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June 1965

TECHNICAL PUBLICATION

PHOTOGRAPHIC EVALUATION REPORT

MISSION 1015-1 19-24 DECEMBER 1964

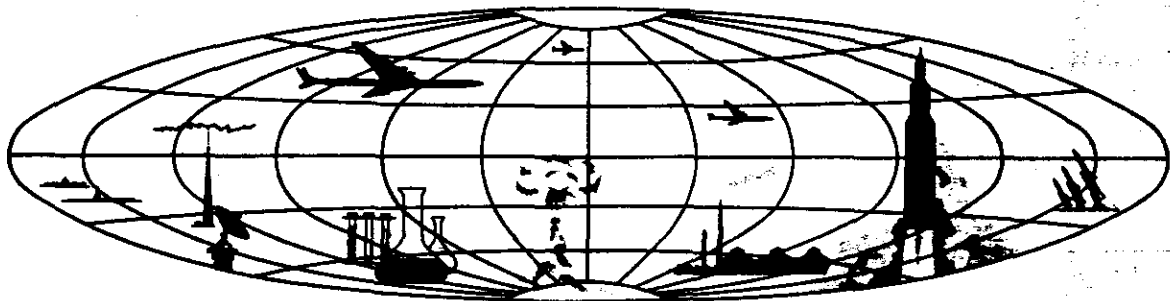
MISSION 1015-2 25 DECEMBER 1964 28-30 DECEMBER 1964

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SYNOPSIS

Mission 1015 (System No J-17) the 15th of the "J" reconnaissance series was launched 19 December 1964. Two operational phases were programmed and designated Missions 1015-1 and 1015-2, respectively.

Mission 1015-1 (19-24 December 1964) accomplished 39 photographic revolutions, including 3 engineering and 4 domestic passes. The first-phase payload was recovered by air catch on 24 December and second-phase photography was initiated on 25 December 1964. Operations were suspended upon completion of pass 89AE and the vehicle was commanded into a controlled deactivated mode. The vehicle was reactivated on 28 December 1964 and photographic operations resumed with pass 142D.

Mission 1015-2 (25 December and 28-30 December 1964) accomplished 30 photographic revolutions, including 5 engineering and 3 domestic passes. Termination of operations and payload recovery were effected on 30 December because the telemetry signalled potential electrical difficulties. However, operation subsequent to recovery of the payload indicated that a mission of normal duration could have been performed.

All cameras functioned satisfactorily and produced good-quality photography. The panoramic record was assigned a Mission Information Potential (MIP) rating of 85 and the photography, in general, is comparable to that achieved in Mission 1012, 17-23 October 1964. However, the slave (AFT) panoramic imagery is degraded by the presence of an out-of-focus area at the supply end of the data block edge of the format. This condition is first observed in pass 4D and is detectable, to some degree, in all following passes. Fortunately, the overall degradation is relatively minor. The affected area is not extensive in size or consistent in severity of degradation and is, at times, difficult to detect. A detailed discussion of this anomaly is contained in Item 2 of Part I Camera Operation.

Clouds obscured 33 percent of the panoramic photography obtained in Mission 1015-1 and increased to 45 percent in Mission 1015-2. Solar elevations ranged from 4 degrees to 69 degrees in Mission 1015-1 and from 2 degrees to 79 degrees in Mission 1015-2. However, most of the photography was acquired with solar elevations between 5 and 35 degrees.



GENERAL FLIGHT DATA

Mission 1015-1	Launch Date	19 December 1964
	Recovery Date	24 December 1964
Mission 1015-2	Activation Date	25 December 1964
	Deactivation Period	26, 27 December 1964
	Reactivation Date	28 December 1964
	Recovery Date	30 December 1964

Orbital Parameters

	Mission 1015-1 (Rev 10)	Mission 1015-2 (Rev 145)
Period	90.535 Min	90.1996 Min
Perigee	96.56 nm	98.141 nm
Apogee	230.64 nm	220.27 nm
Eccentricity	0.01860	0.016977
Inclination Angle	74.973° N	74.96° N

Photographic Operations

	Mission 1015-1	Mission 1015-2
Operational Passes	32	22
Domestic Passes	4	3
Engineering Passes	3	5
Recovery Revolutions	81D	175D



PART I. CAMERA OPERATION

1. Master (FWD) Panoramic Camera No 138:

The instrument was operational throughout the mission and camera-induced degradations consist mainly of various light-struck areas at the beginning and end of the photography acquired in each pass. The light leaks produced the following patterns in Mission 1015-1 (noted in order of appearance from head to tail of the individual pass records):

- (a) 1st frame: a small flare inside the format, originating on the data block edge and generally found in the take-up half of the frame.
- (b) 5th-from-last frame: an edge-to-edge plus-density area 3 to 6 inches wide.
- (c) 4th-from-last frame: an irregular light trace resembling a corona static discharge, oriented toward take-up, and more intense on the data block edge of the film.
- (d) Next-to-last frame: same as in (c) above, but generally less intense and more prominent on the frequency marks edge.
- (e) Last frame: a small flare similar to that noted in the first frame, but less intense.

In Mission 1015-2 the following repetitive patterns are present:

- (a) 1st frame: a small flare and/or a bar-type light trace approximately $\frac{1}{4}$ -inch wide, extending from edge to edge within the format.
- (b) Next-to-last frame: a small, irregular light trace resembling a corona static discharge.
- (c) Last frame: a faint equipment shadowgraph.

Degradation of imagery within the affected areas is minimal in most cases. However, in an isolated case outside the general pattern, heavy fog and dense equipment shadowgraphs severely degrade all of frame 5 and a portion of frame 6 in pass 142D.

Intermittent, fine base scratches are present throughout the film. Both edges contain continuous rail scratches. There are no outstanding or excessive camera-induced emulsion scratches or abrasions.

2. Slave (AFT) Panoramic Camera No 141:

The camera was operational throughout the mission and the photographic record contains light-struck areas on the order of those noted in Item 1 above. Degradation is slight and will be discussed at a later point. A more notable anomaly is the presence of an out-of-focus area at the supply end of the data block edge of most formats following pass 4D, frame 25. Water, cloud cover, and atmospheric haze in the photography immediately following frame 25 preclude precise determination of the initial appearance of the degradation. Similar out-of-focus areas have been observed in a number of previous mission records, such as Missions 1004, 1007, 1010, 1011, where the degradation appeared almost exclusively in the master (FWD) camera material.

The area affected by the out-of-focus condition in this mission varies slightly in dimensions, contour, and severity of degradation, but its location within the format is reasonably stable. At worst, the degradation extends 4 inches along the edge of the format (taken from the supply end shrinkage marker and measured toward take-up) and intrudes approximately 1 inch into the format in an irregular curve.

The factors involved in this anomaly have not yet been positively established. However, extensive study has resulted in an apparent correlation between film tracking and presence of the out-of-focus condition, which seems to be induced by variations in pitch of the formats (their alignment on the film, relative to the film edges). For example, the format pitch measurements in the master (FWD) camera material are relatively stable and no degradation is detectable:

Pitch range @ take-up: 0.260" - 0.265". Average 0.265".

Pitch range @ supply: 0.215" - 0.230". Average 0.220".

(Note: Pitch values are measured from the format edge to the film edge immediately adjacent to the shrinkage markers at supply and take-up.)

Measurements of format pitch in the slave (AFT) camera material reveal that the take-up values are fairly stable, but the supply values are erratic and the out-of-focus condition appears to be induced by this variation. Sample readings and pertinent comments are tabulated, as follows:



<u>Pass</u>	<u>Frame</u>	<u>Pitch at Take-up (inches)</u>	<u>Pitch at Supply (inches)</u>	<u>Comments</u>
1D	1	0.250	0.250	Out-of-focus condition not present.
	5	0.250	0.240	
	10	0.255	0.245	
	14	0.255	0.255	
3D	1	0.255	0.240	Large displacement occurs at supply in frame 12, but water/clouds preclude detection of degradation.
	12	0.260	0.265	
	27	0.260	0.255	
4D	1	0.260	0.250	Degradation is readily detectable when supply pitch attains 0.2675 inches but not prior to that. Take-up pitch stabilized at 0.260 inches.
	25	0.255	0.265	
	50	0.260	0.2675	
	75	0.260	0.2675	
5D	1	0.260	0.2675	Haze precludes detection of degradation, frame 1. None present in frames 20 and 45.
	20	0.257	0.245	
	45	0.260	0.265	
6D	1	0.260	0.2675	Supply pitch measurement stabilizes at apparent critical value and degradation exists in all frames.
	50	0.260	0.2675	
	75	0.260	0.2675	

Numerous additional pitch readings were taken as the mission evaluation progressed but no significant departures from the apparent degradation pattern were observed. Summing up, it appears that the following conditions exist when degradation is present:

(a) A critical pitch measurement is attained, either by the supply or take-up end of the format. In this case, it is located at supply and the critical or threshold value is 0.2675 inches.

(b) The pitch differences between take-up and supply vary, but unless a critical displacement has taken place at one end or the other the take-up and supply pitch relationships are of little significance. In this mission the difference in pitch between take-up and supply ranges as high as 0.010 inches with an average difference of 0.0075 inches. Regardless, no degradation is detectable at any time unless the supply pitch reading is at the critical value.



The reader is cautioned that the foregoing conclusions are derived from study of the film record of Mission 1015 only. Exhaustive study of previous mission records is currently underway and will provide more detailed information and data on the relationship between film tracking and presence of the focus anomaly.

The following light-induced degradations are present in the aft camera material, Mission 1015-1 (noted in most passes):

(a) 7th-from-last frame: a plus density area near supply, which occasionally shifts into the take-up end of the 6th frame from last.

(b) 6th-from-last frame: an intense corona-type light trace, which also affects the 5th-from-last frame in a number of cases.

(c) 3rd-from-last frame: a smaller, less intense corona-type light trace and a faint equipment shadowgraph.

(d) 2nd-from-last frame: a faint equipment shadowgraph at supply, which occasionally shifts into the take-up end of the next-to-last frame.

(e) Next-to-last frame: a small corona-type light trace.

In Mission 1015-2 the following frames of most passes are affected:

(a) 1st frame: a faint equipment shadowgraph at take-up.

(b) Next-to-last frame: a small light trace.

(c) Last frame: faint equipment shadowgraphs in a number of passes.

The aft photography exhibits banding at the start of scan in most frames. This has been observed in previous mission records. In addition, the aft material contains intermittent minus density streaks. However, neither condition appreciably degrades the imagery.



3. Master (FWD) Horizon Cameras:

The port (supply) and starboard (take-up) horizon cameras were operational throughout the mission. The image 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. Slave (AFT) Horizon Cameras:

The port (take-up) and starboard (supply) horizon cameras were operational throughout the mission. Quality of the photography is similar to that obtained with the Master (FWD) instruments. The corner vignetting does not deny use of the horizon curves for the purpose of vehicle attitude determination, and exposure was adequate except where low solar elevations prevailed.

5. Stellar Camera No 61 (Mission 1015-1):

The instrument was operational throughout the mission, but approximately 50 percent of each format is degraded by assorted flares and lens element reflections. At least 30 stellar images are recorded, but the majority of frames contain doublets and/or elongated stellar images. Uncertainty of mensuration is approximately 15 minutes of arc. The title edge of the film contains fine, transverse emulsion cracks which extend 0.10 inch into the film (frames 50-384). Fine, edge-to-edge emulsion cracks are present in frames 160-384. Minor abrasions appear intermittently on the title edge but no sequence of occurrence is definable.

6. Stellar Camera No 58 (Mission 1015-2):

The camera performed satisfactorily throughout the mission. A double exposure occurred in the first frame, but is not classified as a malfunction. This anomaly is occasionally induced by the camera programmer at the start of the second phase of a two-section mission, dependent on the position of the camera programmer at launch. Of the 7 possible positions, 3 may cause double exposure of the initial second-phase frame. Quality of the photography is similar to that achieved in Mission 1015-1. The various degradations noted in the first-phase stellar record are also present in this material. In addition, minor dendritic static discharges are present at the end of the film record.



