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TECHNICAL PUBLICATION

→2. FILE

PHOTOGRAPHIC EVALUATION REPORT MISSION 1049

SPECIAL STUDY FOR PER: IMAGE QUALITY COMPARISON MISSION 1102 -- ORIGINAL NEGATIVE VS. DUPLICATE POSITIVE

[redacted]

APRIL 1969

COPY [redacted]

188 PAGES

[redacted]

GROUP 1 EXCLUDED FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION

TECHNICAL PUBLICATION

PHOTOGRAPHIC EVALUATION REPORT

MISSION 1049

APRIL 1969

NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

GLOSSARY OF TERMS

ABSOLUTE HEIGHT	Vertical distance from the vehicle to the mean ground level of the area being photographed.
ACUITY	Sharpness - Edge definition.
ACUTANCE	Measure of the ability of a lens to reproduce sharp images.
AIR BASE	Ground distance between 2 exposure stations.
ALTITUDE	Vertical distance from the vehicle to the Hough Ellipsoid at the time of exposure.
AZIMUTH OF THE PRINCIPAL RAY	Horizontal clockwise angle, measured from true north to the camera principal ray.
BASE HEIGHT RATIO	Ratio between the air base and the absolute altitude of a stereoscopic pair of photographs.
CAMERA NADIR	Geodetic latitude and longitude of a point vertically beneath the perspective center of the camera lens on the Hough Ellipsoid.
CONE ANGLE	Angle between the principal ray and the vehicle nadir.
COPY GENERATION	Number of reproductive steps by which a negative or positive photographic copy is separated from the original, i.e. the original negative is copy 1, a positive made from the original negative is copy 2, etc.
DATE OF PHOTOGRAPHY	Indicates the day, month, and year (GMT) that the photography was acquired.
EXPOSURE *	Total quantity of light received per unit area on a sensitized plate or film.

EXPOSURE DURATION	Time during which a light-sensitive material is subjected to the influence of light. Expressed in this text in fractions of a second. Formula: Exposure Time (sec) = $\frac{\text{Slit Width (in)}}{\text{Scan Rate (rads per sec)}}$
EXPOSURE STATION	Position occupied by the camera lens at the moment of exposure.
FIDUCIAL MARK	A standard geometrical reference point imaged at the margin of a photograph. The intersection of the primary fiducial marks usually defines the principal point.
FOCAL LENGTH: CALIBRATED	Adjusted value of the equivalent focal length. Computed to distribute the effect of lens distortion over the entire field.
FOCAL LENGTH: EQUIVALENT	Distance measured along the lens axis from the rear nodal point to the plane of best average definition over the entire field. Points other than the rear nodal point may be used but must be specified for correct interpretation of data.
FOCAL PLANE	Plane perpendicular to the lens axis, in which images of points in the object field of the lens are focused.
FRAME	One of a series of full-format photographs comprising a roll of film.
GROUND RESOLUTION*	Resolved ground distance as determined from standard bar target resolution targets. A target is considered to be resolved when a grouping of 3 bars can be distinguished as 3 distinct lines. The lines need not have linear form.
HOLEY RAIL DOTS	Images of the rail holes associated with the pan geometry calibration of the camera.

IMC (Image Motion Compensation)	Correction for the forward motion of the vehicle while photographing the terrain.
ISODENSITOMETER	An instrument which is basically a microdensitometer with the capability of repeatedly scanning an image at pre-set intervals. Its output is in the form of a plot representing distance along 2 axes and density differences as code changes within each scan line.
LOCAL SUN TIME	Time of day computed from the position of the sun relative to the imaged terrain.
MICRODENSITOMETER	An instrument which measures the optical density of very small areas in an image. Its output is in the form of a continuous plot of density versus distance across an image. The microdensitometer used in NPIC can accurately measure distances as small as 1 micron and densities up to 5.0+.
NOD INDICATORS	A series of marks imaged in the border area of each frame for the purpose of defining the relative orientation of the optical axis and the ground scene.
NODAL TRACE	A continuous line imaged along the major axis of each frame to define the optical axis of the lens relative to any given instant of exposure.
PANORAMIC CAMERA	Photographs a partial or complete panorama of the terrain in a transverse direction through a scanning motion of the lens system.
PARALLAX	Apparent displacement of the position of an object in relation to a reference point, caused by a change in the point of observation.
PASS	Operational portion of an orbital revolution. A suffix D indicates the descending node and a suffix A indicates the

	ascending node. An additional suffix E indicates that the associated photography was generated for engineering purposes.
PITCH	Rotation of the camera about its transverse axis. Positive pitch indicates nose-up attitude.
PROCESSING LEVEL	Degree of development. Three levels of processing are currently employed: Primary, intermediate, and full.
PRINCIPAL RAY	That ray of light which emanates from a point in object space and passes undeviated through the lens to become imaged at the principal point of the camera system. It is co-incident with the optical axis of the lens.
RESOLUTION	Measure of the smallest array of point objects distinguishable as independent point images, expressed in lines/mm.
ROLL	Rotation of the camera about its longitudinal axis. Positive roll indicates left wing up attitude.
SHADOW FACTOR	A constant for each frame, used to calculate heights from shadow lengths.
SHRINKAGE MARKERS	Calibrated reference points used to calculate deformations of the photographic material.
SOLAR ELEVATION	Vertical angle measured from a plane (tangent to the surface of the earth at the point of intersection of the principal ray) to the sun, the vertex being at the center of the format.
STELLAR CAMERA	Used simultaneously with the index camera to photograph stars in order to determine vehicle attitude.
SYSTEM TIME LABEL	Binary presentation of the accumulative system time.

UNIVERSAL GRID	X, Y coordinate system used to locate images on photographic formats.
VEHICLE AZIMUTH	Clockwise horizontal angle measured from true north to the vehicle ground track.
VIGNETTING	Gradual reduction in density of parts of a photographic image due to the stopping of some of the rays entering the lens.
YAW	Rotation of the camera about its vertical axis. Positive yaw represents nose-left attitude, as viewed from the top of the camera.

*Defined differently than in the "Glossary of NPIC Terminology."

