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PHOTOGRAPHIC

18-23 MAY 1965

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TECHNICAL PUBLICATION

PHOTOGRAPHIC EVALUATION REPORT  
MISSION 1021-1  
18-23 MAY 1965  
MISSION 1021-2  
23-28 MAY 1965

JANUARY 1966

NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

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## SYNOPSIS

Mission 1021 (System J-21) was a 2-part photographic mission programmed to achieve coverage for cartographic purposes. The mission was intentionally flown with the camera system rotated horizontally 180 degrees from its normal position, orbiting nose-first instead of tail-first. As a result of this change in orientation certain variations in normal system parameters should be noted. At the descending mode, the stellar camera looks westward. The master camera is the aft-looking and the slave camera is the forward-looking camera.

A normal orbit was achieved. Photographic coverage was accomplished between 18 and 28 May 1965. Clouds covered approximately 30 percent of the entire mission. The panoramic cameras functioned properly on the first part. The Stellar/Index cameras of Mission 1021-1 performed normally through frame 359. From frame 360 through 380, there were several multi-exposure frames that were not usable. On the second part of the mission the forward-looking camera and associated photographic equipment functioned properly throughout. However, an anomaly occurred in the aft-looking camera causing a termination of the photographic record on pass 102D frame 8. As a result, only a total of 12 million square nautical miles of plottable photographic coverage was acquired.

The recovery capsules from missions 1021-1 and 1021-2 were retrieved by air catch during revolutions 81 and 161 respectively.

There is no significant differences in the image quality of the panoramic material between missions 1021-1 and 1021-2 except for the anomaly mentioned above. Both payloads were assigned an MIP rating of 85.

- 1 -



**GENERAL FLIGHT DATA**

1. Launch and Recovery Dates

Launch Date, Mission 1021-1	18 May 1965
Recovery Date, Mission 1021-1	23 May 1965
Activation Date, Mission 1021-2	23 May 1965
Recovery Date, Mission 1021-2	28 May 1965

2. Orbital Parameters (Actual)

	<u>Mission 1021-1</u> <u>Rev 40</u>	<u>Mission 1021-2</u> <u>Rev 120</u>
Period	89.81 Min	89.74 Min
Perigee	109.71 NM	110.52 NM
Apogee	180.06 NM	179.67 NM
Eccentricity	0.00988	0.00965
Inclination Angle	75.02°N	75.02°N
Perigee Latitude	24.288°N	37.707°N

3. Photographic Operations

A. Pass Information

	<u>Mission 1021-1</u>	<u>Mission 1021-2</u>
Operational Passes	44	38
Operational/Domestic Passes	1	
Domestic Passes	2	5
Domestic/Engineering Passes	2	5
Total Photo Passes	49	48
Recovery Revolution	81	161

B. Film Footage/Frame Totals

	<u>Master</u>	<u>Slave</u>
Footage Available	16,000 (Approx)	16,000 (Approx)
Preflight Footage	428	298
Process Footage (1021-1)	7,994	7,696
Process Footage (1021-2)	2,250	8,361
Titled Frames (1021-1)	2,841	2,772
Titled Frames (1021-2)	342	3,177



## PART I. CAMERA OPERATION

### 1. Master (Aft-Looking) Panoramic Camera No 166

The master panoramic camera functioned properly on the first part of the mission and through a portion of pass 85D of the second part. Good quality photography was obtained up to this point. However, the film came out of the guide rails on pass 85D, frame 11, and severely degraded the imagery through pass 102D, frame 10. At this time, the film jammed and caused a premature termination of the master camera record. The malfunction was caused by a cut that existed in the film when it was transported into the platen area prior to exposure. Because of the cut the film slipped from the rails as it was being transported. The film contractor conceded that a cut is made during film manufacturing to signal the end of a useable roll of film. The conclusion is that the cut was made in the customary manner by the film manufacturer and a splice was erroneously made on the wrong side of the cut. For a more detailed analysis of the anomaly see Part II, Section 3. Degradations attributed to camera operation include:

- a. A group of longitudinal scratches just inside the format are present beneath the binary and at the take-up ends of the frames on the emulsion side of the film throughout the mission.
- b. Continuous scratches, parallel to the edges of the negative, are present throughout the mission. These scratches are attributed to the rails which support the film during transport.
- c. Banding is present on the take-up ends of most frames throughout the mission. Its noted severity is commensurate with contrast and density.
- d. Fog that appears to have been caused by light reflected from a curved surface is present near the take-up end of the next-to-last frame of most camera operations and extends partially into the supply end of the third frame from the end. Equipment shadowgraphs are present on the last frame of most camera operations. A transverse band of fog is located on the first frame of most camera operations. The degree of fog density is associated with the duration of the camera-off period and the sun angle during this time.