7. Index Camera No D61 (Mission 1015-1):

The camera was operational throughout the mission and produced good-quality photography.

8. Index Camera No D58 (Mission 1015-2):

The camera operated satisfactorily throughout the mission and quality of the photography is good. As in the stellar material, the first frame contains a double exposure.

9. Associated Equipment:

The binary data block was operational throughout the mission. No lamp failures were noted except in pass 167D, frame 27, where the time word is not recorded. However, the index lamp image adjacent to the camera number in the master (FWD) panoramic camera material is bloomed and the entire data block in the slave (AFT) film contains bloomed lamp images, resulting in non-uniform image sizes and shapes. The frequency marks are flared, but are recorded outside the formats. Single end-of-pass markers are recorded at all camera-off positions. The camera numbers are flared but readable. The horizon camera fiducials are well defined, with little or no flare present.



PART II. FILM

1. Film Footage:

The film footage/frame totals for Mission 1015 are as follows:

	1015-1	1015-2
Master (FWD) Panoramic Camera	7,826 ft/2,690 frames	7,067 ft/2,664 frames
Slave (AFT) Panoramic Camera	7,706 ft/2,648 frames	7,019 ft/2,654 frames
Stellar Camera	61 ft/ 384 frames	53 ft/ 379 frames
Index Camera	104 ft/ 384 frames	78 ft/ 379 frames
<hr/>		
Total Footage/Frames, Master (FWD) Panoramic Camera	14,893 ft/5,354 frames	
Total Footage/Frames, Slave (AFT) Panoramic Camera	14,725 ft/5,302 frames	
Total Footage/Frames, Panoramic Photography	29,618 ft/10,856 frames	

Note: All footage figures are process machine footages.

2. Film Processing:

This section provides evaluation of processing, exposure, density, contrast, and physical condition of the original negatives. Processing data are abstracted from records maintained by the processing contractor. Evaluation of exposure and physical condition of the processed film are accomplished by on-site inspection of the negative material as it is made available for breakdown and titling. A final, more thorough examination of the original negatives is conducted by photographic analysts at a later date.

In general, most of the photography obtained in this mission received adequate exposure. However, low solar elevations and/or variations in terrain reflectivity caused some departures from normal. Densities range from thin (in photography acquired at low solar elevations) to medium. The contrast varies from low to medium, dependent on solar elevation, terrain type, cloud shadow, and similar related factors. Some high contrast photography is present in snow-covered areas (particularly in mountainous terrain) and in shoreline areas. The physical condition of the processed film was good.



The following development levels were employed in processing the film:

	1015-1		1015-2	
	Master	Slave	Master	Slave
Primary	2%	0%	0%	0%
Intermediate	2%	5%	10%	9%
Full	96%	95%	90%	91%

Four development level changes were made in processing the master record and 11 changes in the slave record, Mission 1015-1. In Mission 1015-2, the master film record required 18 development level changes and the slave record 10. Nine parts were special-printed in Mission 1015-1 and 6 parts required similar treatment in Mission 1015-2.

3. Physical Film Degradations:

There are no outstanding or excessive physical degradations other than an unusual, arrow-shaped scratch in frame 25 of pass 88D. The scratch is oriented to the long axis of the film with the "arrowhead" projected towards the take-up end of the format. Slightly curved, the scratch is approximately 0.40 inch long and 0.05 inch wide. Location of the scratch is 0.50 inch inboard of the frequency marks edge and 11.50 inches from take-up. Image destruction is severe; several buildings and a section of road have been obliterated. Investigation indicates that the degradation occurred after the film had been processed, inspected, and titled. More precise determination of the time the damage was caused is not possible.

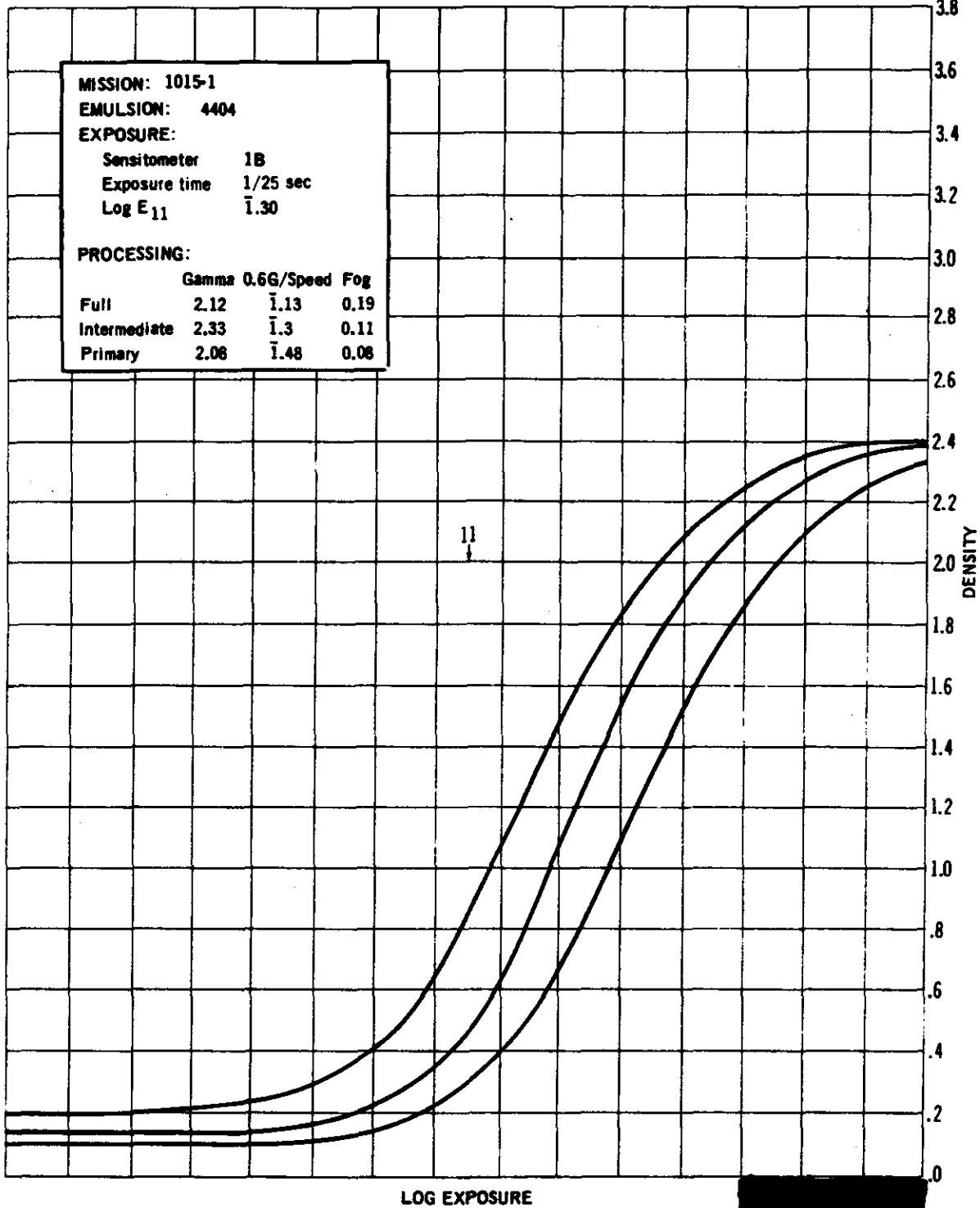


4. Film Processing Curves:

The following graphs are reproductions of the film processing curves for missions 1015-1 and 1015-2 provided by the processing contractor.



