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This document contains 13 pages

Analysis of Photographic Image to Evaluate System Performance Mission 1015-2

14 January 1965

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TITLE:

Summary of Microdensitometer Derived Image Quality Data Collected from Mission 1015-2

SECTION I: INTRODUCTION

Microdensitometer tracing of scene edges has been used as an objective technique for evaluating photographic system performance. In this report, the evaluation data is presented as spread function width in microns and resolving power in lines per millimeter. A statistical summary of the edge data for this mission is presented in Section II, giving the arithmetic mean, standard deviation, coefficient of dispersion, and number of edges. Section IIA is included to show a statistical breakdown of the

(a) forward and aft camera quality and

(b) the analysis of buildings and airfields used as scene objects.

Section III is a summary of all C/M/J Missions that have been recomputed with the new SWRDR computer program. Image Quality Ranking of all C/M/J Missions is listed in Section IIIA. Frequency plots of the spread function and resolving power data are presented as Section IV, to show the distribution of values. A tabulation of the location, description, and image quality data for each edge is presented as Section V.

Appendix A is included to show the edge orientation reference system and edge location grid. In use, the film is placed on an illuminator with the titling correct reading (i.e. emulsion down) with the camera take-up end at the right and the supply at the left. The orientation of an edge is described as 000 for longitudinal and 090 for transverse edges; the numbering system runs in a clockwise direction. The coordinate locator grid consists of centimeter squares numbered such that the center of the frame is given as X46.0, Y12.0. X numbers increase toward the take-up and Y numbers increase toward the title.

The image quality data was obtained from sharp scene edges in the original negative by scanning with a Kodak Model 5 microdensitometer. A 1 x 80 micron slit was used. The data reduction consisted of the following steps:

(a) hand smoothing of the microdensitometer strip chart recording,

(b) key punching of chart (density) values at sample distance increments of 0.420 microns,

(c) I.B.M. 7044 computer conversion of chart values to relative exposure values, and

(d) computer conversion of exposure data to line spread function and modulation transfer function by numerical methods.

The edge resolving power was predicted graphically as the intersection of the MTF curve and the aerial image modulation curve for 4404 film at a test object contrast of 2:1. The spread function width was calculated from the first differences of relative exposure as the width at which the gradient became 50% of the maximum gradient.

Each edge was traced three times on the microdensitometer, and the average of the computed spread function and resolution is presented in Section V.

Analysis of Photographic Image to Evaluate System Performance

SECTION II SUMMARY SHEET

Mission 1015-2

Resolution in lines/mm based on the aerial image modulation - 4404 curve from edge trace data reduced by computer techniques.

Arithmetic Mean	89.7 l/mm
Standard Deviation	17.8 l/mm
Coefficient of Dispersion	20%
Number of Edges	40
M.I.P. Frame	86 l/mm

Spread function width at 50% amplitude in microns from edge trace data reduced by computer techniques.

Arithmetic Mean	9.2 μ
Standard Deviation	2.3 μ
Coefficient of Dispersion	25%
Number of Edges	40
M.I.P. Frame	8.4 μ

Analysis of Photographic Image to Evaluate System Performance

SECTION IIA SUMMARY SHEET

Mission 1015-2

Resolution in lines/mm based on the aerial image modulation - 4404 curve from edge trace data reduced by computer techniques.

	FWD Camera	AFT Camera	Airfields	Buildings
Arithmetic Mean	89.2 l/mm	90.3 l/mm	78.0 l/mm	91.8 l/mm
Standard Deviation	15.9 l/mm	20.0 l/mm	13.5 l/mm	17.9 l/mm
Coefficient of Dispersion	18%	22%	17%	19%
Number of Edges	20	20	6.0	34

Spread function width at 50% amplitude in microns from edge trace data reduced by computer techniques.

