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Analysis of Photographic Image to Evaluate System Performance Mission 1014-1

24 December 1964

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TITLE:

Summary of Microdensitometer Derived Image Quality Data Collected from Mission 1014-1

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 has been eliminated in this report, because the quality rating of this mission has a different basis than earlier missions. Previous missions are being recomputed and will be reported at a later date. 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.

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SECTION II SUMMARY SHEET

Mission 1014-1

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

Arithmetic Mean	83.0 l/mm
Standard Deviation	24.7 l/mm
Coefficient of Dispersion	30%
Number of Edges	92
M.I.P. Frame	109 l/mm

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

Arithmetic Mean	10.8
Standard Deviation	4.5
Coefficient of Dispersion	41%
Number of Edges	92
M.I.P. Frame	5.6

Analysis of Photographic Image to Evaluate System Performance

SECTION IIA SUMMARY SHEET

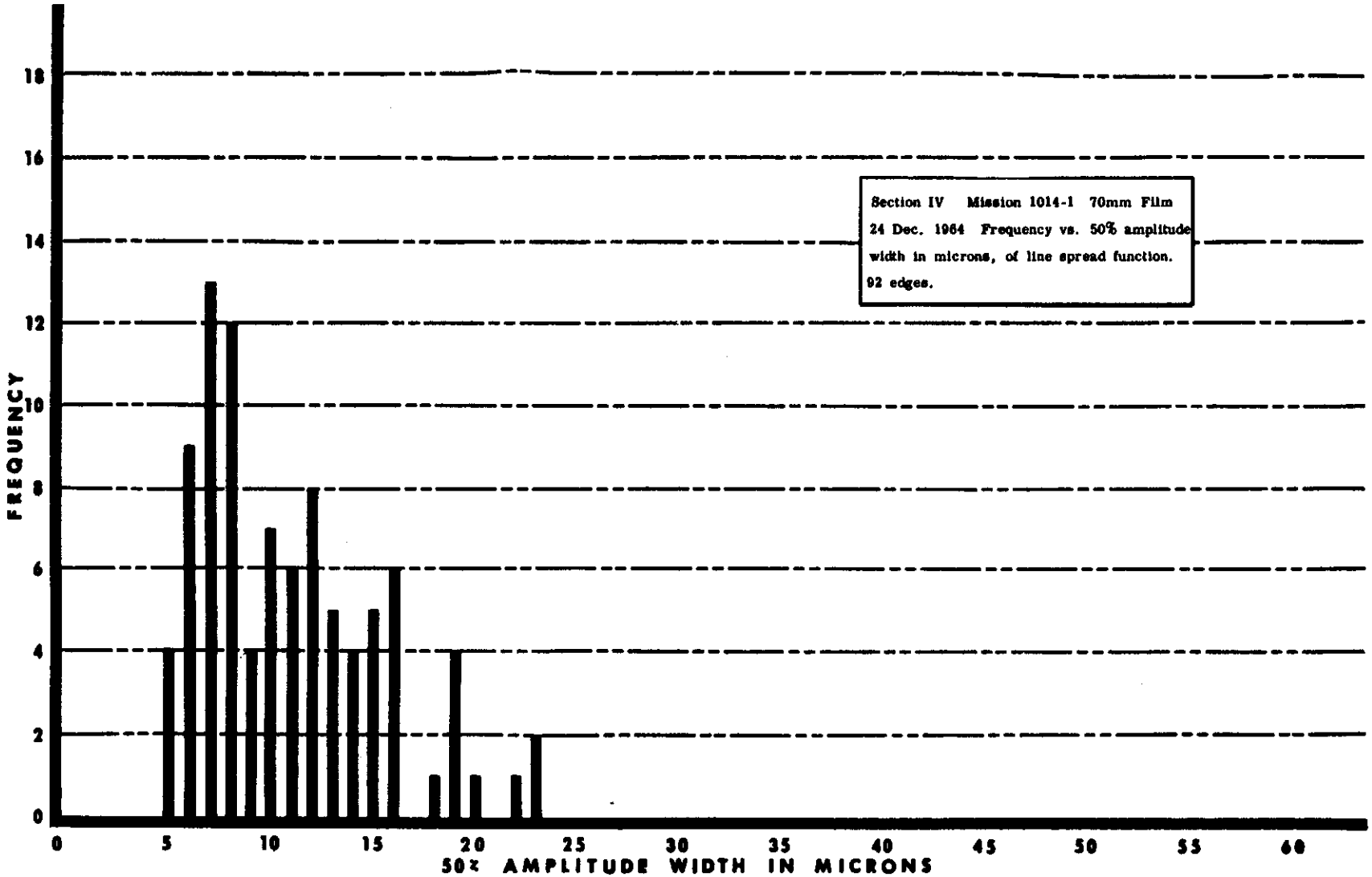
Mission 1014-1

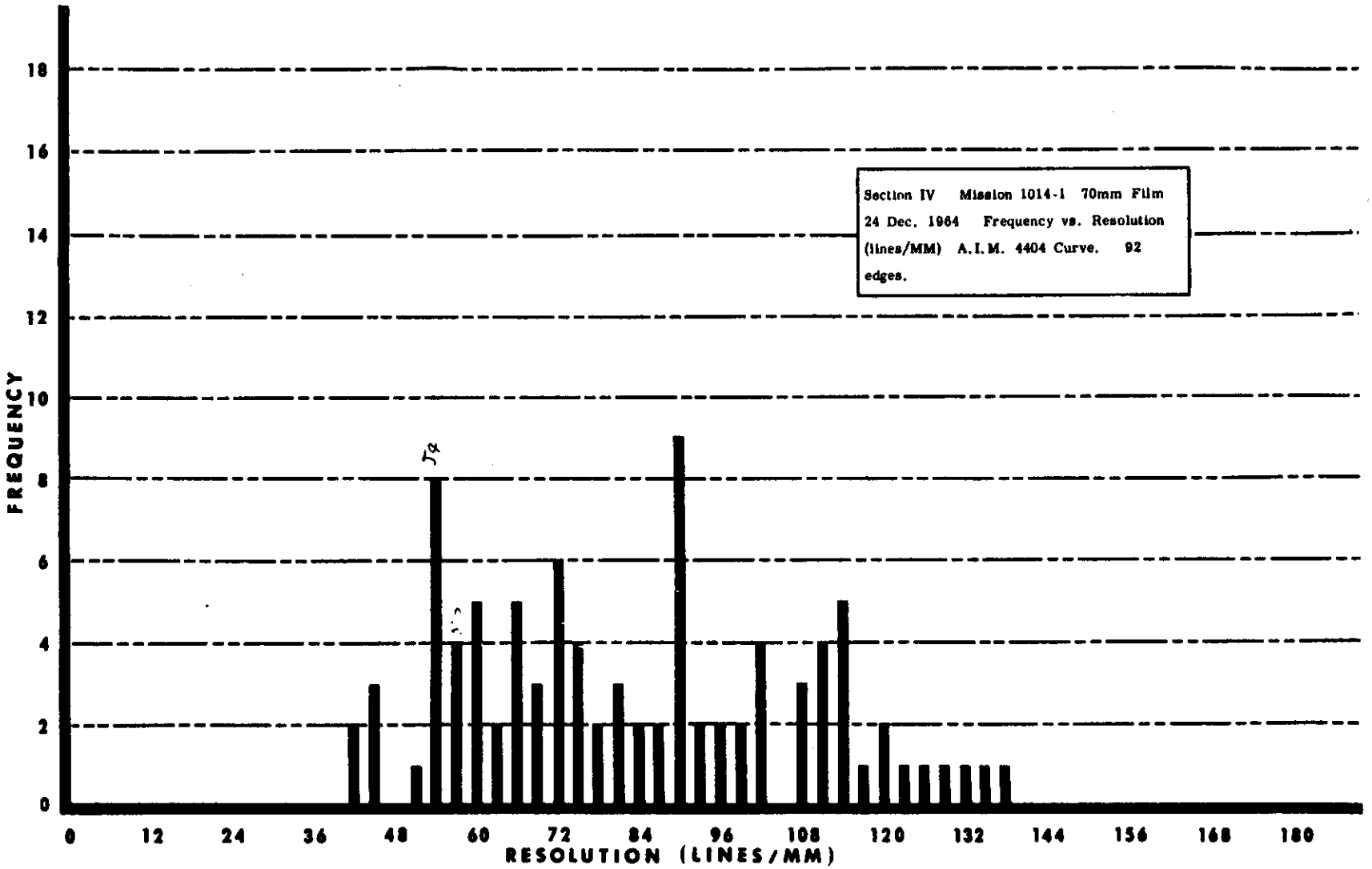
Resolution in lines/mm based on the aerial image modulation - 4404 curve from edge trace data reduced by computer techniques.