INDEX OF PHOTOGRAPHIC EVALUATION REPORTS AND SPECIAL STUDIES

[redacted]	[redacted]	SPECIAL STUDY
1033		None
1034		None
1036		None
1037		None
1038		None
1039		None
1040		None
1041		Slant Range Computations Related to Universal Grid Coordinates for the KH4A Camera System
1042		None
1043		Scan Speed Deviation Analysis of the Forward Camera, Mission 1043
1044		Dual Gamma/Viscose Vs Conventional/Spray Processing Analysis (Mission 1044)
1045		None
1046		S0230 Vs 3404 Evaluation
1047		None
[redacted]		None
1049		Image Quality Comparison Mission 1102--Original Negative vs Duplicate Positive
1101		Slant Range Computations Related to Universal Grid Coordinates for the KH4B Camera System
1102		None
1103		None
1104		SO-180 Evaluation Mission 1104
[redacted]		SO-180 Evaluation Supplement
		SO-121 Evaluation Mission 1105

SYNOPSIS

Mission 1049, a two part photographic satellite reconnaissance mission, was launched on 12 December 1968/2222Z. Both buckets were recovered dry, the first on 19 December 1968/0122Z and the second on 23 December 1968/2330Z.

All cameras operated properly throughout the mission. A full load of film type SO-230 was used in both main cameras.

The image quality is rated as fair to poor throughout the mission due to an apparent out-of-focus condition of both main camera records. Portions of the aft-looking camera record are noticeably better than that of the fwd-looking camera record during the first part of the mission. During the second part of the mission, the image quality of both main camera records is comparable. However, the overall image quality is noticeably poorer than that of the first part of the mission.

An MIP of 85 has been assigned to pass 90D, frame 10 of the aft camera for Mission 1049-1. An MIP of 80 has been assigned to pass 129D, frame 4 of the aft camera for Mission 1049-2.

Approximately 25 percent of the mission is obscured by clouds.

[redacted]

PART I. GENERAL SYSTEM INFORMATION

A. Camera Numbers

Fwd-Looking Panoramic Camera	224
Aft-Looking Panoramic Camera	225
Stellar/Index Camera (Mission 1049-1)	D123/157/162
Stellar/Index Camera (Mission 1049-2)	D124/158/165

B. Launch and Recovery Dates

	Mission 1049-1	Mission 1049-2
Launch	12 Dec 1968/2222Z	
Recovery	19 Dec 68/0122Z/Rev 99	23 Dec 68/2330Z/Rev 179

C. Orbit Elements

Element	Planned	Actual 1049-1	Actual 1049-2	Photo Range
Period (min)	NA	88.750	88.577	
Perigee (nm)	NA	95.956	98.793	91.924, 25D
Apogee (nm)	NA	136.420	135.010	110.549, 06D
Eccentricity	NA	0.00569	0.00510	
Inclination (deg)	NA	81.039	81.039	
Perigee Latitude (deg)	NA	22.236N	56.328N	

[redacted]

D. Photographic Operations

1. Panoramic Cameras

Type	Mission 1049-1 Revs	Mission 1049-1 Frames	Mission 1049-2 Revs	Mission 1049-2 Frames	Total Revs	Total Frames
Operational						
Fwd	40	2,823	32	2,974	72	5,797
Aft	40	2,812	32	2,973	72	5,785
Operational/Domestic						
Fwd	0	0	0	0	0	0
Aft	0	0	0	0	0	0
Domestic						
Fwd	6	131	7	105	13	236
Aft	6	131	7	102	13	233
Engineering (no imagery)						
Fwd	2	34	1	4	3	38
Aft	2	33	2	17	4	50
Totals						
Fwd	48	2,988	40	3,083	88	6,071
Aft	48	2,976	41	3,092	89	6,068

2. Secondary Cameras

Camera	Frames
Stellar (Mission 1049-1)	459
Index (Mission 1049-1)	459
Stellar (Mission 1049-2)	473
Index (Mission 1049-2)	473

E. Film Usage

	Film Load (Total, ft)	Pre-Flight Footage	Processed Footage
Fwd-Looking (Mission 1049-1)	16,300*	227	8,090
Aft-Looking (Mission 1049-1)	16,300*	227	8,060
Fwd-Looking (Mission 1049-2)	NA	NA	8,117
Aft-Looking (Mission 1049-2)	NA	NA	8,157
Stellar (Mission 1049-1)	150	5	52
Stellar (Mission 1049-2)	150	9'1"	59
Index (Mission 1049-1)	270	10'8"	112
Index (Mission 1049-2)	270	18'4"	122

*Total Load for Both Buckets.
NA - Not Applicable.

PART II. IMAGE ANALYSIS

A. Fwd-Looking Panoramic Camera

1. Density: Approximately 60 percent of the original negative has densities considered to be heavy. The mission contained a full load of film type SO-230. Since this film is approximately 2/3 of a stop faster than film type 3404, the slit widths were reduced to reflect the speed difference between the films. However, the majority of the mission was slightly overexposed.

2. Contrast: The contrast of the original negative is generally medium to high.

3. Image Quality: An out-of-focus condition is apparent throughout the mission. The severity of the out-of-focus condition increases as the mission progresses, with the second part of the mission being noticeably poorer. The probable causes of the out-of-focus condition are explained in the image quality statement for the aft-looking panoramic camera, Part II, B 3. The V/H programmer failed during rev 68D and remained inoperative for the remainder of the mission. After this failure, effective forward motion compensation (FMC) control was adjusted for each orbit by real time commands. Analysis of the imagery at and near the failure did not reveal the image smear which was expected.

4. Imaged Degradations

a. Light Leaks: Light-leak-induced fog patterns are imaged on the fifth frame, the fifth frame from the end, the second frame from the end, and last frame of most camera operations. These fog patterns are minor and do not seriously degrade the imagery. However, their density is heavier than on previous missions due to the use of a more sensitive film (SO-230). The fog patterns are illustrated in Graphics 1, 2, 3, and 4 on page 10.

b. Static: Minor dendritic static fog patterns are present intermittently along both film edges throughout the mission. These fog patterns occasionally enter the active format area.

c. Other:

(1) Very faint minus density bands appear intermittently throughout the mission. Similar bands were observed on Mission 1046 material (SO-230), as well as on material from pre-flight testing using SO-230. This is a characteristic of the film when the camera is inoperative for extended periods. The bands are

images of system film path components which are formed as a function of environment, not because of a light leak. The relative sizes and shapes, not position, are illustrated in graphic 5 on page 11.

(2) Minor banding is present at the take-up end of most frames.

5. Physical Degradations

a. The format edge, along the binary side take-up end, becomes very ragged, due to emulsion build-up on the film guide rails and almost totally obscures the middle fiducial marks by the end of the mission.

b. Minor rail scratches are present throughout the mission.