STANDARD PROCESSING CONTROL CURVES

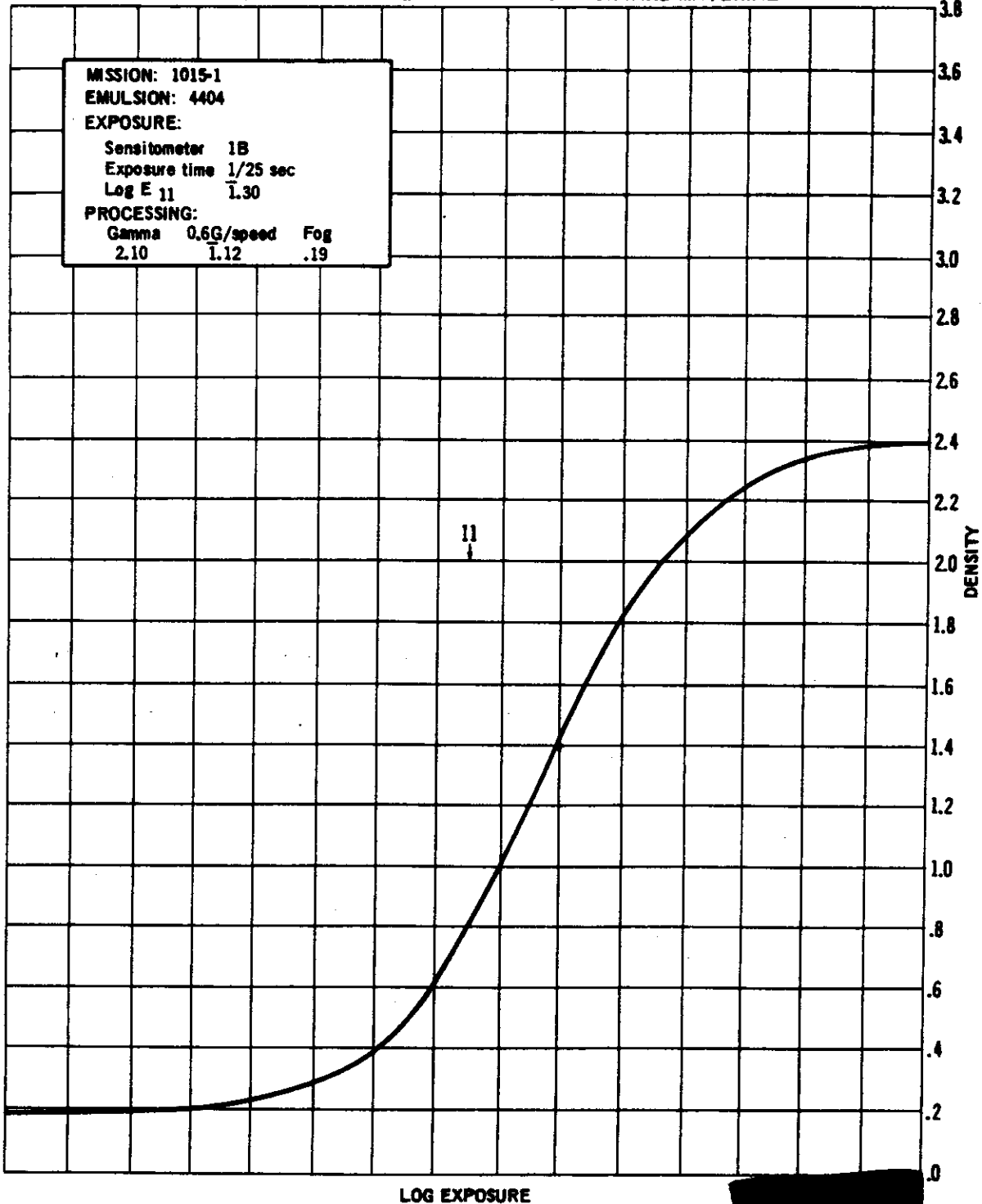


LOG EXPOSURE

DENSITY

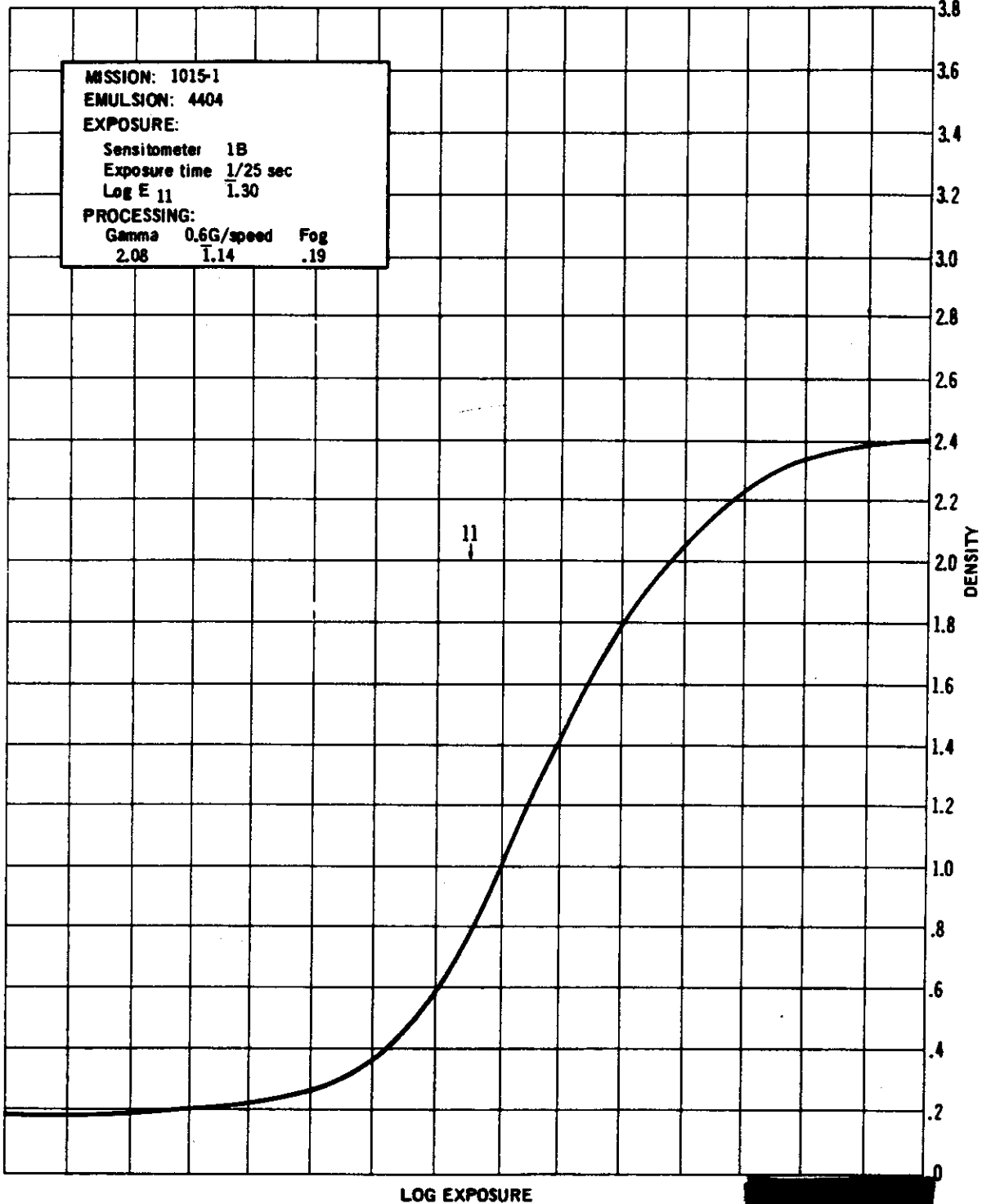


CONTROL CURVE FOR HEAD AND TAIL OF FORWARD MATERIAL





CONTROL CURVE FOR HEAD AND TAIL OF AFT MATERIAL

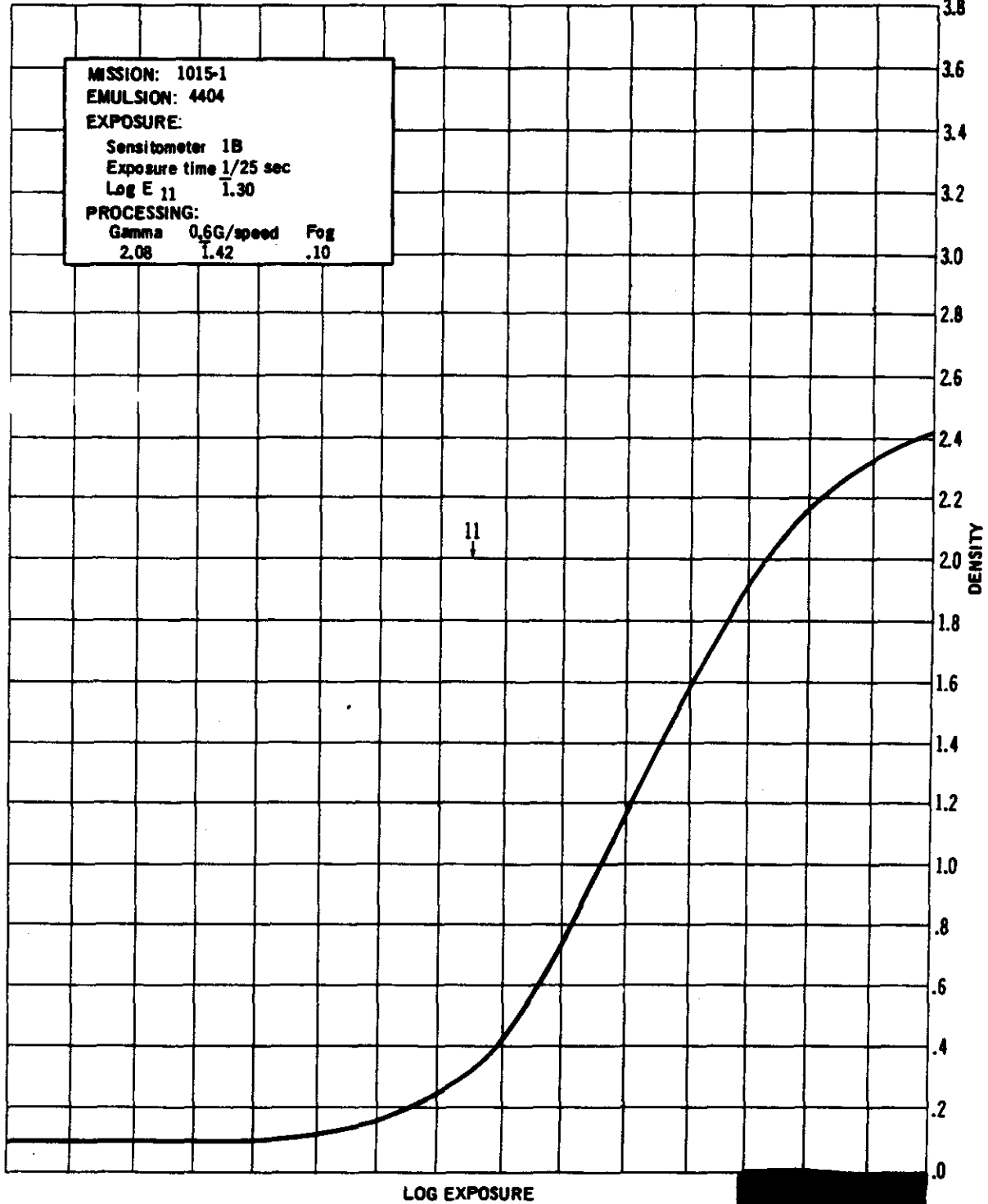


LOG EXPOSURE



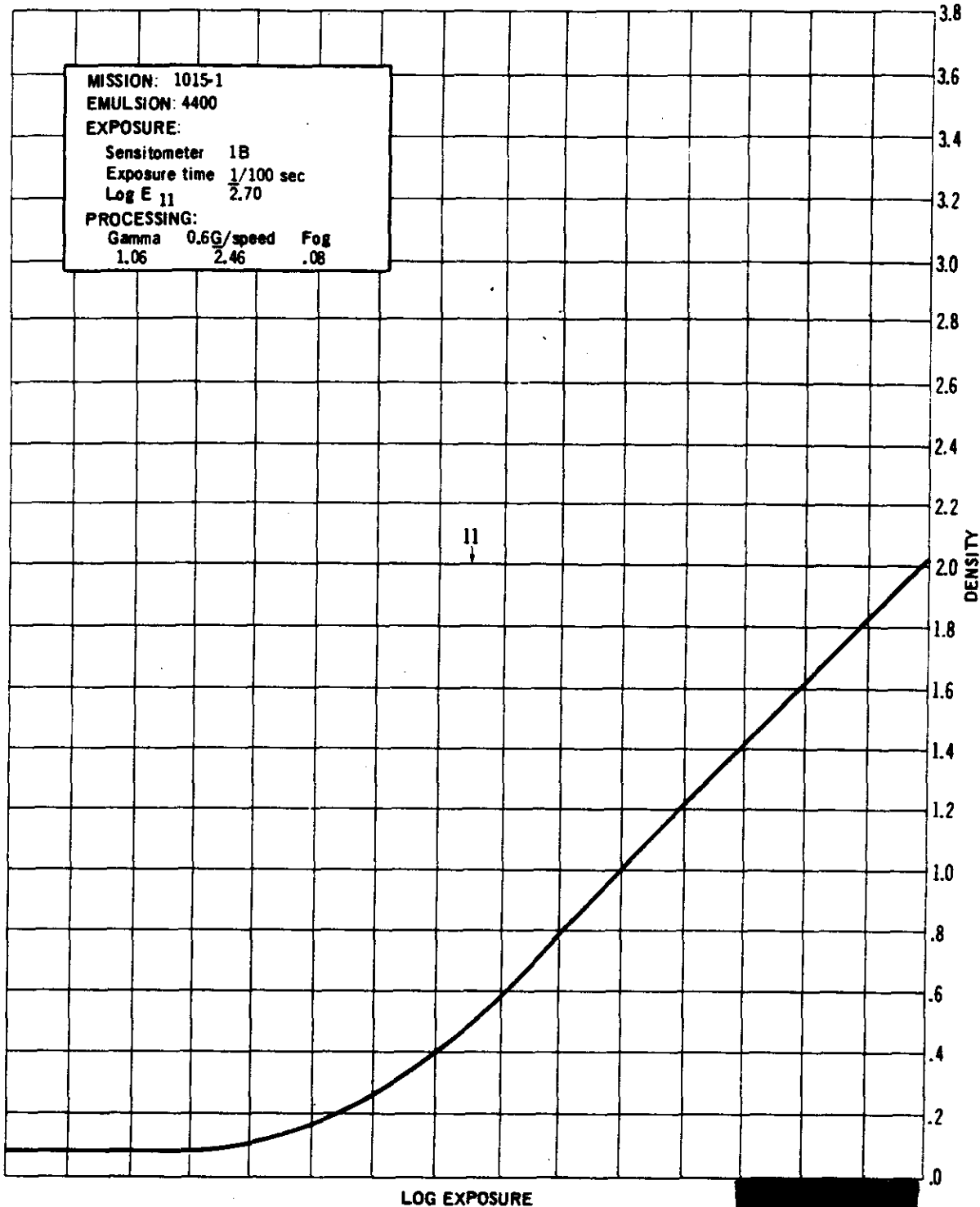