2. Slave (Fwd-Looking) Panoramic Camera No 167

The slave panoramic camera functioned properly throughout both parts of this mission. The majority of the detriments to the photographic record associated with the operation of this camera are similar to those present on previous missions of this type. These degradations include:

- a. A scratch is present just inside the format of both edges of the take-up end of each frame and on both edges of the format beneath the camera number. A group of short, fine emulsion scratches are located across the format beneath the camera number.
- b. Continuous scratches, parallel to the edges of the negative, are present throughout the mission. These scratches are attributed to the rails which support the film during film transport.
- c. Minus density streaks following the general path of the field flattener appear intermittently through pass 18D.
- d. Fogged areas of plus density and equipment shadowgraphs caused by extraneous light are present on the last 4 frames of most camera operations. Their pattern is repetitive and the degree of density is commensurate with the duration of the camera-off period and the sun angle during this time.

3. Master (Aft-Looking) Horizon Cameras

- a. The port (take-up) horizon camera functioned properly throughout the mission. However, due to the film jam (covered in Item 1 of Part I) there was a termination of the photographic record on pass 102D frame 10. Exposure was commensurate with the solar elevation. Vignetting occurred in the corners of the imagery but did not interfere with the determination of vehicle attitude.
- b. The starboard (supply) horizon camera functioned properly throughout the mission. However, due to the anomaly which caused the film to come out of the rails, the imagery is smeared and out of focus from pass 85D, frame 12, through pass 102D, frame 10. At this point the film jammed and caused a termination of photographic record. The exposure was commensurate with the solar elevation. Vignetting is more pronounced than in the port horizon camera, but did not interfere with the determination of vehicle attitude.

4. Slave (Fwd-Looking) Horizon Cameras

a. The port (supply) horizon camera functioned properly throughout the mission. The film has a veiled appearance which is attributed to atmospheric attenuation, but under magnification the imagery appears to be sharp. Vignetting is extensive in the corners of the format, but does not interfere with camera attitude determination. Exposure is commensurate with solar elevation.

b. The starboard (take-up) horizon camera functioned properly throughout the mission. Obstructions, possibly film scrapings, appear in the format edges but do not interfere with the determination of vehicle attitude. The obstructions are present throughout the mission. Exposure is commensurate with solar elevation.

5. Stellar Camera No D63 (1021-1)

The stellar camera performed extremely well through frame 359. There are 9 multiple exposed frames from 360 to 380 that were not usable. Of the 380 total frames, 369 were used for attitude determination. The photography provided stellar images with good geometric distribution. Approximately 25 stars are visible in the field of view. The change in the stellar field from pass to pass was minimal.

Earth flare was normal with stellar images visible in the fogged areas. A continuous plus density streak is located along the correlation mark edge throughout the first 75 percent of the mission. Emulsion cracking parallel to the minor axis is present on the last 50 percent of the film. Narrow bands of fog parallel to the mirror axis occur near the take-up end of several frames. The configuration of the fog is similar to that caused by corona static. The fog is more severe on the last 19 frames in association with the multiple exposures.

6. Stellar Camera No D25 (1021-2)

Although the film jammed in the master (aft-looking) camera, it continued to operate throughout the mission. Also, the stellar camera was operational throughout. However, due to the malfunction the binary record was not recorded on the panoramic material and the time could not be directly related for the 2 cameras. Therefore, the stellar material was not used for attitude determination in Mission 1021-2. The pitch and roll for the slave (fwd-looking) photography was determined from the horizon camera record.