	FWD Camera	AFT Camera	Airfields	Buildings
Arithmetic Mean	9.2 μ	9.1 μ	10.6 μ	8.9 μ
Standard Deviation	2.2 μ	2.5 μ	1.8 μ	2.3 μ
Coefficient of Dispersion	24%	27%	17%	26%
Number of Edges	20	20	6.0	34

Analysis of Photographic Image to Evaluate System Performance

SECTION III - MISSION 1015-2

Summary of all C/M/J Missions Traced to Date

Mission Number	Number of Edges	Spread Function Width at 50% Amplitude in Microns, Computer Calculations			Resolution in lines/mm from A.I.M. 4404 Curve, Computer Calculations		
		Arithmetic Mean	Standard Deviation	Coefficient of Dispersion	Arithmetic Mean	Standard Deviation	Coefficient of Dispersion
1007-2*	106	12.2	3.9	32%	71.0	18.0	25%
1008-1*	103	10.6	3.2	30%	83.0	21.1	25%
1008-2*	123	10.2	3.9	38%	84.3	21.0	25%
1009-1	80	11.7	4.2	36%	75.3	19.9	26%
1009-2	110	13.0	5.0	39%	74.1	21.7	29%
1010-1	119	9.8	3.3	33%	89.4	22.7	25%
1010-2	110	9.8	3.2	32%	84.3	21.4	25%
1011-1	115	10.9	3.8	35%	80.5	21.6	27%
1012-1	94	10.1	3.7	36%	86.1	20.4	24%
1012-2	100	10.2	3.1	31%	84.0	21.4	26%
1013-1	49	10.8	4.1	38%	83.3	27.3	33%
1014-1	92	10.8	4.5	41%	83.0	24.7	30%
1014-2	90	11.7	3.9	34%	74.2	20.1	27%
1015-1	35	8.8	2.3	26%	93.1	16.5	18%
1015-2	40	9.2	2.3	25%	89.7	17.8	20%

*A 1 x 320 micron slit was used

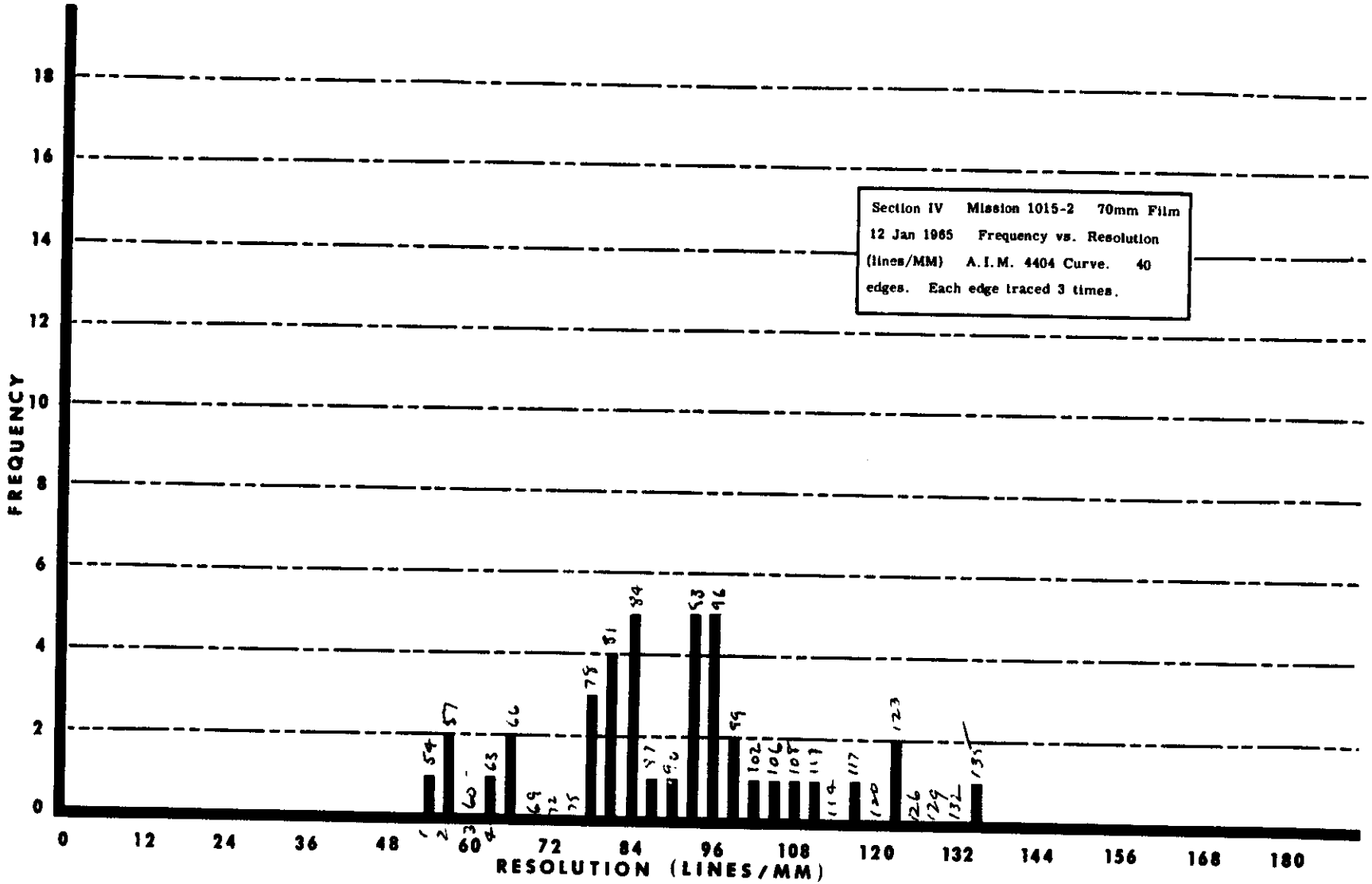
Analysis of Photographic Image to Evaluate System Performance