SENSITOMETRIC CURVE FROM MISSION MATERIAL





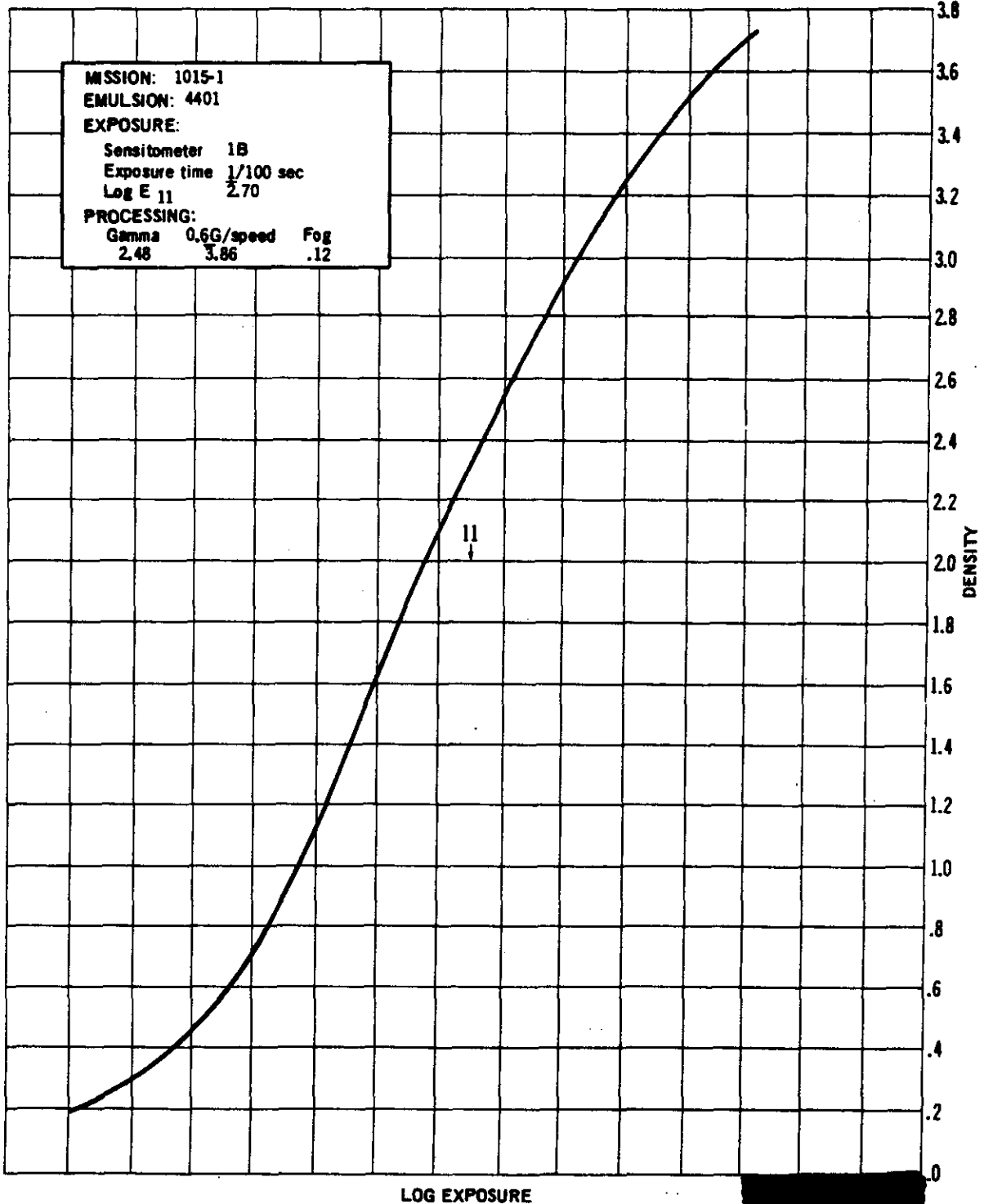
CONTROL CURVE FOR HEAD AND TAIL OF MISSION MATERIAL





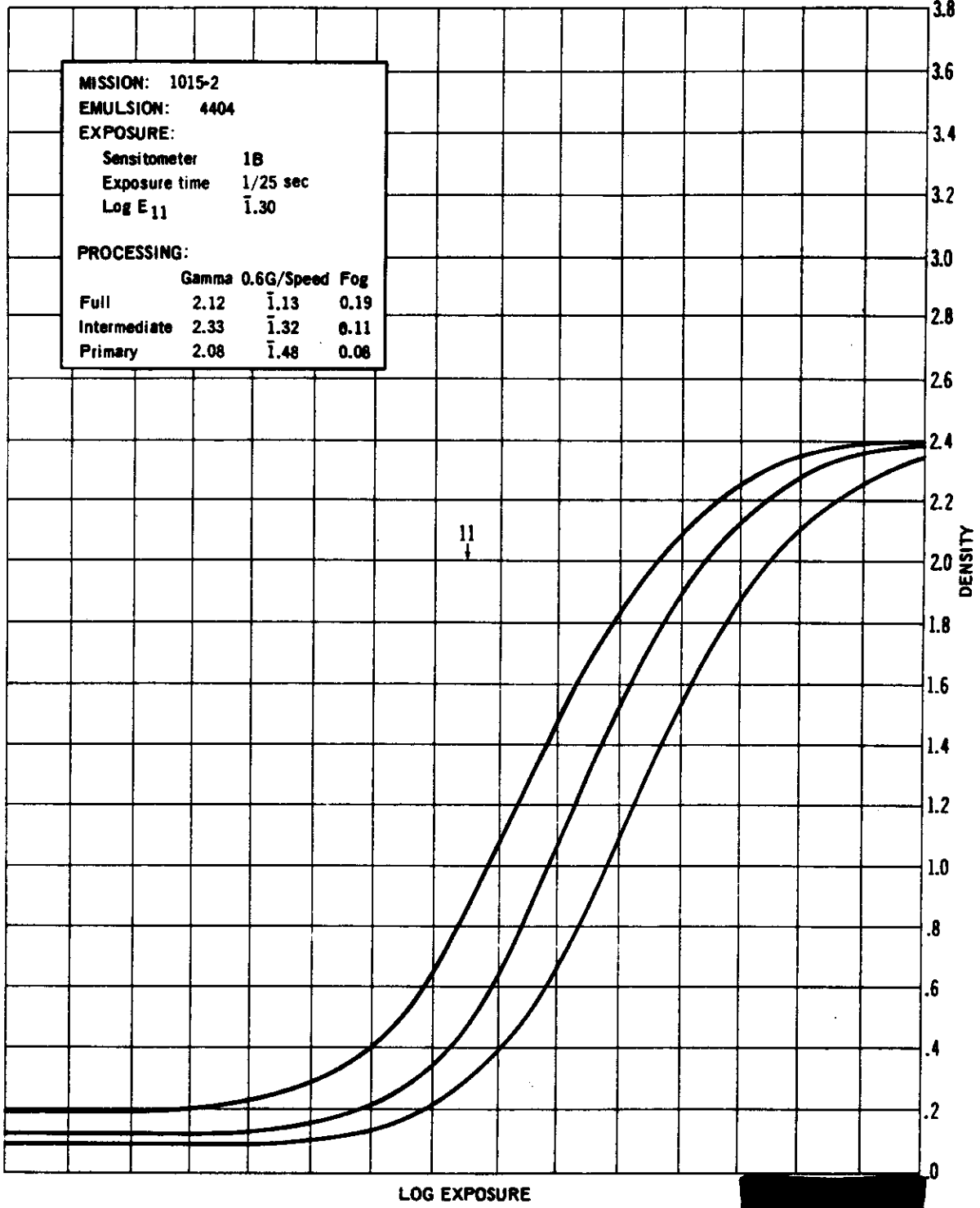
CONTROL CURVE FOR HEAD AND TAIL OF STELLAR MATERIAL

MISSION: 1015-1
EMULSION: 4401
EXPOSURE:
Sensitometer 1B
Exposure time 1/100 sec
Log E 11 2.70
PROCESSING:
Gamma 0.6G/speed Fog
2.48 3.86 .12



