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This document contains 16 pages

Analysis of Photographic Image to Evaluate System Performance Mission 1008-1

6 August 1964

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TITLE:

Summary of Microdensitometer Derived Image Quality Data Collected from Mission 1008-1

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 is presented in Section II, giving the arithmetic mean, standard deviation, coefficient of dispersion, and number of edges. Section III is a tabulation of the location, description, and image quality data for each edge. Frequency plots of the spread function and resolving power data are presented as Section IV, to show the distribution of values. Summary of all C/M/J Missions traced to date is presented in Section V. Section VI is included to show the sensitometric data for this mission. A diagram of the reference system used in describing the orientation of an edge and a temporary coordinate system used to locate the edges within a frame are presented as Appendix A.

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 320 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 0.450 microns,

(c) I.B.M. 1620 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.

Analysis of Photographic Image to Evaluate System Performance

SECTION II SUMMARY SHEET

Mission 1008-1

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

Arithmetic Mean	96.3
Standard Deviation	25.4
Coefficient of Dispersion	26%
Number of Edges	95

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

Arithmetic Mean	10.8
Standard Deviation	3.1
Coefficient of Dispersion	29%
Number of Edges	95

Analysis of Photographic Image to Evaluate System Performance

Mission 1008-1

Section III

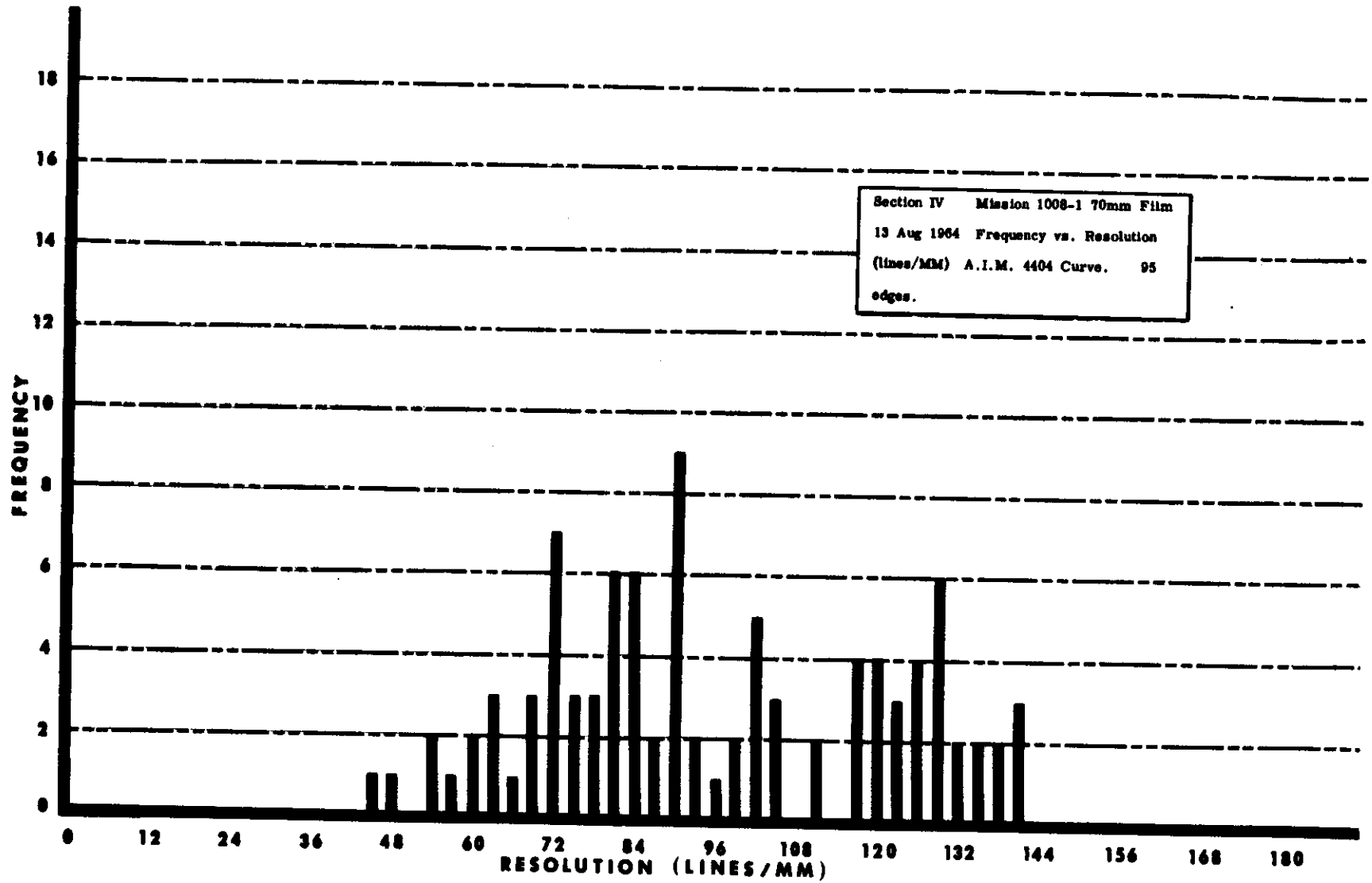
Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
1	Fwd	D08	041	B-C-2	110	Airfield	12.9	121
1A	Fwd	D08	041	B-C-2	110	Airfield	12.5	74
2	Fwd	D40	092	A-13	020	Airfield	10.6	80
2A	Fwd	D40	092	A-13	020	Airfield	9.6	89
3	Fwd	D40	099	C-4	035	Dam	15.0	53
3A	Fwd	D40	099	C-4	035	Dam	14.6	58
4	Fwd	D40	151	A-5	066	Airfield	22.2	73
4A	Fwd	D40	151	A-5	066	Airfield	16.2	84
5	Fwd	D40	179	B-12	140	Airfield	7.4	122
5A	Fwd	D40	179	B-12	140	Airfield	7.0	126
6	Fwd	D40	183	A-6	171	Airfield	11.6	85
6A	Fwd	D40	183	A-6	171	Airfield	11.4	119
7	Fwd	D40	197	C-12	100	Airfield	7.7	122
7A	Fwd	D40	197	C-12	100	Airfield	11.2	91
8	Fwd	D40	198	A-6	105	Airfield	11.1	106
8A	Fwd	D40	198	A-6	105	Airfield	9.3	123
9	Fwd	D40	206	B-7	172	Airfield	6.4	134
9A	Fwd	D40	206	B-7	172	Airfield	7.2	118
10	Aft	D40	211	A-6	172	Airfield	7.1	133
10A	Aft	D40	211	A-6	172	Airfield	9.0	117
11	Aft	D40	203	B-8	105	Airfield	10.1	91