6. Product Quality: The imaged and physical degradations had only a minor effect on the product quality.

B. Aft-Looking Panoramic Camera

1. Density: Same as reported for the fwd-looking camera.

2. Contrast: Same as reported for the fwd-looking camera.

3. Image Quality: An out-of-focus condition is present throughout the mission. However, portions of the imagery provided by the aft-looking camera are noticeably better than that provided by the fwd-looking camera. This difference in image quality between the two records is not apparent on the second part of the mission. The out-of-focus condition increases in severity as the mission progresses with the image quality of part one noticeably better than part two. There are several potential contributing factors to this out-of-focus condition. These include thermal distortion of the lens cells and/or rails; emulsion build-up, changing film lift characteristics; and other possible sources. The PET believes that the thermal problem is the overriding consideration due to the abnormal temperature profile obtained on this mission. A grossly out-of-focus band of imagery is present on every frame during the first part of the mission. This out-of-focus band extends approximately 1/4 inch into the format from the time track edge and runs parallel to the major axis of the film. The cause remains unknown. This condition was also present on Mission 1049-2 but to a noticeably lesser degree of severity.

4. Imaged Degradations:

[redacted]

a. Light Leaks: Light-leak-induced fog patterns are imaged on the first frame and the third and second frame from the end of most camera operations. These fog patterns are minor and do not seriously degrade the imagery. However, their density is heavier than on previous missions due to the use of a more sensitive film (SO-230). The fog patterns are illustrated in Graphics 6, 7, and 8 on pages 11, 12.

b. Static: Minor dendritic static fog patterns are present intermittently along the film edges and in the active format area. Static discharges were observed during capsule defilming and processing.

c. Other:

(1) Very faint minus density bands appear intermittently throughout the mission. The cause is the same as reported for the fwd-looking camera. The relative sizes and shapes, not position, are illustrated in Graphic 9 on page 12.

(2) Minor banding is present at the take-up end of most frames.

(3) Crimp marks located along the time track edge and spaced at 0.3 inch intervals are present intermittently from pass 104D through pass 106D. The cause of these marks is unknown.

(4) Very fine minus density lines, parallel to the major axis of the film near the time track edge, are present throughout the mission. They are most apparent in areas of even density.

5. Physical Degradations:

a. The format edge along the binary side, take-up end, becomes very ragged due to emulsion build-up on the film guide rails and almost totally obscures the middle fiducial marks by the end of the mission.

b. Minor rail scratches are present throughout the mission.

6. Product Quality: The imaged and physical degradations were minor and had very little degrading effect on the product quality.

C. Stellar Camera (Mission 1049-1)

1. Density: Suitable for the detection of stellar images.

2. Contrast: Adequate for the detection of stellar images.

3. Image Shape: Most stellar images are slightly elongated.

4. Images per Frame: Approximately 20 stellar images are detectable in most frames.

5. Flare Level: Flare affects approximately 35 percent of each format.

6. Imaged Degradations:

a. Light Leaks: None.

b. Static: Minor dendritic edge static is present intermittently throughout the mission.

7. Physical Degradations: None noted.

8. Product Quality: A sufficient number of stellar images is present to satisfactorily perform attitude reduction.

D. Stellar Camera (Mission 1049-2)

1. Density: Suitable for the detection of stellar images.

2. Contrast: Adequate for the detection of stellar images.

3. Image Shape: Most stellar images are slightly elongated.

4. Images per Frame: Approximately 15 stellar images are detectable in most frames.

5. Flare Level: Flare affects approximately 20 percent of each format.

6. Image Degradations:

a. Light Leaks: None noted.

b. Static: Minor dendritic edge static is present intermittently throughout the mission.

7. Physical Degradations: None noted.

8. Product Quality: A sufficient number of stellar images is present to satisfactorily perform attitude reduction.

E. Index Camera (Mission 1049-1)

1. Density: The density is generally thin to medium. The shutter

tested to a speed of 1/410 of a second, while the shutter used in the index camera for Mission 1049-2 tested to a speed of 1/222 of a second. The exposure obtained on Mission 1049-2 is considered better than that obtained on Mission 1049-1.

2. Contrast: Medium. The index record was processed to a gamma of 1.03.

3. Sharpness: The image quality is good and comparable to recent missions of this system.

4. Image Degradations:

a. Light Leaks: None noted.

b. Static: None noted.

5. Physical Degradations: None noted.

6. Product Quality: Good and comparable to that of recent missions of this system. Frame 1 was not exposed.

F. Index Camera (Mission 1049-2)

1. Density: The density is generally medium.

2. Contrast: Medium. The index record was processed to a gamma of 0.96.

3. Sharpness: The image quality is good and comparable to recent missions of this system.

4. Imaged Degradations:

a. Light Leaks: None noted.

b. Static: None noted.

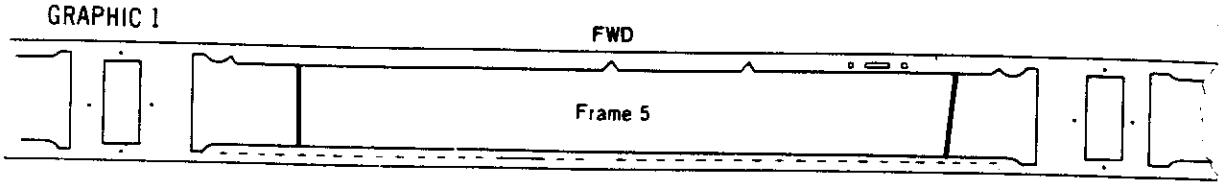
5. Physical Degradations: None noted.

6. Product Quality: Good and comparable to that of recent missions of this system.

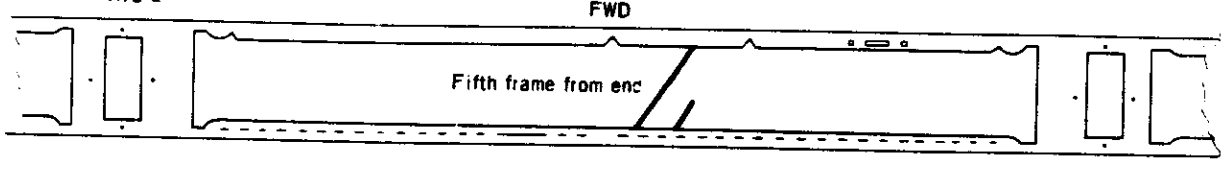
G. Graphic Display (Mission 1049)

The patterns illustrated below are referenced in the text of this report.

