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Analysis of Photographic Image to Evaluate System Performance Mission 1013-1

19 November 1964

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ITLE:

Summary of Microdensitometer Derived Image Quality Data Collected from Mission 1013-1

ECTION I: INTRODUCTION

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

(a) forward and aft camera quality and

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

ction III is a summary of all C/M/J Missions traced to date. Image Quality Ranking of all M/J Missions is listed in Section IIIA. Frequency plots of the spread function and resolving wer data are presented as Section IV, to show the distribution of values. A tabulation of the cation, 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 id. In use, the film is placed on an illuminator with the titling correct reading (i.e. emulsion wn) with the camera take-up end at the right and the supply at the left. The orientation of an dge is described as 000 for longitudinal and 090 for transverse edges; the numbering system runs a clockwise direction. The coordinate locator grid consists of centimeter squares numbered ich that the center of the frame is given as X46.0, Y12.0. X numbers increase toward the ake-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.

There were fewer edges traced on this mission than on previous missions because of (a) the large amount of cloud cover over populated areas and (b) a random out-of-focus condition noted on many of the frames.

Analysis of Photographic Image to Evaluate System Performance

SECTION II SUMMARY SHEET

Mission 1013-1

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

Arithmetic Mean	83.3 l/mm
Standard Deviation	27.3 l/mm
Coefficient of Dispersion	33%
Number of Edges	49
M. I. P. Frame	95 l/mm

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

Arithmetic Mean	10.8
Standard Deviation	4.1
Coefficient of Dispersion	38%
Number of Edges	49
M. I. P. Frame	9.2

Analysis of Photographic Image to Evaluate System Performance

SECTION IIA SUMMARY SHEET

Mission 1013-1

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	84.8	81.1	79.3	90.7
Standard Deviation	23.1	33.0	24.9	30.8
Coefficient of Dispersion	27%	41%	31%	34%
Number of Edges	29	20	32	17

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

	FWD Camera	AFT Camera	Airfields	Buildings
Arithmetic Mean	10.2	11.8	11.4	9.7
Standard Deviation	2.7	5.4	4.2	3.8
Coefficient of Dispersion	27%	46%	36%	39%
Number of Edges	29	20	32	17

Analysis of Photographic Image to Evaluate System Performance

SECTION III - MISSION 1013-1

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
9054	12	14.3	4.6	32%	81.7	27.9	34%
9057	35	12.0	4.1	34%	81.3	30.2	37%
9062	69	12.0	4.5	37%	89.4	30.3	34%
1001	117	25.6	11.3	44%	45.9	16.8	37%
1004-1	60	10.1	5.6	56%	115.7	38.8	34%
1004-2	69	12.6	4.9	39%	84.6	31.3	37%
1006-1	93	12.0	4.3	36%	85.3	26.4	31%
1006-2	109	11.4	3.3	29%	85.5	22.1	26%
1007-1	107	11.9	3.6	30%	89.7	22.2	25%
1007-2	106	12.3	3.9	31%	85.8	25.1	29%
1008-1	95	10.8	3.1	29%	96.3	25.4	26%
1008-2	114	10.5	3.8	36%	97.7	24.8	25%
1009-1*	74	11.5	3.5	30%	92.2	25.2	27%
1009-2*	101	13.4	5.3	40%	83.5	26.3	31%
1010-1*	94	10.7	3.1	29%	98.5	25.1	26%
1010-2*	111	9.8	3.2	33%	79.6	13.1	16%
1011-1*	116	10.9	3.9	36%	76.3	15.1	20%
1012-1*	95	10.1	3.7	36%	80.4	12.7	16%
1012-2*	102	10.0	3.2	32%	80.2	13.1	16%
1013-1*	49	10.8	4.1	38%	83.3	27.3	33%

*A 1 x 80 micron slit was used.