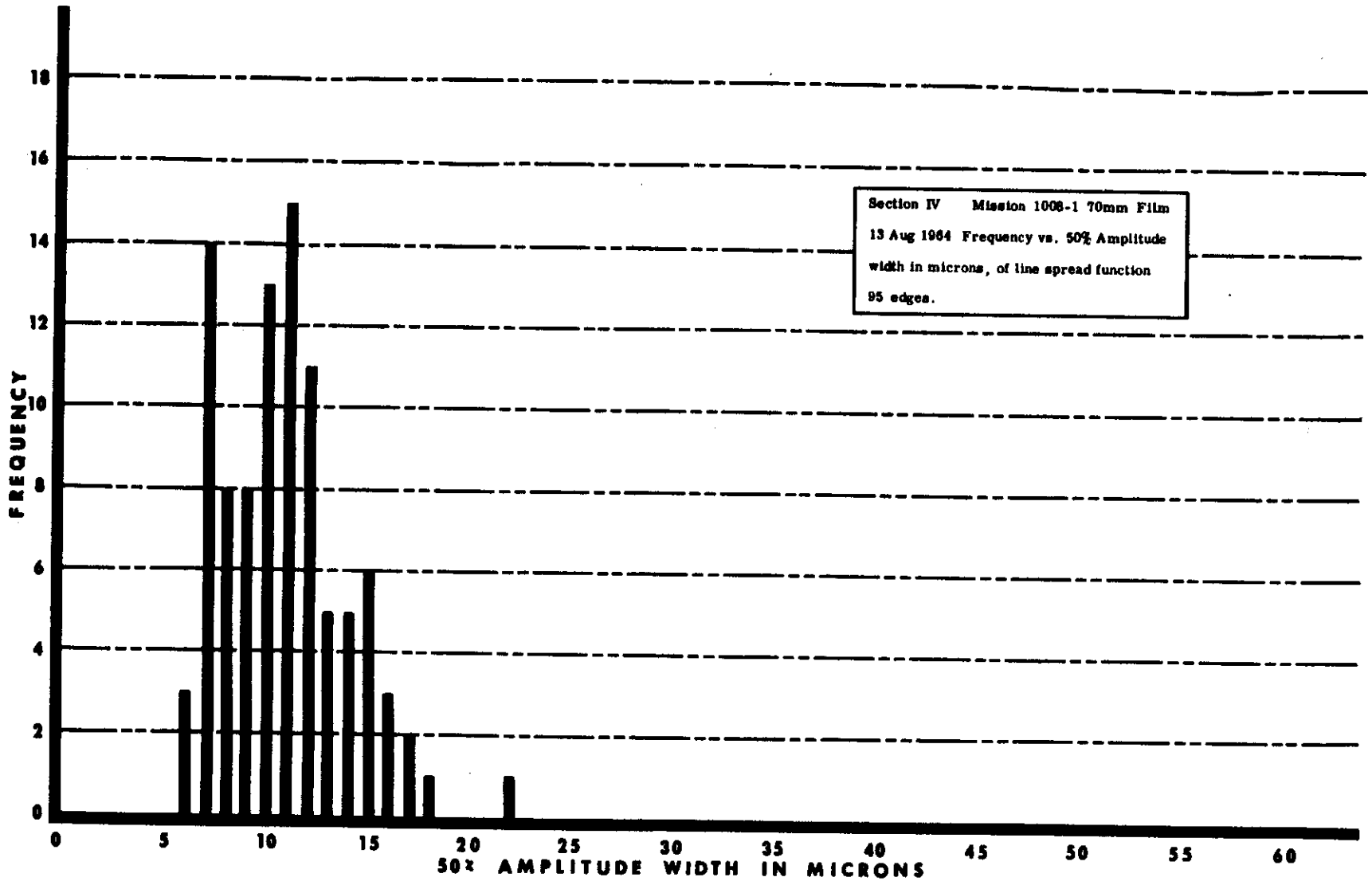
Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
11A	Aft	D40	203	B-8	105	Airfield	6.2	140
12	Aft	D40	203	C-3	088	Airfield	12.2	70
12A	Aft	D40	203	C-3	088	Airfield	9.6	101
13	Aft	D40	202	B-10	119	Airfield	9.2	112
13A	Aft	D40	202	B-10	119	Airfield	9.4	99
14	Aft	D40	188	C-9	171	Airfield	6.8	129
15	Aft	D40	184	B-2	131	Airfield	7.4	127
15A	Aft	D40	184	B-2	131	Airfield	6.7	141
16	Aft	D40	156	A-8	010	Airfield	10.4	90
16A	Aft	D40	156	A-8	010	Airfield	9.9	88
17	Aft	D40	156	A-7	120	Dam	10.7	127
17A	Aft	D40	156	A-7	120	Dam	9.9	100
18	Aft	D41	078	B-6	030	Airfield	9.1	116
18A	Aft	D41	078	B-6	030	Airfield	10.6	80
19A	Aft	D41	083	B-2	131	Airfield	12.4	61
20	Fwd	D09	054	B-10	006	Airfield	13.1	68
20A	Fwd	D09	054	B-10	006	Airfield	12.7	83
21	Fwd	D09	065	B-12	126	Airfield	8.2	110
21A	Fwd	D09	065	B-12	126	Airfield	9.5	102
22	Fwd	D09	073	C-9	156	Airfield	10.6	102
22A	Fwd	D09	073	C-9	156	Airfield	14.2	90
23	Fwd	D09	078	C-9	158	Airfield	7.7	130
24	Fwd	D09	082	A-7	005	Airfield	6.7	126