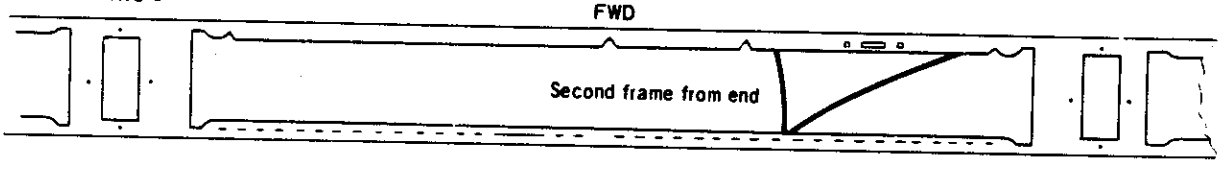
GRAPHIC 1



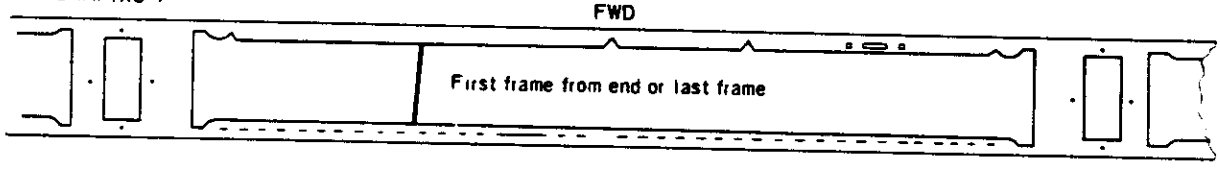
GRAPHIC 2



GRAPHIC 3



GRAPHIC 4



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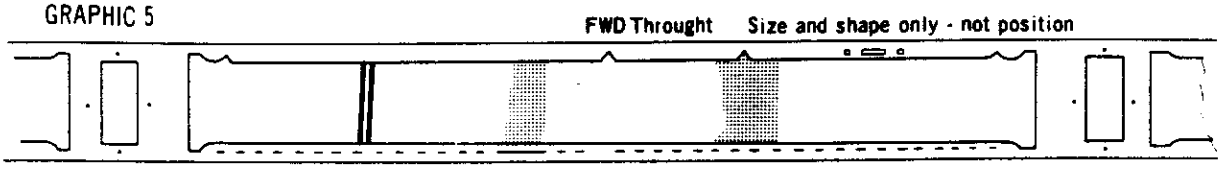
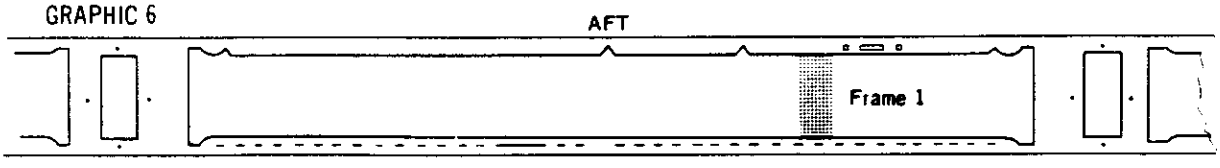
G. Graphic Display (Cont'd)

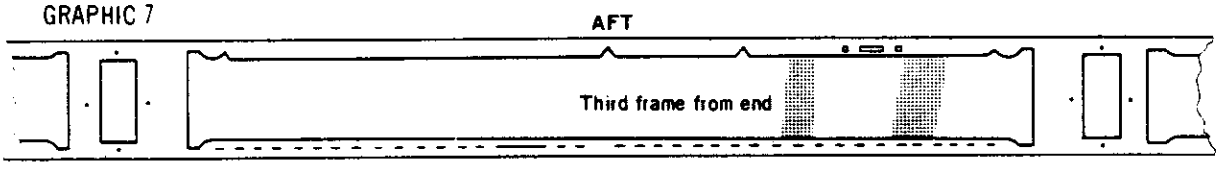
GRAPHIC 5



GRAPHIC 6



GRAPHIC 7



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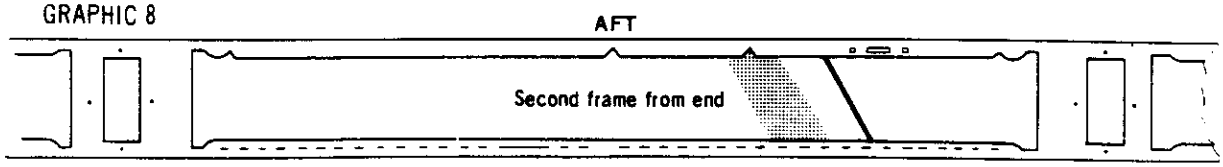
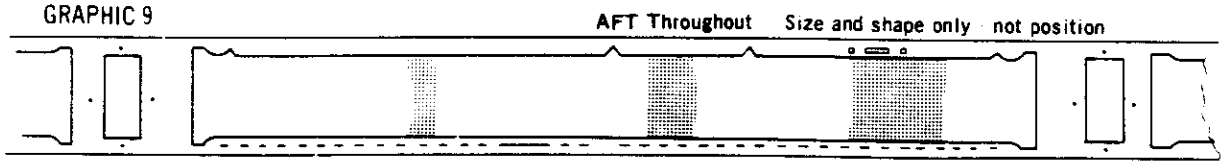
G. Graphic Display (Cont'd)

GRAPHIC 8



GRAPHIC 9



NPIC M-6183

PART III. IMAGED AUXILIARY DATA

A. Fwd-Looking Panoramic Camera

1. Horizon Cameras:

a. Starboard-Looking

(1) Imagery: Clear and distinct.

(2) Fiducials: Sharp and well defined.

b. Port-Looking

(1) Imagery: Clear and distinct.

(2) Fiducials: Sharp and well defined.

2. Frequency Marks: The time track is missing for up to six inches on the first frame of some camera operations.

3. Binary Time Word: Sharp and well defined.

4. Binary Index: The index image is sharp and well defined. The camera number index lamp was masked in an attempt to correct a comet-like flare pattern which has been present on previous missions and has caused numerous problems with automatic readout. The mask prevented the flare pattern. However, the resultant image is too small for automatic readout. As a result, all binary time words were read manually.

5. Camera Number: Readable.

B. Aft-Looking Panoramic Camera

1. Horizon Camera:

a. Starboard-Looking

(1) Imagery: Clear and distinct.

(2) Fiducials: Sharp and well defined.

b. Port-Looking

(1) Imagery: Veiling of the horizon imagery was noted during the first part of this mission. Initially, the veiling was severe.

However, a gradual clearing was apparent as the mission progressed, and Mission 1049-2 cleared completely after five passes.

(2) Fiducials: Sharp and well defined.

2. Frequency Marks: Same as reported for the fwd-looking camera.

3. Binary Time Word: Sharp and well defined.

4. Binary Index: Same as reported for the fwd-looking camera.

5. Camera Number: Readable.

C. Stellar Camera (Mission 1049-1)

1. Grid Image Quality: Sharp and well defined.

2. Correlation Lamp Image Quality: Sharp and well defined.

D. Stellar Camera (Mission 1049-2)

1. Grid Image Quality: Sharp and well defined in areas affected by flare. In areas unaffected by flare, the grid is poorly defined.

