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Analysis of Photographic Image to Evaluate System Performance Mission 1026-1 and -2

22 November 1965

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Analysis of Photographic Image to Evaluate System Performance

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Mission 1026

TITLE:

Summary of Microdensitometer Derived Image Quality Data Collected from Mission 1026-1 and 1026-2.

SECTION I: INTRODUCTION

The normal quality evaluation of a photographic reconnaissance mission is based on a subjective judgment of the ground detail resolved on the film. In an attempt to find an objective measurement technique for image evaluation, the microdensitometer has been used to scan sharp scene edges present on the film.

EDGE SELECTION

Edges suitable for use in microdensitometer edge tracing should fulfill the criteria of the mathematical unit step function. In practice, the following restrictions are placed on the edges selected for tracing.

(1) The edge should appear sharp visually at 100X magnification. Additionally, the two density levels extending away from the edge should be uniform for several resolution widths (15 or more microns on each side of the edge).

The minimum length of an edge is 150μ. The most common type of scene edge having these characteristics is found in the image of the intersection of the shadow and roof of a large industrial building.

(2) The contrast of the edge must be high enough so that the edge can be readily aligned in the microdensitometer and yet not be of such high contrast that bleeding or halation is present.

(3) The subject must be free of cloud cover and cloud shadows and have a minimum amount of haze.

(4) The first 5 frames after each camera start up and the last 3 frames before shut down are avoided.

(5) Two inches from each end of the frame are not used.

(6) Subjects which occur in areas of soft spots or minus density are not used.

(7) Within acceptable portions of the frame there are no limiations nor restrictions on the location or orientation of the edge.

REPORT

In this report, the evaluation data are presented as spread function width in microns, reciprocal of spread function width, and resolving power in lines per millimeter. Three or more separate random sections of each edge were traced. Multiple tracings were made without changing focus or edge alignment. An illustration showing the conversion of a scene edge to M.T.F. and spread function is presented in Section IA. 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 III is a summary of all C/M/J Missions that have been computed with the new SWRDR computer program. Image Quality Ranking of all C/M/J Missions is listed in Section IIIA. A summary of the P.I. rating and the computed values for the M.I.P. frame are listed in Section IIIB. A 10 diameter and a 40 diameter enlargement of the M.I.P. frame are presented in Section IV. A tabulation of the location, description, and image quality data for each edge is presented as Section V. Section VI is a plot of relative illuminance vs. distance for the spread function, and the percent response vs. frequency for the system MTF for the edge trace in the M.I.P. frame. Frequency plots of the spread function and resolving power data are presented as Section VII to show the distribution of values. Sections VIII, IX, X and XI are included to show plots of computed resolving power and spread function width versus pass number, latitude, longitude and solar elevation. The original edge trace (solid line) and the hand smoothing of the trace (dashed line) from the M.I.P. frame are reproduced in Section XII. A replication series from three tracings at different locations on the same edge (identified as traces A, B, and C) and a repetition series of five tracings of the same location on the edge (identified as traces C, D, E, F and G) are presented in Section XIII to show comparative image quality.

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 index is given as X46.0, Y12.0. X numbers increase toward the take-up and Y numbers increase toward the title.

COMPUTATION

The image quality data were obtained from sharp scene edges on 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 0.412 microns,

(c) I. B. M. 7044 computer conversion of chart values to relative exposure values, and transfer function by numerical methods.

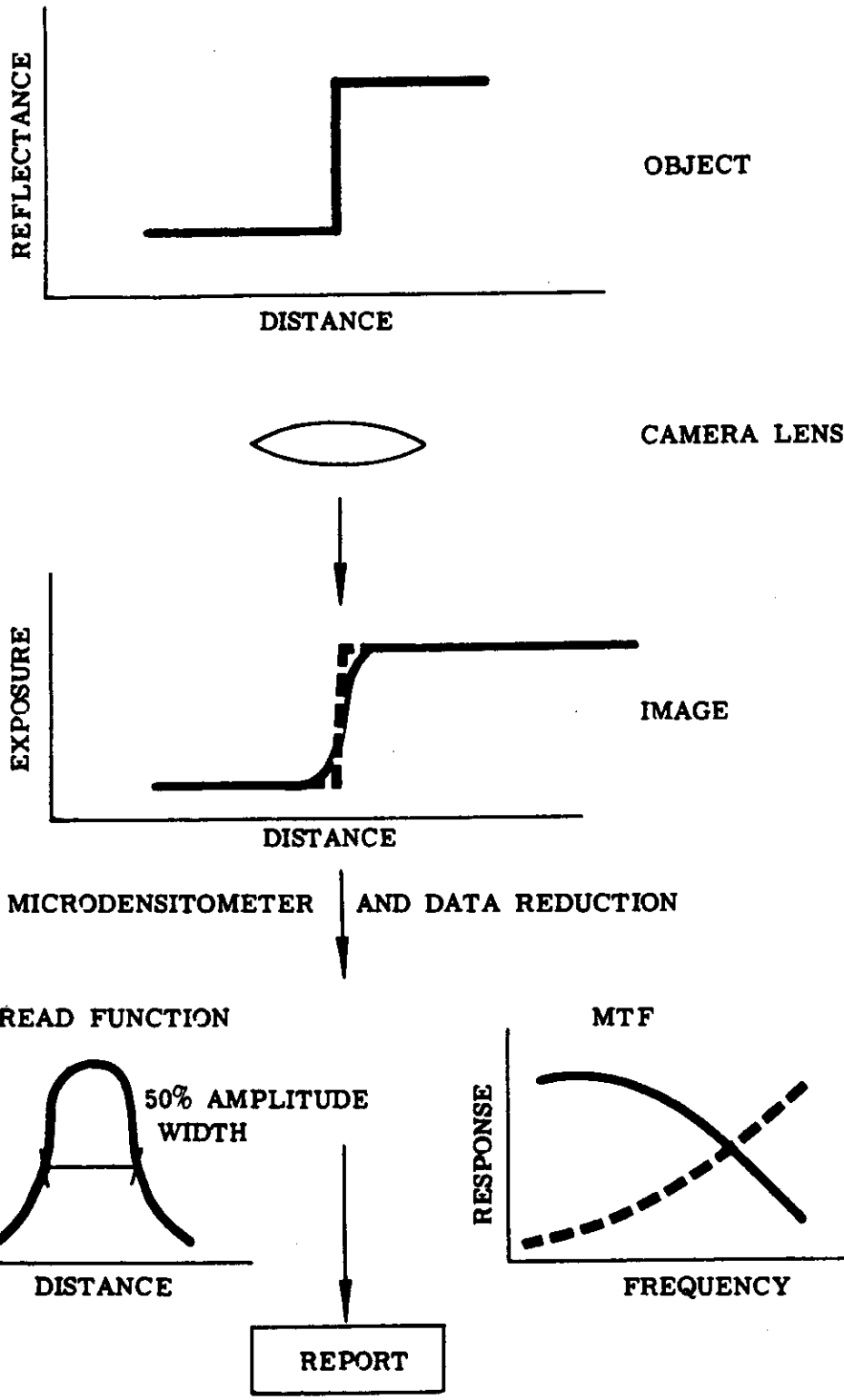
The edge resolving power was predicted graphically as the intersection of the MTF curve and the aerial image modulation curve for 3404 film at a test object contrast of 2:1. The spread function width was calculated from the first differences of relative exposure as the width at which the gradient became 50% of the maximum gradient. The width at the 50% level was used to generate the reciprocal spread function width.

To obtain the average resolution for an edge, the multiple tracings of separate sections of the edge are averaged at the exposure level. The composite exposure edge is then reduced in the computer giving resolution and spread function width. It should be noted the results of exposure averaging may be different from the arithmetic mean of the individual tracings.

Analysis of Photographic Image to Evaluate System Performance

SECTION IA

Conversion of Scene Edge to MTF and Spread Function



Analysis of Photographic Image to Evaluate System Performance

SECTION II SUMMARY SHEET

Mission 1026

Resolution in lines/mm based on the aerial image modulation 3404 curve from edge trace data reduced by computer techniques.

	1026-1	1026-2
Arithmetic Mean	89.5 l/mm	91.1 l/mm
Standard Deviation	21.3 l/mm	18.9 l/mm
Coefficient of Dispersion	24%	21%
Number of Edges	43	38

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

Arithmetic Mean	8.9 μ	8.6 μ
Standard Deviation	2.8 μ	2.2 μ
Coefficient of Dispersion	32%	26%
Number of Edges	43	38

Reciprocal of spread function width at 50% amplitude

Arithmetic Mean	121.9 μ^{-1}	124.3 μ^{-1}
Standard Deviation	32.6 μ^{-1}	30.6 μ^{-1}
Coefficient of Dispersion	27%	25%
Number of Edges	43	38

Analysis of Photographic Image to Evaluate System Performance

SECTION IIA SUMMARY SHEET

Mission 1026-1

Resolution in lines/mm based on the aerial image modulation - 3404 curve from edge trace data reduced by computer techniques.

	FWD Camera	AFT Camera
Arithmetic Mean	80.1 l/mm	97.7 l/mm
Standard Deviation	20.0 l/mm	19.2 l/mm
Coefficient of Dispersion	25%	20%
Number of Edges	20	23

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

	FWD Camera	AFT Camera
Arithmetic Mean	10.1 μ	7.8 μ
Standard Deviation	3.2 μ	2.0 μ
Coefficient of Dispersion	31%	25%
Number of Edges	20	23

Reciprocal of spread function width at 50% amplitude

	FWD Camera	AFT Camera
Arithmetic Mean	107.1 μ^{-1}	134.8 μ^{-1}
Standard Deviation	27.4 μ^{-1}	31.7 μ^{-1}
Coefficient of Dispersion	26%	24%
Number of Edges	20	23

Analysis of Photographic Image to Evaluate System Performance

SECTION IIA SUMMARY SHEET

Mission 1026-2

Resolution in lines/mm based on the aerial image modulation - 3404 curve from edge trace data reduced by computer techniques.

	FWD Camera	AFT Camera
Arithmetic Mean	91.9 l/mm	90.2 l/mm
Standard Deviation	17.6 l/mm	20.7 l/mm
Coefficient of Dispersion	19%	23%
Number of Edges	20	18

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

	FWD Camera	AFT Camera
Arithmetic Mean	8.5 μ	8.6 μ
Standard Deviation	2.3 μ	2.2 μ
Coefficient of Dispersion	27%	26%
Number of Edges	20	18

Reciprocal of spread function width at 50% amplitude

	FWD Camera	AFT Camera
Arithmetic Mean	124.3 μ^{-1}	124.3 μ^{-1}
Standard Deviation	30.0 μ^{-1}	32.1 μ^{-1}
Coefficient of Dispersion	24%	26%
Number of Edges	20	18

Analysis of Photographic Image to Evaluate System Performance

SECTION III - MISSION 1026

Summary of all C/M/J Missions Traced and Computed
With the New SWRDR Computer Program

Mission Number	Number of Edges	Spread Function Width at 50% Amplitude in Microns, Computer Calculations			Resolution in lines/mm from A.I.M. 3404 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%
1016-1	31**	9.7	2.3	24%	88.0	18.6	21%
1016-2	33**	9.8	3.2	32%	91.5	16.1	18%
1017-1	42**	10.2	3.5	34%	86.6	18.8	22%
1017-2	45**	11.4	3.6	31%	82.2	17.8	22%
1018-1	34**	9.6	2.5	26%	88.7	18.3	21%
1018-2	44**	10.1	2.4	23%	84.8	17.4	21%

*A 1 x 320 micron slit was used
**Each edge was traced three or more times on the microdensitometer

Mission 1026

Mission Number	Number of Edges	Spread Function Width at 50% Amplitude in Microns, Computer Calculations			Resolution in lines/mm from A.I.M. 3404 Curve, Computer Calculations		
		Arithmetic Mean	Standard Deviation	Coefficient of Dispersion	Arithmetic Mean	Standard Deviation	Coefficient of Dispersion
1019-1	40**	9.6	2.4	25%	87.1	15.8	18%
1020-1	40**	9.7	2.3	23%	86.2	17.7	21%
1021-1	20**	9.4	2.9	31%	92.1	22.4	24%
1021-2	15**	9.8	1.4	14%	87.6	10.7	12%
1022-1	44**	10.0	2.8	28%	89.9	19.6	22%
1022-2	48**	10.6	3.9	37%	85.4	23.1	27%
1023-1	42**	9.2	2.6	28%	90.2	20.3	23%
1023-2	31**	11.9	3.9	33%	71.9	16.5	23%
1024-1	46**	8.7	2.9	33%	91.6	19.4	21%
1024-2	44**	8.3	2.0	24%	94.1	18.2	19%
1025-1	29**	8.7	2.0	23%	91.3	18.4	20%
1025-2	25**	8.8	2.6	30%	92.2	21.1	23%
1026-1	43**	8.9	2.8	32%	89.5	21.3	24%
1026-2	38**	8.6	2.2	26%	91.1	18.9	21%

**Each edge was traced three or more times on the microdensitometer

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SECTION IIIA - MISSION 1026

Image Quality Ranking of C/M/J Missions

Mission Number	Average Resolution in lines/mm for A.I.M. 3404 Curve	Mission Number	Average Resolution in lines/mm for A.I.M. 3404 Curve
1024-2	94.1 l/mm	1020-1	86.2 l/mm
1015-1	93.1 l/mm	1012-1	86.1 l/mm
1025-2	92.2 l/mm	1022-2	85.4 l/mm
1021-1	92.1 l/mm	1018-2	84.8 l/mm
1024-1	91.6 l/mm	1008-2	84.3 l/mm
1016-2	91.5 l/mm	1010-2	84.3 l/mm
1025-1	91.3 l/mm	1012-2	84.0 l/mm
1026-2	91.1 l/mm	1013-1	83.3 l/mm
1023-1	90.2 l/mm	1008-1	83.0 l/mm
1022-1	89.9 l/mm	1014-1	83.0 l/mm
1015-2	89.7 l/mm	1017-2	82.2 l/mm
1026-1	89.5 l/mm	1011-1	80.5 l/mm
1010-1	89.4 l/mm	1009-1	75.3 l/mm
1018-1	88.7 l/mm	1014-2	74.2 l/mm
1016-1	88.0 l/mm	1009-2	74.1 l/mm
1021-2	87.6 l/mm	1023-2	71.9 l/mm
1019-1	87.1 l/mm	1007-2	71.0 l/mm
1017-1	86.6 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. Caution is advised in making system comparisons based on lines per millimeter resolution or spread function width until better methods become available for calibration of the edge tracing technique.

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SECTION IIIB M.I.P. SUMMARY SHEET

Mission 1026

Mission Number	PI M.I.P. Rating	Resolution in lines/mm	Spread Function
1009-1	85	112 l/mm	7.3 μ
1009-2	85	---	---
1010-1	85	134 l/mm	5.3 μ
1010-2	85	136 l/mm	5.0 μ
1011-1	85	113 l/mm	6.3 μ
1012-1	85	120 l/mm	6.7 μ
1012-2	85	117 l/mm	5.0 μ
1013-1	85	95 l/mm	9.2 μ
1014-1	80	109 l/mm	5.6 μ
1014-2	80	---	---
1015-1	85	92 l/mm	8.6 μ
1015-2	85	86 l/mm	8.4 μ
1016-1	85	114 l/mm	6.0 μ
1016-2	85	106 l/mm	7.6 μ
1017-1	85	112 l/mm	7.6 μ
1017-2	85	97 l/mm	8.6 μ
1018-1	85	78 l/mm	9.9 μ
1018-2	85	90 l/mm	9.7 μ
1019-1	85	82 l/mm	8.9 μ
1020-1	--	97 l/mm	8.5 μ
1021-1	85	89 l/mm	8.2 μ
1021-2	--	72 l/mm	10.7 μ
1022-1	85	120 l/mm	5.4 μ
1022-2	85	79 l/mm	10.3 μ

The M.I.P. rating is an arbitrary figure assigned by the PI to indicate the quality of the best photography obtained in a particular mission. The pass and frame are selected by the PI and the target to be traced is selected by the Microdensitometer operator.

Analysis of Photographic Image to Evaluate System Performance

SECTION IIIB M.I.P. SUMMARY SHEET

Mission 1026

Mission Number	PI M.I.P. Rating	Resolution in lines/mm	Spread Function
1023-1	85	113 l/mm	6.0 μ
1023-2*	85	86 l/mm	9.6 μ
1024-1	85	58 l/mm	14.1 μ
1024-2	85	111 l/mm	6.8 μ
1025-1*	85	95 l/mm	7.7 μ
1025-2	85	97 l/mm	7.8 μ
1026-1	85	107 l/mm	7.2 μ
1026-2	85	66 l/mm	11.2 μ

The M.I.P. rating is an arbitrary figure assigned by the PI to indicate the quality of the best photography obtained in a particular mission. The pass and frame are selected by the PI and the target to be traced is selected by the Microdensitometer operator.