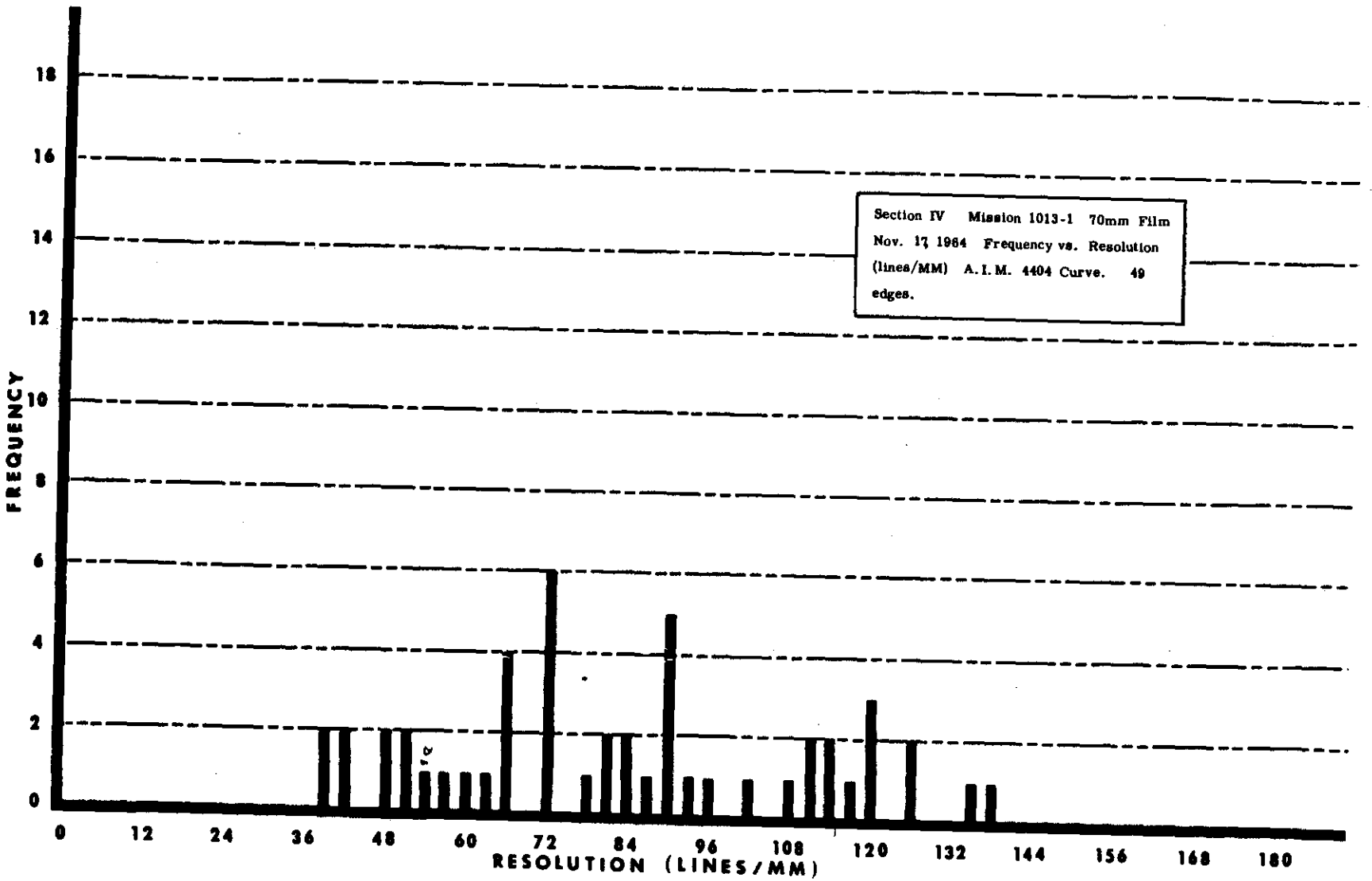
Analysis of Photographic Image to Evaluate System Performance