2. Correlation Lamp Image Quality: Sharp and well defined.

E. Index Camera (Mission 1049-1)

1. Grid Image Quality: Sharp and well defined.

2. Correlation Lamp Image Quality: Sharp and well defined.

3. Camera Number Legibility: Good.

F. Index Camera (Mission 1049-2)

1. Grid Image Quality: Sharp and well defined.

2. Correlation Lamp Image Quality: Sharp and well defined.

3. Camera Number Legibility: Good.

PART IV. MENSURATION QUALITY

A. Fwd-Looking Panoramic Camera

A total of 37 requests was received for mensuration on this mission. No problems were encountered, and from a mensuration standpoint, the image quality was considered normal for this system.

B. Aft-Looking Panoramic Camera

Same as reported for the fwd-looking camera.

PART V. FILM PROCESSING

A. Processing Machines and Processing Gamma

Film	Processor	Average Gamma
Fwd (Mission 1049-1)	Yardleigh	1.70
Aft (Mission 1049-1)	Yardleigh	1.73
Fwd (Mission 1049-2)	Yardleigh	1.82
Aft (Mission 1049-2)	Yardleigh	1.82
Stellar (Mission 1049-1)	Trenton	2.10
Stellar (Mission 1049-2)	Trenton	2.10
Index (Mission 1049-1)	Drape	1.03
Index (Mission 1049-2)	Drape	0.96

B. Processing Levels

1. Panoramic Cameras: A single level dual gamma process was used.

2. Secondary Cameras:

a. Stellar Cameras: Single level process used.

b. Index Cameras: Single level process used.

C. Film Handling Summary

1. Fwd-Looking Camera (Mission 1049):

a. Capsule De-Filming: Minor intermittent static discharges were observed during the de-filming of both capsules.

b. Pre-Spooling: No problems encountered.

c. Manufacturing Splices:

(1) Mission 1049-1: 38D, fr 5
68D, fr 9

(2) Mission 1049-2: 100D, fr 54
136D, fr 40

d. Processing Splices: None other than normal.

e. Manufacturing Defects: None noted.

f. Processing Anomalies: None.

g. Breakdown: No problems encountered.

2. Aft-Looking Camera (Mission 1049):

a. Capsule De-Filming: Minor intermittent static discharges were observed during the de-filming process of both capsules.

b. Pre-Spooling: No problems encountered.

c. Manufacturing Splices:

(1) Mission 1049-1: 38D, fr 80
73D, fr 6

(2) Mission 1049-2: 102D, fr 7
136D, fr 72

d. Processing Splices: None other than normal.

e. Manufacturing Defects: None noted.

f. Processing Anomalies: None.

g. Breakdown: No problems encountered.

3. Index Camera (Missions 1049-1 and 1049-2):

a. Capsule De-Filming: No problems encountered.

b. Pre-Spooling: No problems encountered.

c. Manufacturing Splices: None.

d. Processing Splices: None other than normal.

e. Manufacturing Defects: None noted.

f. Processing Anomalies: None.

g. Breakdown: No problems encountered.

4. Stellar Camera (Missions 1049-1 and 1049-2):

a. Capsule De-Filming: No problems encountered.

b. Pre-Spooling: No problems encountered.

c. Manufacturing Splices: None.

d. Processing Splices: None other than normal.

e. Manufacturing Defects: None noted.

f. Processing Anomalies: None.

g. Breakdown: No problems encountered.

D. Timetable

Film	Recovered	Received at Processing Site	Spec Ship at NPIC Recd	Priority 1A at NPIC Recd
Fwd (Mission 1049-1)	19 Dec 68/0122Z	19 Dec 68/1820Z	None	22 Dec 68/0318Z
Aft (Mission 1049-1)	"	"	"	"
Stellar (Mission 1049-1)	"	"	"	"
Index (Mission 1049-1)	"	"	"	"
Fwd (Mission 1049-2)	23 Dec 68/2330Z	24 Dec 68/1540Z	"	29 Dec 68/1926Z
Aft (Mission 1049-2)	"	"	"	"
Stellar (Mission 1049-2)	"	"	"	"
Index (Mission 1049-2)	"	"	"	"

PART VI. PI SUITABILITY

A. Definition of Photographic Interpretation (PI) Suitability

The PI suitability is an assessment of the information content of photographic reconnaissance material and its interpretability. A number of interrelated factors are involved, such as the quality of the photography, the extent of target coverage, scale, and weather limitations. However, the fundamental criteria for assigning a PI suitability rating may be reduced to (a) the scope of the photographic coverage and (b) the degree to which a photographic interpreter may extract useful and reliable information from the material.

PI suitability ratings are categorized as Excellent, Good, Fair, Poor, and Unuseable. These ratings refer to the overall interpretive value of the photography obtained from a particular reconnaissance mission. Individual targets may also be assigned PI suitability ratings. The standards that determine assignment of the various ratings are:

Excellent: The photography is free of degradations by camera malfunctions or processing faults and the weather conditions are favorable throughout. The imagery contains sharp, well-defined edges and corners with no unusual distortions. Contrast is optimum and shadow details, as well as details in the highlight areas, are readily detectable. Observation of small objects and a high order of mensuration are made possible by the consistently good quality of the photography.

Good: The photography is relatively free of degradation or limiting atmospheric conditions. Edges and corners are well defined. No unusual distortions are present. Detection and accurate mensuration of small objects are feasible, but to a lesser degree than in material rated as "Excellent."

Fair: Degradation is present and the acuity of the photography is less than optimum. Edges and corners are not crisply defined and there is loss of detail in shadow and/or highlight areas. Detection and identification of small objects are possible, but accuracy of mensuration is reduced by the fall-off in image quality and the less-than-optimum contrast that prevails.

Poor: Camera-induced degradations and/or weather limitations severely reduce the effectiveness of the photography. Definition of edges and corners is not sharp. Only gross terrain features and culture may be detected or identified and distortion of form may exist. Accurate mensuration of even large objects is doubtful.

Unuseable: Degradation of photography completely precludes detection, identification, and mensuration of cultural details.

B. PI Statistics

1. Target Coverage

	Mission 1049-1	Mission 1049-2	Totals
Priority 1 Targets Programmed	NA	NA	244
Priority 1 Targets Covered	56	135	191

2. PI Quality Appraisal

Rating	Missiles	Nuclear Energy	Air Facilities	Ports	Elect Commo	Military Activity	Complex
Good	0	0	4	1	0	0	4
Fair	37	31	19	2	0	18	12
Poor	16	8	9	11	0	26	9
Totals*	53	39	32	14	0	44	25

3. Summary of PI Quality Ratings

Good	9 or 4%
Fair	119 or 58%
Poor	79 or 38%

*A discrepancy can exist between the total number of targets covered and the total the PI reported because some targets are covered more than once.