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
24A	Fwd	D09	082	A-7	005	Airfield	8.1	136
25	Fwd	D09	085	B-13	173	Airfield	10.1	90
25A	Fwd	D09	085	B-13	173	Airfield	10.5	92
26	Fwd	D09	086	A-11	085	Airfield	7.1	129
26A	Fwd	D09	086	A-11	085	Airfield	10.3	79
27	Fwd	D09	086	B-13	128	Airfield	9.4	103
27A	Fwd	D09	086	B-13	128	Airfield	12.4	67
28	Fwd	D09	089	B-13	068	Airfield	16.1	96
28A	Fwd	D09	089	B-13	068	Airfield	14.9	63
29	Aft	D41	053	B-3	150	Airfield	10.7	81
30A	Aft	D41	051	C-12	167	Airfield	6.5	138
31	Aft	D41	050	A-10	115	Airfield	12.1	74
33	Aft	D41	050	C-7	155	Airfield	9.7	90
33A	Aft	D41	050	C-7	155	Airfield	8.2	121
34	Aft	D41	050	B-3	154	Airfield	7.4	121
35	Aft	D41	048	A-9	000	Airfield	11.1	82
35A	Aft	D41	048	A-9	000	Airfield	8.8	118
36	Aft	D41	042	B-10	067	Airfield	10.0	85
36A	Aft	D41	042	B-10	067	Airfield	6.8	133
37	Aft	D41	033	C-9	045	Airfield	8.8	103
37A	Aft	D41	033	C-9	045	Airfield	11.3	73
38	Aft	D09	083	A-5	160	Airfield	9.0	106
38A	Aft	D09	083	A-5	160	Airfield	6.6	130

