[redacted]

[redacted]

Copy [redacted]

This document contains 17 pages

Analysis of Photographic Image to Evaluate System Performance Mission 1010-2

6 October 1964

[redacted]

6 October 1964

TITLE:

Summary of Microdensitometer Derived Image Quality Data Collected from Mission 1010-2

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 is presented in Section II, giving the arithmetic mean, standard deviation, coefficient of dispersion and number of edges. Section III is a summary of all C/M/J Missions traced to date. 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 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 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. 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.

SECTION II SUMMARY SHEET

Mission 1010-2

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

Arithmetic Mean	79.6
Standard Deviation	13.1
Coefficient of Dispersion	16%
Number of Edges	111
M.I.P. Frame	88.3

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

Arithmetic Mean	9.8
Standard Deviation	3.2
Coefficient of Dispersion	33%
Number of Edges	111
M.I.P. Frame	7.5

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

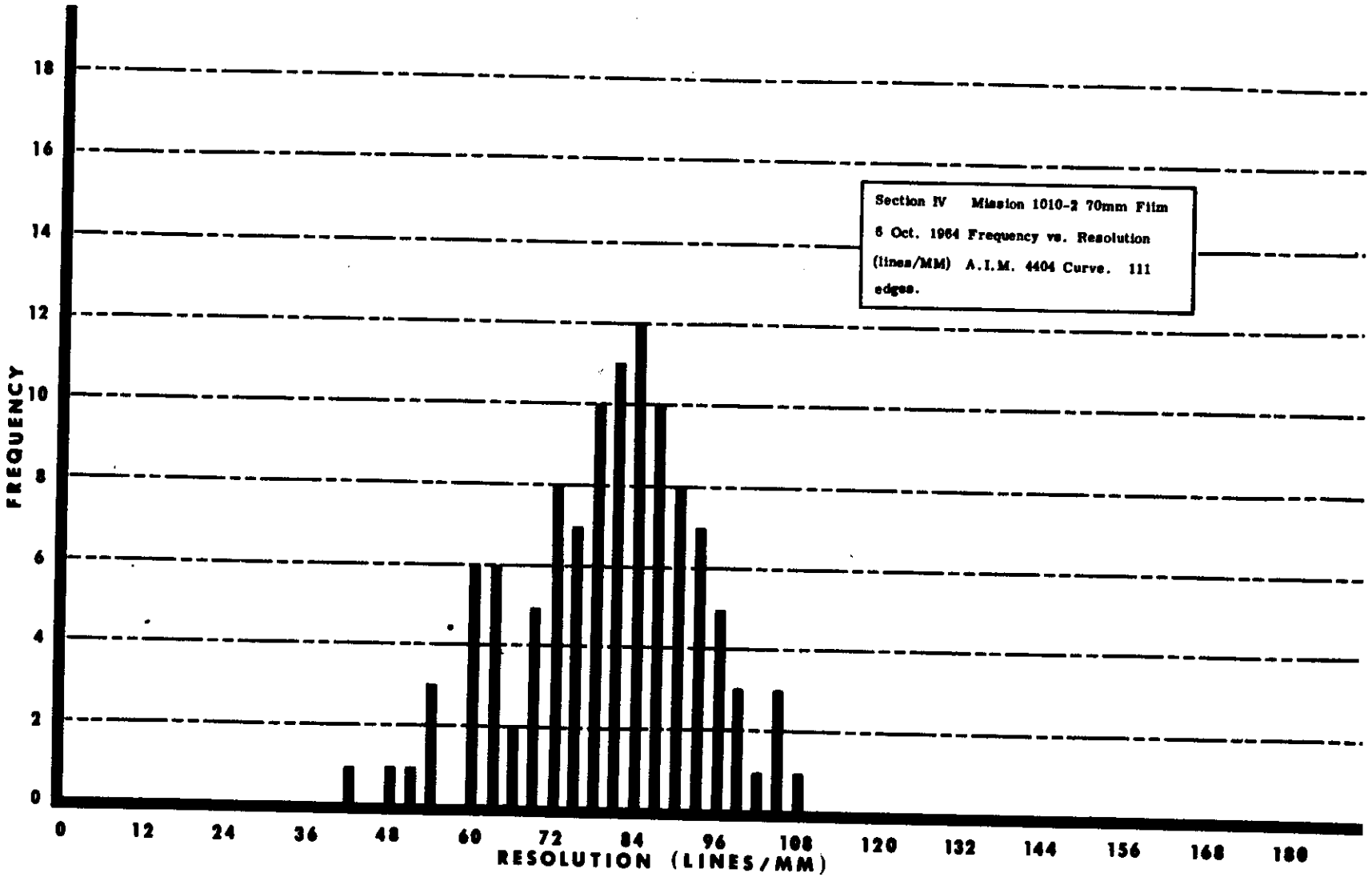
Mission Number	Number of Edges	Spread Function Width at 50% Amplitude in Microns, Computer Calculations			Resolution in lines/mm from A.I.M. 4404 Curve, Computer Calculations		
		Arithmetic Mean	Standard Deviation	Coefficient of Dispersion	Arithmetic Mean	Standard Deviation	Coefficient of Dispersion
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%