C. PI Comments

1. Atmospheric Attenuation: The following is an analysis of the atmospheric conditions affecting the priority targets as reported by the photo interpreters during the initial readout of the mission.

Weather	Number of Targets
a. Clear	100 or 49 percent
b. Scattered Clouds	67 or 32 percent
c. Heavy Clouds	7 or 3 percent
d. Haze	29 or 14 percent
e. Snow	4 or 2 percent

2. Terrain Conditions: The terrain conditions were considered fair to good. The terrain in the northern latitudes was generally snow covered which aided the interpretation of some targets.

3. Product Interpretability: The interpretability is considered fair for Mission 1049-1 and poor to fair for Mission 1049-2. The out-of-focus imagery is the major degrading factor in the interpretability of the imagery obtained from this mission.

RESOLUTION TARGET DATA

Target Designator	A	
Camera (Looking)	Fwd	Aft
Pass	16D	16D
Frame	6	6
Date of Photography	13 Dec 68	13 Dec 68
Universal Grid Coordinates	42.9 - 12.3	45.2 - 9.7
Geographic Coordinates of Format Center	34-50N 117-44W	34-64N 117-49W
Altitude (ft)	601,163	599,082
Camera		
Pitch	14° 51'	-15° 2'
Roll	-0° 8'	0° 1'
Yaw	-2° 38'	-2° 49'
Local Sun Time	1522	1522
Solar Elevation	22° 24'	22° 29'
Solar Azimuth	133°	133°
Exposure (sec)	1/403	1/494
Processing Level	Dual Gamma	Dual Gamma
Vehicle Azimuth (deg)	168	168
Filter (Wratten)	23A	21
Target Type	Edwards B-2	-
Target Contrast	25:1	-
Weather Conditions	Haze	Cloud Covered

GROUND RESOLUTION IN FEET

		A			
		Along Track		Across Track	
		Fwd	Aft	Fwd	Aft
Observer 1	ON	11'4"	-	*	-
	DP	11'4"	-	*	-
Observer 2	ON	*	-	*	-
	DP	*	-	*	-
Observer 3	ON	11'4"	-	*	-
	DP	11'4"	-	*	-

*No Bar Groups Resolved.

	B		C	
Target Designator	Fwd	Aft	Fwd	Aft
Camera (Looking)	48D	48D	145D	145D
Pass	8	8	11	11
Frame	15 Dec 68	15 Dec 68	21 Dec 68	21 Dec 68
Date of Photography	70.8 - 10.8	13.7 - 10.8	80.6 - 11.3	11.6 - 10.8
Universal Grid Coordinates	31-32N 111-15W	31-27N 111-20W	36-34N 116-47W	36-30N 116-49W
Geographic Coordinates of Format Center	594,302	593,131	597,373	596,751
Altitude (ft)				
Camera				
Pitch	14° 47'	-15° 7'	14° 49'	-14° 58'
Roll	-0° 1'	0° 7'	-0° 30'	-0° 43'
Yaw	-2° 57'	-3° 3'	-12° 18'	-2° 31'
Local Sun Time	1400	1400	1301	1301
Solar Elevation	27° 0'	27° 5'	28° 0'	28° 4'
Solar Azimuth	149°	149°	164°	164°
Exposure (sec)	1/406	1/498	1/409	1/498
Processing Level	Dual Gamma	Dual Gamma	Dual Gamma	Dual Gamma
Vehicle Azimuth	169°	169°	169°	169°
Filter (Wratten)	23A	21	23A	21
Target Type	Ft. Huachuca		Indian Springs	
Target Contrast	11:1	11:1	8.8:1	8.8:1
Weather Conditions	Clear	Clear	Clear	Clear

GROUND RESOLUTION IN FEET

		B					C			
		Along Track		Across Track			Along Track		Across Track	
		Fwd	Aft	Fwd	Aft		Fwd	Aft	Fwd	Aft
Observer 1	ON	*	*	15'10"	15'10"	Observer 1	*	*	*	*
	DP	*	*	15'10"	15'10"		*	*	*	*
Observer 2	ON	*	*	15'10"	*	Observer 2	*	*	*	*
	DP	*	*	15'10"	15'10"		*	*	*	*
Observer 3	ON	*	*	15'10"	15'10"	Observer 3	*	*	*	*
	DP	*	*	15'10"	15'10"		*	*	*	*

*No Bar Groups Resolved.

PART VII. MISSION DATA

	Fwd-Looking Pan	Fwd-Looking Take-up Horizon	Fwd Looking Supply Horizon	Aft-Looking Pan	Aft-Looking Take-up Horizon	Aft-Looking Supply Horizon	Mission 1049-1 Stellar	Mission 1049-1 Index	Mission 1049-2 Stellar	Mission 1049-2 Index
							D123/157/162		D124/158/165	
Camera Number	224	NA	NA	225	NA	NA	162	157	165	158
Reseau Number	NA	NA	NA	NA	NA	NA	11759	825506	11202	825507
Lens Serial Number	178	23800	23801	177	19104	28514	NA	NA	NA	NA
Slit Width	.165	NA	NA	.135	NA	NA	F/1.8	F/4.5	F/1.8	F/4.5
Aperture	F/3.5	F/8.0	F/6.3	F/3.5	F/6.3	F/8.0	1.0	1/417	1.0	1/222
Exposure Time (sec)	1/410 Avg	1/100	1/100	1/480 Avg	1/100	1/100	None	21	None	21
Filter (Wratten)	23A	25	25	21	25	25	85	38.404	85	38.448
Focal Length (mm)	609.628	54.87	54.65	609.602	54.95	54.65	75	135	75	135
Film Length (ft)	16,300	NA	NA	16,300	NA	NA	None	None	None	None
Splices	4	NA	NA	4	NA	NA	231-9-9-7	148-3-9-7	231-9-9-7	148-3-9-7
Emulsion		301-5-2/2-2/31-1			103-6-5-2/32-11		3401	3400	3401	3400
Film Type		SO-230			SO-230			77 AWAR††		83 AWAR††
Resolution Data (L/mm)										
Static†										
High Contrast	*	*	*	*	*	*	*	*	*	*
Low Contrast	146	*	*	146	*	*	*	*	*	*
Dynamic†										
I High Contrast	191	*	*	200	*	*	*	*	*	*
I Low Contrast	123	*	*	130	*	*	*	*	*	*
P High Contrast	181	*	*	190	*	*	*	*	*	*
P Low Contrast	134	*	*	130	*	*	*	*	*	*

* Not Available.
NA Not Applicable.
† Film Type 3404
†† Film 3400

FIGURE 1. BEST IMAGE QUALITY
Image quality comparable to the best of this mission.