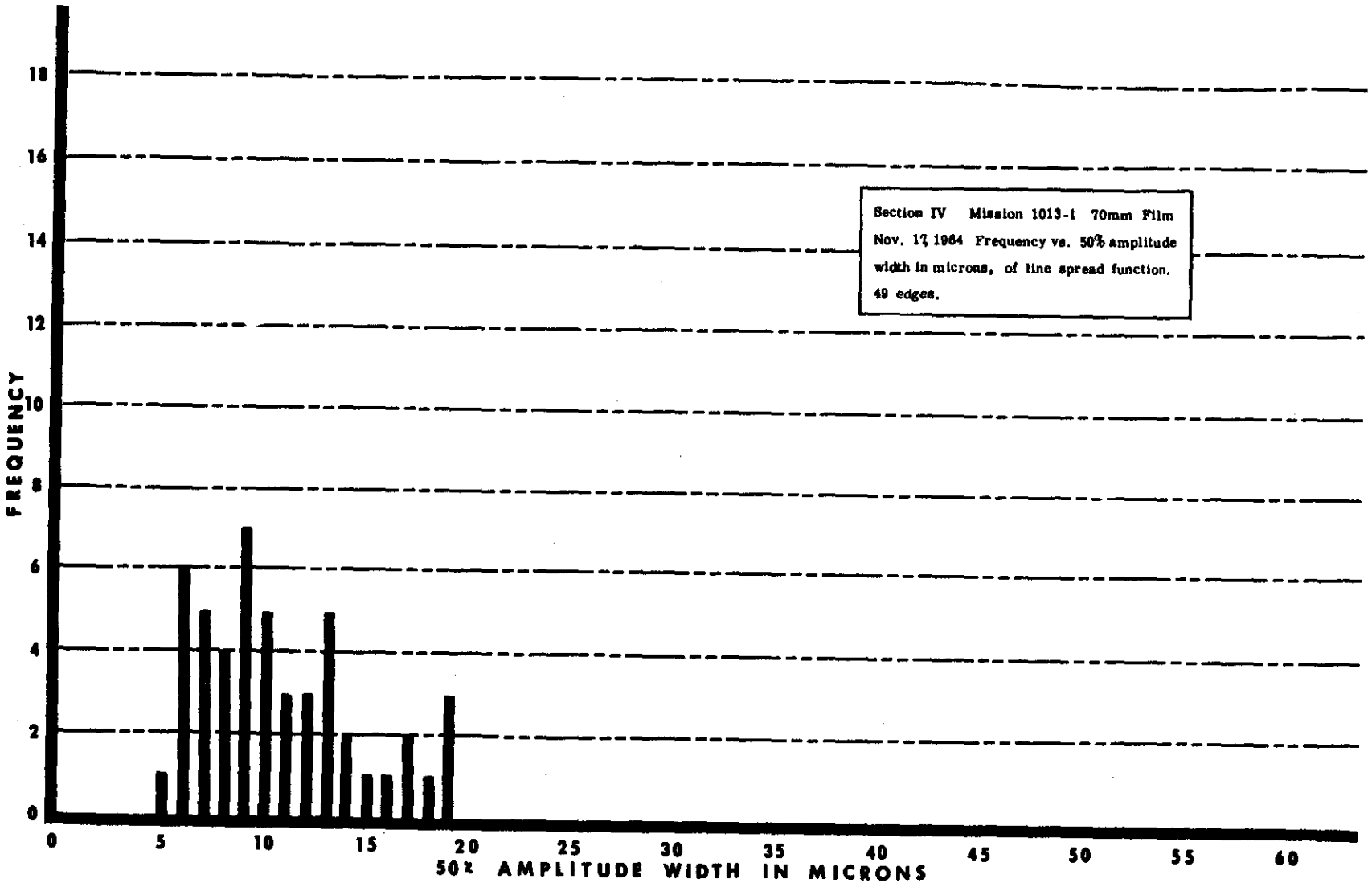
SECTION IIIA - MISSION 1013-1

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
1004-1	115.7
1010-1	98.5
1008-2	97.7
1008-1	96.3
1009-1	92.2
1007-1	89.7
9062	89.4
1007-2	85.8
1006-2	85.5
1006-1	85.3
1004-2	84.6
1009-2	83.5
1013-1	83.3
9054	81.7
9057	81.3
1012-1	80.4
1012-2	80.2
1010-2	79.6
1011-1	76.3
1001	45.9

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 1013-1 70mm Film
Nov. 17 1964 Frequency vs. Resolution
(lines/MM) A.I.M. 4404 Curve. 49
edges.
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)


Section IV Mission 1013-1 70mm Film
Nov. 17, 1964 Frequency vs. 50% amplitude width in microns, of line spread function.
49 edges.
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 1013-1
Section V