	FWD Camera	AFT Camera	Airfields	Buildings
	75.3	91.8		
Arithmetic Mean	73.8	95.0	82.7	84.2
Standard Deviation	21.6	23.5	25.6	20.4
Coefficient of Dispersion	29%	25%	31%	24%
Number of Edges	52	40	76	16

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

	FWD Camera	AFT Camera	Airfields	Buildings
Arithmetic Mean	12.0	9.3	11.0	9.8
Standard Deviation	4.4	4.1	4.6	3.6
Coefficient of Dispersion	37%	44%	42%	37%
Number of Edges	52	40	76	16


Section IV Mission 1014-1 70mm Film
24 Dec. 1964 Frequency vs. 50% amplitude
width in microns, of line spread function.
92 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


Section IV Mission 1014-1 70mm Film
24 Dec. 1964 Frequency vs. Resolution
(lines/MM) A.I.M. 4404 Curve. 92
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)

Analysis of Photographic Image to Evaluate System Performance

Mission 1014-1
Section V

Forward Camera

Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
D-21	065	X80.5 Y10.6	000	Airfield	11.6	70
					11.4	86
D-21	066	X36.3 Y12.4	000	Airfield	18.8	44
					10.6	67
D-21	066	X34.5 Y12.0	075	Dam	10.5	71
					7.5	100
D-21	067	X48.0 Y13.5	115°	Bldg. near	8.3	90
				Airfield	7.6	88
D-21	076	X68.5 Y10.0	065	Bldg. near	15.9	54
				Airfield	5.7	129
D-21	085	X53.8 Y10.0	155	Airfield	4.0	144
					12.5	59
D-37	029	X38.3 Y10.4	060°	Airfield	4.8	132
					6.5	103
D-37	029	X54.7 Y14.0	045	Dam	6.1	115
					7.4	103
D-37	030	X51.0 Y10.0	110°	Airfield	14.6	56
					10.1	78
D-37	031	X42.6 Y09.5	110	Airfield	11.1	68
					6.2	90
D-37	032	X35.0 Y14.5	110	Airfield	7.7	89
					9.4	80
D-37	032	X48.8 Y11.5	110	Airfield	23.4	54
					18.5	45
D-37	033	X25.0 Y11.3	155	Airfield	14.6	54
					13.9	57

Forward Camera

Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
D-37	035	X45.6 Y10.3	090	Airfield	12.1 19.3	67 42
D-37	036	X72.1 Y11.9	088	Dam	18.6 14.2	45 53
D-37	037	X48.4 Y10.3	090	Airfield	16.2 14.8	53 58
D-37	040	X29.6 Y10.0	090	Airfield	14.4 10.0	67 76
D-53	070	X65.0 Y12.3	170	Airfield	21.6 18.3	55 51
D-53	072	X48.3 Y10.7	010	Airfield	12.6 11.8	77 73
D-62	006	X49.2 Y11.2	170	Dam	7.6 11.1	90 81
D-62	010	X12.5 Y13.5	080	Airfield	7.1 16.0	90 76
D-62	015	X76.2 Y10.0	135	Airfield	12.1 12.6	66 60
D-79	005	X50.5 Y12.2	075	Airfield	11.8 6.7	70 108
D-79	008	X55.2 Y12.6	115	Bldg. 1 Bldg. 2	7.9 14.9	84 65
D-79	008	X55.5 Y12.4	020	Bldg.	13.2	59
D-79	008	X55.8 Y12.8	075	Airfield	13.3 13.5	56 64
D-79	008	X58.7 Y13.6	070	Airfield	12.1 5.6	60 109