FIGURE 2. CORRESPONDING COVERAGE
Corresponding coverage as imaged by the fwd camera.

	FIGURE 1	FIGURE 2
Camera	Aft	Fwd
Pass	90D	90D
Frame	10	11
Date of Photography (GMT)	18 Dec 68	18 Dec 68
Universal Grid Coordinates	56.0-13.0	36.0-14.0
Enlargement Factor	20X	20X
Geographic Coordinates	31-02N 31-27E	30-58N 31-33E
Altitude (ft)	597,460	597,890
Camera Attitude:		
Pitch	-14° 59'	14° 52'
Roll	-0° 7'	-0° 11'
Yaw	-2° 46'	-2° 38'
Local Sun Time	1329	1329
Solar Elevation	30° 7'	30° 9'
Solar Azimuth	155°	155°
Exposure (sec)	1/501	1/412
Filter (Wratten)	21	23A
Vehicle Azimuth (deg)	169	169
Processing Level	Dual Gamma	Dual Gamma

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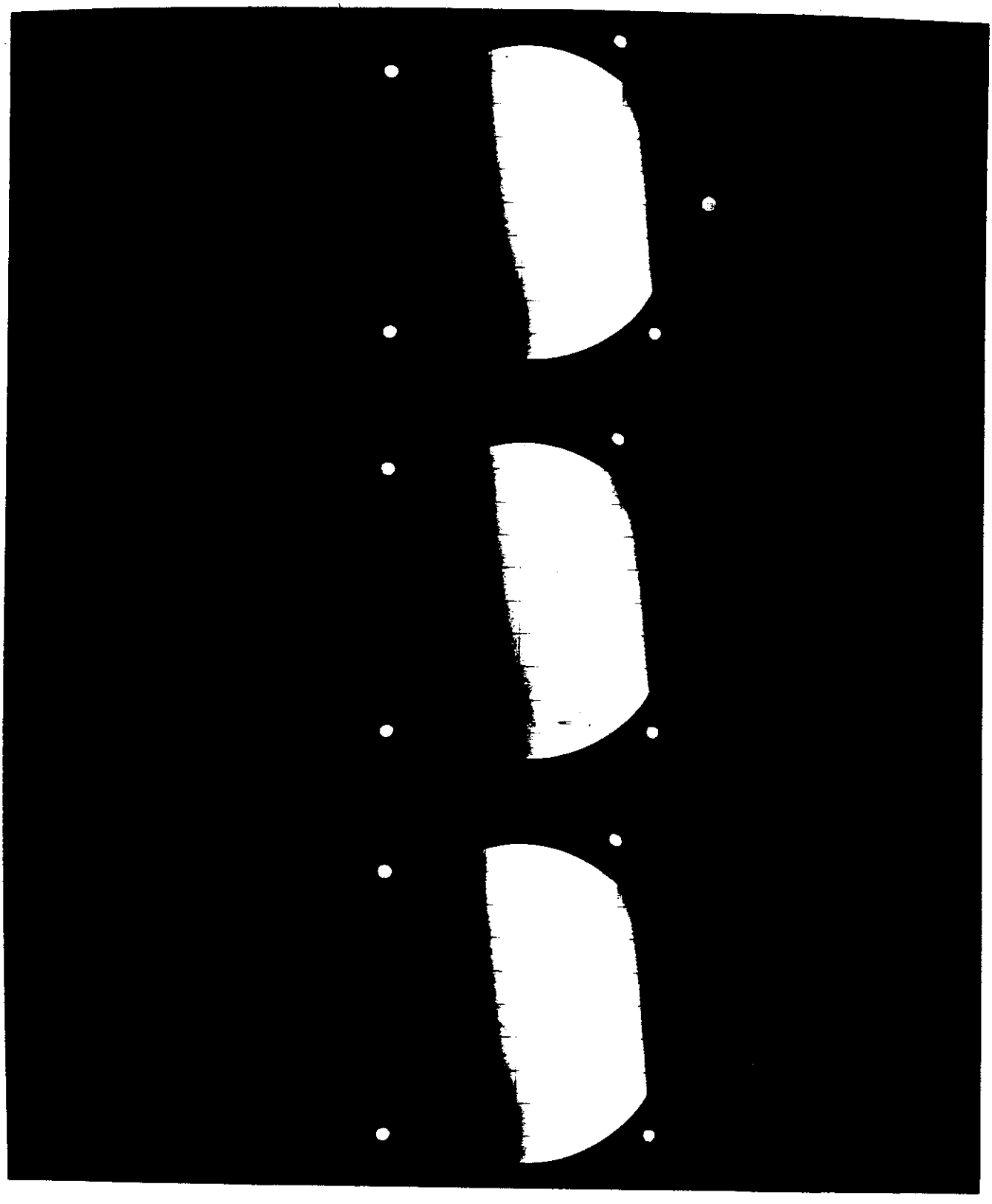
FIGURE 3. STELLAR FORMAT (Mission 1049-1)

FIGURE 4. STELLAR FORMAT (Mission 1049-2)

The following photographs exhibit the flare pattern prevalent throughout the mission.

	FIGURE 3	FIGURE 4
Mission Number	1049-1	1049-2
Stellar Frame Numbers	16, 17, 18	23, 24, 25
Correlates with		
Main Camera Number		
Pass	6D	102D
Frames	43, 50, 57	8, 15, 22
Date of Photography	13 Dec 68	19 Dec 68
Enlargement Factor	2.5X	2.5X
Exposure Time (sec)	1.0	1.0