*Selected Frame (M.I.P. Frame not known)

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Section IV Mission 1026-1 10X Enlargement

Selected Frame FWD Camera

Edge Location: Pass D-047, Frame 012, X65.7 Y12.7

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Section IV Mission 1026-1 40X Enlargement

Selected Frame FWD Camera

Edge Location: Pass D-047, Frame 012, X65.7 Y12.7

Analysis of Photographic Image to Evaluate System Performance

Section IV Mission 1026-2 10X Enlargement

Selected Frame AFT Camera

Edge Location: Pass D-094, Frame 026, X66.6 Y13.6

Analysis of Photographic Image to Evaluate System Performance

Section IV Mission 1026-2 40X Enlargement

Selected Frame AFT Camera

Edge Location: Pass D-094, Frame 026, X66.6 Y13.6

Mission 1026 -1
Section V

Pass	Frame	Location	Orientation	Subject (see page 27)	50% Amplitude Spread Function Width (microns)		Reciprocal of 50% Amp. Spread Function Width (microns)		A.I.M. Resolution (lines/mm)		Camera
D-014	4	X 50.1 Y 11.9	040	D	6.3	6.9	158	145	107	98	F
					6.5		153		110		F
					7.8		127		81		F
D-014	5	X 50.0 Y 13.0	010	B	9.5	9.4	105	106	82	77	F
					8.7		114		84		F
					10.1		98		66		F
D-014	6	X 46.0 Y 14.1	065	B	8.8	8.8	113	113	74	75	F
					8.9		112		72		F
					8.7		115		80		F
D-014	7	X 43.0 Y 11.6	020	B	12.4	13.8	80	72	57	48	F
					11.4		87		53		F
					16.1		62		44		F
D-014	11	X 36.5 Y 11.5	110	B	9.7	11.9	103	83	80	65	F
					11.0		91		59		F
					13.2		75		59		F
D-014	12	X 34.8 Y 12.4	005	B	8.6	7.5	116	133	78	93	F
					8.9		112		85		F
					5.8		173		108		F
D-014	14	X 39.9 Y 13.5	070	B	15.9	13.6	62	73	68	54	F
					10.5		95		88		F
					13.2		75		54		F
D-014	15	X 39.3 Y 13.4	015	B	15.5	17.4	64	57	46	45	F
					18.6		53		50		F
					17.1		58		50		F
D-031	7	X 22.2 Y 11.2	020	B	15.5	17.1	64	58	57	49	F
					19.1		52		43		F
					17.6		56		47		F
D-046	17	X 22.6 Y 11.3	015	B	9.6	9.5	104	104	80	82	F
					11.2		89		79		F
					7.0		143		92		F
D-046	18	X 50.1 Y 12.5	030	B	6.9	7.4	144	134	112	109	F
					7.5		133		106		F
					7.5		132		108		F

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Mission 1026-1
Section V

Pass	Frame	Location	Orientation	Subject (see page 27)	50% Amplitude Spread Function Width (microns)		Reciprocal of 50% Amp. Spread Function Width (microns)		A.I.M. Resolution (lines/mm)		Camera
D-046	18	X 50.2 Y 12.4	015	B	11.6	10.4	86	96	64	73	F
					11.5		86		70		F
					8.0		124		86		F
D-047	8	X 56.4 Y 10.7	020	A	13.1	9.9	76	101	63	72	F
					8.1		123		88		F
					8.5		117		86		F
D-047	10	X 44.6 Y 12.1	C05	T	6.5	7.0	154	143	104	99	F
					6.6		150		102		F
					7.6		131		95		F
D-047	12	X 65.7 Y 12.7	050	B	7.3	9.8	136	102	97	79	F
					10.6		94		70		F
					11.3		88		78		F
D-047	13	X 69.2 Y 13.8	010	B	8.9	9.4	111	106	89	87	F
					9.9		101		80		F
					8.7		114		89		F
D-047	16	X 11.7 Y 10.2	C55	B	8.5	8.7	117	115	90	88	F
					7.5		133		100		F
					10.2		97		77		F
D-061	8	X 28.3 Y 13.2	020	B	7.6	7.0	132	142	106	111	F
					7.7		129		101		F
					5.6		178		128		F
D-061	10	X 41.8 Y 13.3	020	B	9.3	7.7	107	130	78	88	F
					5.1		197		111		F
					8.4		118		86		F
D-078	7	X 56.8 Y 12.5	020	B	10.3	8.4	96	118	92	103	F
					8.1		124		89		F
					6.0		166		125		F

Mission 1026-1
Section V

Pass	Frame	Location	Orientation	Subject (see page 27)	50% Amplitude Spread Function Width (microns)	Reciprocal of 50% Amp. Spread Function Width (microns)	A.I.M. Resolution (lines/mm)	Camera
D-009	8	X 34.3 Y 12.3	070	B	11.1 9.0	90 111	77 85	A
					6.7	148	107	A
					8.9	112	92	A
D-009	24	X 40.9 Y 14.1	045	B	5.2 6.6	192 151	129 114	A
					6.8	147	110	A
					7.4	134	108	A
D-014	10	X 40.2 Y 13.0	040	D	4.3 4.7	231 211	148 136	A
					5.4	186	120	A
					4.5	223	141	A
D-014	11	X 40.2 Y 11.5	015	B	7.0 10.8	142 92	97 59	A
					8.8	113	86	A
					14.6	68	53	A
D-014	12	X 44.5 Y 11.0	080	B	9.8 7.9	102 125	79 98	A
					6.6	150	101	A
					5.9	168	101	A
D-031	13	X 68.5 Y 13.2	015	B	8.8 7.0	113 143	88 105	A
					6.2	161	111	A
					5.7	174	123	A
D-038	47	X 47.6 Y 11.2	060	B	6.3 10.0	159 100	108 73	A
					9.3	107	69	A
					10.3	96	71	A
D-040	48	X 51.1 Y 11.2	080	B	10.4 10.7	96 93	70 72	A
					9.7	102	80	A
					10.6	94	76	A
D-040	49	X 35.3 Y 12.7	040	B	5.4 6.3	184 158	118 110	A
					6.7	149	110	A
					7.1	141	104	A
D-040	60	X 44.9 Y 14.2	005	B	6.1 7.1	164 141	116 101	A
					7.2	138	96	A
					8.0	125	96	A
D-040	69	X 26.5 Y 14.0	045	B	4.3 6.7	233 148	128 104	A
					6.5	152	111	A
					6.6	152	104	A

Mission 1026-1
Section V

	Pass	Frame	Location	Orientation	Subject (see page 27)	50% Amplitude Spread Function Width (microns)		Reciprocal of 50% Amp. Spread Function Width (microns)		A.I.M. Resolution (lines/mm)		Camera
	D-046	9	X 56.5 Y 13.8	020	A	6.9	6.4	145	157	97	112	A
						6.6		151		110		A
						5.4		186		130		A
	D-046	10	X 56.6 Y 12.7	115	B	6.7	6.9	150	145	101	102	A
						5.9		169		109		A
						7.7		129		100		A
	D-047	14	X 33.0 Y 14.5	110	R	9.4	9.3	106	107	85	93	A
						9.6		104		85		A
						8.2		122		117		A
	D-047	16	X 45.5 Y 12.6	110	T	7.5	7.2	133	138	98	105	A
						6.8		146		119		A
						7.0		143		109		A
	D-047	18	X 25.3 Y 13.8	015	B	5.8	7.2	171	138	121	98	A
						6.8		146		112		A
						7.7		130		93		A
	D-061	7	X 34.0 Y 14.1	050	B	7.7	10.3	129	97	98	71	A
						11.5		87		77		A
						11.6		86		62		A
	D-061	11	X 40.3 Y 12.6	170	B	4.4	5.2	228	192	129	121	A
						5.4		184		120		A
						5.2		192		126		A
	D-061	14	X 49.6 Y 13.3	075	B	5.9	6.9	169	144	119	104	A
						6.5		154		103		A
						8.4		118		87		A
	D-061	15	X 53.1 Y 13.4	045	B	7.1	7.6	140	130	107	100	A
						8.5		118		96		A
						7.5		133		100		A
	D-078	8	X 33.7 Y 10.3	180	D	13.4	12.9	74	77	66	63	A
						12.7		78		64		A
						12.4		80		59		A
*	D-078	13	X 40.4 Y 13.6	105	B	6.5	7.2	154	139	113	107	A
						7.1		140		109		A
						7.7		129		97		A

* M.I.P. Frame

Analysis of Photographic Image to Evaluate System Performance

Mission 1026-1
Section V

Pass	Frame	Location	Orientation	Subject (see page 27)	50% Amplitude Spread Function Width (microns)	Reciprocal of 50% Amp. Spread Function Width (microns)	A.I.M. Resolution (lines/mm)	Camera
D-078	14	X 38.6 Y 13.6	020	B	7.4 6.6	135 151	96 109	A
					6.5	154	113	A
					5.9	168	122	A

Pass	Frame	Location	Orientation	Subject (see page 27)	50% Amplitude Spread Function Width (microns)		Reciprocal of 50% Amp. Spread Function Width (microns)		A.I.M. Resolution (lines/mm)		Camera
D-[illegible]64	[illegible]	X 20.3 Y 13.5	[illegible]45	D	11.8	10.6	87	94	80	71	F
					11.2		9[illegible]		6[illegible]		F
					9.3		107		83		F
D-[illegible]64	1[illegible]	X 20.[illegible] Y 12.4	[illegible]9F	A	12.4	12.7	80	79	71	67	F
					12.7		7[illegible]		61		F
					12.9		77		66		F
D-[illegible]64	1[illegible]	X 24.2 Y 11.2	090	A	11.0	8.0	90	124	7[illegible]	92	F
					6.6		150		103		F
					6.5		152		100		F
D-[illegible]64	17	X 23.[illegible] Y 14.0	020	B	9.8	7.0	101	143	79	101	F
					5.8		171		119		F
					5.6		179		118		F
D-[illegible]64	1[illegible]	X 34.[illegible] Y 13.[illegible]	04[illegible]	B	13.5	15.1	64	66	[illegible]3	64	F
					15.7		63		67		F
					13.6		73		[illegible]3		F
D-[illegible]85	72	X 37.[illegible] Y 11.1	020	B	8.3	7.2	120	138	88	98	F
					8.4		119		88		F
					5.9		169		127		F
D-[illegible]85	73	X 44.7 Y 11.6	170	B	8.0	8.9	124	111	87	83	F
					7.2		139		94		F
					7.4		135		96		F
D-[illegible]88	117	X 41.[illegible] Y 13.[illegible]	[illegible]25	B	6.4	8.9	155	112	105	85	F
					9.8		102		82		F
					10.5		95		77		F
D-[illegible]94	26	X 21.5 Y 13.7	020	B	5.5	6.9	180	144	114	106	F
					6.7		149		106		F
					7.2		139		101		F
D-1[illegible]	67	X 19.8 Y 13.8	165	B	6.8	8.0	146	124	112	96	F
					5.2		191		115		F
					9.0		111		91		F
D-11[illegible]	5	X 77.1 Y 9.8	025	B	11.1	9.9	90	101	70	77	F
					9.7		103		80		F
					8.6		116		81		F

Mission 1026-2
Section V

Pass	Frame	Location	Orientation		Subject (see page 27)	50% Amplitude Spread Function Width (microns)		Reciprocal of 50% Amp. Spread Function Width (microns)		A.I.M. Resolution (lines/mm)		Camera
D-110	5	X 73.5 Y 10.0	025	B	11.5	8.2		87	121	73	67	F
					6.4			155		104		F
					5.7			174		109		F
D-117	73	X 59.3 Y 11.0	050	B	8.3	9.0		120	110	81	82	F
					8.5			118		87		F
					10.0			99		76		F
D-117	78	X 23.2 Y 13.4	160	B	6.5	6.2		154	162	115	118	F
					6.3			159		119		F
					5.4			185		123		F
D-117	79	X 63.4 Y 12.3	030	B	6.1	7.4		162	135	107	94	F
					7.7			130		87		F
					8.2			121		93		F
D-117	81	X 24.7 Y 10.6	010	B	10.7	8.8		93	113	70	87	F
					7.7			130		94		F
					8.3			120		99		F
D-131	81	X 24.5 Y 11.8	050	B	6.8	6.3		148	158	115	118	F
					8.3			120		110		F
					4.2			239		145		F
D-131	84	X 15.6 Y 11.1	175	B	7.0	7.2		143	138	100	101	F
					7.2			139		102		F
					7.2			138		104		F
D-131	92	X 37.2 Y 11.4	020	B	8.7	9.4		114	106	93	86	F
					9.6			104		78		F
					9.8			101		89		F
D-131	93	X 37.7 Y 11.9	025	B	4.8	5.0		208	198	131	124	F
					4.7			213		134		F
					4.6			216		125		F

Analysis of Photographic Image to Evaluate System Performance

Mission 1026-2
Section V

	Pass	Frame	Location	Orientation	Subject (see page 27)	50% Amplitude Spread Function Width (microns)		Reciprocal of 50% Amp. Spread Function Width (microns)		A.I.M. Resolution (lines/mm)		Camera
	D-084	14	X 61.4 Y 12.2	055	D	12.8	10.5	78	94	51	58	A
						6.7		150		107		A
						10.1		98		60		A
	D-084	16	X 71.4 Y 13.2	010	B	5.6	6.1	178	165	125	116	A
						5.2		191		134		A
						8.1		123		95		A
	D-084	17	X 77.6 Y 13.0	110	B	7.2	7.3	139	137	104	103	A
						6.9		144		103		A
						6.7		148		105		A
★	D-084	21	X 34.2 Y 13.6	020	B	10.7	11.2	93	89	68	66	A
						11.5		86		65		A
						11.2		89		64		A
	D-084	23	X 66.2 Y 13.8	025	B	5.9	5.9	168	170	118	117	A
						5.8		173		119		A
						5.1		197		126		A
	D-084	25	X 53.9 Y 11.0	045	B	9.1	9.4	109	106	77	76	A
						7.7		129		108		A
						10.7		93		70		A
	D-088	99	X 73.4 Y 12.3	040	B	6.5	6.7	153	148	108	109	A
						7.4		135		104		A
						6.1		164		116		A
	D-088	123	X 49.2 Y 12.3	010	B	3.9	6.0	254	167	132	109	A
						4.8		208		127		A
						9.3		108		94		A
	D-094	26	X 66.6 Y 13.6	115	B	14.2	11.8	70	84	57	63	A
						11.0		90		70		A
						10.0		99		74		A
	D-094	28	X 69.0 Y 12.5	150	B	9.1	11.3	109	88	79	69	A
						11.2		89		66		A
						9.8		102		67		A
	D-094	29	X 69.5 Y 11.0	065	B	7.8	9.0	128	111	86	83	A
						10.0		99		75		A
						8.0		125		93		A

★ M.I.P. Frame

Analysis of Photographic Image to Evaluate System Performance

Mission 1026-2
Section V

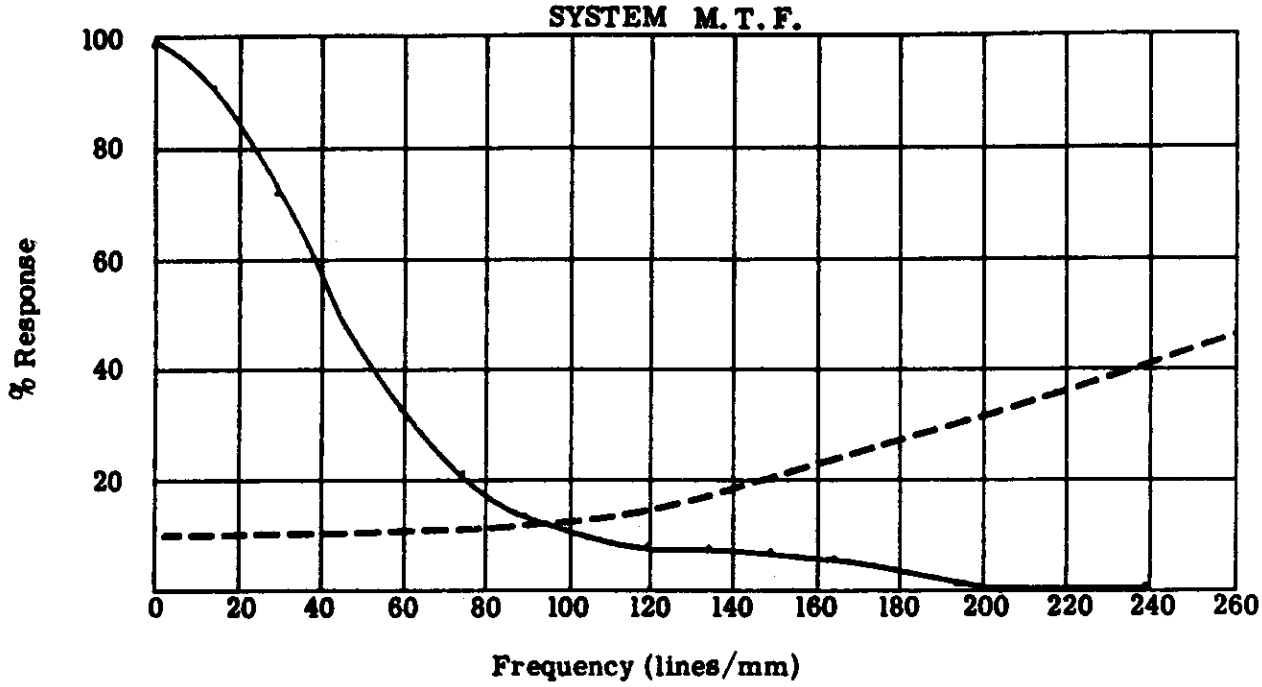
Pass	Frame	Location	Orientation	Subject	50% Amplitude Spread Function Width (microns)		Reciprocal of 50% Amp. Spread Function Width (microns)		A.I.M. Resolution (lines/mm)		Camera
D-094	31	X 71.7 Y 13.1	020	B	7.0	7.6	143	131	106	95	A
					6.8		146		96		A
					6.4		155		100		A
D-094	32	X 69.3 Y 10.4	020	B	10.2	10.2	98	98	74	74	A
					9.6		104		80		A
					11.1		90		73		A
D-11[illegible]	11	X 13.0 Y 13.1	020	B	9.4	11.8	105	64	90	69	A
					12.7		78		68		A
					14.4		69		58		A
D-117	78	X 65.2 Y 12.2	160	B	7.7	8.7	129	114	105	90	A
					11.1		89		64		A
					8.2		122		93		A
D-117	79	X 47.[illegible] Y 10.9	010	B	8.9	8.4	111	118	85	92	A
					8.1		123		94		A
					6.9		144		103		A
D-117	80	X 31.3 Y 10.3	040	B	5.7	6.6	175	151	110	103	A
					6.6		152		108		A
					6.8		148		99		A
D-117	85	X 27.3 Y 13.9	020	B	5.4	5.7	183	174	120	120	A
					4.7		215		127		A
					6.4		155		119		A