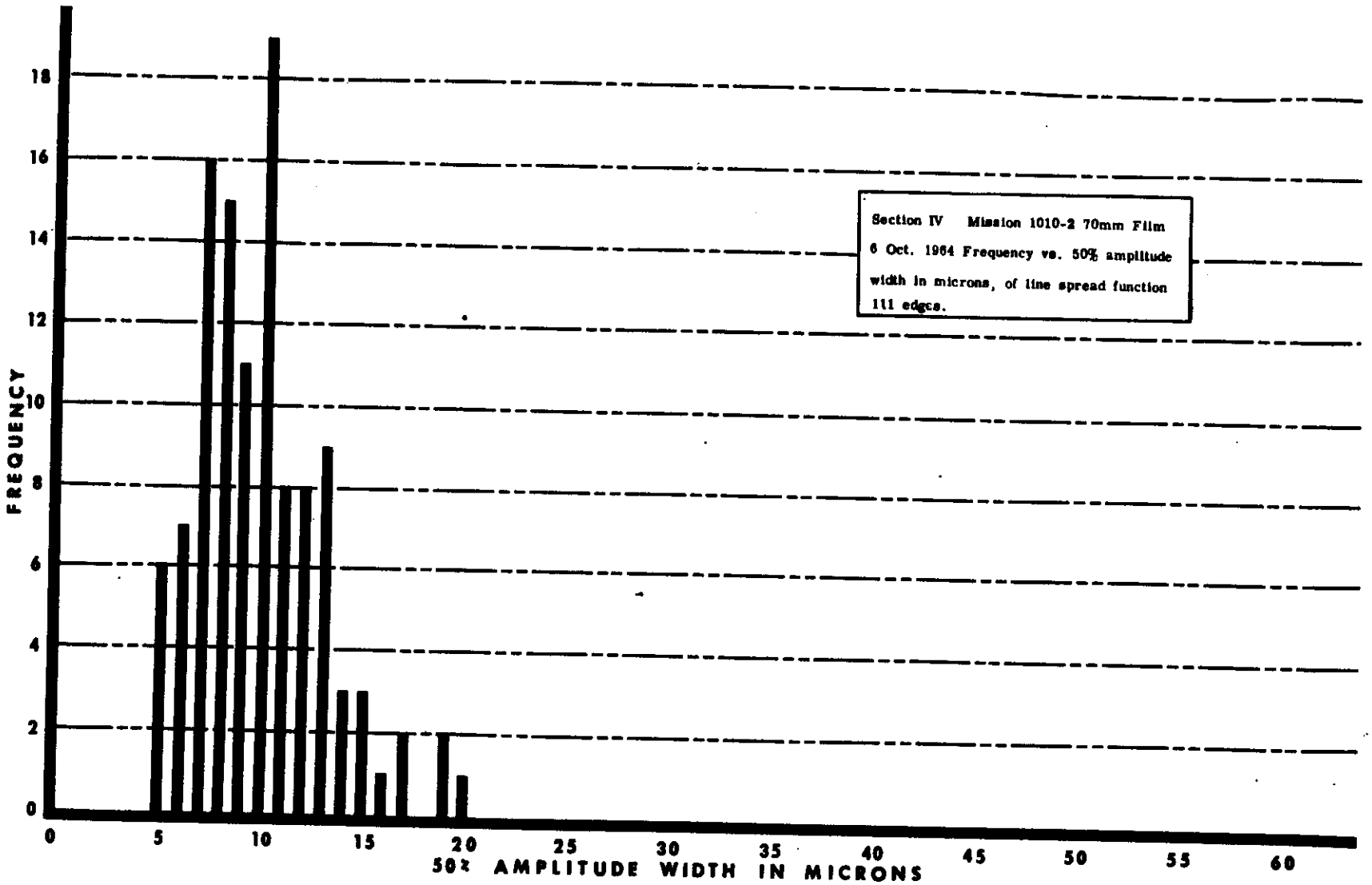
*A 1 x 80 micron slit was used.

