step function for a length of at least 120 microns are selected for scanning with the microdensitometer.

The microdensitometer used is a Joyce-Lobel Double Beam Model III CS. It is used with an effective slit of 1 micron by 75 microns. The recording table and specimen table are directly linked with a 1000:1 ratio arm. The speed of the scan is proportional to the rate of pen deflection (as the pen deflection rate increases the speed is decreased giving the pen time to reach its maximum response). The trace thus produced represents a plot of deflection versus distance. The deflection of the pen is essentially linear with density.

Several computer programs that have as output both the spread function and MTF are currently being investigated. The best features of each will be incorporated into a program for the UNIVAC 490. In the interim the data reduction is done manually.

[redacted]

The microdensitometer plots, which exhibit the steeper density gradients and fall on the straight-line portion of the H & D curve for the material, are traced and smoothed. They are then digitized in a comparator into values of distance (X) and deflection (Y). Since the instrument response is linear with density, it is also linear with exposure on the straight-line portion of the applicable D Log E curve. The values of Y are converted to Log E and the antilog taken to obtain values of relative exposure. The difference between adjacent values of E is divided by the corresponding difference of the measured values of X to produce the slope values (dE/dX) of the original object reflectance distribution. Finally, 50 percent of the maximum slope is computed, and the distance between the 50 percent slope values is determined by interpolation. The Line Spread Function (LSF) may also be plotted (slope versus distance) and the 50 percent amplitude width measured for verification of the calculated value.

The following table shows the 50 percent amplitude width of the LSF determined from the enclosed microdensitometric edge traces made on the original negative. The lines per millimeter is determined by taking the reciprocal of the 50 percent amplitude width LSF and converting to mm.

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SUMMARY TABLE OF EDGE TRACES

Trace Number	Line Spread Function width at 50% amplitude	Reciprocal of LSF width at 50% amplitude
1	9.72 microns	102.9 L/mm
2	10.84 microns	92.3 L/mm
3	9.47 microns	105.6 L/mm