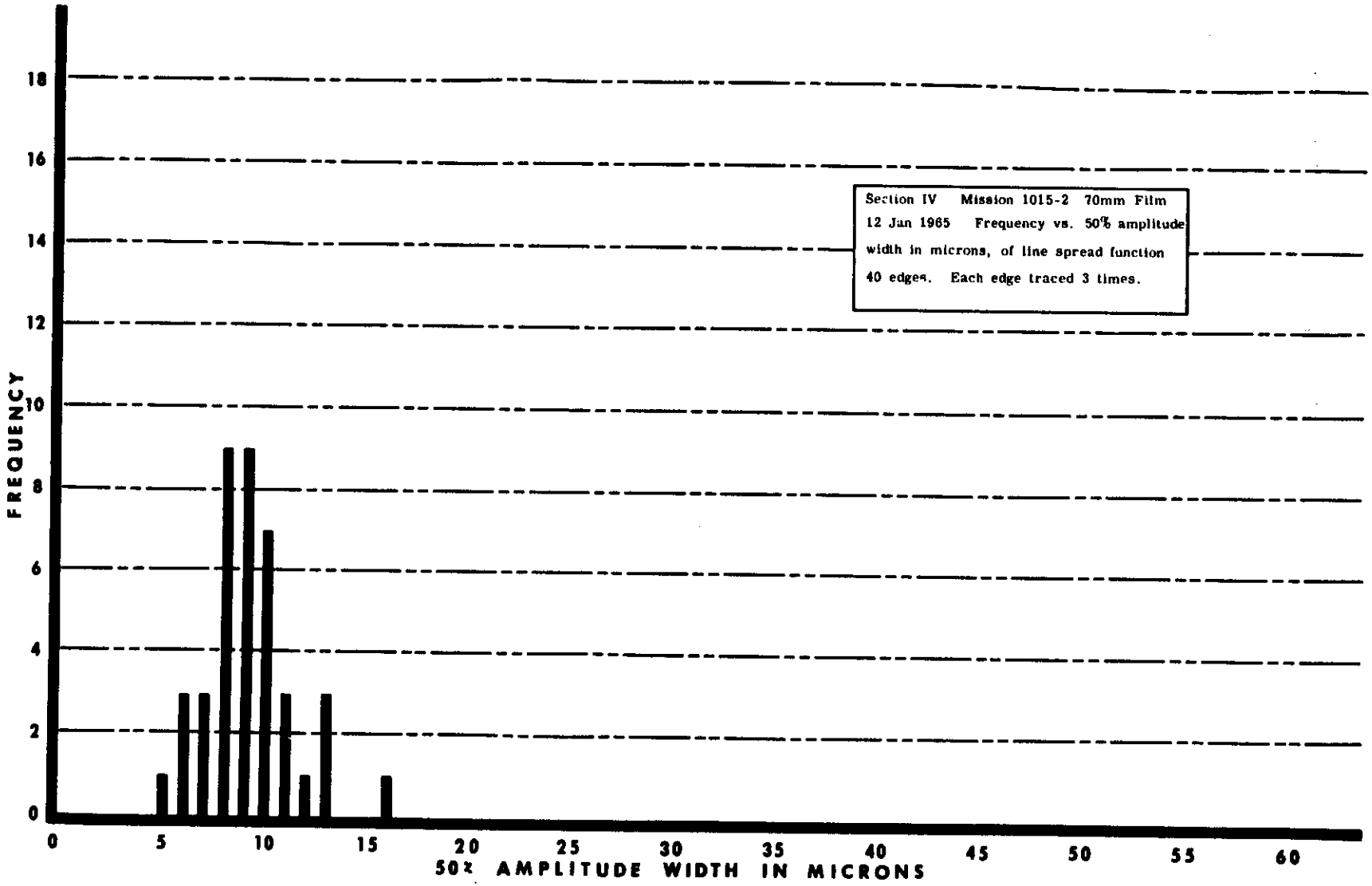
SECTION IIIA - MISSION 1015-2

Image Quality Ranking of all C/M/J Missions Traced to Date

Mission Number	Average Resolution in lines/mm for A.I.M. 4404 Curve
1015-1	93.1 l/mm
1015-2	89.7 l/mm
1010-1	89.4 l/mm
1012-1	86.1 l/mm
1008-2	84.3 l/mm
1010-2	84.3 l/mm
1012-2	84.0 l/mm
1013-1	83.3 l/mm
1008-1	83.0 l/mm
1014-1	83.0 l/mm
1011-1	80.5 l/mm
1009-1	75.3 l/mm
1014-2	74.2 l/mm
1009-2	74.1 l/mm
1007-2	71.0 l/mm

NOTE: Since this is a research and development effort, modifications and improvements are continually being made in the methods of collecting edge data and in the computer data reduction. The quality rating of current missions may have a slightly different basis than earlier missions, which could affect the quality ranking.


Section IV Mission 1015-2 70mm Film
12 Jan 1965 Frequency vs. Resolution
(lines/MM) A.I.M. 4404 Curve. 40
edges. Each edge traced 3 times.
FREQUENCY
0
2
4
6
8
10
12
14
16
18
0
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
RESOLUTION (LINES/MM)
54
57
60
63
66
69
72
75
81
84
87
90
93
96
99
102
106
108
111
114
117
120
123
126
129
132
135


Section IV Mission 1015-2 70mm Film
12 Jan 1965 Frequency vs. 50% amplitude