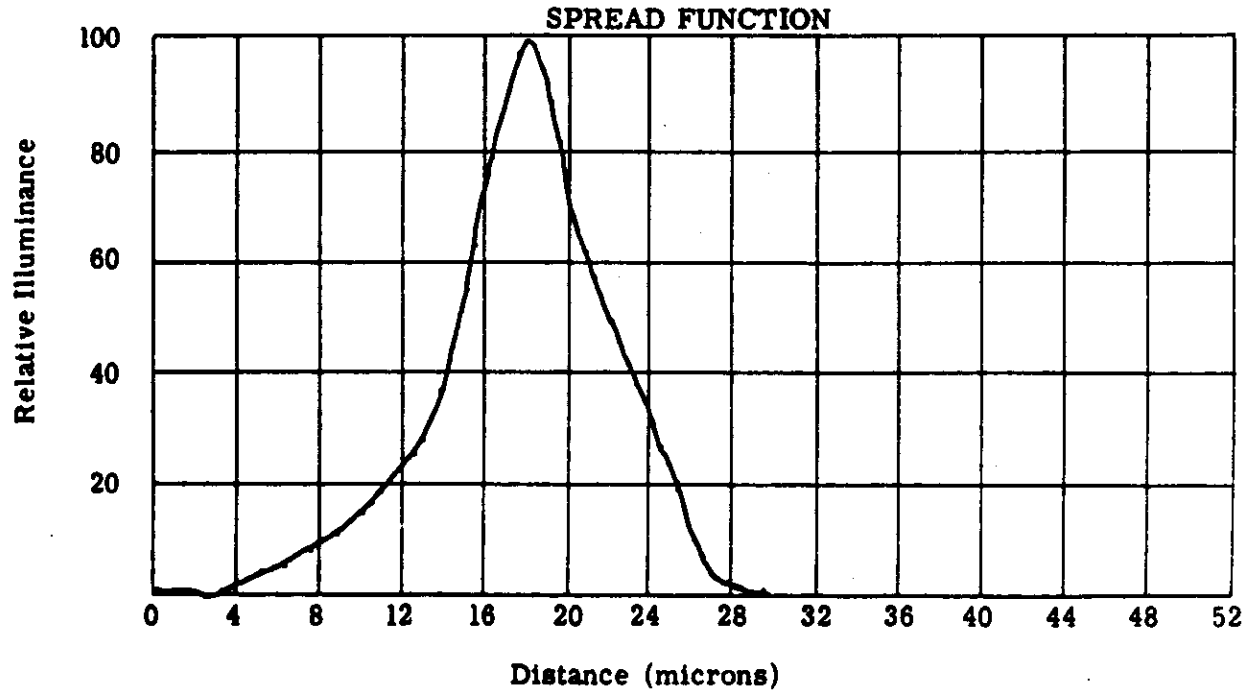
A = Airfield
B = Building
D = Dam
R = Reservoir or Settling Bed
T = CORN Target

Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-1 Selected Frame
Camera: FWD
Edge Location: Pass D047 , Frame 012, X65.7 Y12.7

Trace A

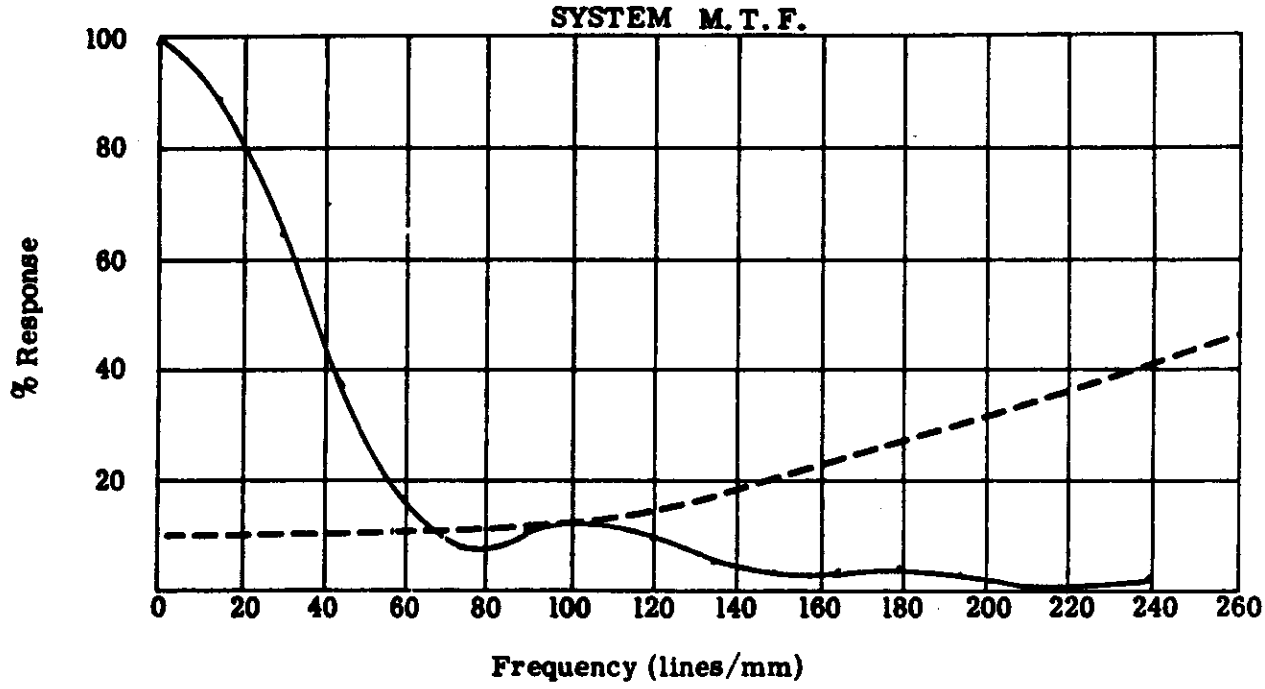


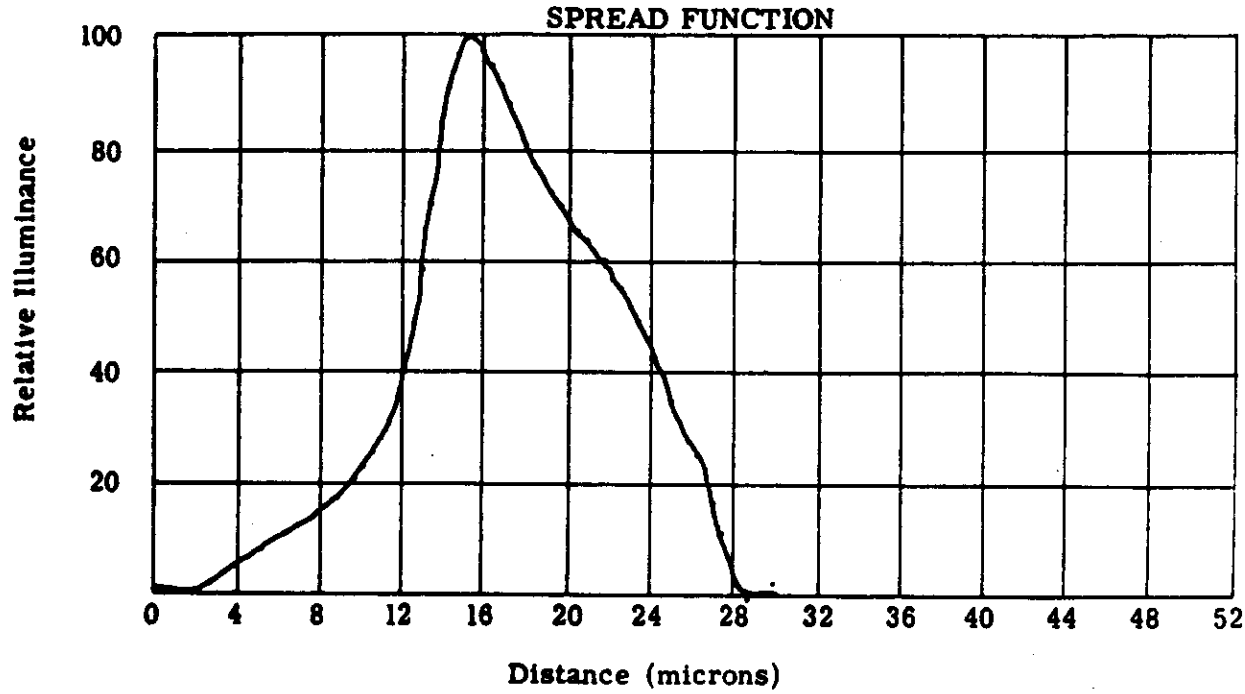


Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-1 Selected Frame
Camera: FWD
Edge Location: Pass D047, Frame 012, X65.7 Y12.7

Trace B

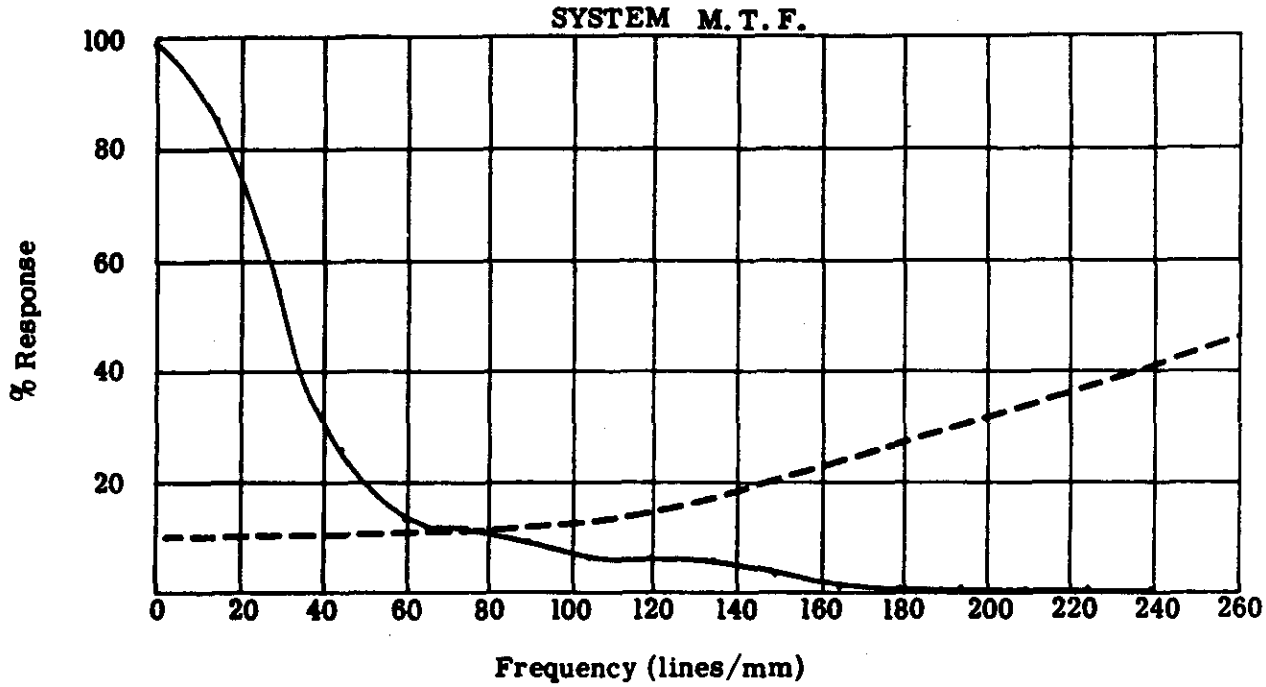


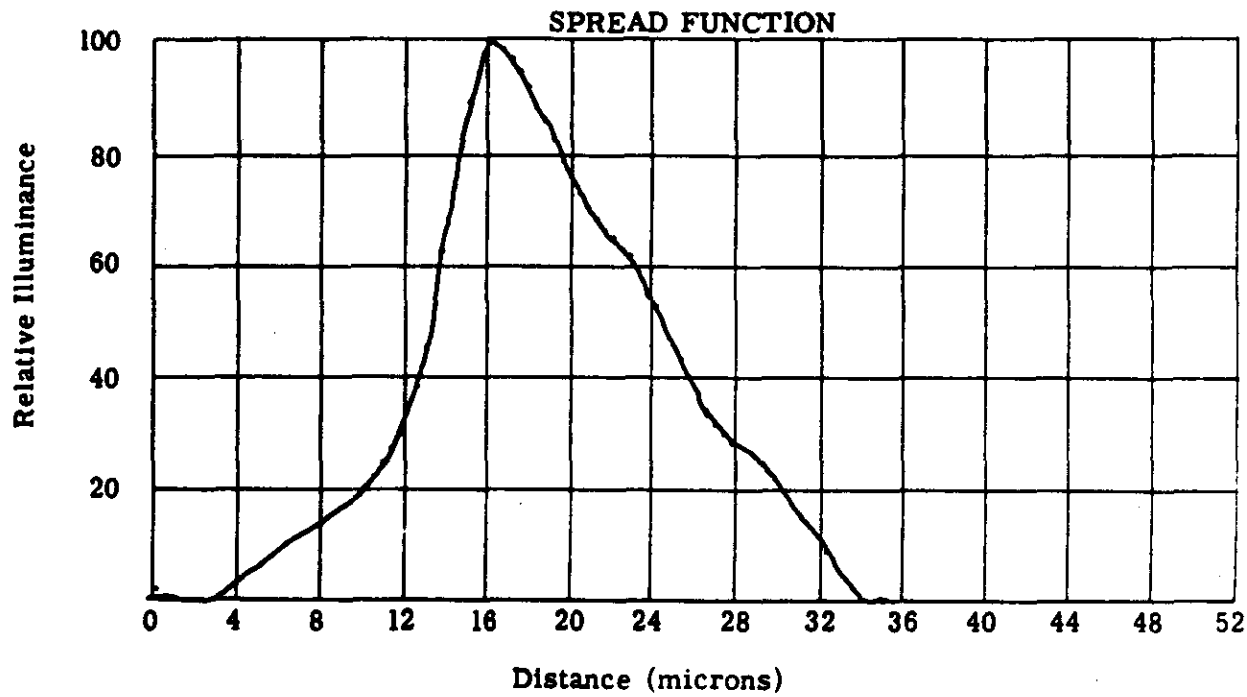


Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-1 Selected Frame
Camera: FWD
Edge Location: Pass D047, Frame 012, X65.7 Y12.7