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
39	Aft	D09	087	C-7	005	Airfield	11.8	72
39A	Aft	D09	087	C-7	005	Airfield	16.5	70
40	Aft	D09	090	C-2	105	Airfield	14.9	60
40A	Aft	D09	090	C-2	105	Airfield	16.5	48
41	Aft	D09	091	C-3	075	Airfield	10.8	87
41A	Aft	D09	091	C-3	075	Airfield	10.5	78
42	Aft	D09	091	B-1	115	Airfield	9.6	90
42A	Aft	D09	091	B-1	115	Airfield	12.7	73
43	Aft	D09	094	B-1	053	Airfield	18.3	46
45	Fwd	D41	027	B-6	041	Airfield	12.3	72
45A	Fwd	D41	027	B-6	041	Airfield	11.5	84
46	Fwd	D41	043	A-6	000	Airfield	13.6	62
46A	Fwd	D41	043	A-6	000	Airfield	12.6	72
48	Fwd	D41	044	B-7	154	Airfield	12.2	71
48A	Fwd	D41	044	B-7	154	Airfield	14.0	89
49	Fwd	D41	045	A-12	158	Airfield	7.2	140
50	Fwd	D41	045	B-3	170	Airfield	14.9	55
50A	Fwd	D41	045	B-3	170	Airfield	13.7	64
51A	Fwd	D41	045	A-5	152	Airfield	10.6	84
52	Fwd	D41	045	A-5	105	Airfield	9.6	92
52A	Fwd	D41	045	A-5	105	Airfield	13.9	104
54	Fwd	D41	048	B-7	005	Airfield	17.2	80
57	Fwd	D41	057	C-10	151	Airfield	11.6	76

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
57A	Fwd	D41	057	C-10	151	Airfield	7.7	129
58	Fwd	D41	057	C-11	005	Airfield	6.6	139
58A	Fwd	D41	057	C-11	005	Airfield	8.0	130
59	Fwd	D41	072	C-9	030	Airfield	12.3	78
59A	Fwd	D41	072	C-9	030	Airfield	14.6	80


Section IV Mission 1008-1 70mm Film
13 Aug 1964 Frequency vs. Resolution
(lines/MM) A.I.M. 4404 Curve. 95
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 1008-1 70mm Film
13 Aug 1964 Frequency vs. 50% Amplitude
width in microns, of line spread function
95 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 V
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%

Sensitometric Data

Mission 1008-1

Film Manufacturer: Eastman Kodak Company

Exposure Date: May 26, 1964

Emulsion No.: 4404-42

Lamp No.: 1903

Exposure Time: 1/25 second

Wedge No.: 711-15

Filter: Daylight

Development Conditions:

Primary: P-693, 2' 15", 74°F

Intermediate: Primary Development Plus 12DX90, 25", 67°F

Full: Primary Development Plus 12DX90, 1' 41", 67°F

Absolute Log E 11th Step: 1.30 M.C.S.