width in microns, of line spread function
40 edges. Each edge traced 3 times.
FREQUENCY
0
2
4
6
8
10
12
14
16
18
0
5
10
15
20
25
30
35
40
45
50
55
60
50% AMPLITUDE WIDTH IN MICRONS

Analysis of Photographic Image to Evaluate System Performance

Mission 1015-2
Section V

Forward Camera

Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
D-84	053	X51.6 Y10.5	015	Buildings	8.2	95
D-84	057	X42.9 Y10.1	010	Buildings	12.2	67
D-84	058	X51.8 Y14.0	175	Buildings	5.9	124
D-84	064	X70.9 Y12.2	035	Buildings	9.6	85
D-84	073	X38.1 Y13.3	045	Buildings	8.8	85
D-86	023	X21.0 Y10.4	025	Buildings	10.4	85
D-86	036	X23.8 Y12.3	175	Buildings	9.1	78
D-87	046	X52.2 Y10.8	180	Buildings	10.9	81
D-87	047	X54.5 Y13.2	005	Canal	10.0	82
D-87	051	X44.8 Y13.9	165	Buildings	7.9	94
D-88	018	X59.1 Y10.3	035	Buildings	7.8	96
D-88	020	X24.6 Y11.5	025	Buildings	8.5	102
D-88	021	X56.0 Y11.5	105	Canal Bank	15.9	54
D-88	022	X42.3 Y11.9	050	Buildings	6.3	118
D-88	023	X31.3 Y13.9	095	Airfield	8.9	95
D-88	024 (M.I.P.)	X23.6 Y12.5	085	Airfield	8.4	86
D-142	024	X24.8 Y13.7	020	Buildings	7.8	94
D-147	077	X49.8 Y11.2	015	Buildings	9.1	81
D-149	099	X66.2 Y13.8	065	Buildings	10.1	79
D-149	114	X47.7 Y12.8	015	Buildings	7.9	104