Fog caused by dendritic static occurred on the film during the last 50 percent of the mission. The static is discharged inside the format on a few frames. Biased plus density streaks, located through the middle of the format, are present during the last 25 percent of the photography. They are about 0.5 inches long and when they occur are spaced about 0.25 inches apart. Minor emulsion cracking is noted on the last 50 percent of the film. Severe abrasions and fog on the last 4 feet of the film are associated with film exhaustion.

7. Index Camera No D63 (1021-1)

The index camera operated normally through frame 359. Thereafter, multiple exposures occurred on frames 360, 361, 362, 364, 371, 374, 378, 379, and 380. A continuous plus density streak, beginning in the preflight and in line with the camera number, is present through the first 75 percent of the mission. Toward the end of the mission the plus density streak becomes intermittent and faint. Emulsion cracks emanating from the plus density streak appear to be caused by an emulsion rub. Minor static traces occur along both edges of the film. Newton rings are visible on a number of frames. Small particles of foreign matter, possibly specks of emulsion, are present intermittently throughout the mission. Several particles of dirt on the reseau grid caused minus density spots on most frames.

8. Index Camera No D25 (Mission 1021-2)

The index camera was operational throughout the mission. The imagery is good in the middle of the frames, but the fall-off toward the edges is greater than normal. Newton rings are present on most frames throughout the mission. Abrasions and fog occurring on the last 4 feet of the film are caused by film run-out. The correlation lamp on this camera is slightly offset, allowing crescent-shaped ground images to appear on the film when the lamp is not lit. The film was titled over the correlation fiducial.

9. Associated Equipment

This equipment records technical information for the correlation and mensuration of the primary cameras.



Several horizon camera fiducials are slightly bloomed. Flare emanating from and adjacent to the camera number and the end of pass marker is present throughout the mission. The 200 cycles per second timing pips were recorded outside the format. However, the density is less than optimum and relative to the processing level used.

The binary time for missions 1021-1 and 1021-2 was read automatically from positives. Difficulties were experienced for the following reasons:

1021-1 Fwd

1. The No 17 binary light had the top one-third cut off, making it very difficult to read.
2. The alignment of the binary block was very irregular on many passes.
3. A light streak appeared on the third frame from the end of each pass.
4. The binary was missing on pass 25D, frame 50.
5. All lights were smaller than most previous missions.

1021-1 Aft

1. The No 19 light was faint on passes 2, 9, 30, 56, 57, 66, 72, and 73.
2. The No 23 light was faint on passes 2, 6, 11, 41, 45, 56, 72, 73, 75, and 79.
3. The No 24 light was faint on passes 2, 11, 73, and 75.
4. The No 3 light was faint on passes 6 and 73.
5. The No 21 light was faint on passes 9, 66, and 72.
6. The No 5 light was faint on passes 55 and 57.
7. The No 10 light was faint on pass 57.
8. The No 16 light was faint on pass 75.
9. The alignment was poor on most passes, but pass 66 appeared to be exceptionally poor.



10. The binary was missing on pass 37D, frame 39.
11. A light streak appeared on the third frame from the end of each pass.

1021-2 Fwd

1. The No 18 light was faint on passes 86 and 88.
2. The No 17 light was faint on passes 88, 89, and 90.
3. The binary was missing on pass 117D, frame 7, and pass 152D, frame 112.
4. On the last frame of the mission, frame 21, pass 158D, the binary lights were so smeared that they had to be translated manually.
5. A light streak appeared on the third frame from the end of each pass.

1021-2 Aft

1. Due to the film coming out of the rails only 15 frames had a binary block. These were pass 81D, frames 1 thru 5, and pass 85D, frames 1 thru 10.

FIGURE 1. DESCRIPTION OF PHOTOGRAPHIC DATA

The data pertaining to photographs contained in this publication are defined as follows:

**PASS:** A pass is the operational portion of an orbital revolution. A suffix D indicates that the photography was acquired during the descending portion; a suffix A indicates that the photography was acquired during the ascending portion; and a suffix M indicates that the photography was acquired during a pass that includes both ascending and descending portions. An additional suffix E indicates that the pass was an engineering operation or that a portion of the pass has been edited.

**DATE OF PHOTOGRAPHY:** The data of photography indicates the day, month, and year (GMT) that the photography was acquired.

**UNIVERSAL GRID COORDINATES:** These coordinates are included to locate the illustrated photography within the panoramic format.