Trace C

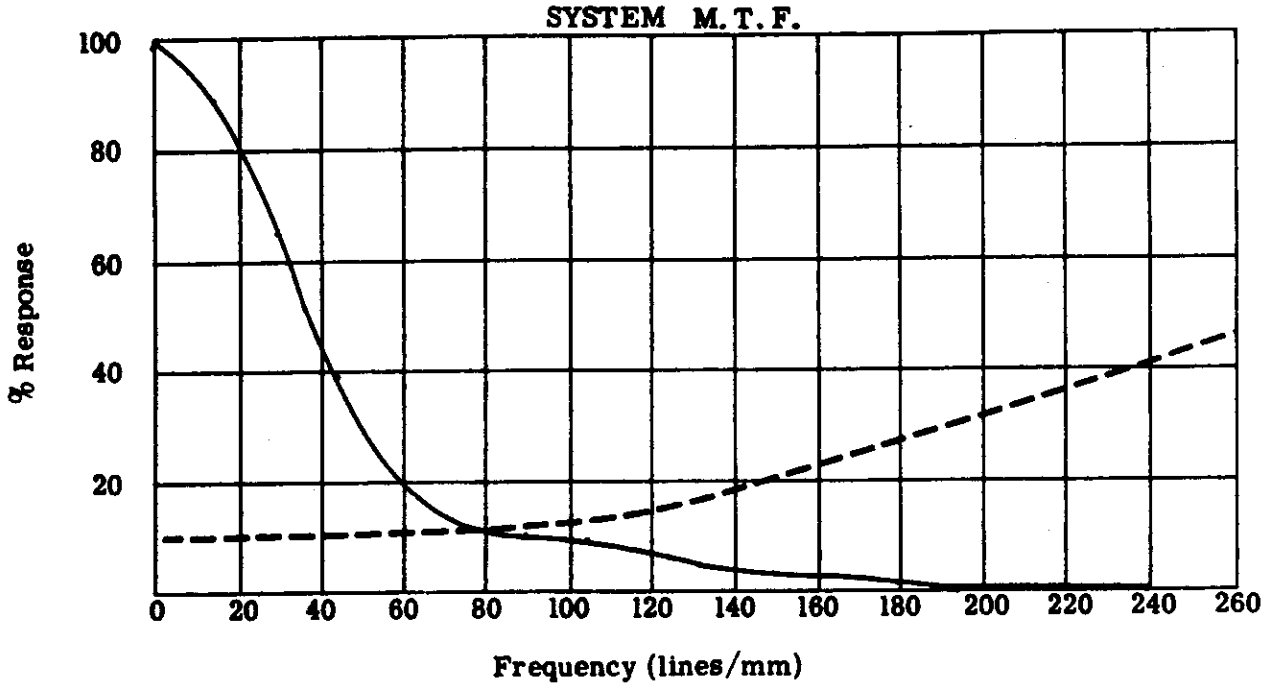


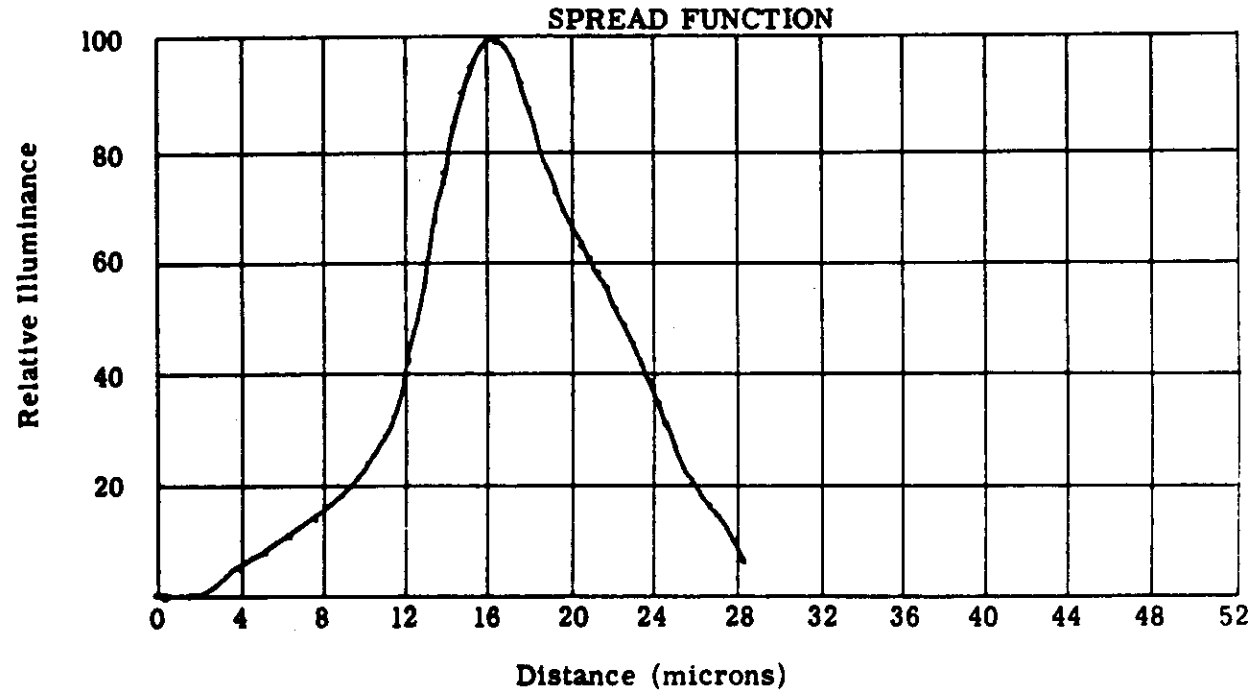


Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-1 Selected Frame
Camera: FWD
Edge Location: Pass D047, Frame 012, X65.7 Y12.7

Average

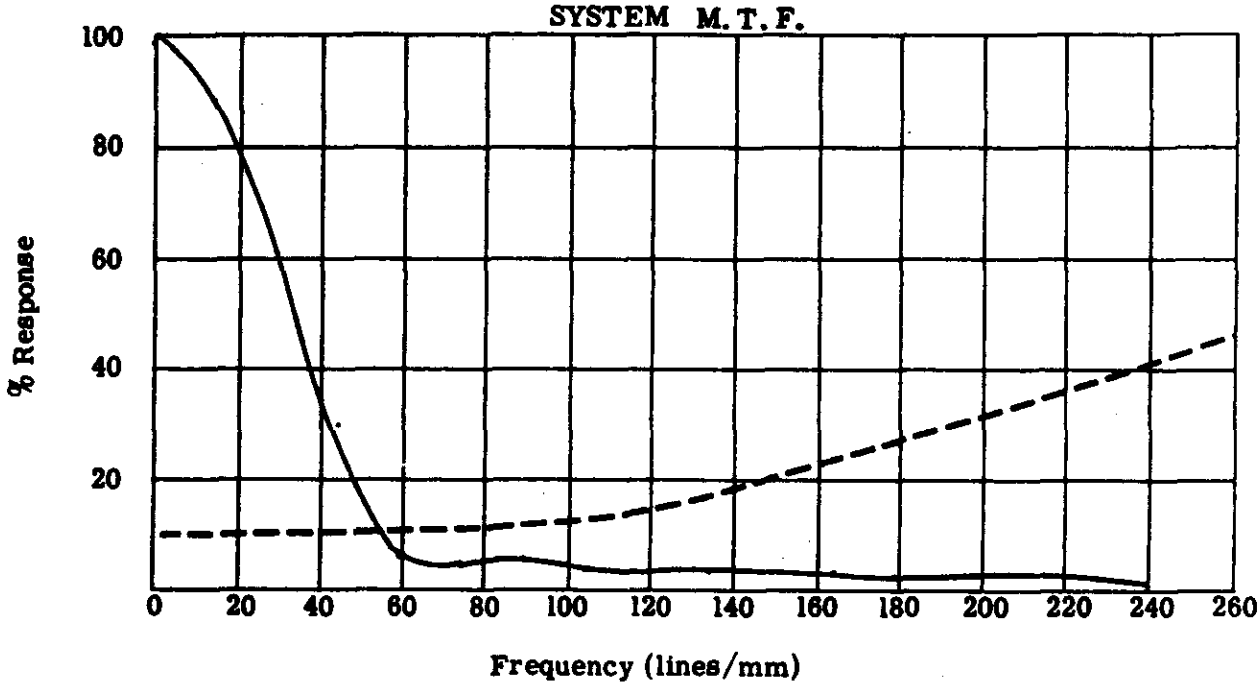


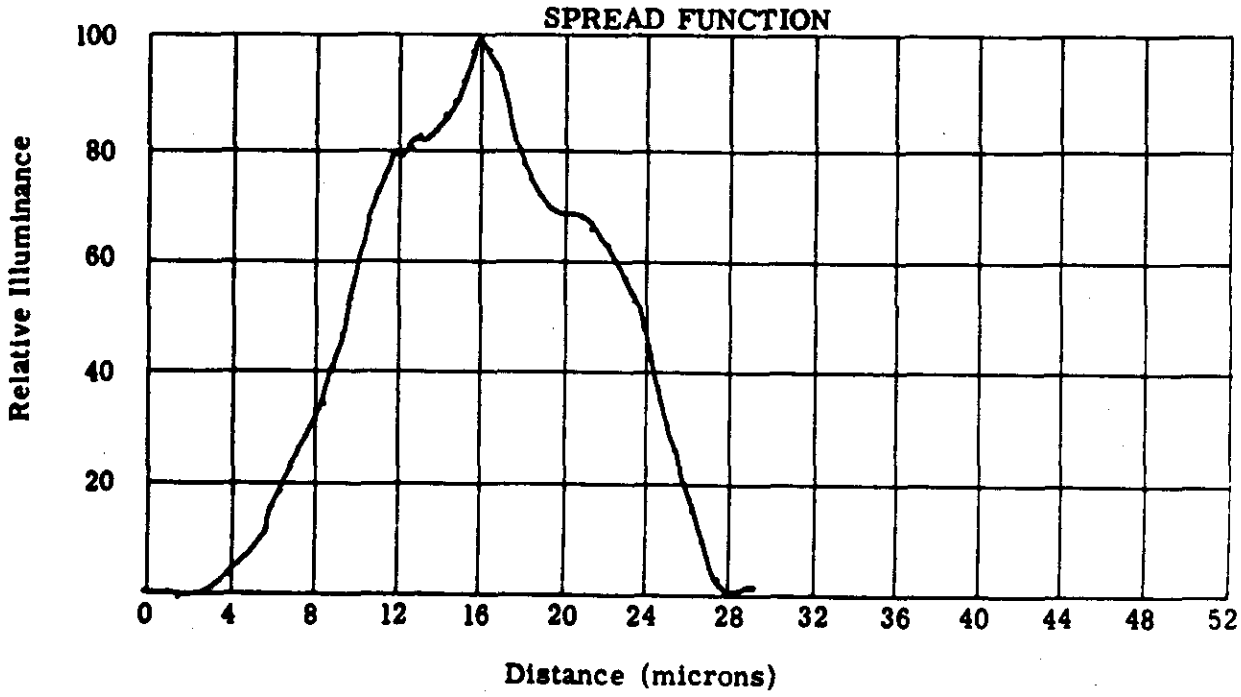


Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-2 Selected Frame
Camera: AFT
Edge Location: Pass D094, Frame 026, X66.6 Y13.6

Trace A

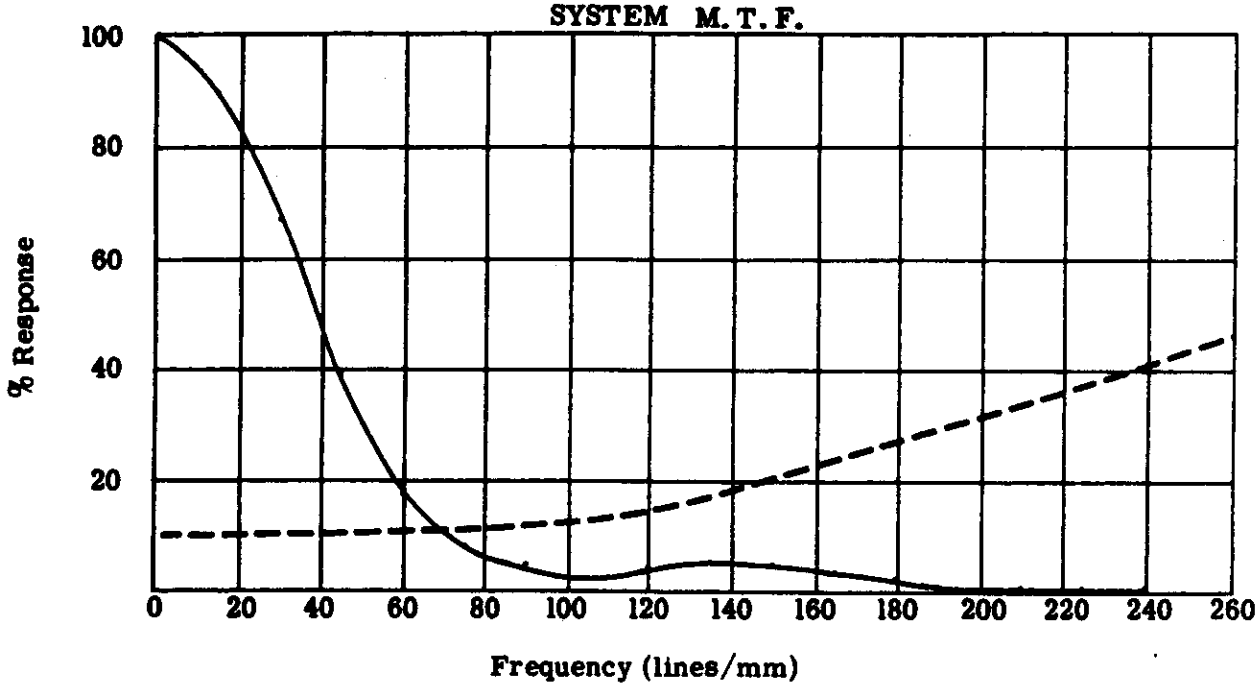


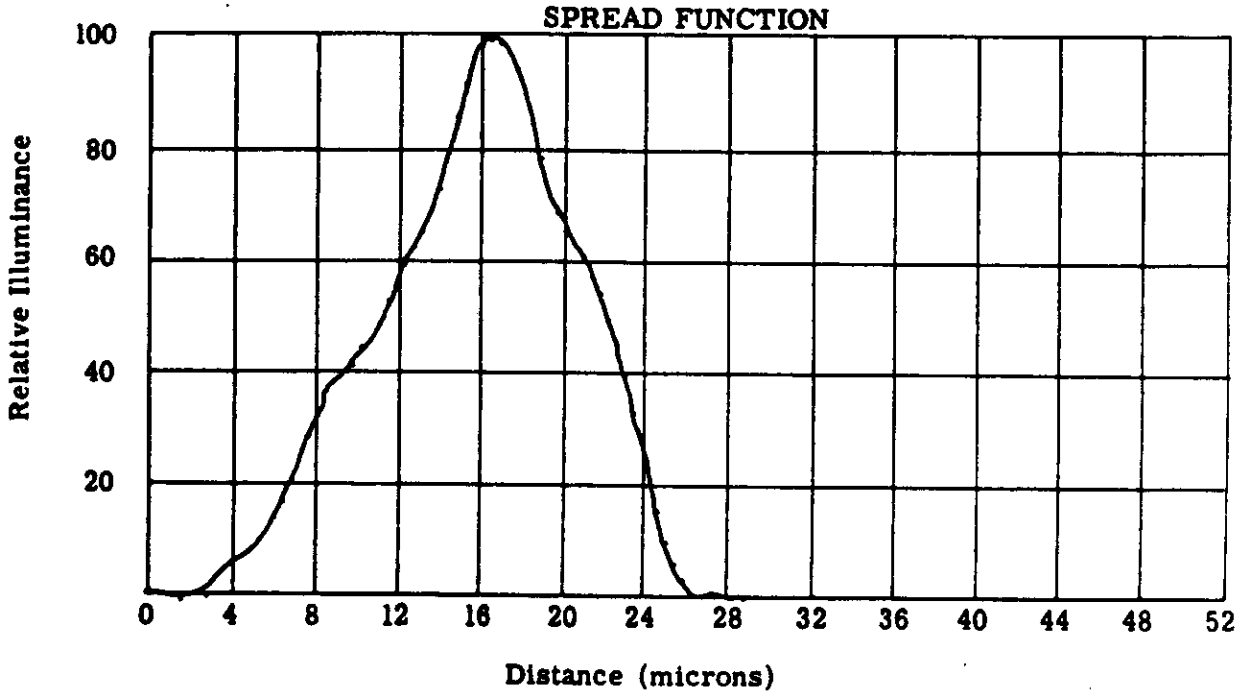


Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-2 Selected Frame
Camera: AFT
Edge Location: Pass D094, Frame 026, X66.6 Y13.6