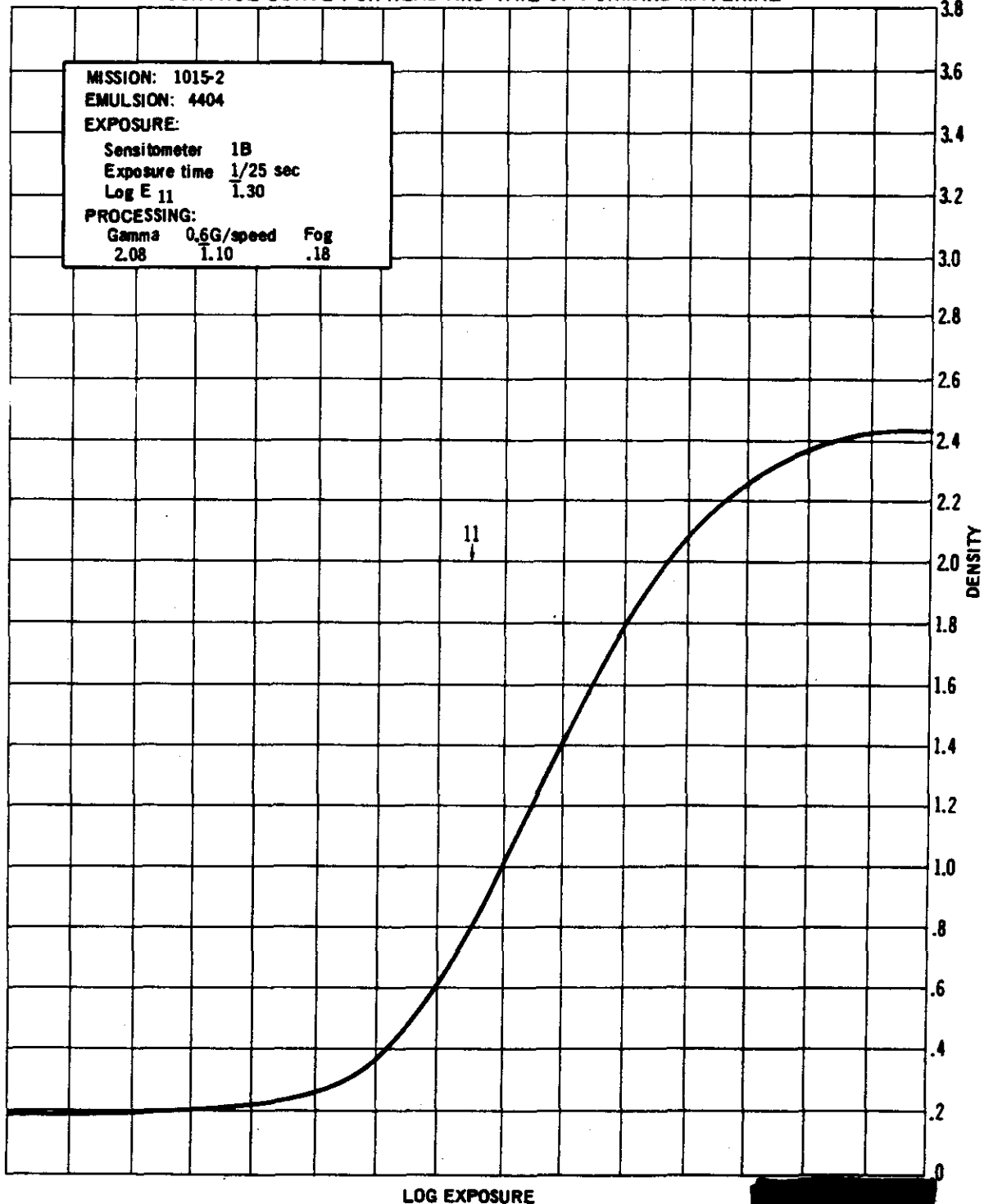


STANDARD PROCESSING CONTROL CURVES



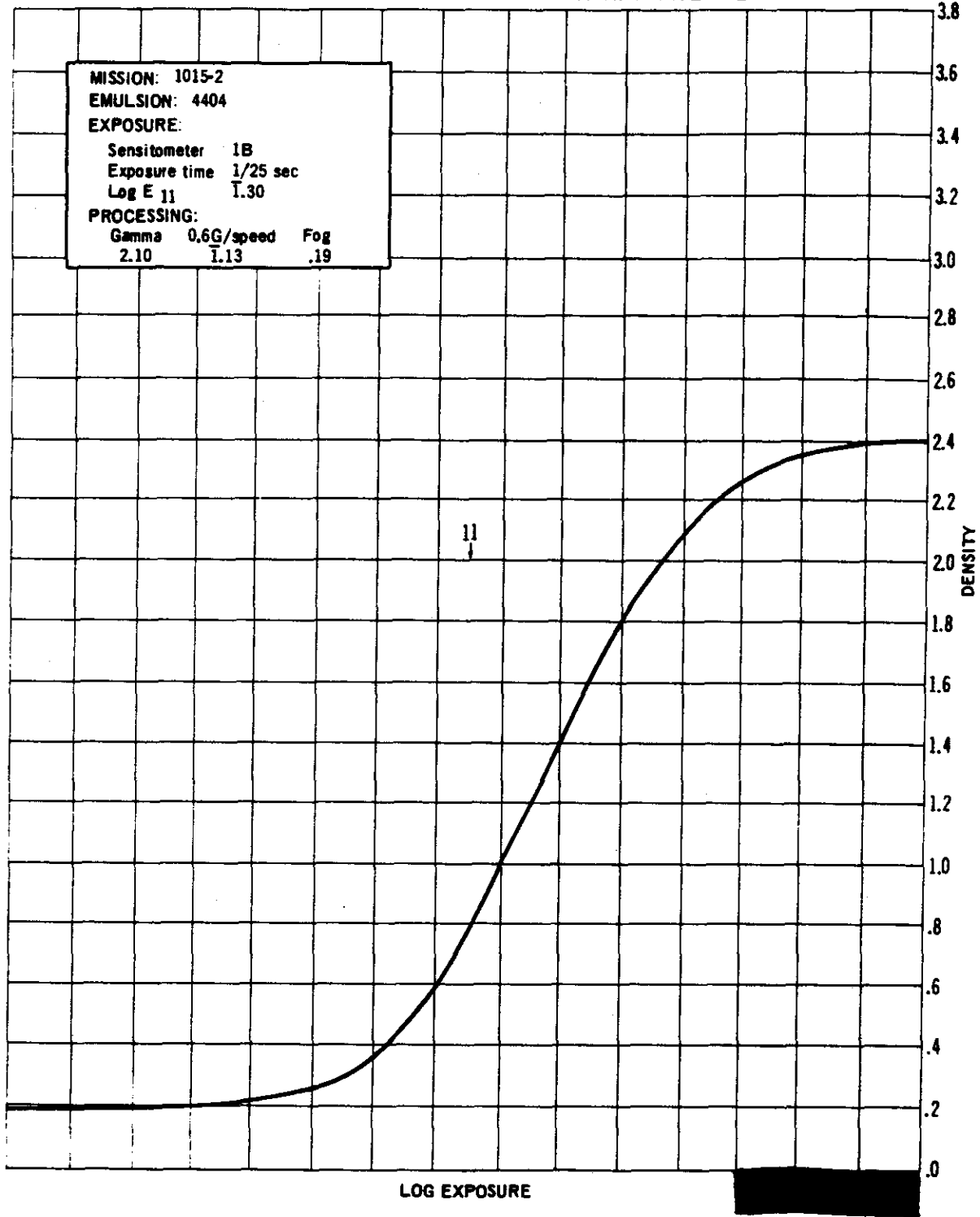


CONTROL CURVE FOR HEAD AND TAIL OF FORWARD MATERIAL





CONTROL CURVE FOR HEAD AND TAIL OF AFT MATERIAL

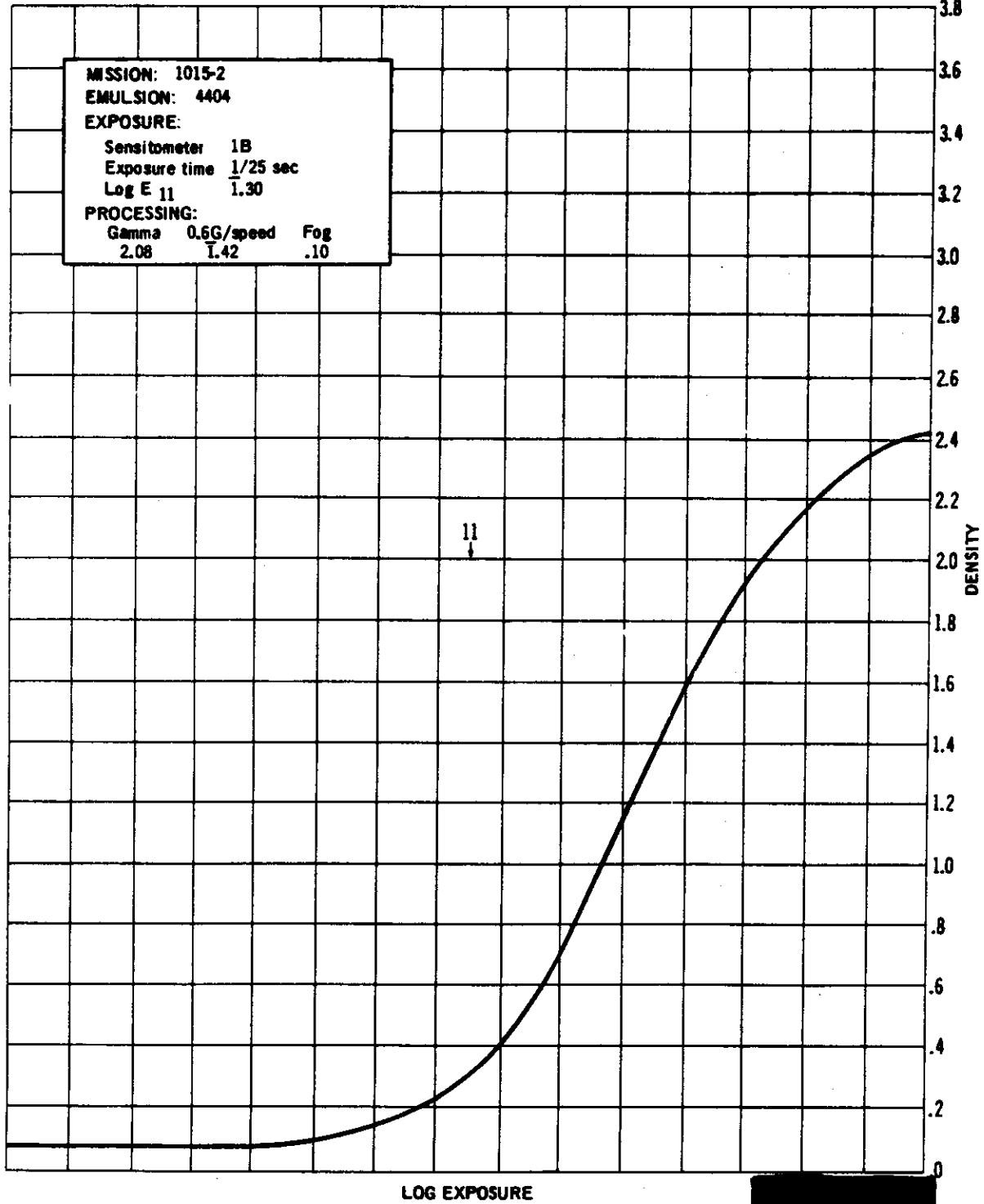


LOG EXPOSURE



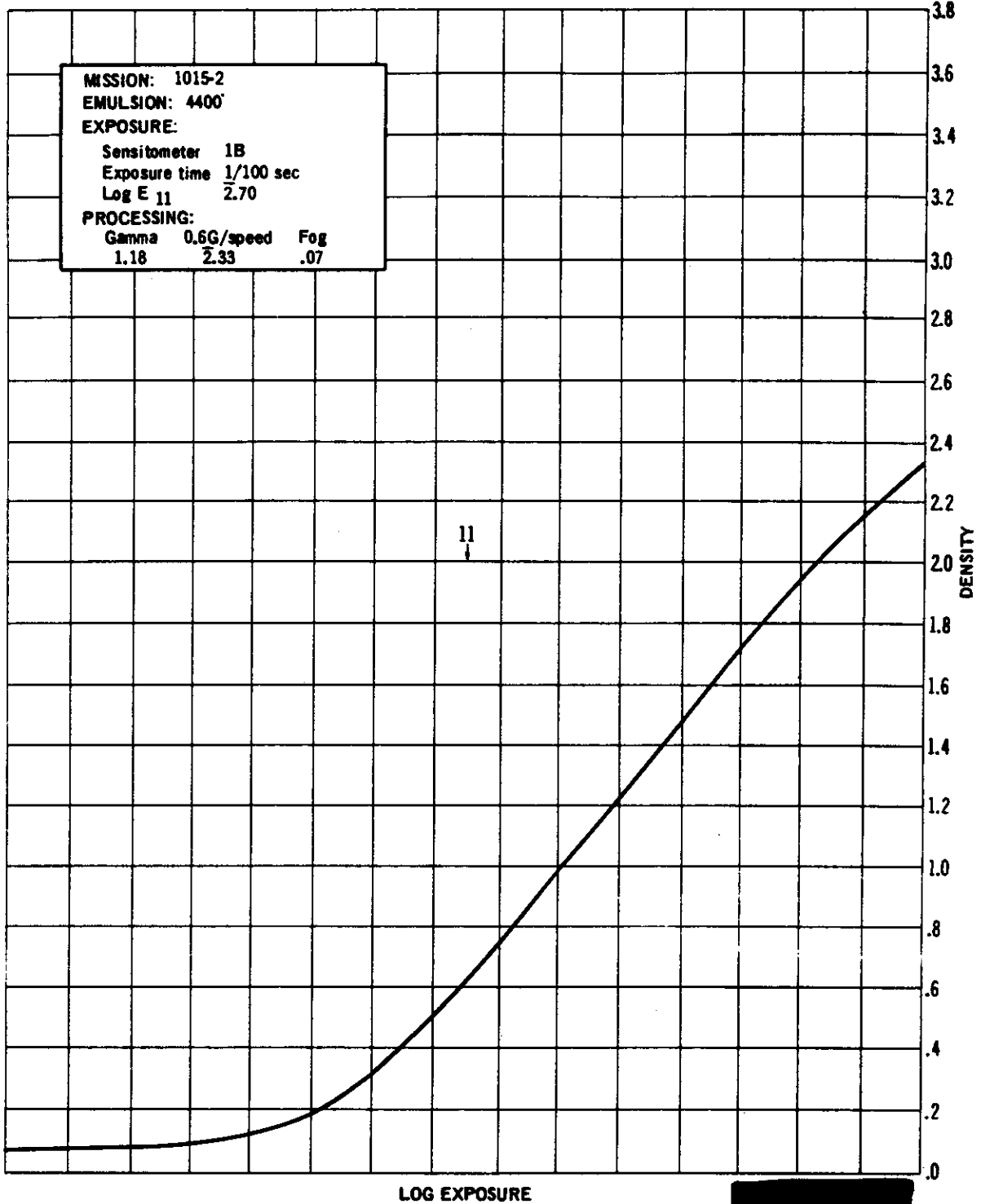


SENSITOMETRIC CURVE FROM MISSION MATERIAL





CONTROL CURVE FOR HEAD AND TAIL OF INDEX MATERIAL



LOG EXPOSURE



PART III. IMAGE QUALITY

1. Definition of Photographic Interpretation (PI) Suitability

PI suitability 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 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 photographic interpreter may extract useful and reliable information from the material.

PI suitability ratings are: 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. The standards that determine assignment of the various ratings are:

Excellent: The photography is free of degradations 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 optimum 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 present and the acuity of the photography is less than optimum. Edges and corners are not crisply defined and there is loss of detail in shadow or highlight areas. Detection and identification of small objects are possible but accuracy of mensuration is limited by the fall-off in image quality and the less-than-optimum contrast.