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A. I. M. Resolution
*1	Fwd	D-47E	009	X50.5 Y14.5	045	Buildings	11.4	65
*1A	Fwd	D-47E	009	X50.5 Y14.5	045	Buildings	13.3	61
*2	Fwd	D-47E	009	X50.3 Y12.8	120	Airfield	10.3	71
*2A	Fwd	D-47E	009	X50.3 Y12.8	120	Airfield	9.5	72
3	Fwd	D-47E	025	X48.7 Y10.3	010	Airfield	9.5	80
3A	Fwd	D-47E	025	X48.7 Y10.3	010	Airfield	9.0	86
4	Fwd	D-47E	029	X18.6 Y10.6	060	Airfield	6.2	121
4A	Fwd	D-47E	029	X18.6 Y10.6	060	Airfield	14.0	62
5	Fwd	D-40	020	X18.1 Y12.3	055	Buildings	6.4	126
5A	Fwd	D-40	020	X18.1 Y12.3	055	Buildings	4.8	145
6	Fwd	D-40	020	X15.6 Y12.7	088	Airfield	12.6	72
7	Fwd	D-39	130	X35.3 Y12.8	010	Dam	10.0	73
7A	Fwd	D-39	130	X35.3 Y12.8	010	Dam	12.0	67

*M.I.P. Frame

Mission 1013-1

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
8	Fwd	D-39	131	X45.3 Y11.1	035	Buildings	5.8	135
8A	Fwd	D-39	131	X45.3 Y11.1	035	Buildings	7.4	115
9	Fwd	D-39	132	X54.5 Y13.3	065	Buildings	9.5	89
9A	Fwd	D-39	132	X54.5 Y13.3	065	Buildings	7.0	115
10	Fwd	D-08	024	X35.3 Y11.0	035	Breakwater	9.4	93
11	Fwd	D-09	047	X67.5 Y11.3	060	Airfield	12.4	47
11A	Fwd	D-09	047	X67.5 Y11.3	060	Airfield	7.6	91
12	Fwd	D-21	062	X24.3 Y13.7	070	Airfield	14.3	80
12A	Fwd	D-21	062	X24.3 Y13.7	070	Airfield	12.4	72
13	Fwd	D-21	060	X20.2 Y12.8	080	Airfield	9.5	90
13A	Fwd	D-21	060	X20.2 Y12.8	080	Airfield	8.3	90
14	Fwd	D-21	057	X14.5 Y13.6	090	Airfield	15.6	55
14A	Fwd	D-21	057	X14.5 Y13.6	090	Airfield	13.0	65

Mission 1013-1

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A. I. M. Resolution
15	Fwd	D-21	114	X48.0 Y11.0	060	Airfield	8.0	103
15A	Fwd	D-21	114	X48.0 Y11.0	060	Airfield	11.3	78
16	Fwd	D-23	090	X51.8 Y12.8	140	Buildings	12.6	65
16A	Fwd	D-23	090	X51.8 Y12.8	140	Buildings	6.5	120
17	Aft	D-08	030	X55.6 Y14.7	040	Breakwater	4.8	137
18	Aft	D-39	138	X55.3 Y13.3	020	Dam	17.8	40
18A	Aft	D-39	138	X55.3 Y13.3	020	Dam	16.7	49
19	Aft	D-47E	038	X43.8 Y11.1	055	Airfield	8.6	90
19A	Aft	D-47E	038	X43.8 Y11.1	055	Airfield	7.4	110
20	Aft	D-47E	035	X72.3 Y13.7	055	Airfield	10.1	83
20A	Aft	D-47E	035	X72.3 Y13.7	055	Airfield	3.6	159
*22	Aft	D-47E	015	X39.8 Y12.2	080	Airfield	9.2	95
*22A	Aft	D-47E	015	X39.8 Y12.2	080	Airfield	10.9	72