Trace B

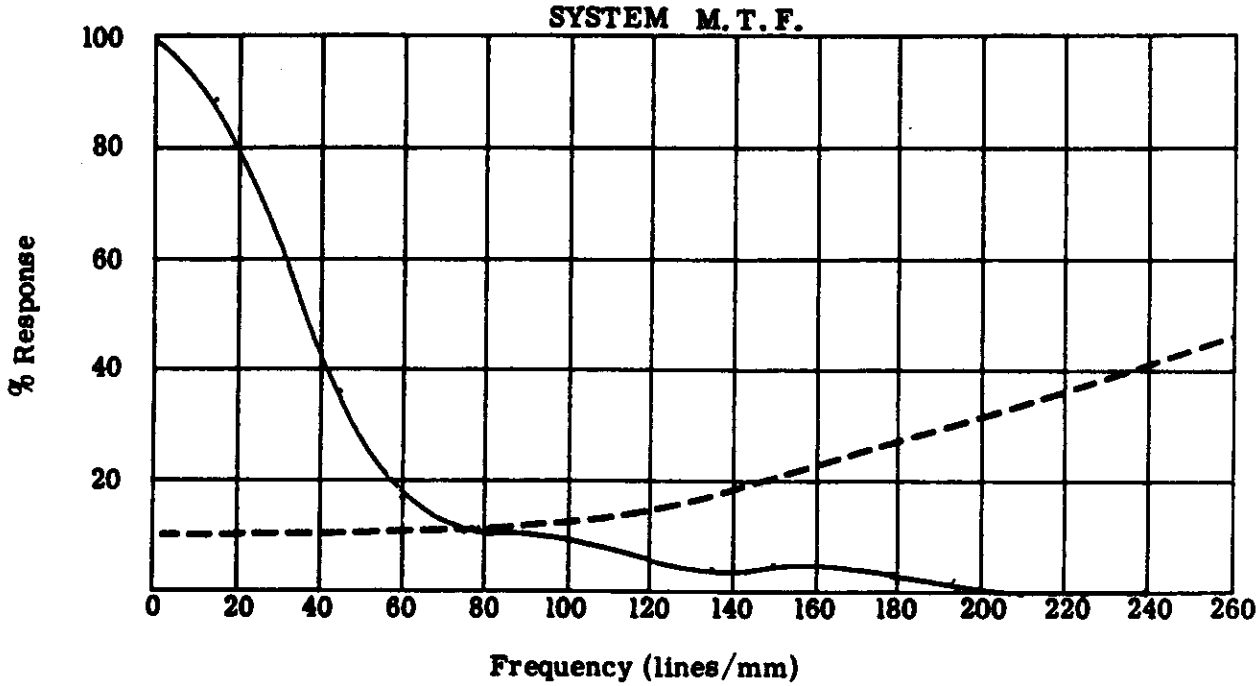


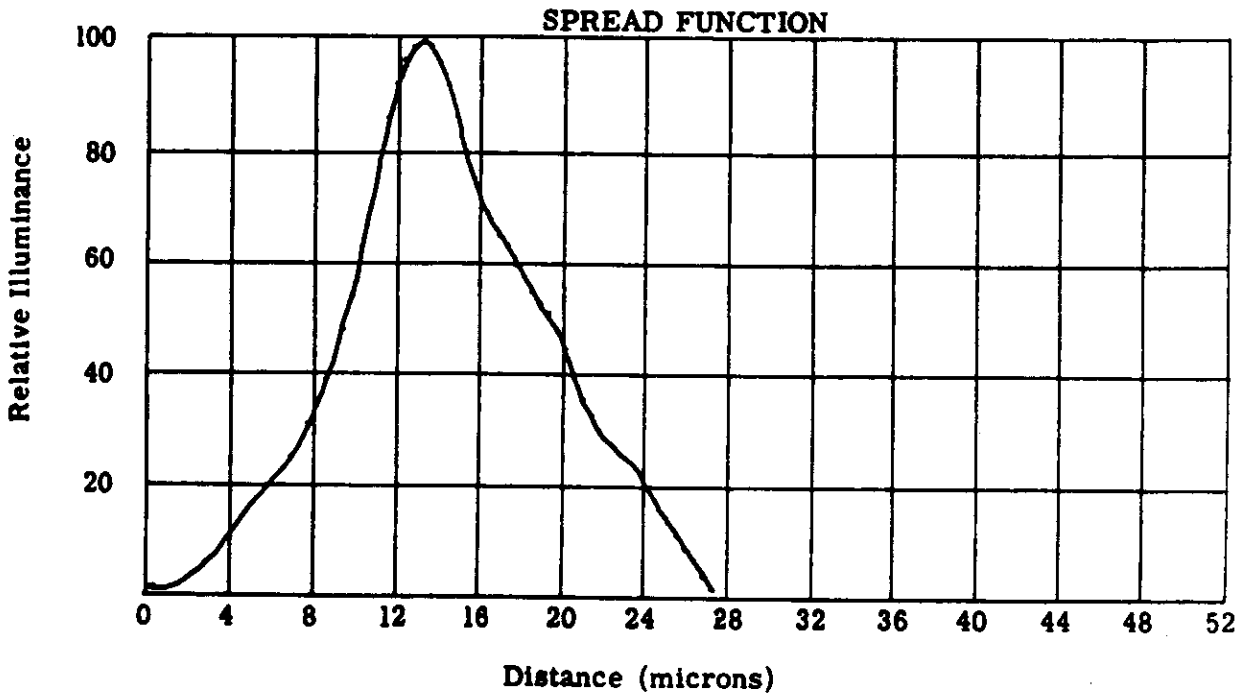


Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-2 Selected Frame
Camera: AFT
Edge Location: Pass D094, Frame 026, X66.6 Y13.6

Trace C

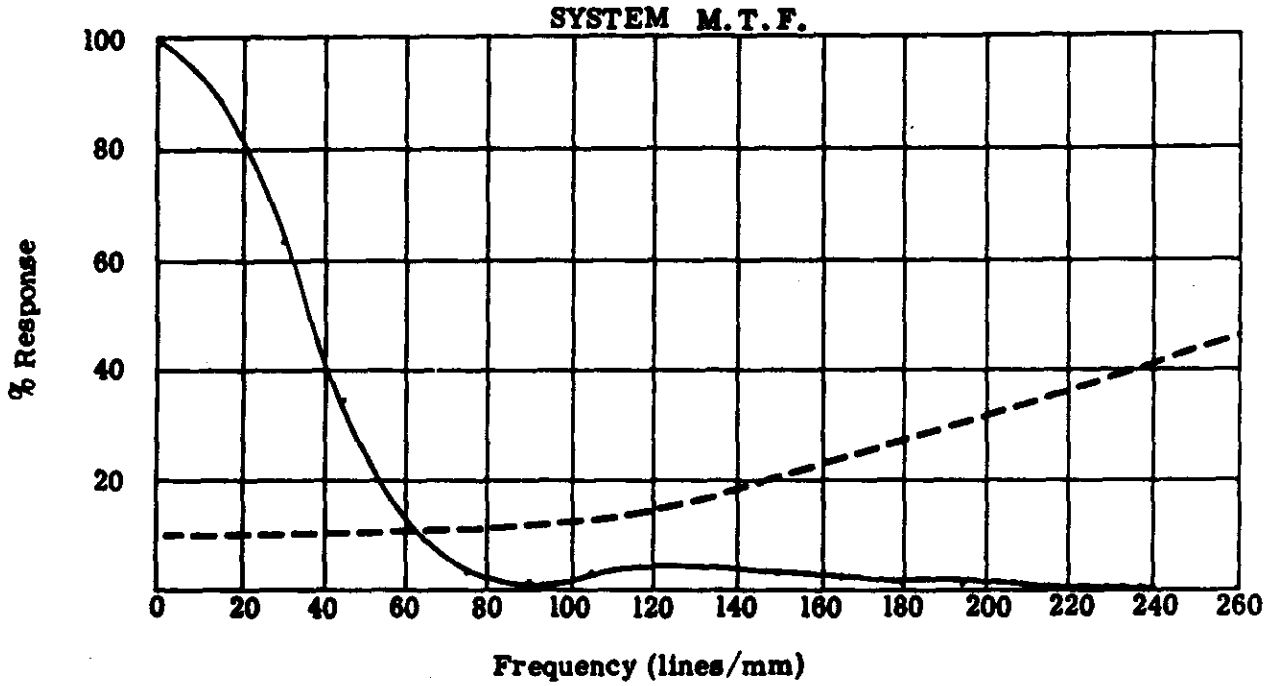


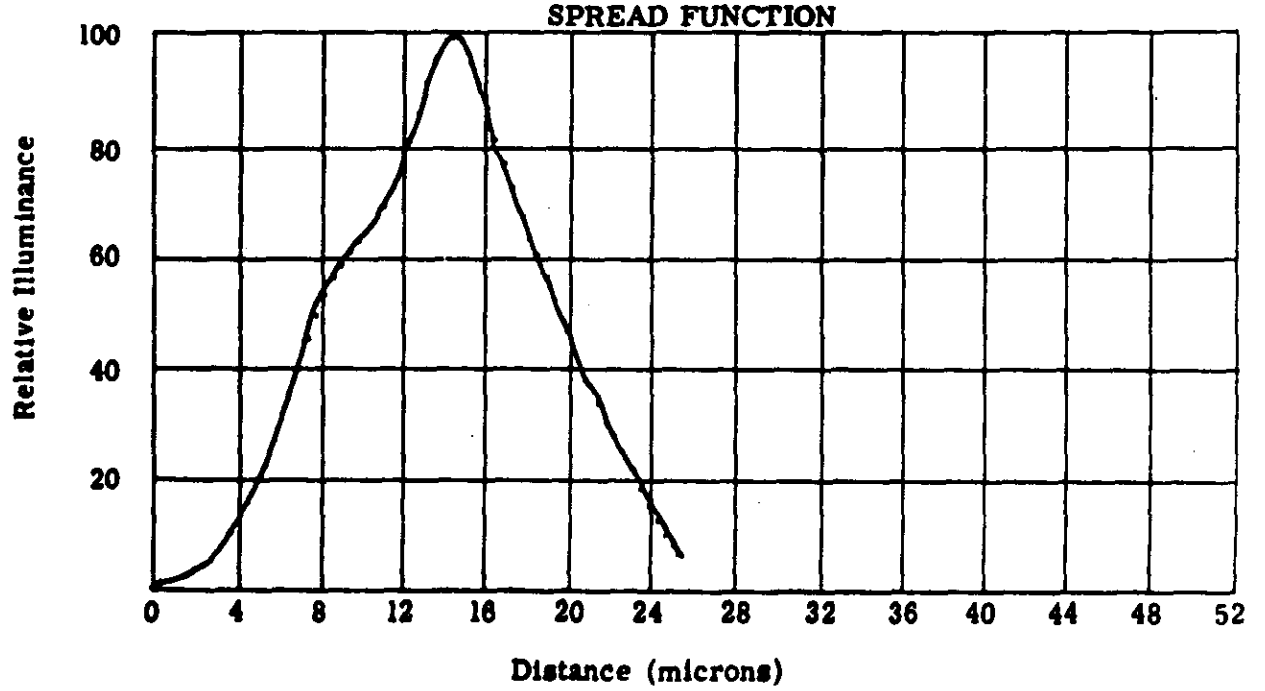


Analysis of Photographic Image to Evaluate System Performance

Section VI Mission 1026-2 Selected Frame
Camera: AFT
Edge Location: Pass D094, Frame 026, X66.6 Y13.6

Average





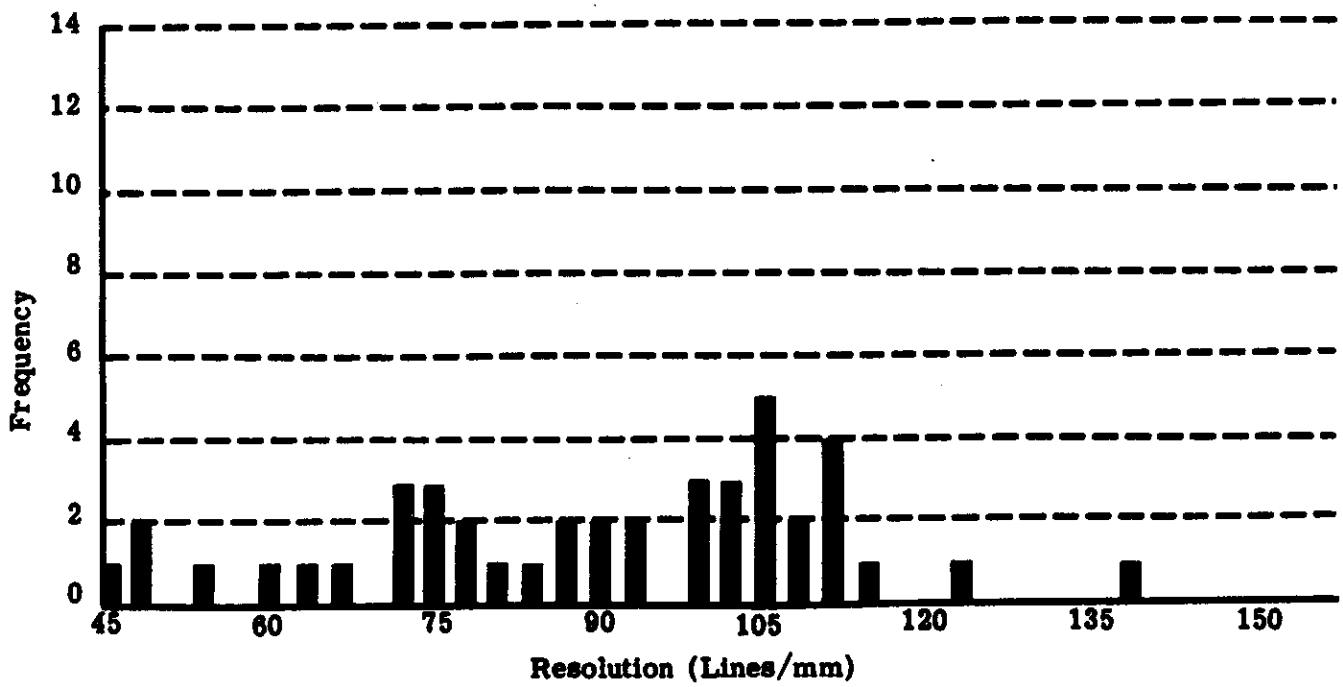
Analysis of Photographic Image to Evaluate System Performance

Section IV Mission 1026-1 70mm Film

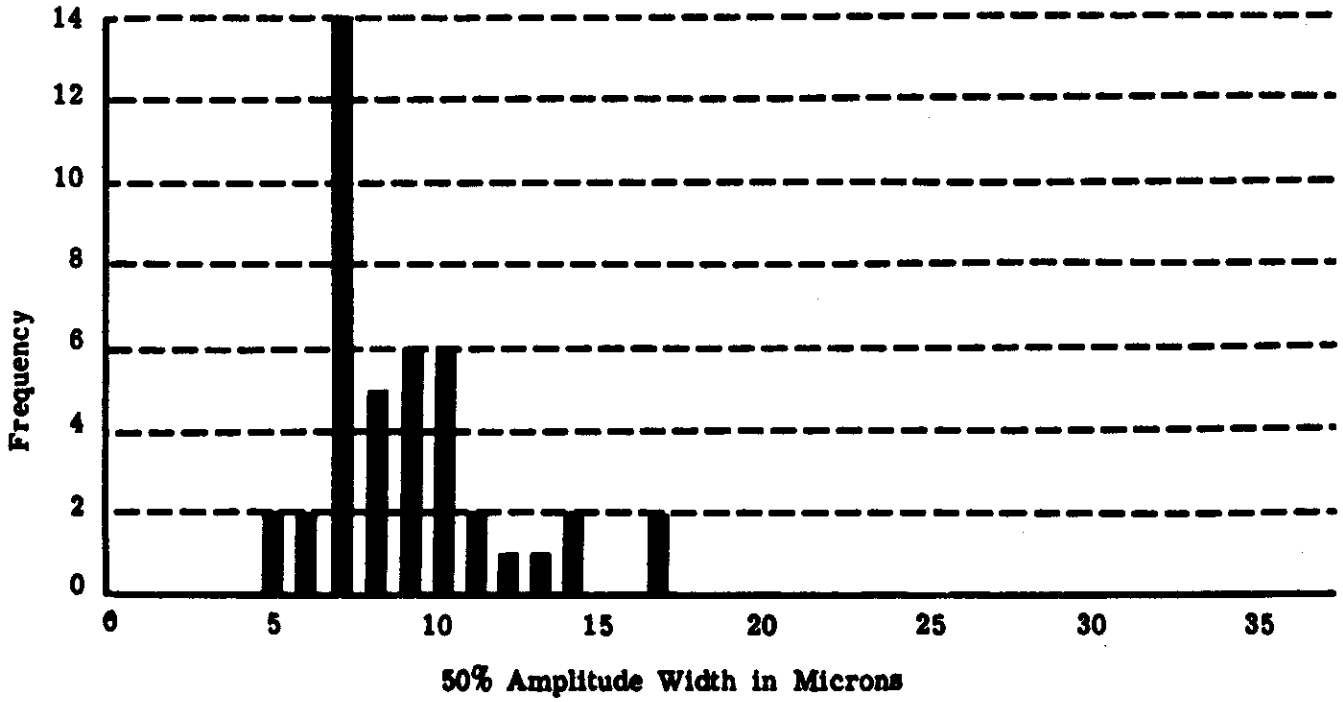
43 Edges

Average of Multiple Tracing

FREQUENCY VS. RESOLUTION A.I.M. 3404 CURVE



FREQUENCY VS. 50% AMPLITUDE WIDTH OF LINE SPREAD FUNCTION



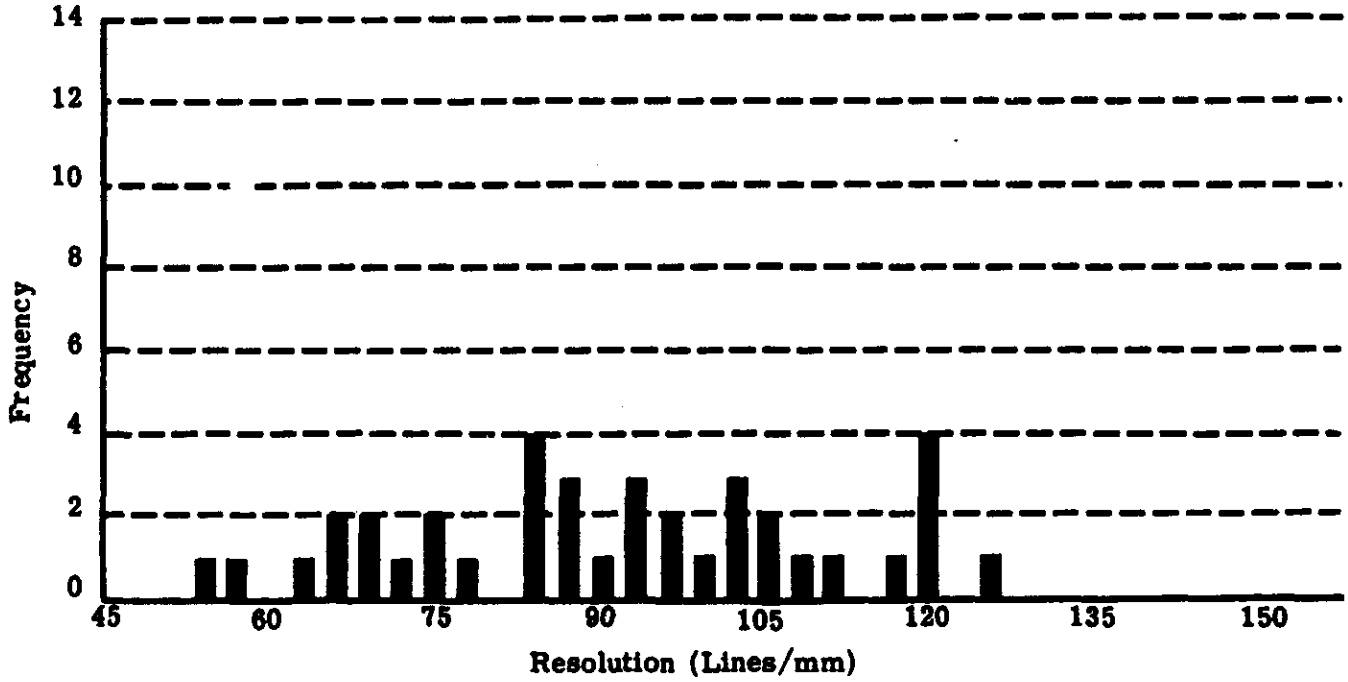
Analysis of Photographic Image to Evaluate System Performance