Poor: Camera-induced degradations or weather limitations severely reduce the effectiveness of the photography. Definition of edges and corners are not well defined. 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, Missions 1015-1 and 1015-2:

The PI suitability of Mission 1015 ranges between fair and good. The photographic coverage permitted observation of 123 targets (74 in Mission 1015-1 and 49 in Mission 1015-2), but snow cover and haze conditions served to reduce the PI suitability in a number of cases.

Frame 7 of pass 26D contains an excellent example of sun-flared water and associated reflectance streaks. Although not severely degrading in many cases, reflectance streaking is an anomaly that merits attention. Basically, it derives from reflected light and is present primarily in photography containing alto cumulus cloud formations, bodies of sun-struck water, and areas of land-water adjacency, such as coastlines, peninsulas, and islands. All of the factors involved in reflectance streaking are not precisely known. It is detectable only when contrast and density permit its observation, but is undoubtedly present to some degree wherever high-reflectance conditions exist. If the streaks were associated solely with specular reflections they would be of less consequence. However, alto cumulus cloud formations also induce reflectance streaking, despite the fact that reflection of the incident light is more or less evenly distributed over a large surface and no concentrated specular reflection is observed. Similarly, streaks are occasionally noted in land-to-water transition areas, although no flare is observed. In view of the orientation of the streaks to the long axis of the film, some relation to the scan and field flattener is suspected. This possibility is currently being investigated with a view to eliminating the streaks by the employment of baffles.

A considerable number of temperature variations were experienced during flight (see Appendix D. Temperature Data) but no effects on photographic quality are detectable. However, the quality-temperature relationship, if any, will continue to be evaluated in each mission.

The following are a few of the coverage highlights reported in the PI summaries of Missions 1015-1 and 1015-2:

- (a) 2 newly identified missile complexes.
- (b) 8 newly identified missile launch sites.
- (c) 1 newly identified radar site.

- (d) 13 newly identified anti-aircraft artillery positions.
- (e) 1st observation of activity at a new rocket engine test facility.
- (f) 1st observation of activity in a nuclear energy test site powerplant.

The initial scan of the mission record was performed in a relatively short time, without the aid of the precise analytical and mensuration instruments normally employed in interpretation of this material. Continued study of the film may increase the number of targets observed and may alter some of the data obtained in the initial scan of the targets already reported.

Definition of 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 missions. It is meant to be a measure of the camera's maximum capability for recording information, discounting adverse atmospheric conditions, minimum 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 to be the best in the mission, they do not indicate the overall success, average quality, or general interpretability of the photography.

Criteria for selection of the MIP frame:

- a. Eliminate all portions of the mission affected by system malfunctions.
- b. Select frames which are free of clouds or atmospheric attenuation.
- c. Eliminate the first 10 frames and last frame of a pass because these may be affected by incorrect scan speed.
- d. Select frames that are in a continuous strip of approximately 10 cloud-free frames because cloud shadows from 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 the 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.
- 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, Missions 1015-1 and 1015-2:

Based on the foregoing criteria, an airfield in frame 14 of pass 47DE AFT and a port facility in frame 24 of pass 88D AFT are selected as the MIP examples for Missions 1015-1 and 1015-2, respectively. Mission 1015 is assigned an MIP rating of 85 and the photographic quality is comparable to that achieved in Mission 1012, 17-23 October 1964. The photography obtained from the slave (AFT) camera is slightly superior to the master (FWD) material.



APPENDIX A. SYSTEM SPECIFICATIONS

1. Cameras:

PANORAMIC CAMERAS	MASTER (FWD)	SLAVE (AFT)
Camera Number	138	141
Lens Serial Number	1152435	1182435
Slit Width	0.250"	0.175"
Aperture	f/3.5	f/3.5
Filter	Wratten 25	Wratten 21
Operational F/L	609.602 mm	609.617 mm
Film Type	7J-40	7J-40
Film Length	16,000 ft	16,000 ft
Splices	4	4
Emulsion	68-6-7-4	68-6-7-4

Static Bench Test:

High Contrast	300 L/mm	258 L/mm
Low Contrast	140 L/mm	158 L/mm

Dynamic Test:

ITEK High Contrast	164 L/mm	165 L/mm
ITEK Low Contrast	120 L/mm	130 L/mm
AP High Contrast	185 L/mm	189 L/mm
AP Low Contrast	117 L/mm	121 L/mm

~~TOP SECRET~~
CORONA

~~CONFIDENTIAL~~



STELLAR/INDEX CAMERAS	STELLAR		INDEX	
	1015-1	1015-2	1015-1	1015-2
Camera Number	61	58	D61	D58
Lens Serial Number	10516	10631	817016	813068
Reseau Serial Number	61	58	61	58
Filter	None	None	Wratten 21	Wratten 21
Aperture	f/1.8	f/1.8	f/4.5	f/4.5
Exposure Time	2 sec	2 sec	1/500 sec	1/500 sec
Operational F/L	Not	Not		
	Applicable	Applicable	38.02 mm	38.334 mm
Film Type	3J-34	3J-34	7J-33	7J-33
Film Length	Not	Not	Not	Not
	Reported	Reported	Reported	Reported
Perpendicularity of Reseau to Optical Axis	.0007/.937"	.0006/.937"	.0002/2.25"	.0003/2.25"
Location of Principal Point	Not	Not	Not	Not
	Reported	Reported	Reported	Reported

HORIZON CAMERAS	MASTER		SLAVE	
	Stbd (Take-up)	Port (Supply)	Stbd (Supply)	Port (Take-up)
Camera Number	138	138	141	141
Lens Serial Number	813525	813558	813534	813526
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 F/L	54.93 mm	54.89 mm	54.80 mm	54.93 mm
Average L/MM	114 L/mm	94 L/mm	106 L/mm	111 L/mm
Radial Distortion:				
10° Off-Axis	0.001 mm	0.001 mm	0.004 mm	0.009 mm
20° Off-Axis	0.002 mm	0.001 mm	0.004 mm	0.015 mm
Tangential Distortion	0.004 mm	0.001 mm	0.007 mm	0.009 mm



MASTER (FWD) HORIZON CAMERAS

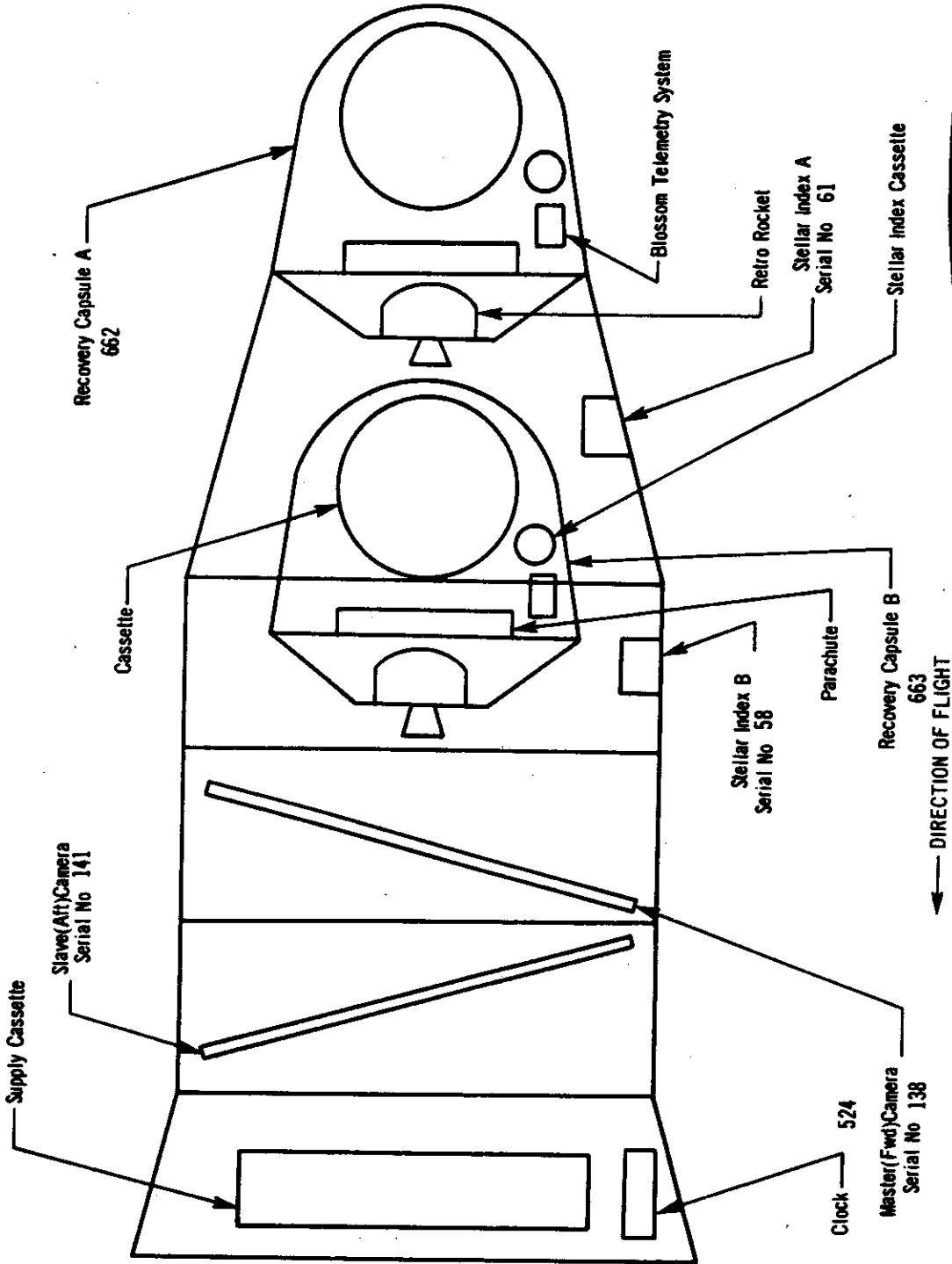
RESOLUTION	Starboard (Take-Up)							Port (Supply)					
Angle Off-Axis	0	5	10	15	20	25	27.5	0	10	15	20	25	30
Radial Resolution	164	155	136	106	87	112	91	170	111	87	75	97	63
Tangential Resolution	164	145	127	102	91	60	51	170	98	89	66	58	42