**ENLARGEMENT FACTOR:** The enlargement factor is included to indicate the number of diameters the original material has been enlarged in the photographic illustration.

**GEOGRAPHIC COORDINATES:** These coordinates are included to indicate the latitude and longitude of the panoramic format.

**ALTITUDE:** This measurement is the vertical distance from the vehicle to the Hough Ellipsoid at the time of the acquisition of the photography.

**PITCH:** Rotation of the camera about its transverse axis. Using appropriate aeronautical terminology, positive readings indicate nose-up attitude and negative readings indicate nose-down attitude.

**ROLL:** Rotation of the camera about its longitudinal axis. Using appropriate aeronautical terminology, positive readings indicate the left wing-up attitude and negative readings indicate right wing-up attitude.

**YAW:** Rotation of the camera about its vertical axis. Positive readings indicate counter-clockwise rotation when viewing the ground nadir from the vehicle mounted camera in-flight.

**LOCAL SUN TIME:** This time is included to present to the viewer a realistic time of acquisition of the photography illustrated.



SOLAR ELEVATION: The solar elevation is the angular elevation of the sun above a plane tangent to the surface of the earth at the center of the panoramic format. A negative solar elevation indicates that the sun is below the plane.

SOLAR AZIMUTH: The solar azimuth is the angular measurement of the rays of the sun measured from true north in a clockwise direction.

EXPOSURE: The exposure is the duration of the photographic exposure expressed in a fraction of a second and is computed from the scan rate and slit width.

VEHICLE AZIMUTH: The clockwise measurement from true north to the longitudinal axis of the vehicle heading.



FIGURE 2. EXAMPLE OF FOREIGN MATTER INSIDE THE HORIZON FORMAT

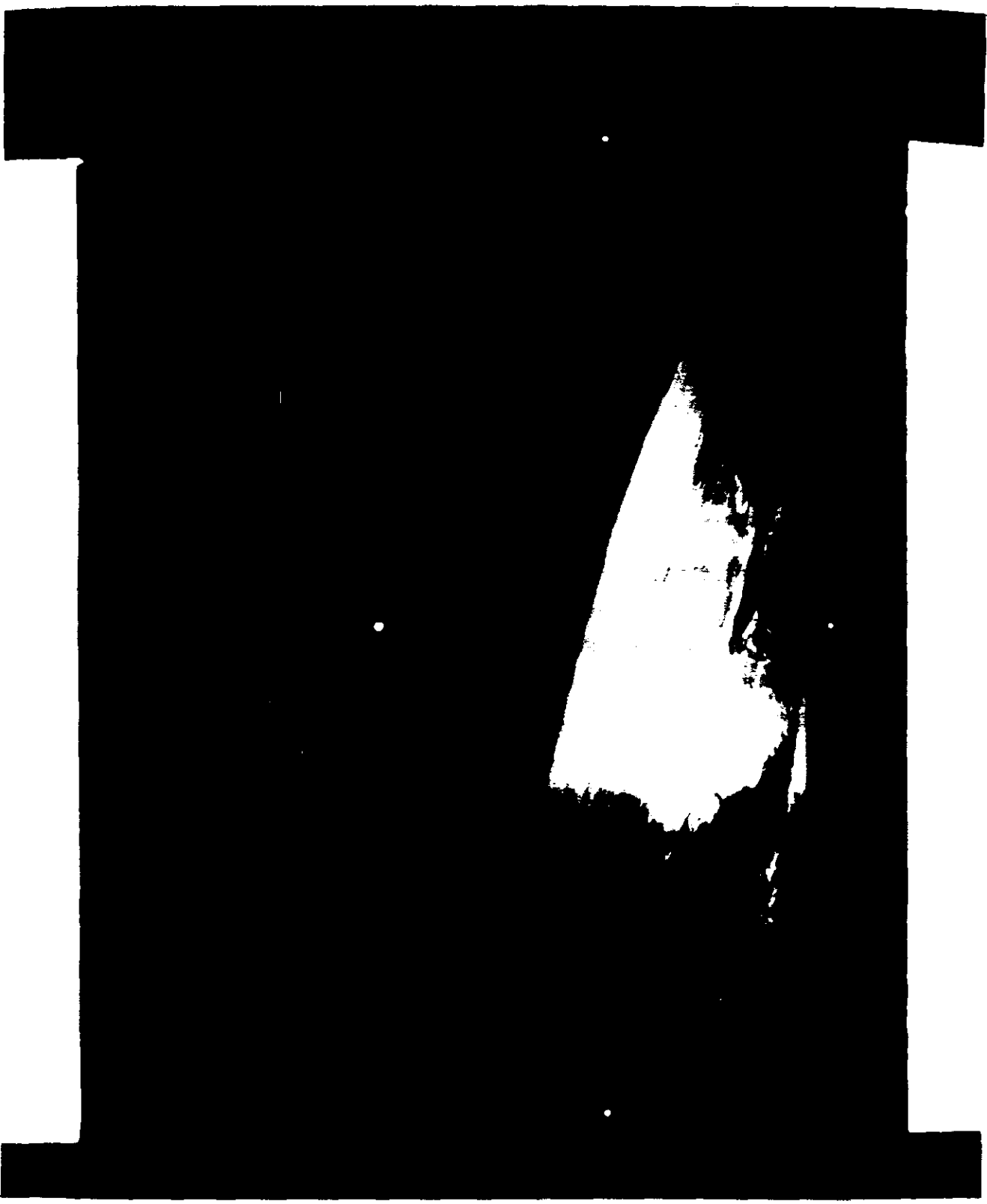
Note the lint-like obstructions in the supply edge of the format, and the vignetting that occurred on the titled and the frequency-mark edges of the horizon format.