Section IV Mission 1026-2 70mm Film

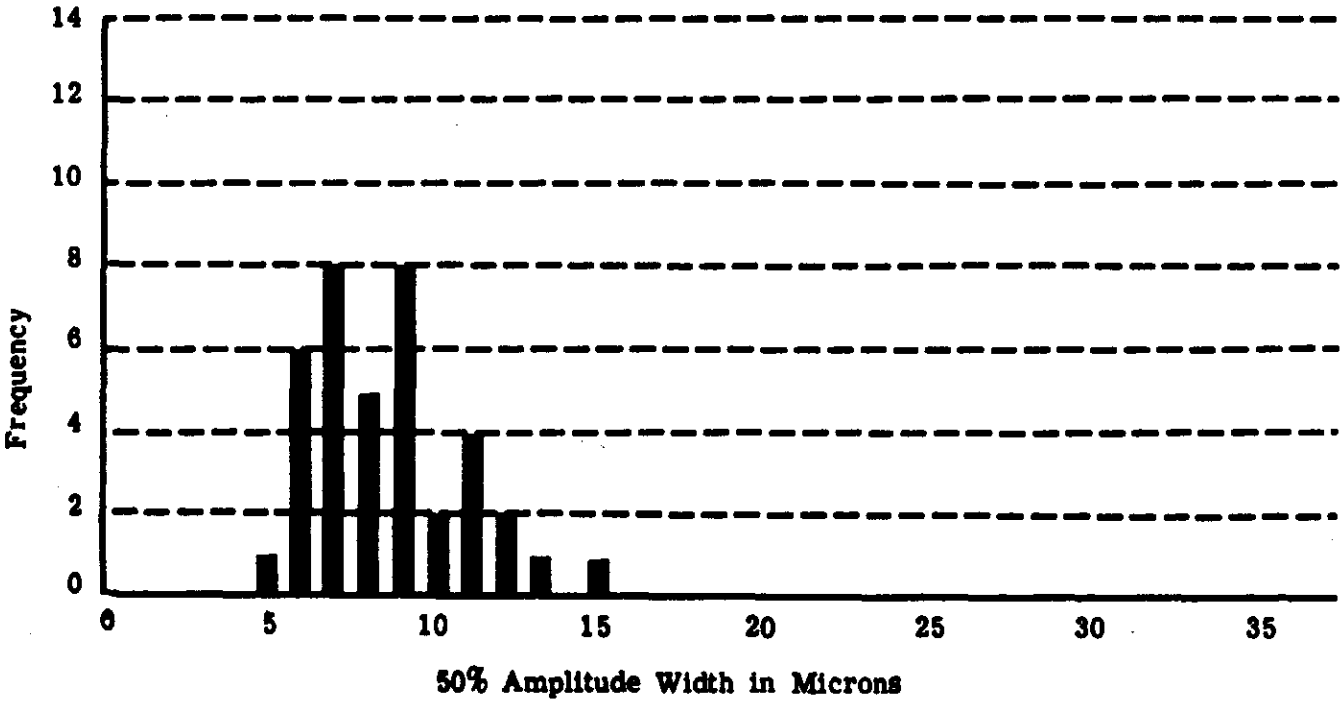
38 Edges

Average of Multiple Tracing

FREQUENCY VS. RESOLUTION A.I.M 3404 CURVE

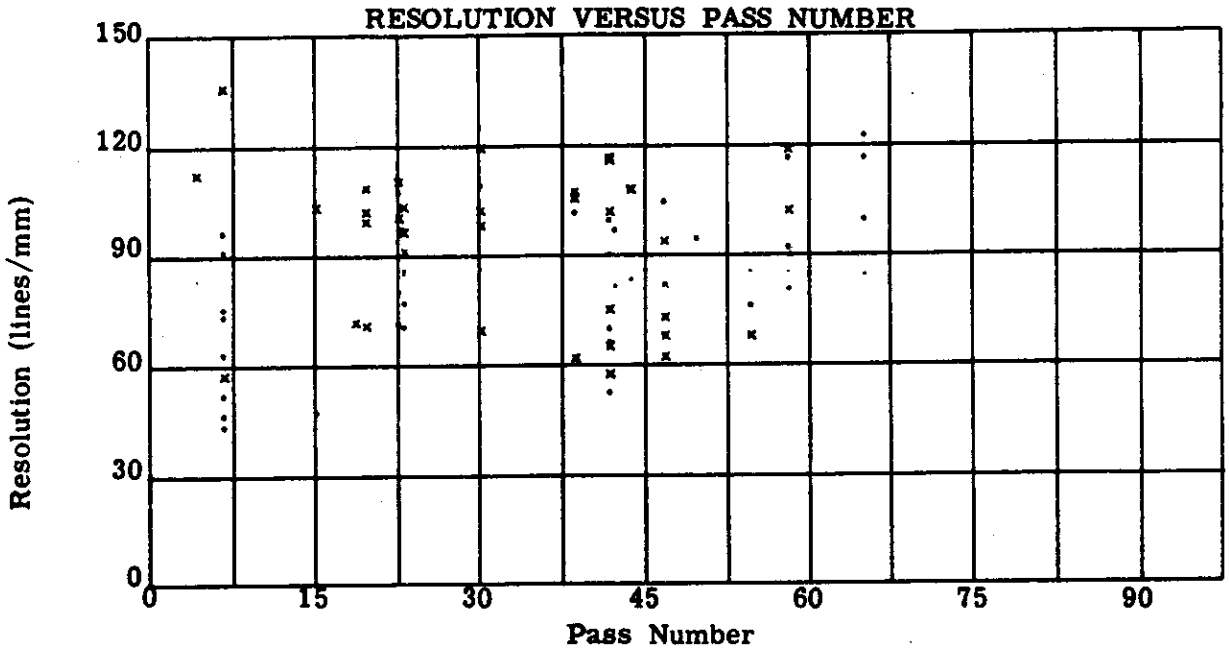


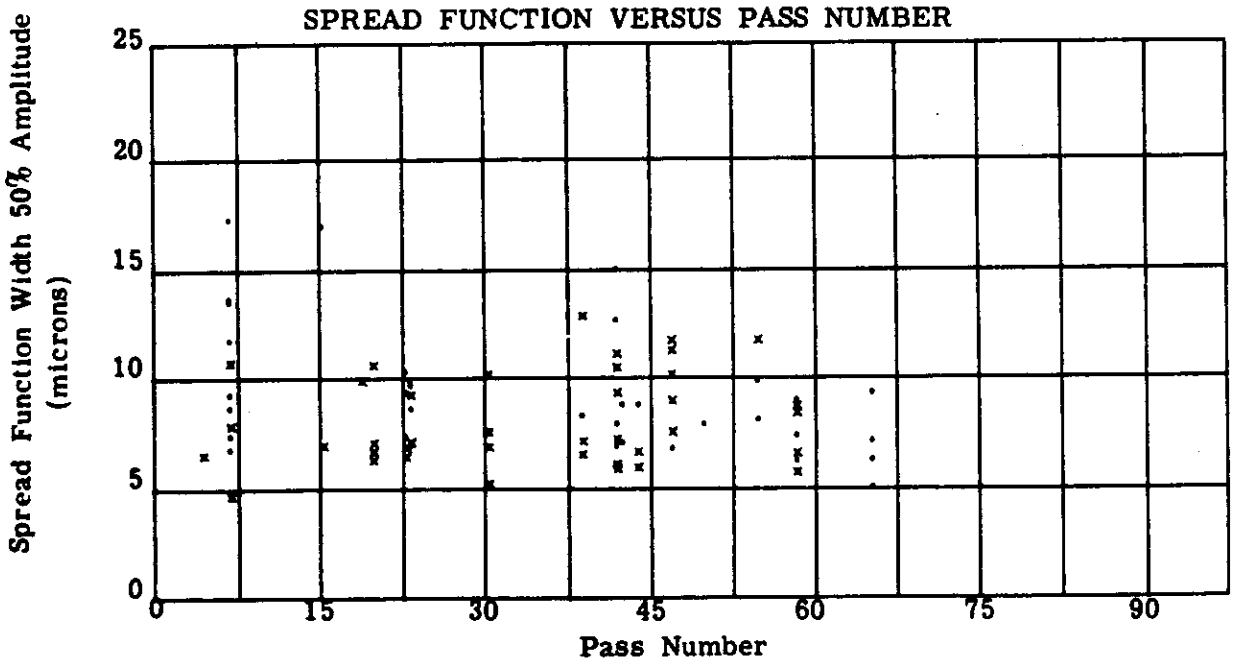
FREQUENCY VS. 50% AMPLITUDE WIDTH OF LINE SPREAD FUNCTION



Analysis of Photographic Image to Evaluate System Performance

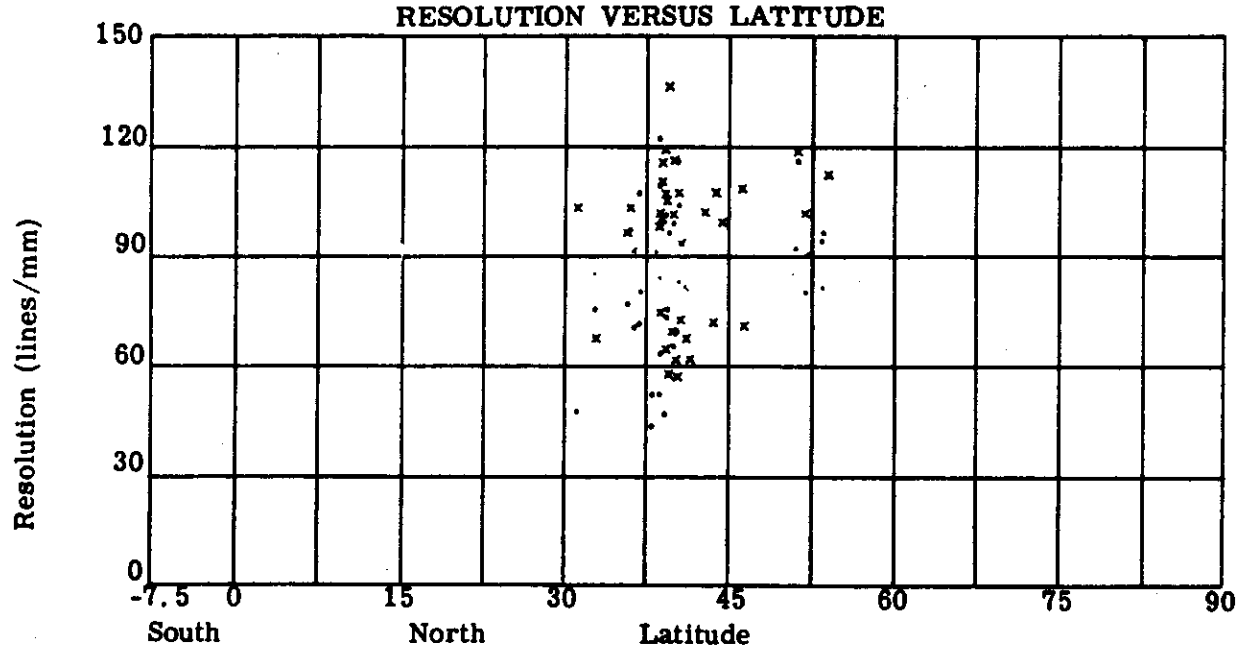
SECTION VIII - MISSION 1026

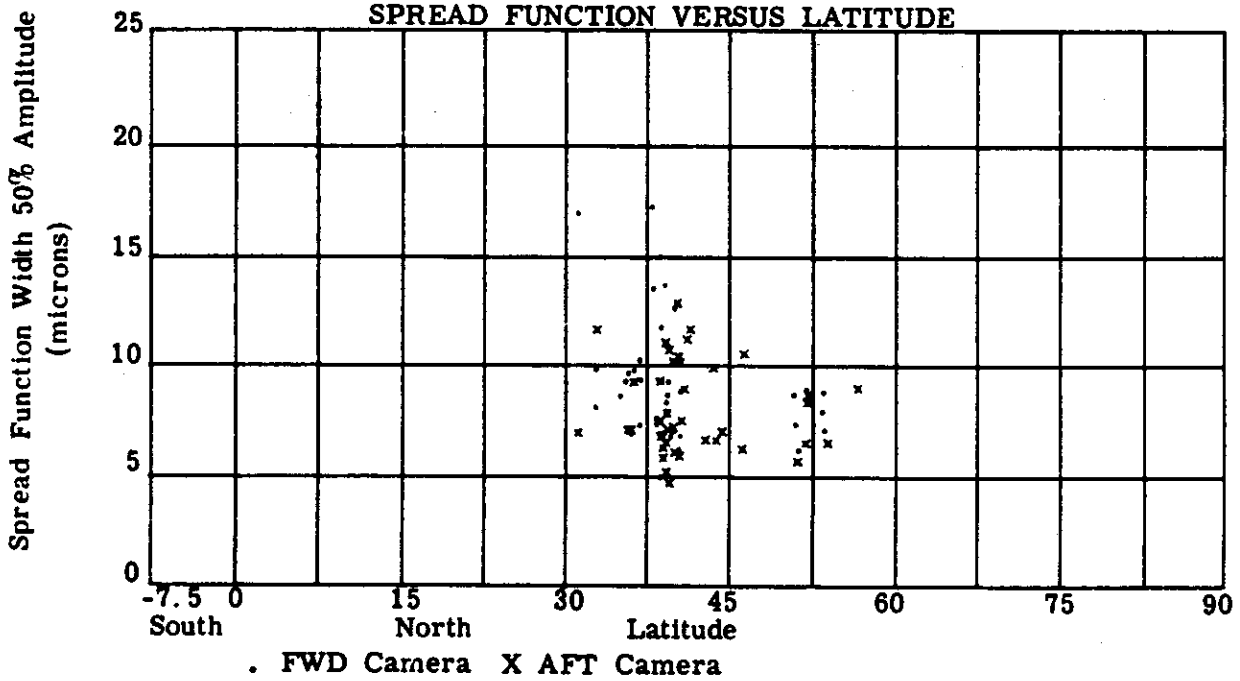




Analysis of Photographic Image to Evaluate System Performance

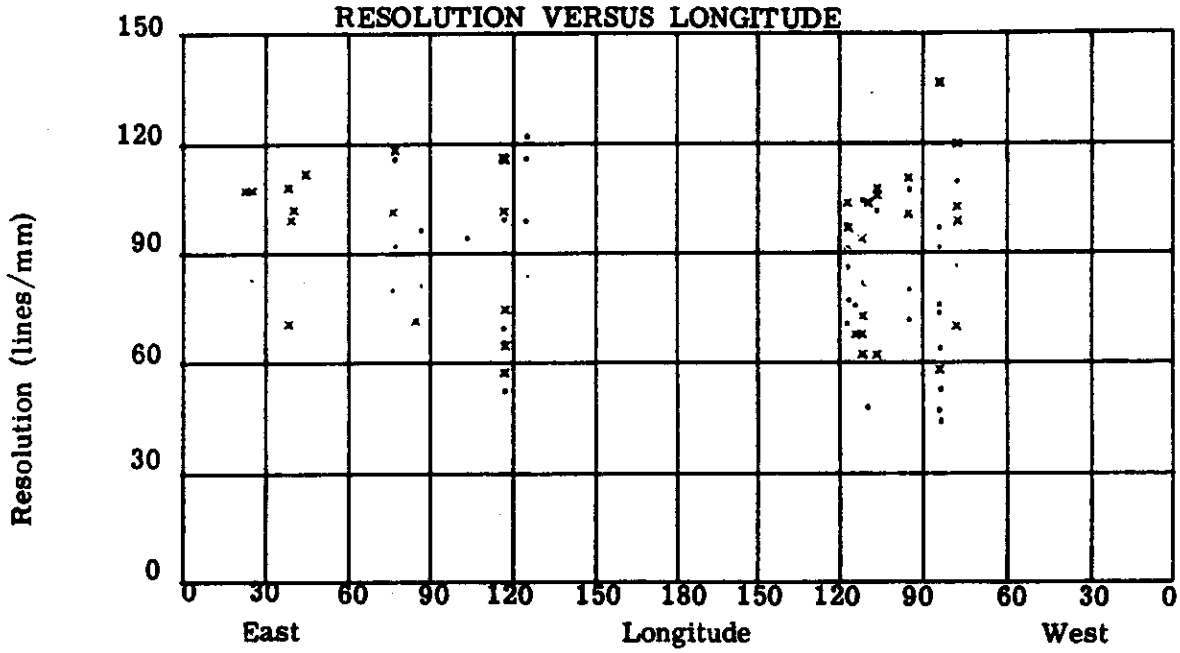
SECTION IX - MISSION 1026

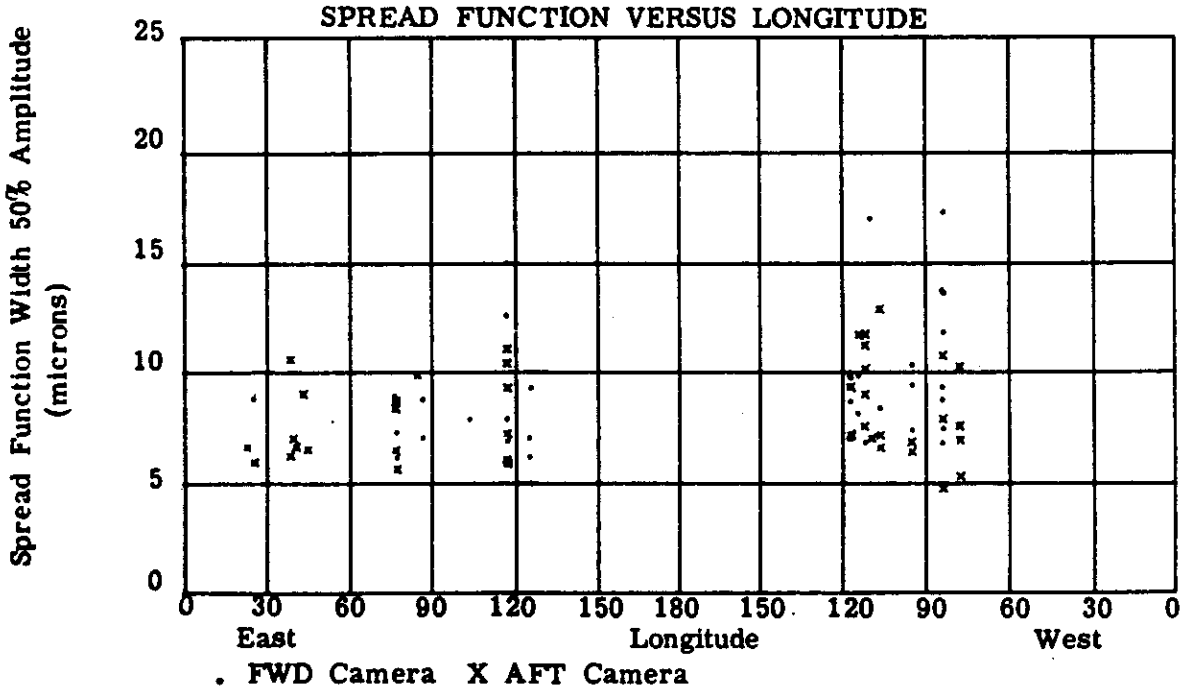




Analysis of Photographic Image to Evaluate System Performance

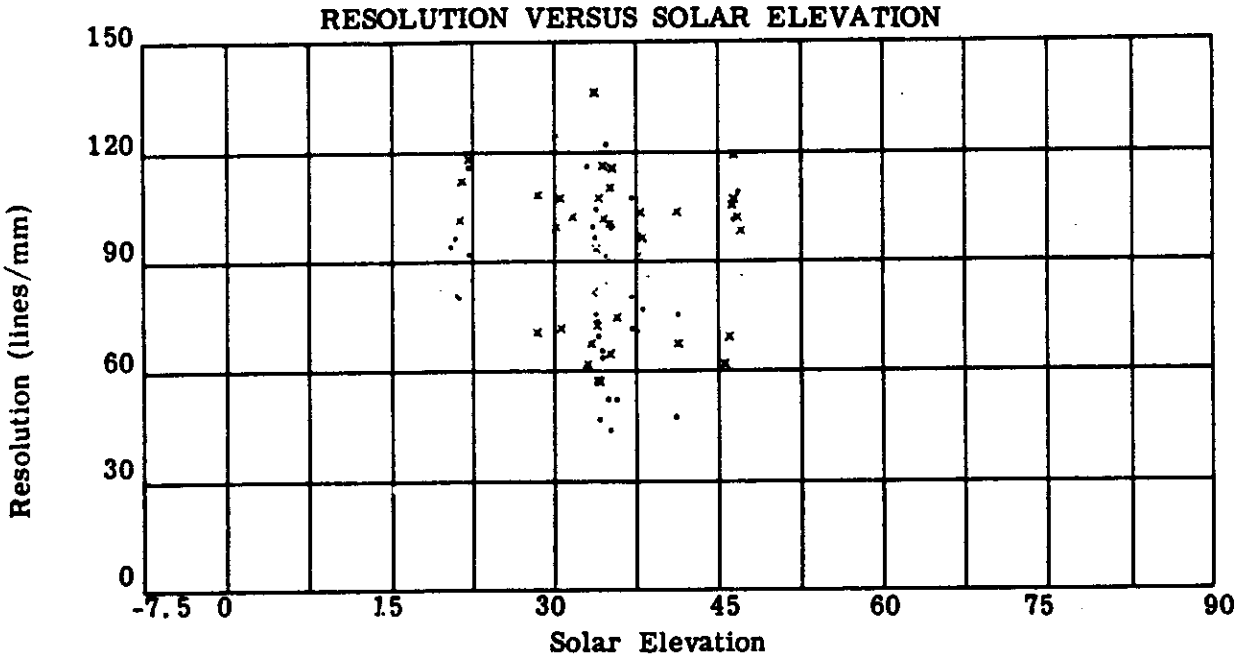
SECTION X - MISSION 1026

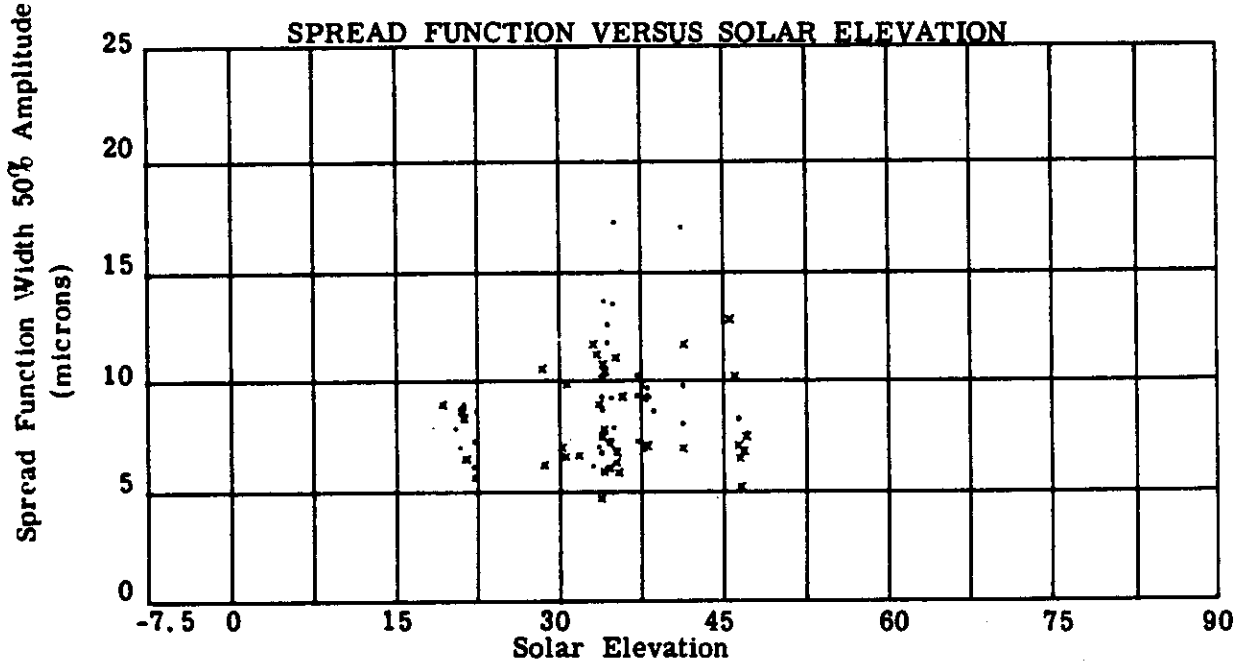




Analysis of Photographic Image to Evaluate System Performance

SECTION XI - MISSION 1026





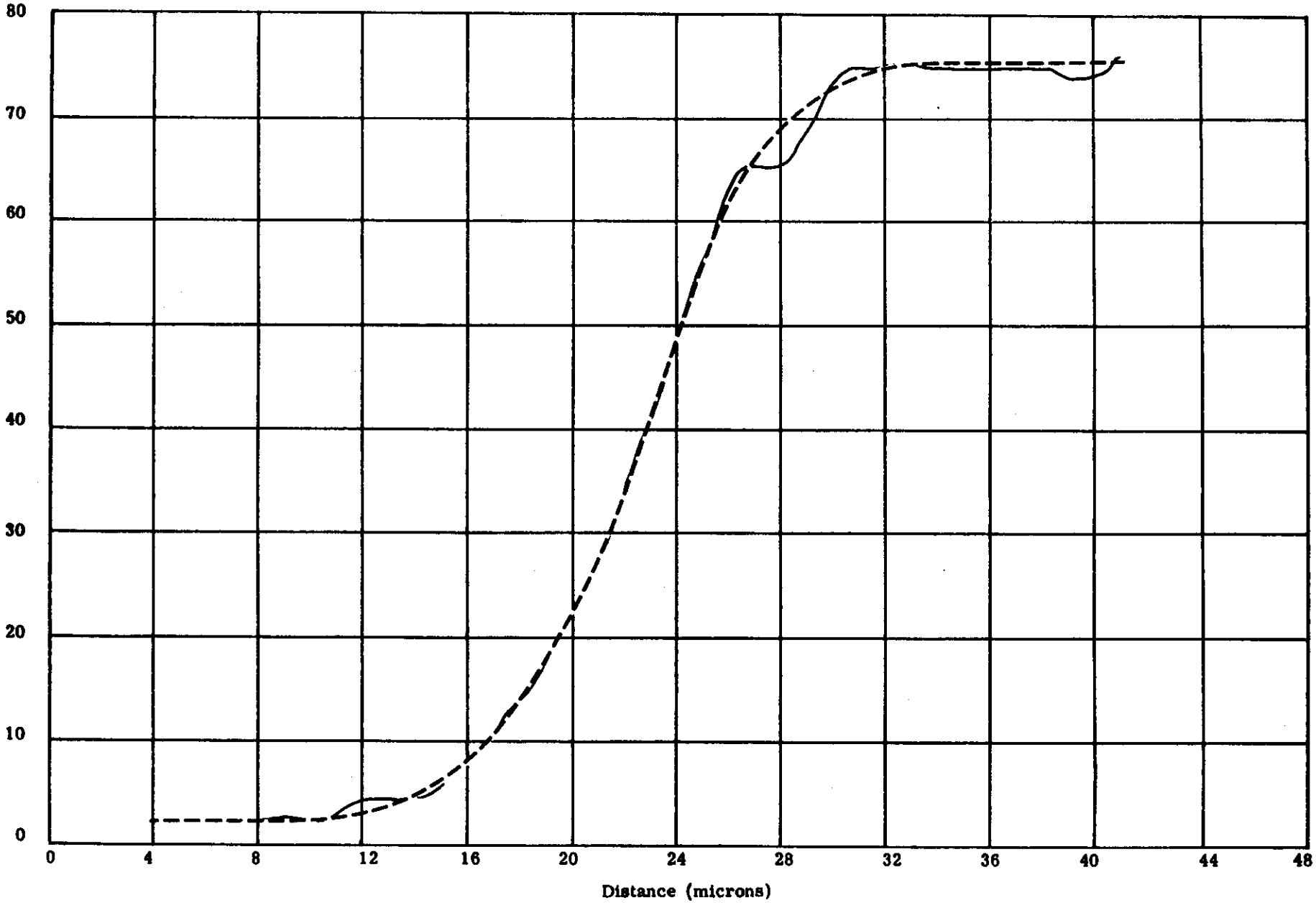