SLAVE (AFT) HORIZON CAMERAS

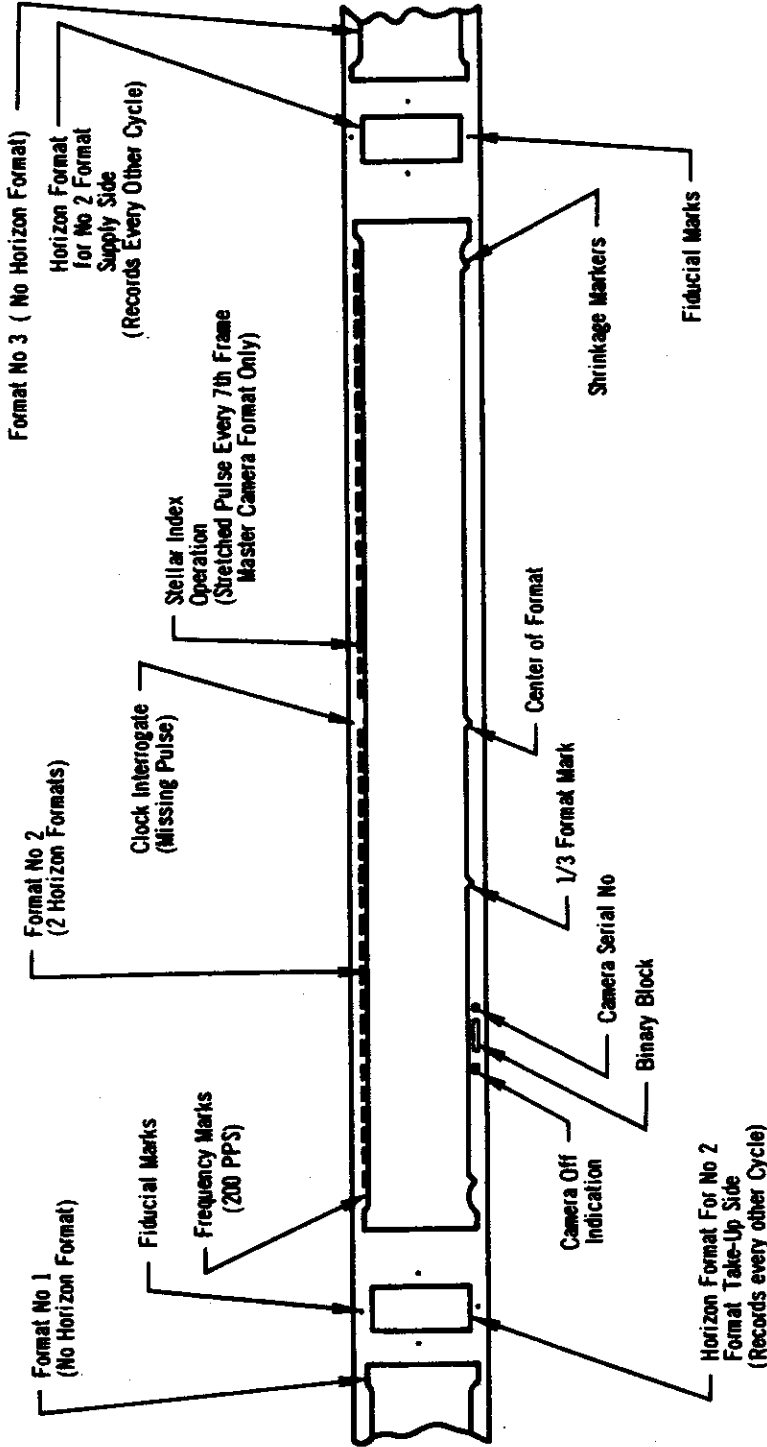
RESOLUTION	Starboard (Supply)							Port (Take-Up)					
Angle Off-Axis	0	5	10	15	20	25	27.5	0	10	15	20	25	27.5
Radial Resolution	164	145	114	99	97	111	103	170	148	101	95	97	75
Tangential Resolution	164	145	112	102	91	60	51	170	138	100	80	55	42



VEHICLE LAYOUT



FILM SPECIFICATIONS
FORMAT LAYOUT



Slave (Alt) Panoramic Camera No 141
Viewed With Negative Emulsion Down
Direction of Film Transport →
Direction of Scan →
Direction of Vehicle Motion ↑

Master (Fwd) Panoramic Camera No 138
Viewed With Negative Emulsion Down
Direction of Film Transport →
Direction of Scan →
Direction of Vehicle Motion ↑

4. 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 3 targets each, are aligned to be coplanar within ± 5 seconds of arc so positioned as to form an angle of -15.00 degrees ± 5 seconds to the mechanical interface for master camera calibrations and an angle of $+15.00$ degrees ± 5 seconds to the mechanical interface for slave camera calibrations.

A. Target 1 of each set is imaged on the terrain format.

B. The second and third targets of each set are at angles of 75.00 degrees ± 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 intersection of lines joining opposite fiducials.

X_{vo} and Y_{vo} are the offsets of target 1 from the indicated center of format of the panoramic cameras as defined in Paragraph 3.

X_s, Y_s and X_t, Y_t 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 slave camera.

Dimensions A, B, and C are the spacings of the shrinkage markers, and dimensions D and E are the spacings 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.

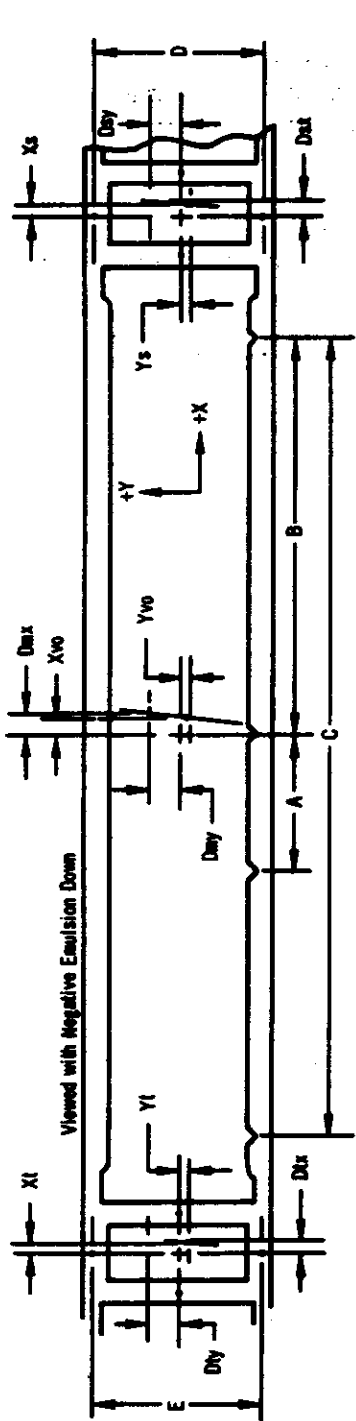
The format dimensions are measured to the best estimate of format edge.



Measurement 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 D_{mx} and D_{my} 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 on 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 D_{tx} , D_{ty} , D_{sx} , and D_{sy} are the offsets of these measurements.

FILM SPECIFICATIONS
FORMAT DIMENSIONS



Master (Fwd) Camera No 136	Vehicle Motion	Scan Direction	Slave (Rr) Camera No 141	Vehicle Motion	Scan Direction
A 76.1	X1 -0.020	Dtx -0.028	A 76.2	X1 -0.186	Dtx -0.191
B 355.1	Y1 0.155	Dty 2.873	B 354.8	Y1 -0.203	Dty 1.762
C 710.2	Xs 0.222	Dsx 0.224	C 710.0	Xs -0.171	Dsx -0.180
D 56.440	Ys 0.121	Dsy 2.476	D 56.454	Ys -0.001	Dsy -2.097
E 56.432	Xvo 1.006	Dmx 0.551	E 56.488	Xvo -1.014	Dmx -1.003
	Yvo	Dmy 4.006		Yvo 0.167	Dmy 3.167

Format dimensions:

Panoramic
Height 55.610
Width 753.80

Format dimensions:

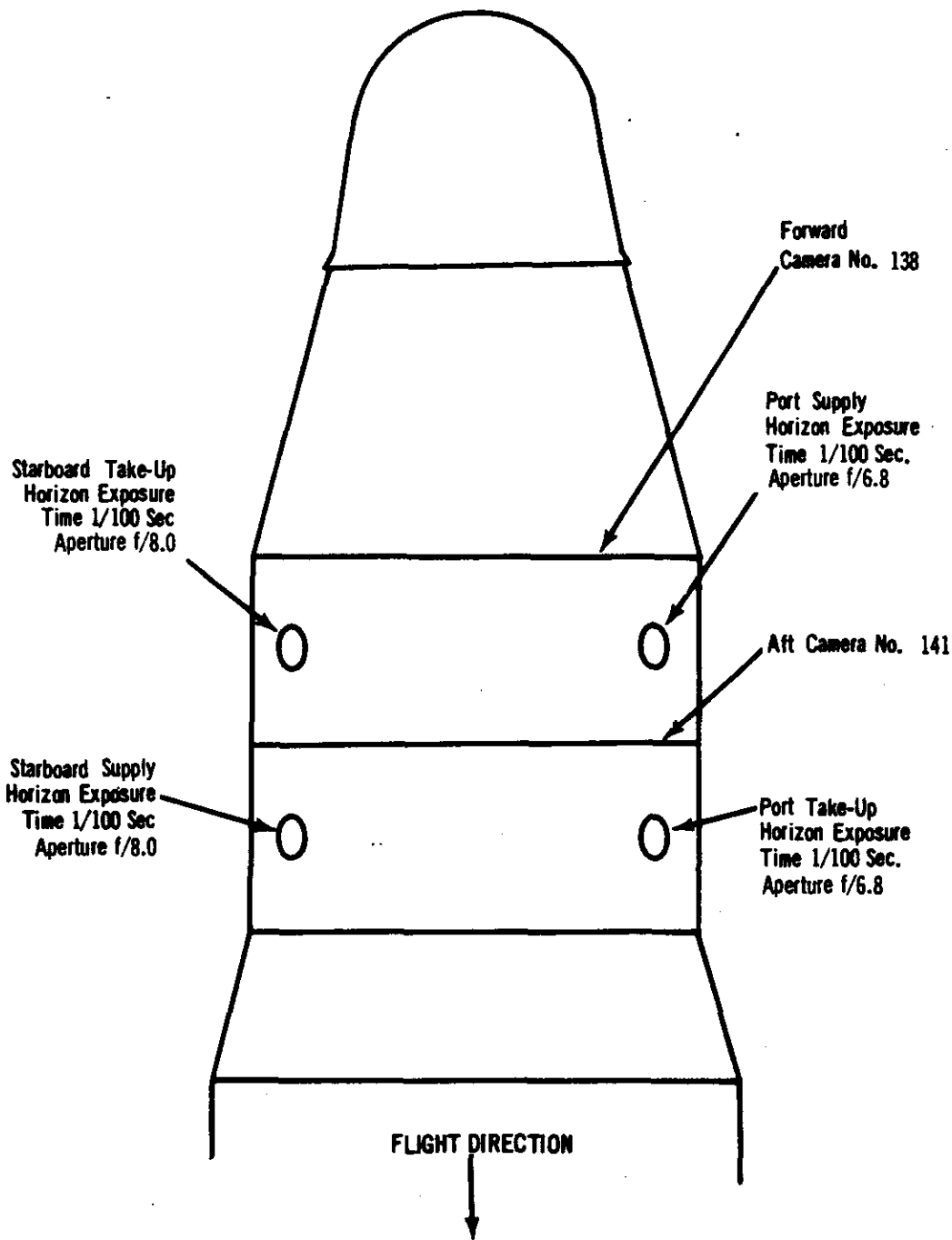
Panoramic
Height 57.055
Width 753.50

- 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. D_x, D_y, D_s, X and Y dimensions are taken 10 mm above point defining target center
 4. Format Sign Convention