SECTION IIIA - MISSION 1010-2

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
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
9054	81.7
9057	81.3
1010-2	79.6
1001	45.9


Section IV Mission 1010-2 70mm Film
6 Oct. 1964 Frequency vs. Resolution
(lines/MM) A.I.M. 4404 Curve. 111
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 1010-2 70mm Film
6 Oct. 1964 Frequency vs. 50% amplitude width in microns, of line spread function 111 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 1010-2

Section V

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
1	Fwd	D-68	074	B-11	140	Airfield	9.8	80
1A	Fwd	D-68	074	B-11	140	Airfield	7.9	85
2	Fwd	D-68	068	B-7	150	Buildings	6.5	90
2A	Fwd	D-68	068	B-7	150	Buildings	6.1	94
3	Fwd	D-68	062	A-2	110	Airfield	7.2	84
3A	Fwd	D-68	062	A-2	110	Airfield	10.5	69
4	Fwd	D-68	080	B-8	170	Airfield	10.3	75
4A	Fwd	D-68	080	B-8	170	Airfield	11.3	75
5	Fwd	D-68	083	B-8	035	Airfield	8.3	87
5A	Fwd	D-68	083	B-8	035	Airfield	9.6	78
6	Fwd	D-68	083	A-8	125	Buildings	13.3	63
6A	Fwd	D-68	083	A-8	125	Buildings	5.6	97
7	Aft	D-68	074	B-8	150	Buildings	5.9	98
8	Aft	D-68	067	A-12	125	Airfield	10.9	78
8A	Aft	D-68	067	A-12	125	Airfield	12.6	69
9	Aft	D-68	089	C-7	035	Airfield	9.6	87
9A	Aft	D-68	089	C-7	035	Airfield	5.1	95
10	Aft	D-68	089	C-7	120	Buildings	8.7	88
11	Aft	D-68	086	B-6	175	Airfield	7.0	92
11A	Aft	D-68	086	B-6	175	Airfield	7.8	82
12	Aft	D-68	080	B-3	125	Airfield	12.5	76

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
12A	Aft	D-68	080	B-3	125	Airfield	12.8	61
*13	Fwd	D-115	053	B-8	060	Airfield	10.6	77
*13A	Fwd	D-115	053	B-8	060	Airfield	5.2	99
14	Fwd	D-115	051	A-12	065	Airfield	6.8	94
14A	Fwd	D-115	051	A-12	065	Airfield	8.6	82
15	Fwd	D-115	051	C-11	070	Airfield	8.6	77
15A	Fwd	D-115	051	C-11	070	Airfield	5 8	95
16	Fwd	D-115	050	C-11	045	Airfield	8.1	83
16A	Fwd	D-115	050	C-11	045	Airfield	6.4	94
17	Fwd	D-115	047	B-12	170	Airfield	11.6	70
17A	Fwd	D-115	047	B-12	170	Airfield	6.9	90
18	Fwd	D-115	046	C-11	075	Airfield	6.7	86
18A	Fwd	D-115	046	C-11	075	Airfield	4.7	90
19	Aft	D-115	052	B-3	065	Airfield	15.9	51
19A	Aft	D-115	052	B-3	065	Airfield	9.2	77
20	Aft	D-115	053	C-2	140	Airfield	10.3	72
20A	Aft	D-115	053	C-2	140	Airfield	8.5	89
21	Aft	D-115	056	B-4	035	Airfield	10.1	74
21A	Aft	D-115	056	B-4	035	Airfield	7.8	83
22	Aft	D-115	057	AB-3	170	Airfield	6.7	93
22A	Aft	D-115	057	AB-3	170	Airfield	10.3	72
23	Aft	D-115	058	B-3	035	Dock	7.3	84
*24	Aft	D-115	059	C-7	045	Airfield	9.2	73