. FWD Camera X AFT Camera

Analysis of Photographic Image to Evaluate System Performance

Section XII Mission 1026-1 Edge Location: Pass D047, Frame 012 , X65.7 Y12.7

Trace A

ORIGINAL AND HAND SMOOTHED EDGE TRACE

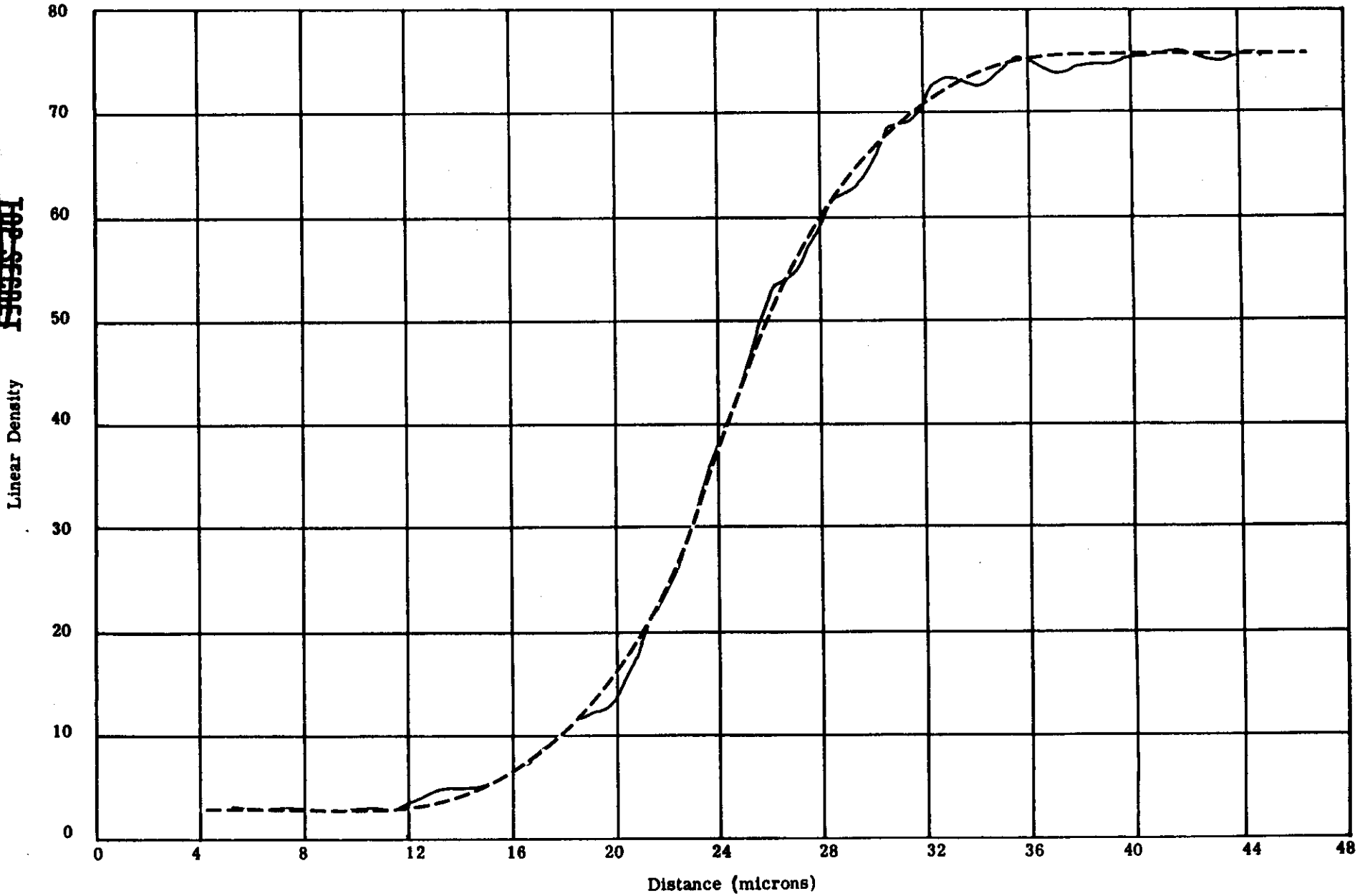


Analysis of Photographic Image to Evaluate System Performance

Section XII Mission 1026-1 Edge Location: Pass D047, Frame 012 , X65.7 Y12.7

Trace B

ORIGINAL AND HAND SMOOTHED EDGE TRACE

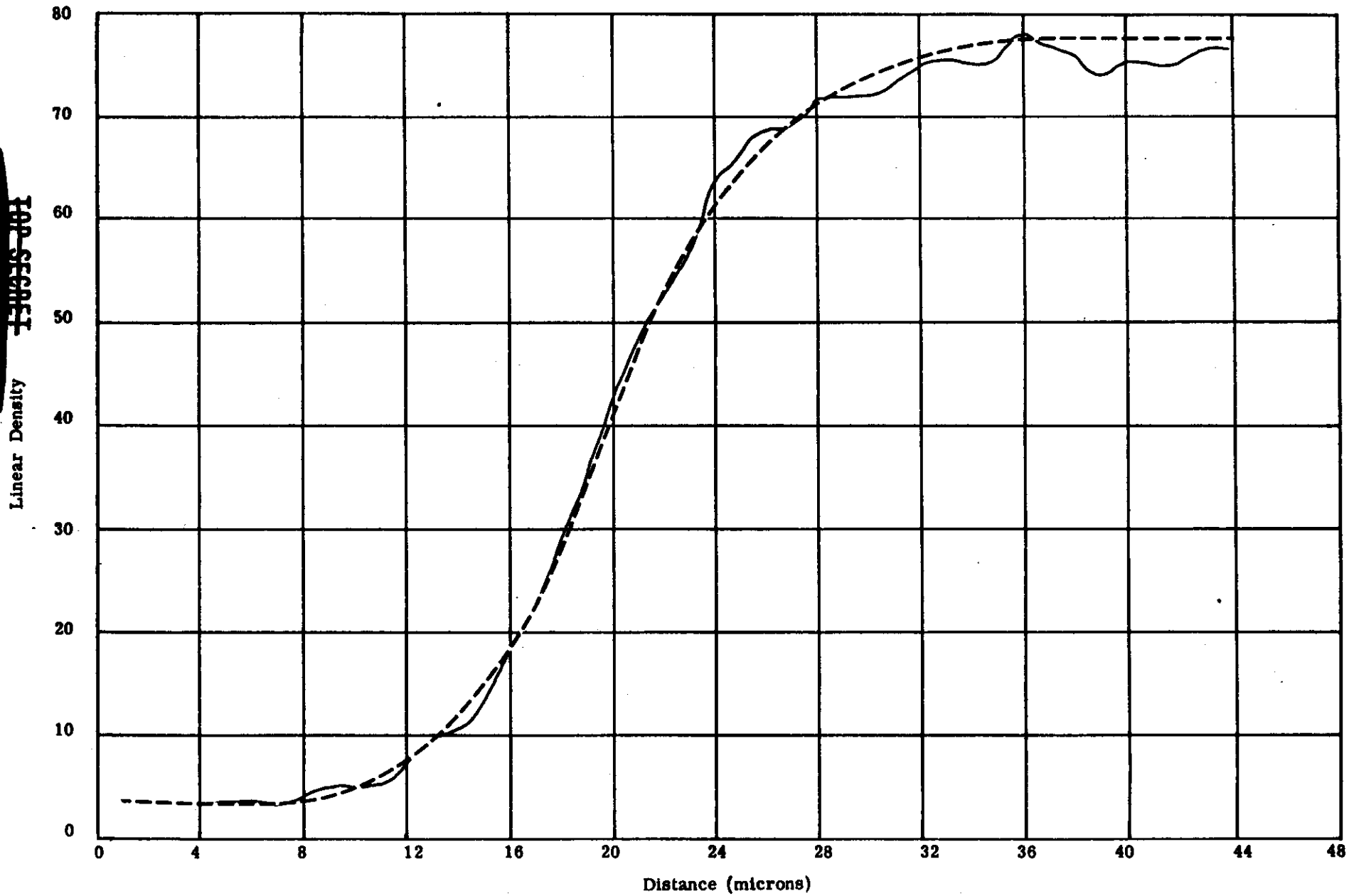


Analysis of Photographic Image to Evaluate System Performance

Section XII Mission 1026-1 Edge Location: Pass D047, Frame 012 , X65.7 Y12.7

Trace C

ORIGINAL AND HAND SMOOTHED EDGE TRACE

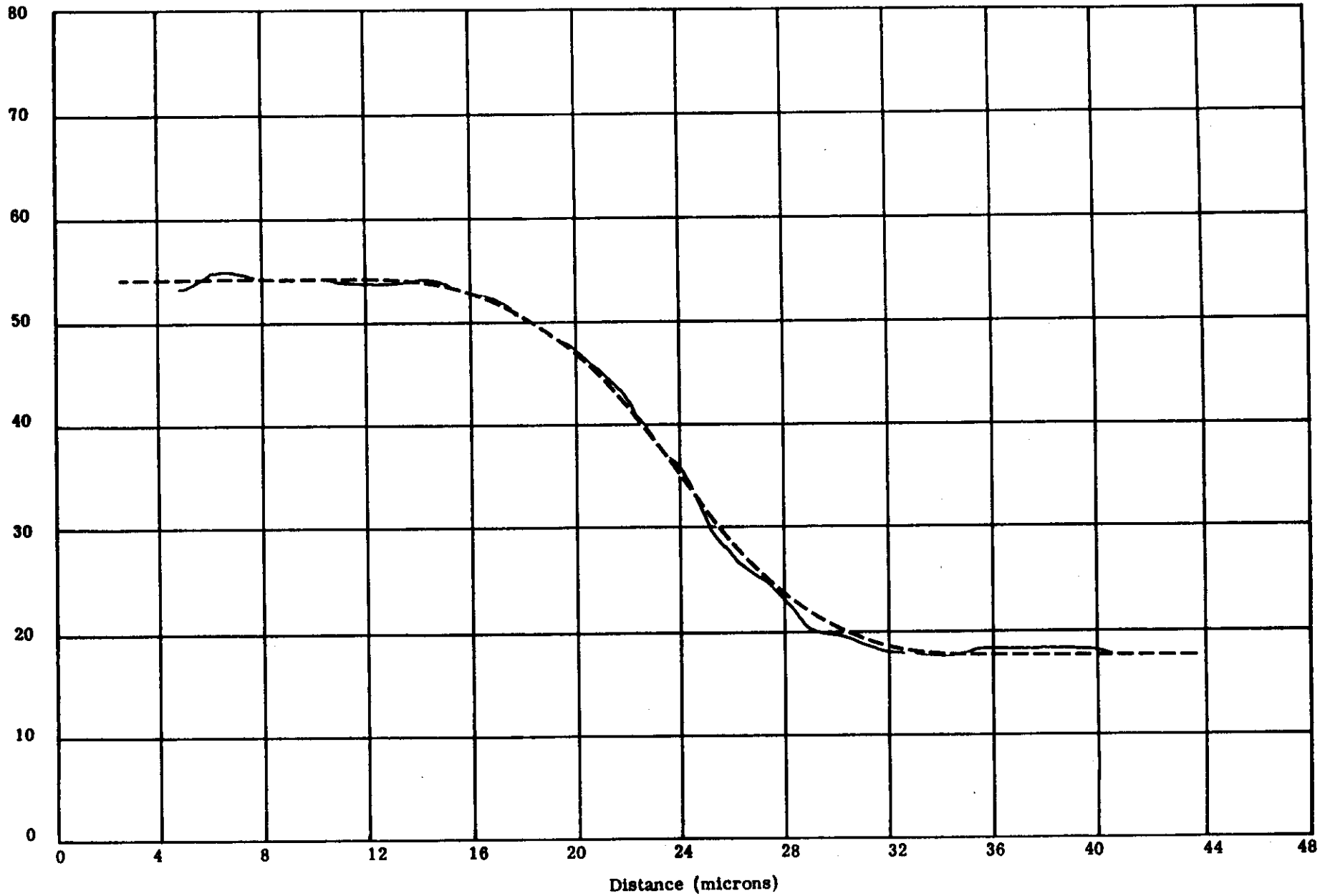


Analysis of Photographic Image to Evaluate System Performance

Section XII Mission 1026-2 Edge Location: Pass D094, Frame 026 , X66.6 Y13.6

Trace A

ORIGINAL AND HAND SMOOTHED EDGE TRACE

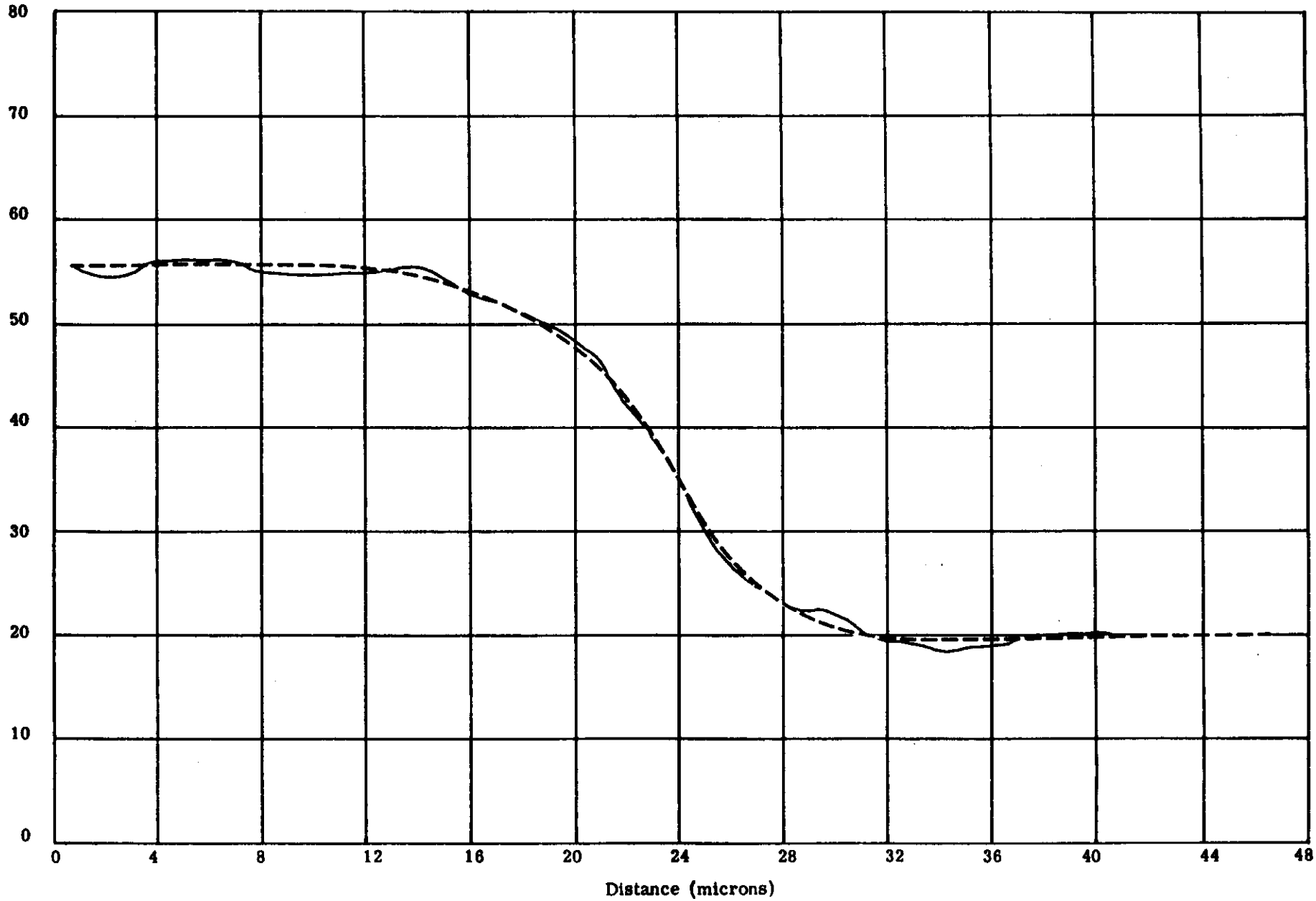


Analysis of Photographic Image to Evaluate System Performance