*M.I.P. Frame

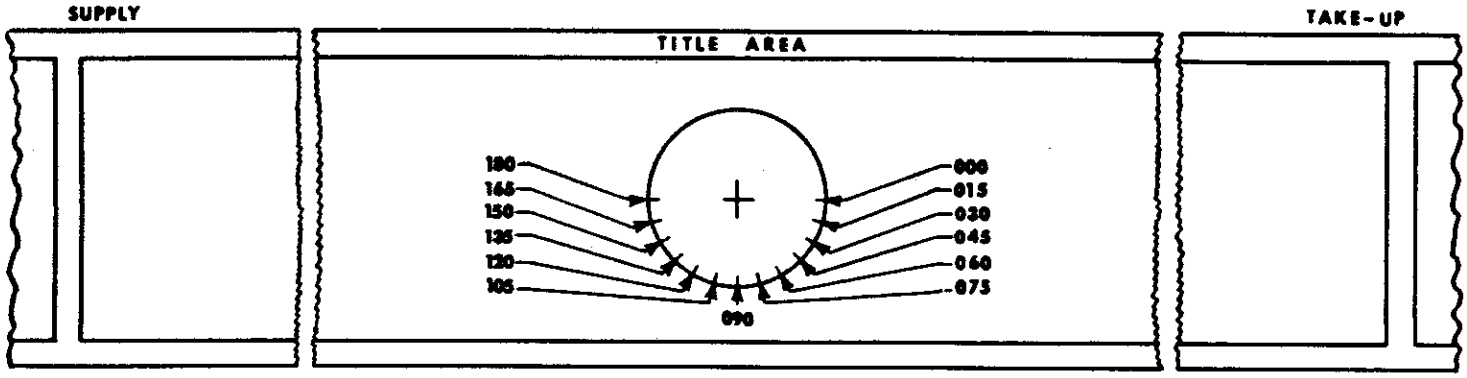
Mission 1013-1

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
*23	Aft	D-47E	015	X39.8 Y10.3	055	Buildings	6.6	108
*23A	Aft	D-47E	015	X39.8 Y10.3	055	Buildings	8.3	84
24	Aft	D-21	068	X66.2 Y13.2	085	Airfield	17.2	57
24A	Aft	D-21	068	X66.2 Y13.2	085	Airfield	20.6	42
25	Aft	D-21	066	X70.4 Y13.5	088	Airfield	15.4	50
25A	Aft	D-21	066	X70.4 Y13.5	088	Airfield	13.4	51
26	Aft	D-21	063	X76.5 Y12.5	100	Airfield	20.6	39
26A	Aft	D-21	063	X76.5 Y12.5	100	Airfield	20.7	42
27	Aft	D-21	121	X41.8 Y14.7	140	Airfield	7.5	118
27A	Aft	D-21	121	X41.8 Y14.7	140	Airfield	5.7	119
28	Aft	D-40	026	X75.7 Y14.0	100	Airfield	6.3	111
28A	Aft	D-40	026	X75.7 Y14.0	100	Airfield	9.0	125

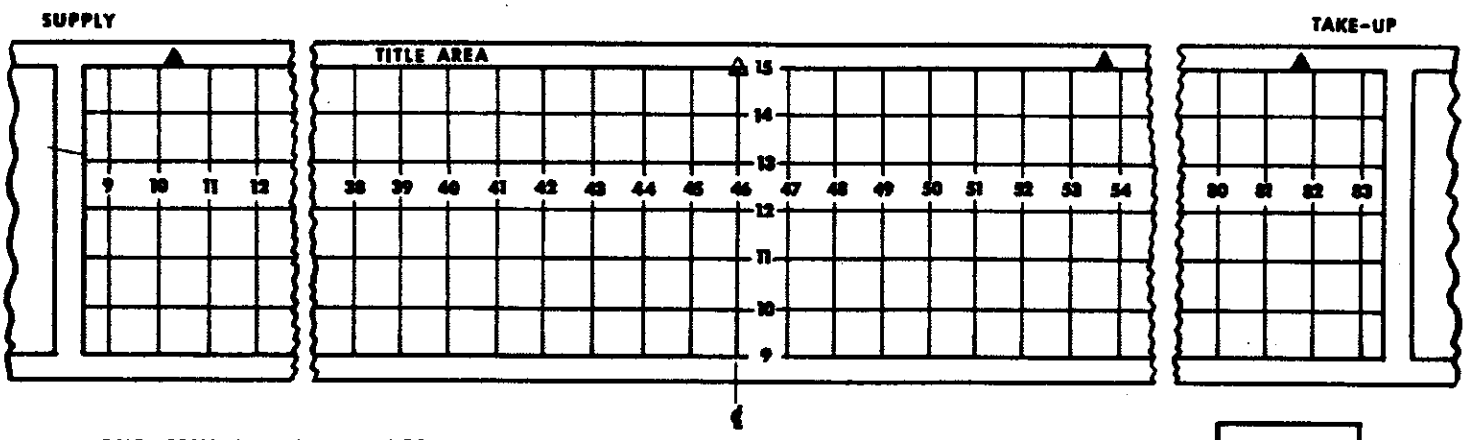
*M.I.P. Frame

APPENDIX "A"