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
*24A	Aft	D-115	059	C-7	045	Airfield	5.0	104
25	Fwd	D-131	028	C-3	105	Airfield	11.0	68
25A	Fwd	D-131	028	C-3	105	Airfield	20.7	41
26	Aft	D-131	034	B-11	105	Airfield	10.7	75
26A	Aft	D-131	034	B-11	105	Airfield	14.8	55
27	Fwd	D-84	094	C-6	075	Airfield	9.8	89
27A	Fwd	D-84	094	C-6	075	Airfield	7.6	83
28	Fwd	D-84	101	B-12	115	Airfield	12.9	60
28A	Fwd	D-84	101	B-12	115	Airfield	10.2	84
29	Fwd	D-84	106	C-3	085	Airfield	19.3	49
29A	Fwd	D-84	106	C-3	085	Airfield	12.9	72
30	Fwd	D-84	107	B-2	090	Airfield	8.5	87
30A	Fwd	D-84	107	B-2	090	Airfield	12.5	64
31	Aft	D-84	101	C-9	070	Airfield	12.0	73
31A	Aft	D-84	101	C-9	070	Airfield	5.5	105
32	Aft	D-84	104	BC-7	110	Airfield	8.4	78
32A	Aft	D-84	104	BC-7	110	Airfield	9.3	80
33	Aft	D-84	107	A-2	115	Airfield	9.0	95
33A	Aft	D-84	107	A-2	115	Airfield	9.8	75
34	Aft	D-84	112	B-12	080	Airfield	12.8	62
34A	Aft	D-84	112	B-12	080	Airfield	11.9	72
35	Aft	D-84	113	B-11	095	Airfield	17.4	80
35A	Aft	D-84	113	B-11	095	Airfield	16.6	54

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
36	Aft	D-71	048	BC-8	115	Airfield	5.4	104
36A	Aft	D-71	048	BC-8	115	Airfield	8.2	83
37	Fwd	D-84	106	C-3	150	Airfield	14.4	61
37A	Fwd	D-84	106	C-3	150	Airfield	11.7	64
38	Aft	D-85	035	B-7	140	Buildings	7.3	96
38A	Aft	D-85	035	B-7	140	Buildings	8.0	86
39	Fwd	D-71	042	B-6	110	Airfield	19.2	59
40	Fwd	D-85	099	B-6	110	Buildings	7.8	86
40A	Fwd	D-85	099	B-6	110	Buildings	11.4	80
41	Fwd	D-86	037	C-2	105	Buildings	7.0	90
41A	Fwd	D-86	037	C-2	105	Buildings	7.1	87
42	Fwd	D-86	031	C-6	020	Airfield	14.6	61
42A	Fwd	D-86	031	C-6	020	Airfield	14.4	55
43	Fwd	D-88	087	C-12	100	Airfield	6.7	87
43A	Fwd	D-88	087	C-12	100	Airfield	9.6	77
44	Fwd	D-88	103	B-8	100	Buildings	5.1	109
45	Fwd	D-88	124	B-6	100	Airfield	12.9	66
45A	Fwd	D-88	124	B-6	100	Airfield	11.6	80
46	Aft	D-86	037	B-9	020	Airfield	8.1	90
46A	Aft	D-86	037	B-9	020	Airfield	7.4	98
47	Aft	D-86	043	B-12	105	Buildings	8.1	92
47A	Aft	D-86	043	B-12	105	Buildings	7.0	85
48	Aft	D-86	108	B-7	155	Dam	10.6	78