Section XII Mission 1026-2 Edge Location: Pass D094, Frame 026 , X66.6 Y13.6

Trace B

ORIGINAL AND HAND SMOOTHED EDGE TRACE



TOP SECRET

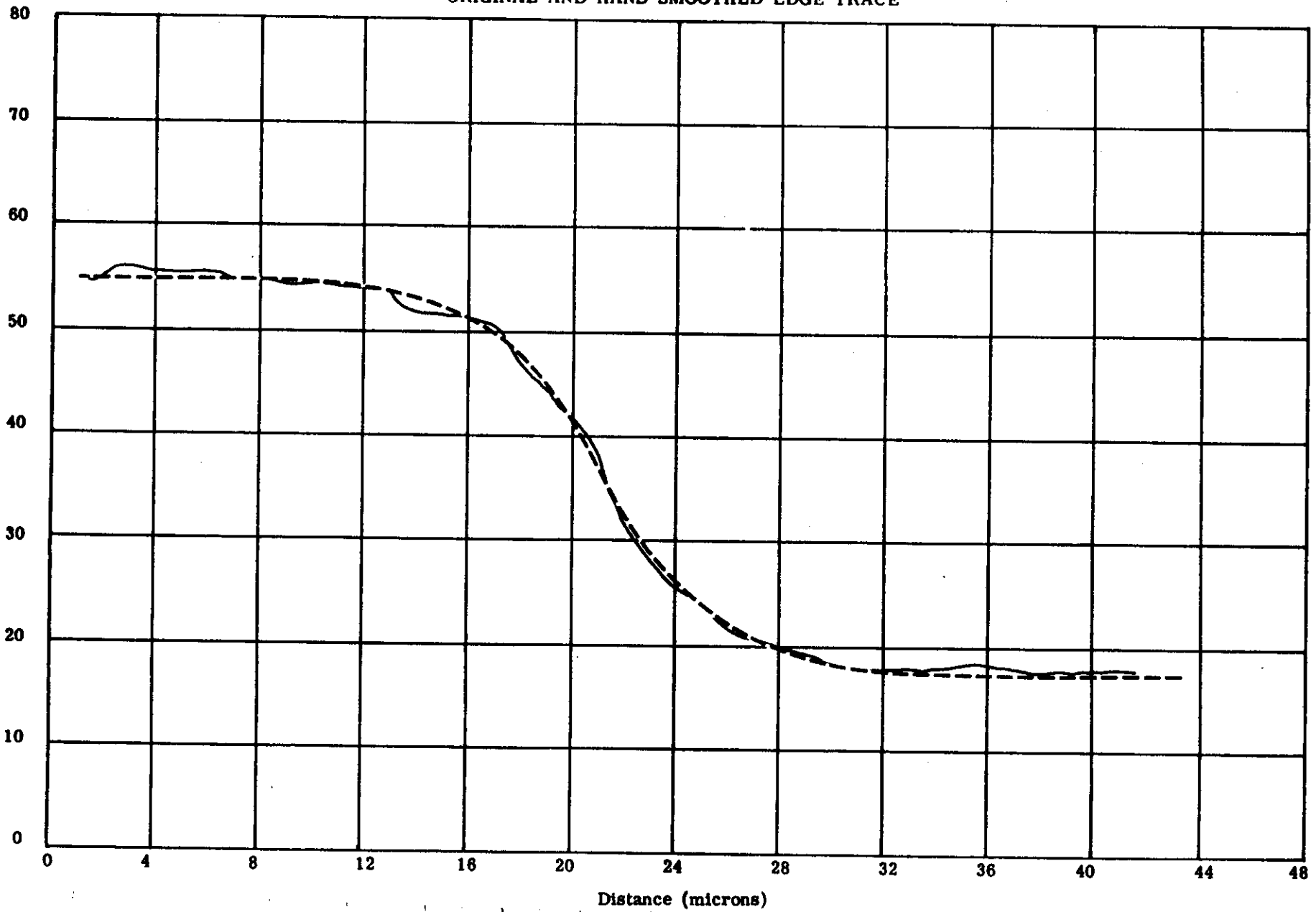
TOP SECRET

Analysis of Photographic Image to Evaluate System Performance

Section XII Mission 1026-2 Edge Location: Pass D094, Frame 026 , X66.6 Y13.6

Trace C

ORIGINAL AND HAND SMOOTHED EDGE TRACE



Analysis of Photographic Image to Evaluate System Performance

SECTION XIII - MISSION 1026-1

Selected Frame FWD Camera

Edge Location: Pass D-047, Frame 012

REPLICATION SERIES

Three tracings at different locations on the same edge:

Trace	Computed Resolution	Spread function width
A	97 l/mm	7.3 μ
B	70 l/mm	10.6 μ
C	78 l/mm	11.3 μ
Average	79 l/mm	9.8 μ

REPETITION SERIES

Five tracings of the same location on the edge:

Trace	Computed Resolution	Spread function width
C	78 l/mm	11.3 μ
D	96 l/mm	9.4 μ
E	86 l/mm	10.0 μ
F	88 l/mm	9.7 μ
G	93 l/mm	9.8 μ
Average	91 l/mm	9.8 μ