$$\begin{array}{c|c} -X+Y & +X+Y \\ \hline -X-Y & +X-Y \end{array}$$



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



APPENDIX B. DENSITY READINGS

Mission 1015-1

Pass	STELLAR CAMERA						INDEX CAMERA								
	Frame	Dmax	Dmin	Delta	Gross Fog		LIMITING			TERRAIN					
							Dmax	Dmin	Delta	Dmax	Dmin	Delta			
1D	1	1.12	0.32	0.80	0.20		.72	.14	.58	.09	.58	.09	NR	.44	NR
3D	3	1.58	0.35	1.23	0.20		.72	.28	.44	.10	.44	.10	.28	.44	NR
4D	6	1.64	0.49	1.15	0.20		.64	.15	.49	.09	.49	.09	NR	.29	NR
5D	7	1.03	0.33	0.70	0.20		.47	.18	.29	.09	.29	.09	.18	.66	NR
21	21	1.98	0.50	1.48	0.19		1.08	.28	.80	.08	.80	.08	.42	.11	NR
31	31	2.17	0.31	0.92	0.19		.44	.17	.27	.09	.27	.09	.19	NR	NR
38	38	1.60	0.56	1.61	0.20		1.06	.21	.85	.09	.85	.09	NR	NR	NR
61	61	2.16	0.42	1.22	0.19		.95	.18	.77	.09	.77	.09	.25	.50	NR
62	62	1.01	0.62	1.54	0.19		1.14	.25	.89	.09	.89	.09	.15	.25	NR
76	76	2.50	0.28	0.73	0.19		.40	.15	.25	.09	.25	.09	.32	.92	NR
9AE	77	NR	0.72	1.78	0.21		1.24	.32	.92	.09	.92	.09	NR	NR	NR
10D	78	2.15	NR	NR	0.20		NR	NR	NR	.22	.22	.09	.60	.22	NR
88	78	2.58	0.58	1.57	0.21		.60	.38	.22	.09	.22	.09	NR	NR	NR
89	88	2.58	0.84	1.74	0.21		1.39	.42	.97	.09	.97	.09	.40	.18	NR
92	89	2.62	0.79	1.83	0.21		1.30	.20	1.10	.09	1.10	.09	.58	.38	NR
93	92	2.38	0.74	1.64	0.21		.98	.14	.84	.09	.84	.09	.56	.18	NR
94	93	2.40	0.72	1.68	0.21		1.11	.16	.95	.09	.95	.09	NR	NR	NR
95	94	2.46	0.76	1.70	0.21		1.20	.22	.98	.09	.98	.09	NR	NR	NR
104	95	1.25	0.32	0.93	0.21		.40	.14	.26	.09	.26	.09	.40	.26	NR
105	104	1.88	0.51	1.37	0.19		1.00	.18	.82	.09	.82	.09	1.00	.82	NR
120	105	1.63	0.42	1.21	0.19		.98	.16	.82	.09	.82	.09	.73	.33	NR
121	120	1.99	0.54	1.45	0.20		1.27	.15	1.12	.09	1.12	.09	NR	NR	NR
136	121	1.40	0.35	1.05	0.20		.70	.15	.52	.09	.52	.09	.70	.40	NR
137	136	2.14	0.51	1.63	0.20		1.58	.19	1.39	.09	1.39	.09	.52	.24	NR
147	137	1.22	0.32	0.90	0.20		.48	.10	.38	.09	.38	.09	.48	.38	NR
148	147	2.48	0.72	1.76	0.20		1.08	.21	.87	.09	.87	.09	1.00	.62	NR
150	148	2.49	0.69	1.80	0.20		1.73	.29	1.44	.09	1.44	.09	.64	.14	NR
151	150	2.53	0.79	1.74	0.21		1.72	.28	1.44	.09	1.44	.09	NR	NR	NR
158	151	2.46	0.80	1.66	0.20		1.22	.21	1.01	.09	1.01	.09	NR	NR	NR
159	158	2.20	0.62	1.58	0.21		1.34	.18	1.16	.09	1.16	.09	NR	NR	NR
162	159	2.34	0.59	1.75	0.21		1.50	.21	1.29	.09	1.29	.09	1.34	1.13	NR
163	162	2.38	0.69	1.69	0.21		1.25	.15	1.10	.09	1.10	.09	.61	.31	NR
168	163	1.19	0.35	0.84	0.21		.42	.20	.22	.09	.22	.09	.42	.22	NR
169	168	2.05	0.61	1.44	0.20		1.36	.22	1.14	.09	1.14	.09	NR	NR	NR
177	169	1.76	0.49	1.27	0.21		.68	.26	.42	.09	.42	.09	.68	.42	NR
	177	2.00	0.51	1.49	0.20		.91	.21	.70	.09	.70	.09	NR	NR	NR

NR - Denotes No Reading Made

Mission 1015-1

Pass	SITE LLAR CAMERA						INDEX CAMERA					
	Frame	Dmax	Dmin	Delta	Gross Fog	Delta	LIMITING			TERRAIN		
							Dmax	Dmin	Delta	Dmax	Dmin	Delta
37D	178	1.81	0.42	1.39	0.19	.78	.20	.58	.09	.66	.20	.46
38D	190	2.15	0.58	1.57	0.20	1.32	.14	1.18	.09	NR	NR	NR
39D	191	1.64	0.49	1.15	0.20	.70	.19	.51	.08	NR	.19	.51
41D	216	2.65	0.72	1.93	0.19	1.55	.28	1.27	.08	.62	.43	.19
47DE	217	1.22	0.30	0.92	0.19	.38	.13	.25	.09	.38	.13	.25
52D	227	2.50	0.72	1.78	0.21	1.22	.62	.62	.09	NR	NR	NR
53D	228	1.59	0.49	1.10	0.21	.70	.20	.50	.09	.70	.20	.50
54D	232	2.02	0.63	1.39	0.21	.75	.19	.56	.09	.66	.24	.42
56AE	233	2.30	0.63	1.67	0.21	.82	.24	.58	.09	.82	.24	.58
57D	238	2.02	0.50	1.52	0.19	.83	.16	.67	.09	.83	.24	.59
63D	239	1.06	0.28	0.78	0.19	.38	.18	.20	.09	.38	.18	.20
66D	250	1.94	0.44	1.50	0.19	.92	.28	.64	.09	.92	.28	.64
67D	251	1.06	0.27	0.79	0.19	.30	.12	.18	.09	.30	.12	.18
69D	277	2.08	0.52	1.56	0.19	1.28	.20	1.08	.09	.58	.32	.26
70D	278	1.44	0.38	1.06	0.19	.68	.19	.49	.09	.68	.19	.41
71D	287	2.33	0.51	1.82	0.19	1.21	.35	.86	.09	1.10	.40	.70
72AE	288	NR	NR	NR	0.19	NR	NR	NR	.09	NR	NR	NR
73D	289	NR	NR	NR	0.19	NR	NR	NR	.09	NR	NR	NR
77D	290	1.79	0.45	1.34	0.19	.72	.22	.50	.09	.72	.22	.50
79D	295	2.00	0.48	1.52	0.19	.82	.18	.64	.09	.82	.22	.60
84E	296	2.37	0.61	1.76	0.19	1.18	.20	.98	.09	NR	NR	NR
85E	298	2.44	0.59	1.85	0.19	1.28	.15	1.13	.09	.52	.28	.24
86E	299	1.33	0.36	0.97	0.19	.69	.20	.49	.09	NR	NR	NR
87E	305	1.71	0.45	1.26	0.20	.38	.20	.18	.09	NR	NR	NR
88E	306	1.19	0.32	0.87	0.20	.37	.12	.25	.09	NR	NR	NR
89E	319	2.27	0.60	1.67	0.19	.88	.17	.71	.09	NR	NR	NR
90E	320	1.28	0.32	0.96	0.19	.50	.17	.33	.09	.50	.17	.33
91E	344	2.27	0.54	1.73	0.19	1.77	.19	1.58	.09	.70	.52	.18
92E	345	0.95	0.29	0.66	0.19	.32	.12	.20	.09	.32	.12	.20
93E	356	2.31	0.53	1.78	0.19	1.00	.22	.78	.09	.84	.37	.47
94E	357	0.94	0.28	0.66	0.19	.39	.16	.23	.09	NR	NR	NR
95E	371	2.37	0.53	1.84	0.19	1.04	.50	.54	.09	1.04	.50	.54
96E	372	NR	NR	NR	0.19	NR	NR	NR	.09	NR	NR	NR
97E	373	2.48	0.73	1.75	0.19	1.45	.28	1.17	.09	NR	NR	NR
98E	378	2.71	0.76	1.95	0.19	1.75	.42	1.33	.08	NR	NR	NR
99E	379	1.98	0.49	1.49	0.19	1.02	.28	.74	.09	1.02	.42	.60
100E	382	2.10	0.56	1.54	0.19	1.72	.20	1.52	.09	.56	.42	.14
101E	383	2.41	0.58	1.83	0.19	1.22	.60	.62	.09	NR	NR	NR
102E	384	2.56	0.71	1.85	0.19	1.10	.52	.38	.09	NR	NR	NR
Summary	Dmax Range	0.94-2.71	Average Dmax	1.93	Limiting Dmax Range	0.30-1.77	Terrain Dmax Range	0.30-1.24				
Summary	Dmin Range	0.19-0.84	Average Dmin	0.52	Average Limiting Dmax	0.96	Average Terrain Dmax	0.69				
Summary	Gross Fog Range	0.19-0.21	Average Gross Fog	0.19	Limiting Dmin Range	0.10-0.52	Terrain Dmin Range	0.10-0.52				
Summary					Average Limiting Dmin	0.22	Average Terrain Dmin	0.27				
Summary					Gross Fog Range	0.08-0.09	Average Gross Fog	0.09				
Summary					Average Gross Fog	0.09						

Mission 1015-2

Stellar Camera No D58											
Pass	Frame	Dmax	Dmin	Delta	Gross Fog	Pass	Frame	Dmax	Dmin	Delta	Gross Fog
81DE	1	3.12	1.27	1.85	0.21	151D	206	2.06	0.72	1.34	0.21
83D	2	1.73	0.48	1.25	0.23	152AE	219	2.26	1.16	1.10	0.20
84D	13	2.40	0.90	1.50	0.29	152D	220	NR	NR	NR	0.21
85D	14	1.88	0.85	1.03	0.23	161D	221	NR	NR	NR	0.21
86D	33	2.42	1.16	1.26	0.27	162D	222	1.93	0.90	1.03	0.21
87D	34	1.60	0.49	1.11	0.20	164D	235	2.50	1.14	1.36	0.21
88AE	55	2.70	1.36	1.34	0.20	165D	236	1.58	0.31	1.57	0.22
88D	56	1.42	0.34	1.08	0.23	166D	242	2.00	0.62	1.38	0.22
89	67	2.59	1.04	1.55	0.20	167AE	243	1.48	0.34	1.14	0.23
95	68	2.38	1.10	1.28	0.21	167D	253	2.21	0.77	1.44	0.21
96	87	2.68	1.44	1.24	0.34	168D	254	1.58	0.34	1.24	0.21
99	88	NR	NR	NR	0.25	172D	288	2.53	1.29	1.24	0.21
100	89	NR	NR	NR	0.25	173D	289	1.99	0.35	1.64	0.21
104	90	2.28	0.92	1.36	0.27	174D	307	2.20	1.10	1.10	0.20
105	95	2.62	1.08	1.54	0.21	175D	308	1.62	0.32	1.30	0.20
112	96	2.45	1.42	1.03	0.22	176D	330	2.20	1.08	1.12	0.20
113	99	2.28	1.20	1.08	0.22	177AE	331	NR	NR	NR	0.21
127	100	1.38	0.38	1.00	0.27	177D	332	NR	NR	NR	0.22
128	104	1.59	0.55	1.04	0.28	178D	333	2.02	0.49	1.53	0.20
146D	105	1.40	0.33	1.07	0.22	179D	346	2.39	1.00	1.39	0.20
147D	112	2.40	0.95	1.45	0.22	180D	347	2.07	1.16	0.91	0.21
148D	113	1.89	0.55	1.34	0.21	181D	359	2.40	1.32	1.08	0.20
149D	127	2.20	1.09	1.11	0.21	182D	360	2.57	1.29	1.28	0.21
150D	128	1.38	0.30	1.08	0.22	183D	367	1.95	0.82	1.13	0.22
	170	2.41	1.08	1.33	0.21	184D	368	2.50	1.22	1.28	0.22
	171	1.80	0.49	1.31	0.21	185D	371	2.61	1.39	1.22	0.22
	192	2.54	1.00	1.54	0.22	186D	372	2.01	1.00	1.01	0.22
	193	1.90	0.62	1.28	0.22	187D	379	2.55	1.32	1.23	0.21
	205	2.22	1.14	1.08	0.22						

The material acquired from Index Camera No D58 (Mission 1015-2) is not available for density readings.

Dmax Range 1.38-3.12 Average Dmax 2.09
 Dmin Range 0.30-1.44 Average Dmin 0.88
 Gross Fog Range 0.20-0.34 Average Gross Fog 0.22



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 percent 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.

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 millimeters.



SUMMARY TABLE OF EDGE TRACES

Trace Number	Line Spread Function Width at 50% Amplitude	Reciprocal of LSF Width at 50% Amplitude
1015-1		
1	16.72 microns	59.80 L/mm
2	13.71 microns	72.90 L/mm
3	13.90 microns	71.60 L/mm
1015-2		
4	15.44 microns	64.80 L/mm
5	18.01 microns	55.50 L/mm