Edge No.	Camera	Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (Microns)	A.I.M. Resolution
48A	Aft	D 86	108	B 7	155	Dam	9.0	84
49	Aft	D-93	027	A-7	070	Airfield	6.7	102
49A	Aft	D-93	027	A-7	070	Airfield	9.1	85
50	Aft	D-93	023	B-9	070	Ground Test Obj.	6.6	94
51	Aft	D-93	023	B-9	160	Ground Test Obj.	14.0	64
52	Aft	D-93	014	C-5	150	Airfield	10.7	72
52A	Aft	D-93	014	C-5	150	Airfield	11.6	67
53	Aft	D-100	020	A-4	100	Airfield	10.4	73
53A	Aft	D-100	020	A-4	100	Airfield	10.4	80
54	Aft	D-101	060	B-8	025	Airfield	13.2	62
54A	Aft	D-101	060	B-8	025	Airfield	10.0	75
55	Fwd	D-93	028	C-8	120	Airfield	10.0	89
55A	Fwd	D-93	028	C-8	120	Airfield	9.8	77
56	Fwd	D-93	021	C-7	060	Airfield	10.0	81
56A	Fwd	D-93	021	C-7	060	Airfield	8.4	81
57	Fwd	D-93	017	C-5	080	Ground Test Obj.	8.6	82
58	Fwd	D-93	017	C-5	170	Ground Test Obj.	7.2	87
59	Fwd	D-100	015	A-10	100	Airfield	9.9	79
59A	Fwd	D-100	015	A-10	100	Airfield	9.1	83
60	Fwd	D-101	054	BC-7	025	Airfield	11.6	70
60A	Fwd	D-101	054	BC-7	025	Airfield	14.6	59

*M.I.P. Frame

Sensitometric Data

Mission 1010-2

Film Manufacturer: Eastman Kodak Company

Exposure Date: August 26, 1964

Emulsion No.: 4404-42

Lamp No.: 1961

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: $\bar{1}.30$ M.C.S.

Sensitometric Data

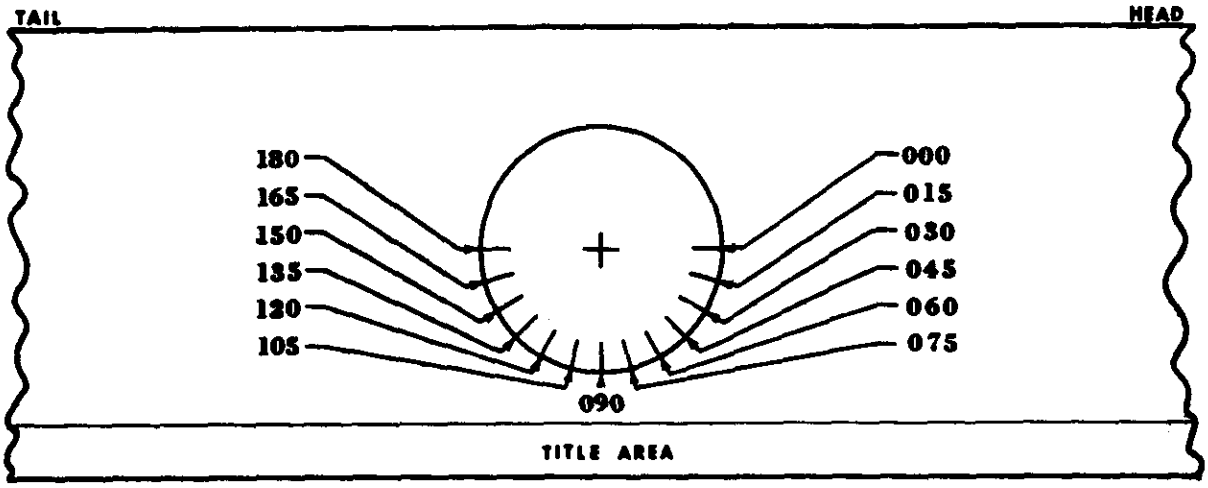
	Process Control Standard			Start Up		
	Primary	Intermed.	Full	Primary	Intermed.	Full
Fog	.08	.10	.19	.09	.11	.20
1						
2						.20
3					.11	.21
4				.09	.12	.22
5			.19	.10	.13	.23
6		.10	.20	.11	.14	.24
7	.08	.12	.23	.12	.15	.27
8	.10	.14	.27	.13	.17	.31
9	.12	.18	.34	.15	.21	.39
10	.16	.26	.50	.20	.29	.52
11	.24	.42	.79	.27	.42	.77
12	.38	.67	1.10	.39	.66	1.06
13	.62	1.03	.43	.62	1.00	1.38
14	.93	1.40	1.72	.90	1.36	1.66
15	1.26	1.71	1.95	1.23	1.66	1.91
16	1.55	1.95	2.13	1.55	1.91	2.09
17	1.83	2.10	2.24	1.81	2.11	2.24
18	2.04	2.22	2.30	2.01	2.23	2.33
19	2.17	2.29	2.35	2.17	2.33	2.39
20	2.25	2.34	2.39	2.27	2.38	2.43
21	2.30	2.37	2.43	2.33	2.41	2.45
δ	2.15	2.38	2.20	2.08	2.26	2.05
0.6G/Speed	1.48	1.30	1.13	1.48	1.34	1.13