Sensitometric Data

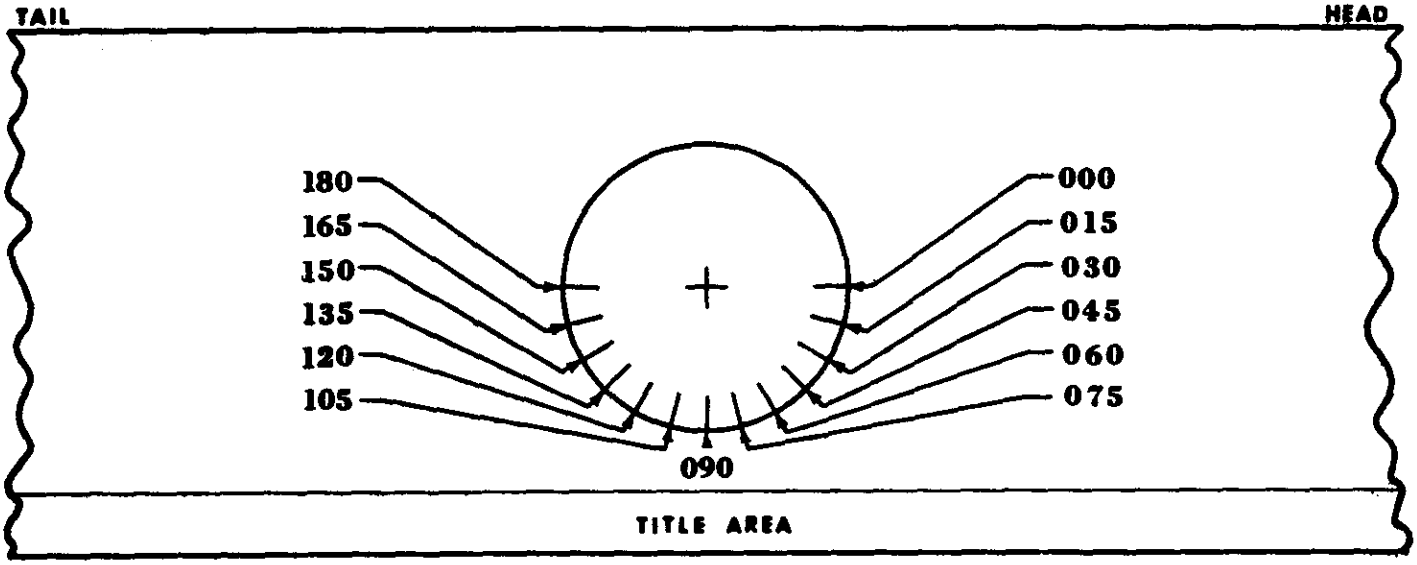
	Process Control Standard			Start Up		
	Primary	Intermed.	Full	Primary	Intermed.	Full
Fog	.08	.10	.19	.08	.10	.19
1						
2						
3						
4						.19
5			.19			.20
6		.10	.20	.08	.10	.22
7	.08	.12	.23	.09	.12	.24
8	.10	.14	.27	.10	.15	.28
9	.12	.18	.34	.12	.18	.39
10	.16	.26	.50	.15	.27	.56
11	.24	.42	.79	.24	.42	.82
12	.38	.67	1.10	.38	.68	1.12
13	.62	1.03	1.43	.60	1.06	1.45
14	.93	1.40	1.72	.90	1.40	1.73
15	1.26	1.71	1.95	1.22	1.70	1.96
16	1.55	1.95	2.13	1.54	1.92	2.12
17	1.83	2.10	2.24	1.80	2.09	2.24
18	2.04	2.22	2.30	1.99	2.21	2.31
19	2.17	2.29	2.35	2.12	2.28	2.37
20	2.25	2.34	2.39	2.20	2.32	2.40
21	2.30	2.37	2.43	2.27	2.36	2.41
γ	2.15	2.38	2.20	2.04	2.41	2.12
0.6G/Speed	$\bar{1}$.48	$\bar{1}$.30	$\bar{1}$.13	$\bar{1}$.47	$\bar{1}$.34	$\bar{1}$.12