NPIC K-8823 (12/65)

- 8c -

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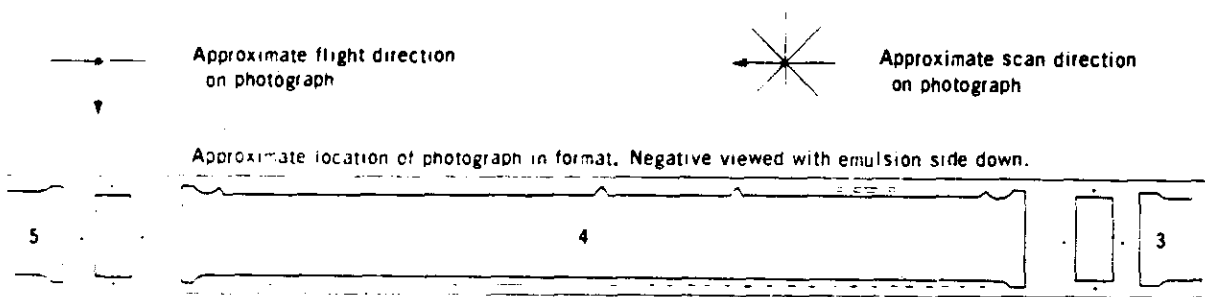
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Camera . . . . . 167  
Pass . . . . . 73D  
Frame. . . . . 4 fwd  
Date of Photography. . . . . 23 May 65  
Universal Grid Coordinates . . . . . Not Applicable  
Enlargement Factor . . . . . 3X  
Geographic Coordinates . . . . . 29-00N 027-02E  
Altitude (feet). . . . . 666,553  
Camera:  
Pitch . . . . . 15°14'  
Roll. . . . . -0°15'  
Yaw . . . . . -0°17'  
Local Sun Time . . . . . 0915  
Solar Elevation. . . . . 51°45'  
Solar Azimuth. . . . . 94°  
Exposure (fractions of second) . . . 1/263  
Processing Level . . . . . Intermediate  
Vehicle Azimuth. . . . . 165°51'



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FIGURE 4. STATIC DISCHARGES INSIDE THE STELLAR FORMAT

NPIC K-5825 (12/65)