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

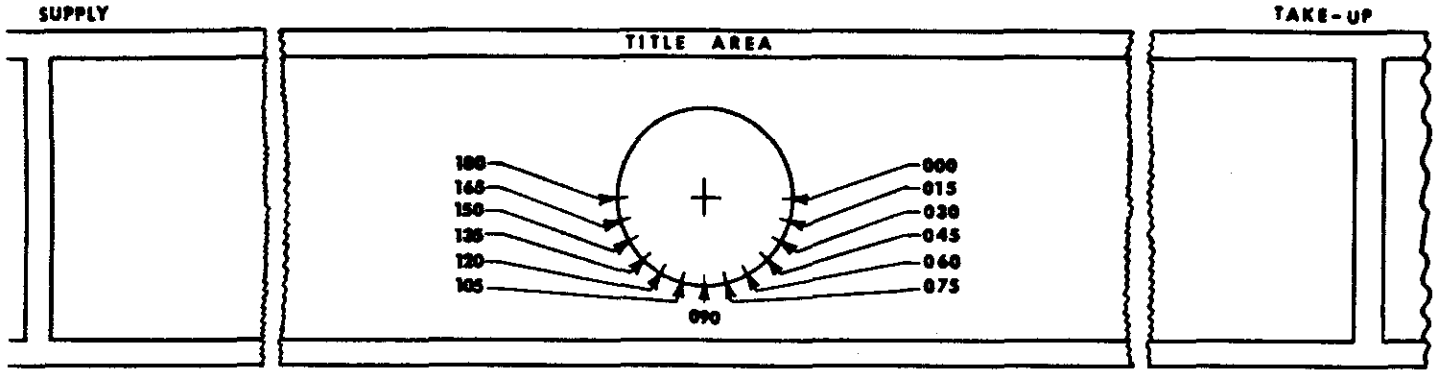


Coordinate Locator Grid For C/M/J Mission Edges
original negative — emulsion down

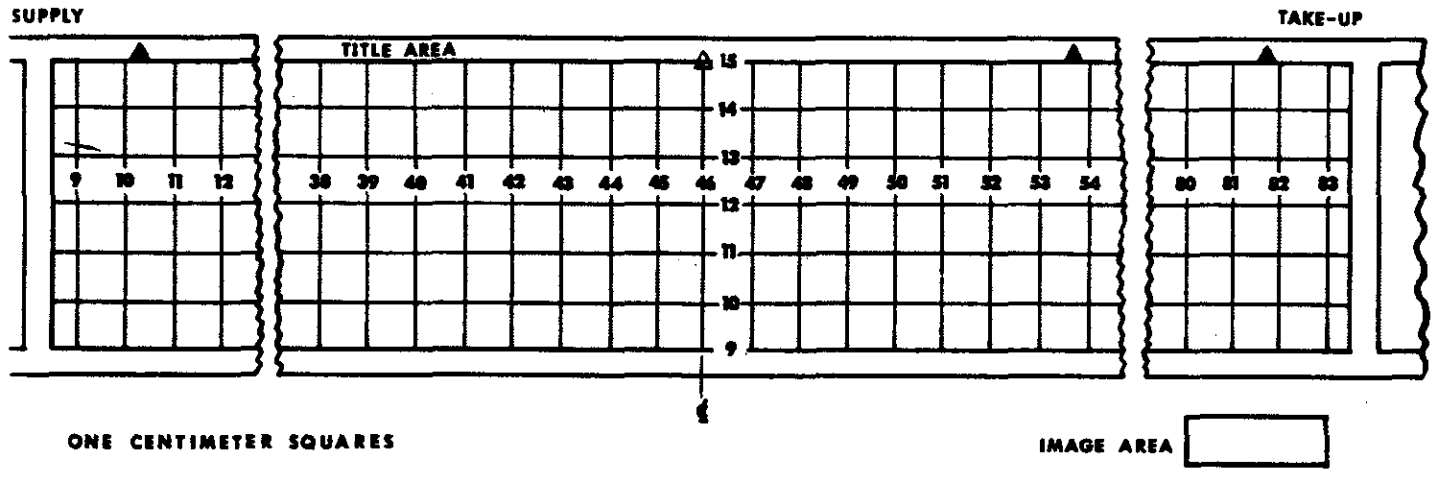


APPENDIX "A"

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



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