	Head and Tail Forward Camera		Head and Tail Aft Camera	
	Head	Tail	Head	Tail
Fog	.20	.20	.19	.19
1				
2				
3				
4	.20	.20	.19	.19
5	.21	.21	.20	.20
6	.23	.23	.21	.21
7	.25	.25	.23	.23
8	.30	.29	.28	.28
9	.39	.38	.36	.36
10	.56	.55	.53	.52
11	.81	.80	.78	.80
12	1.10	1.11	1.08	1.10
13	1.42	1.44	1.42	1.43
14	1.71	1.72	1.70	1.72
15	1.94	1.95	1.94	1.94
16	2.12	2.12	2.11	2.12
17	2.24	2.24	2.24	2.24
18	2.33	2.32	2.32	2.31
19	2.38	2.36	2.36	2.36
20	2.40	2.39	2.40	2.39
21	2.42	2.41	2.41	2.40
r	2.05	2.04	2.09	2.04
0.6G/Speed	$\bar{1}.11$	$\bar{1}.12$	$\bar{1}.13$	$\bar{1}.11$

APPENDIX "A"

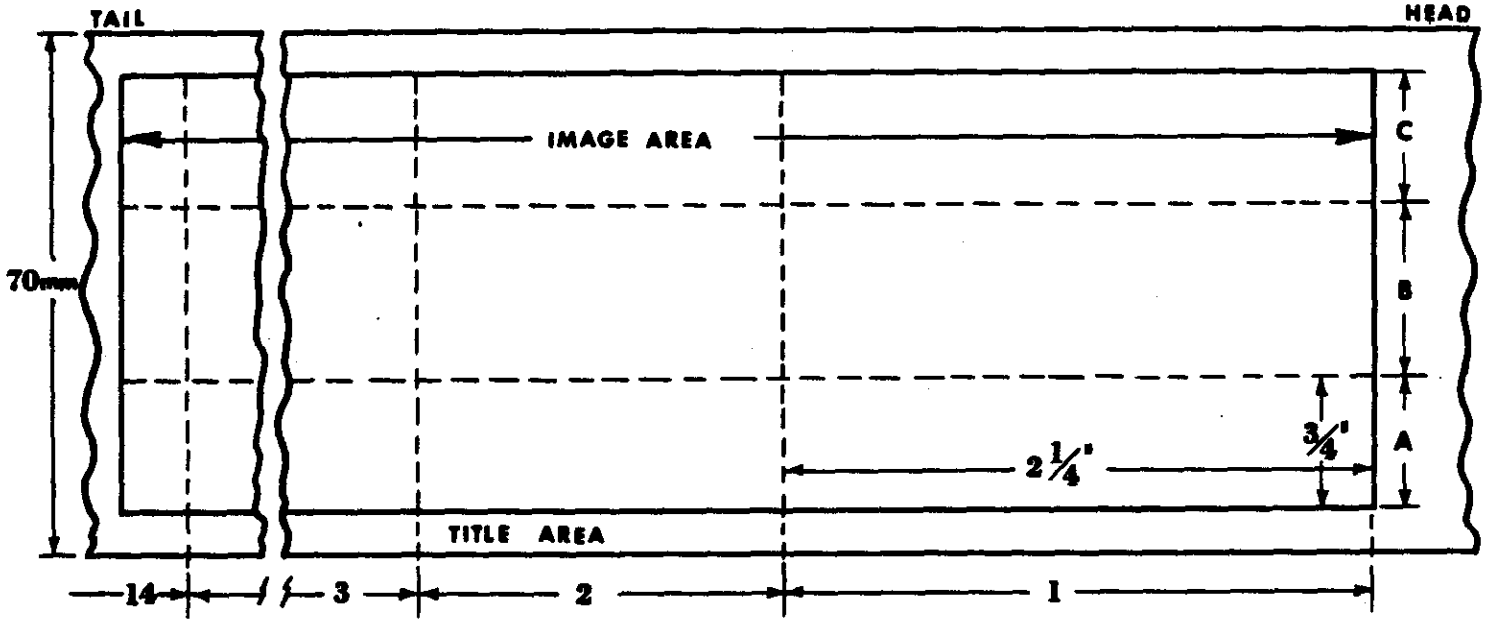
Reference System For Orientation Of C/M/J Mission Edges

original negative - - emulsion up



Grid For Position Of C/M/J Mission Edges

original negative - - emulsion up



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