Analysis of Photographic Image to Evaluate System Performance

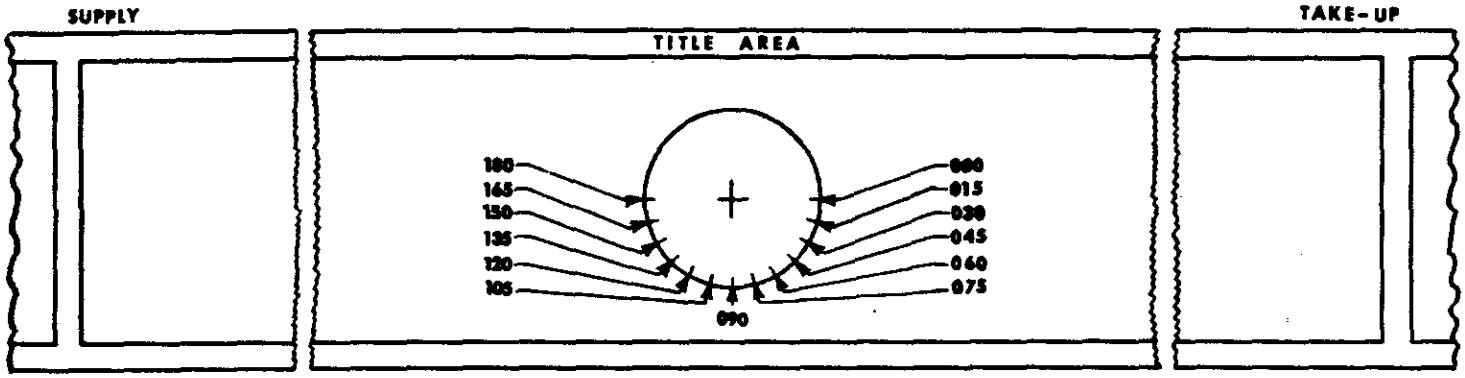
Mission 1015-2
Section V

AFT Camera

Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
D-84	052	X48.3 Y13.3	180	Buildings	8.8	92
D-84	058	X39.4 Y10.7	015	Buildings	13.5	58
D-84	062	X48.0 Y11.2	020	Buildings	10.0	91
D-84	068	X40.5 Y13.2	170	Buildings	7.0	100
D-86	029	X70.8 Y11.1	025	Buildings	9.1	80
D-86	041	X67.8 Y13.5	175	Buildings	6.9	107
D-87	052	X37.7 Y10.0	010	Buildings	13.4	64
D-88	024	X31.4 Y10.9	025	Buildings	4.7	134
D-88	026	X74.1 Y12.5	015	Buildings	5.6	124
D-88	027	X35.0 Y11.5	090	Canal Bank	10.0	84
D-88	028	X60.4 Y11.8	065	Buildings	7.7	100
D-88	029	X67.7 Y13.9	095	Airfield	11.0	84
D-88	033	X35.5 Y09.6	035	Dock	8.7	92
D-142	015	X71.5 Y11.6	015	Buildings	7.5	95
D-149	112	X42.3 Y14.3	010	Buildings	9.0	92
D-166	122	X34.3 Y11.5	100	Airfield	10.4	78
D-166	132	X31.8 Y14.6	095	Airfield	13.3	58
D-166	153	X43.5 Y14.5	020	Buildings	7.1	110
D-166	154	X59.7 Y10.5	040	Buildings	7.8	96
D-173	028	X69.3 Y11.6	075	Airfield	11.3	67

APPENDIX "A"

Reference System For Orientation Of C/M/J Mission Edges
original negative — emulsion down



Coordinate Locator Grid For C/M/J Mission Edges
original negative — emulsion down