- 8g -

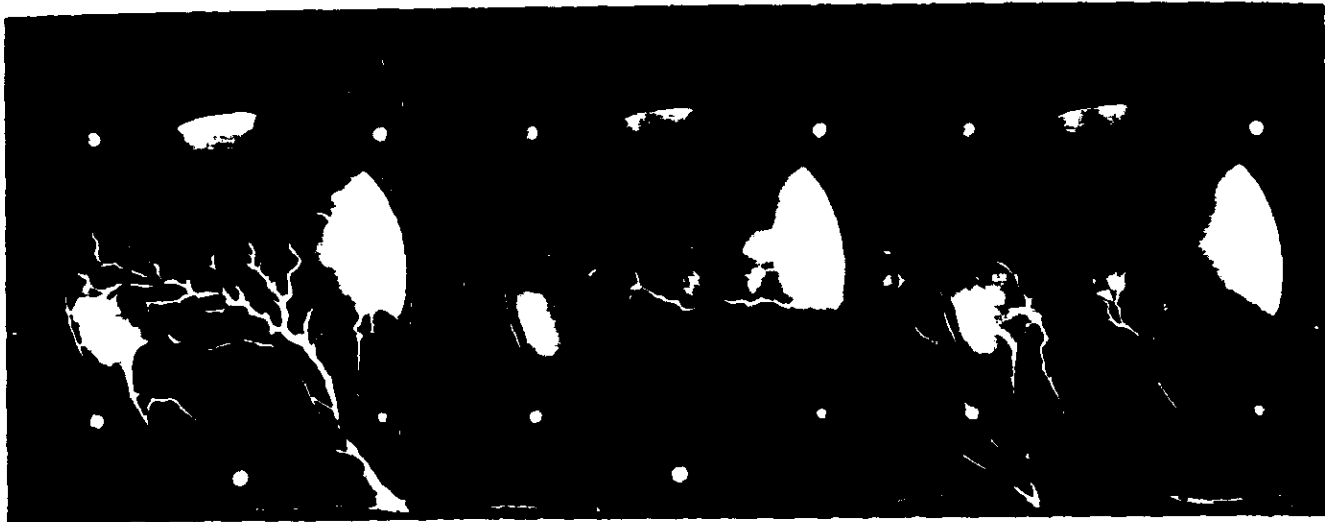


Stellar Frame Numbers . . . . 68, 69, & 70  
Correlates with:  
Aft Camera: . . . . . 166  
Pass . . . . . 89D  
Frame. . . . . \*  
Date of Photography . . . . . 24 May 65  
Enlargement Factor. . . . . 2.5X  
Main Camera Attitude. . . . . Not Determined  
Exposure Time . . . . . 2 sec

\*No Corresponding Master (aft-looking) Panoramic  
Material.



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FIGURE 5. EXAMPLE OF INDEX CAMERA PHOTOGRAPHY

This photograph shows that the quality of this mission compares favorably to that obtained from past missions.

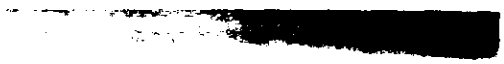
NPIC K-5826 (12/65)





Index Frame Number. . . . . 125  
Correlates with:  
  Aft Camera . . . . . 166  
  Pass . . . . . 102D  
  Frame. . . . . \*  
Date of Photography . . . . . 25 May 65  
Enlargement Factor. . . . . 2.5X  
Main Camera Attitude. . . . . Not Determined  
Exposure. . . . . 1/500 sec

\*No Corresponding Master (aft) Panoramic Material.



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FIGURES 6 AND 7. EXAMPLES OF PAN CAMERA PHOTOGRAPHY

The following 2 photographs show a comparison between the forward and aft film. Note the subtle improvement of the aft material over the forward.

NPIC K-5827 (12/65)

NPIC K-5828 (12/65)

- 8k -



Figure 6

Figure 7

Camera . . . . .	167	166
Pass . . . . .	79D	79D
Frame. . . . .	T fwd	14 aft
Date of Photography. . . . .	23 May 65	23 May 65
Universal Grid Coordinates . . . . .	28.1 - 10.6	62.5 - 10.0
Enlargement Factor . . . . .	20X	20X
Geographic Coordinates . . . . .	32-52N 109-58W	32-44N 110-00W
Altitude (feet). . . . .	670,622	669,478
Camera:		
Pitch . . . . .	15°12'	-14°41'
Roll. . . . .	-0°15'	-0°15'
Yaw . . . . .	Not Determined	Not Determined
Local Sun Time . . . . .	905	905
Solar Elevation. . . . .	49°04'	49°07'
Solar Azimuth. . . . .	94°	94°
Exposure (fractions of second) . . . . .	1/247	1/365
Processing Level . . . . .	Full	Full
Vehicle Azimuth. . . . .	164°53'	165°08'