AFT Camera

Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
D-21	072	X24.0 Y12.5	120	Airfield	8.7	74
					6.9	111
D-21	082	X21.8 Y10.0	050	Airfield	7.2	114
					5.7	115
D-21	090	X36.5 Y13.3	165	Airfield	10.7	83
					7.1	126
D-37	035	X44.5 Y11.5	055	Airfield	4.9	121
					6.3	110
D-37	036	X46.5 Y11.5	115	Airfield	7.9	89
					7.1	94
D-37	037	X55.4 Y12.0	115	Airfield	6.4	113
					4.7	137
D-37	038	X47.4 Y09.8	115	Airfield	8.4	91
					11.9	71
D-37	039	X73.0 Y10.5	155	Airfield	6.4	115
					15.5	53
D-37	041	X44.5 Y11.0	090	Airfield	5.4	135
					8.8	82
D-37	043	X41.5 Y10.5	090	Airfield	23.3	43
					14.5	62
D-37	044	X52.5 Y12.0	090	Airfield	8.7	102
					10.1	76
D-37	046	X60.4 Y11.0	090	Airfield	9.8	71
					20.1	59
D-53	068	X12.3 Y11.5	075	Bridge	7.5	107
					6.6	102

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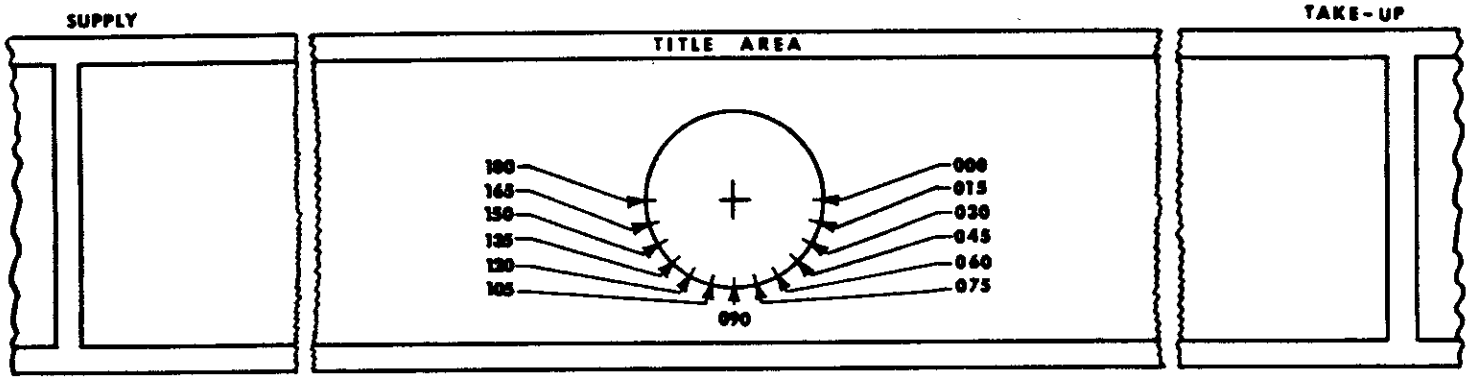
AFT Camera

Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
D-53	077	X41.7 Y12.3	010	Bridge	5.6	122
					7.5	95
D-53	091	X55.2 Y12.5	170	Bridge	6.8	119
D-62	012	X41.0 Y11.5	160	Dam	8.0	94
D-62	015	X78.5 Y13.8	125	Airfield	7.3	89
					7.6	99
D-62	021	X14.7 Y11.8	110	Airfield	9.9	97
					7.0	117
D-69	026	X68.3 Y11.1	180	Airfield	16.4	53
					9.7	91
D-69	050	X65.0 Y13.3	145	Airfield	7.1	110
					15.7	71
D-69	051	X67.4 Y13.8	120	Airfield	4.0	142
D-79	011	X39.8 Y10.5	070	Airfield	9.8	112
					11.8	73

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