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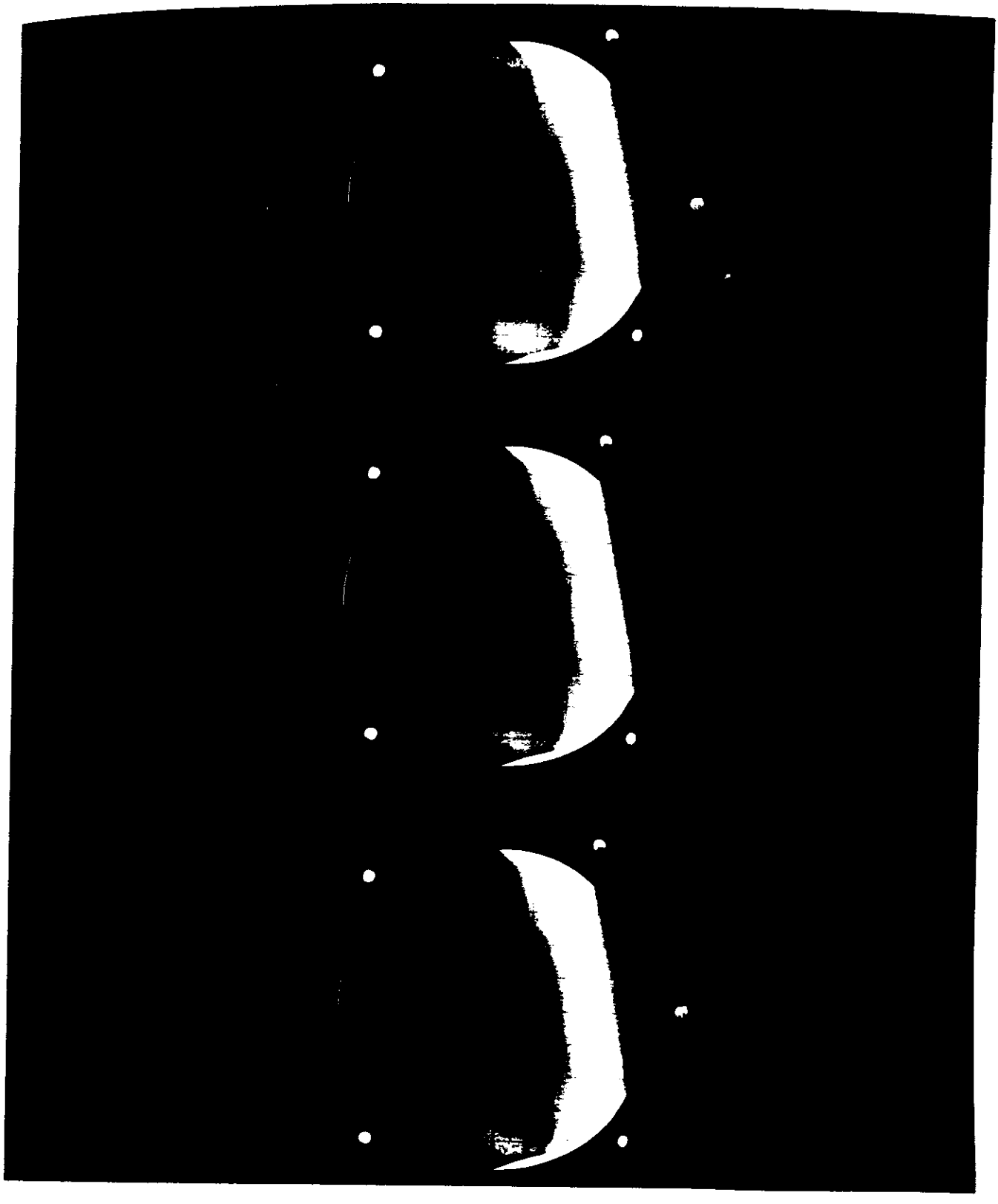

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FIGURES

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ABSTRACT

This study of original negative and duplicate positive image quality is an analysis of resolution target readings, image comparisons, and acutance values from Mission 1102. The results show only a small loss of resolution on the duplicates tested and a minimal loss of information.

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INTRODUCTION

At the request of the 1102 Performance Evaluation Team (PET), the National Photographic Interpretation Center undertook this study to establish the degree of information loss from the original negative to the second generation duplicate positive. Material from Mission 1102 was used because this mission offered the best imagery to date and therefore provided the most challenge for the duplicating system.

This evaluation was both subjective and objective. The subjective phase consisted of 1) reading and evaluating, on both the original negative and the second generation duplicate positive, all resolution targets imaged during the mission, and 2) evaluating image quality (information content) in cultural areas. The objective phase consisted of comparing acutance values of microdensitometric edge traces made on both the original negatives and the duplicate positives.

The second generation duplicate positive used for this evaluation was taken from the Priority 1 shipment prepared by the prime processing contractor.

1. RESOLUTION TARGET ANALYSIS

Mission 1102 provided coverage of ten resolution targets. Four of these were unsuitable for detailed analysis because the first bar group could not be resolved due to adverse weather conditions. Targets numbered 1, 2, 3, 5, 8, and 9 were used in this analysis.

These targets were read by seven PET members and six NPIC analysts. Because not all PET members read all six targets, their data are insufficient for detailed analysis. These readings are shown in Appendix 5.

Bar Group Readings

The most significant problem in assessing the difference between the original negative and duplicate positive is the variation of bar group readings on the same target. The subjective factor of this study is high, as is shown by the reading in which one analyst noted a loss of four bar groups in the positive while another noted a gain of one (see Appendix 3 for distribution readings).

Results of the study are charted in Figure 1, which shows that in 48.7 percent of the readings duplicate positive resolution was equal to or better than the original negative. In the remaining 51.3 percent the original negative afforded slightly better resolution.

Resolution Readings

The bar group readings were converted to resolution readings in lines per millimeter. Then the average resolution was calculated for each target and the percent of loss or gain was determined. Results are presented in Figure 2. An average of the average readings was calculated for the original negative and duplicate positive readings. The combined results indicate that a nine percent loss in resolution is apparent when the original negative is reproduced. However, as seen in Figure 3, there is no resemblance of an even distribution when the difference in resolution between the original negative and the duplicate positive (Δ resolution) is plotted against the number of times a value occurs.

The Δ resolution was plotted against the L/mm resolution of the original negative and a degree of correlation was evident (see Figure 4).

The Δ resolution was then calculated in percent and plotted against the contrast of the resolution, but no correlation was noted (see Figure 5).

2. IMAGE COMPARISON ANALYSIS

Cultural areas selected from frames throughout the mission were compared using a high quality split-field microscope. A comparison of the original negative and the duplicate positive of the same areas showed that differences in tones on the original had corresponding differences in tones on the duplicate. A very small loss of fine detail in the highlight areas and, to a lesser extent, in the shadow areas was noted on some positives. This loss, however, appears to be the result of the print level that the particular frame received and the contrast of the areas selected for comparison. Corrective printing could and did provide most of the otherwise missing detail on the positives.

The resolution targets were also analyzed using the split-field microscope. When compared in this manner, the resolution advantage of the original negative over the duplicate positive is nearly indiscernible.

It should be noted that frames within a pass are not printed individually. The printing level is dictated by a compromise of the best printing level for a number of frames. Therefore the optimum printing level for a particular target is not necessarily achieved.

3. ACUTANCE VALUE ANALYSIS

The objective evaluation consists of generating acutance measurements from the same edge on both the original negative and the duplicate positive.

Three traces were made across edges of large man-made structures with the microdensitometer. These were then hand-smoothed into single traces, and the formula for acutance was applied to the smoothed curves. The acutance values obtained (see Appendix 4) indicate the duplicate positive acutance averaged 19.6 percent higher than the original negative. When the number of times a value occurs was plotted against the percent of acutance lost or gained, no pattern of distribution was apparent (see Figure 6).