	Head and Tail Forward Camera		Head and Tail Aft Camera	
	Head	Tail	Head	Tail
Fog	.20	.20	.20	.19
1				
2				
3				.19
4	.20	.20	.20	.20
5	.21	.21	.21	.21
6	.23	.22	.23	.22
7	.25	.23	.25	.23
8	.30	.28	.28	.27
9	.39	.37	.36	.36
10	.54	.52	.52	.51
11	.78	.78	.76	.78
12	1.09	1.08	1.06	1.07
13	1.39	1.38	1.36	1.38
14	1.68	1.68	1.65	1.69
15	1.91	1.90	1.88	1.91
16	2.09	2.07	2.06	2.09
17	2.23	2.19	2.70	2.21
18	2.32	2.27	2.29	2.30
19	2.37	2.32	2.34	2.35
20	2.39	2.37	2.37	2.38
21	2.40	2.38	2.40	2.39
	2.05	2.03	1.98	2.08
0.6G/Speed	Ī.14	Ī.14	Ī.13	Ī.15

APPENDIX "A"

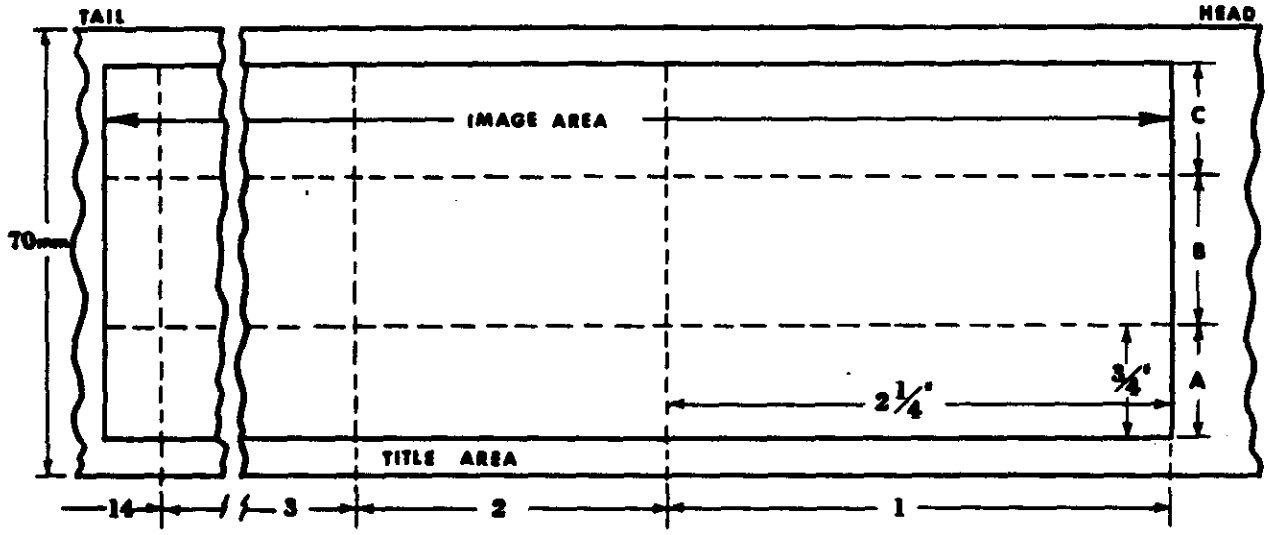
Reference System For Orientation Of C/M/J Mission Edges

original negative - - emulsion up



Grid For Position Of C/M/J Mission Edges

original negative - - emulsion up



[redacted]

Distribution List

[redacted]