..... Approximate flight direction  
on photograph

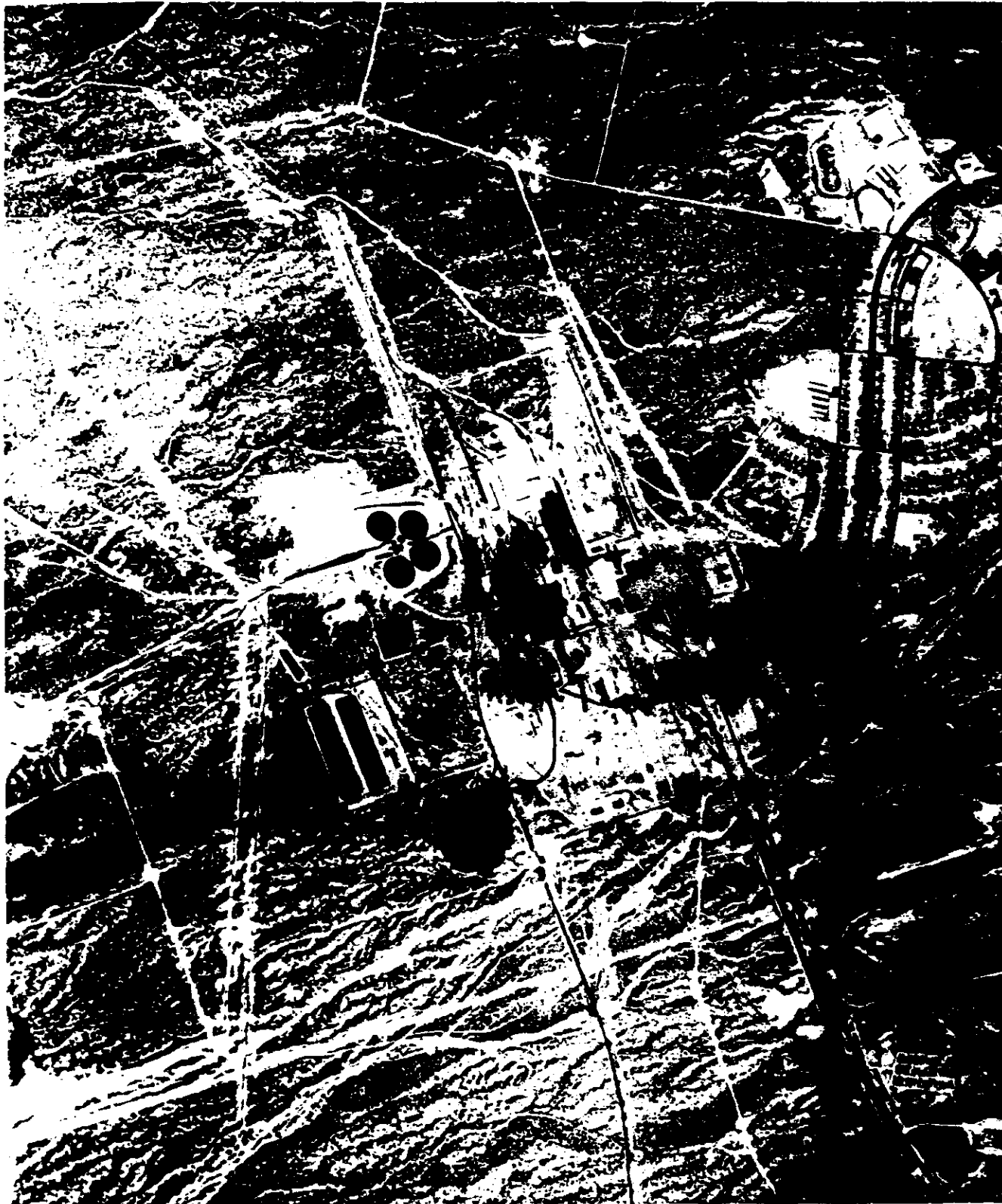
..... Approximate scan direction  
on photograph

Approximate location of photograph in format. Negative viewed with emulsion side down.

● FWD

● AFT

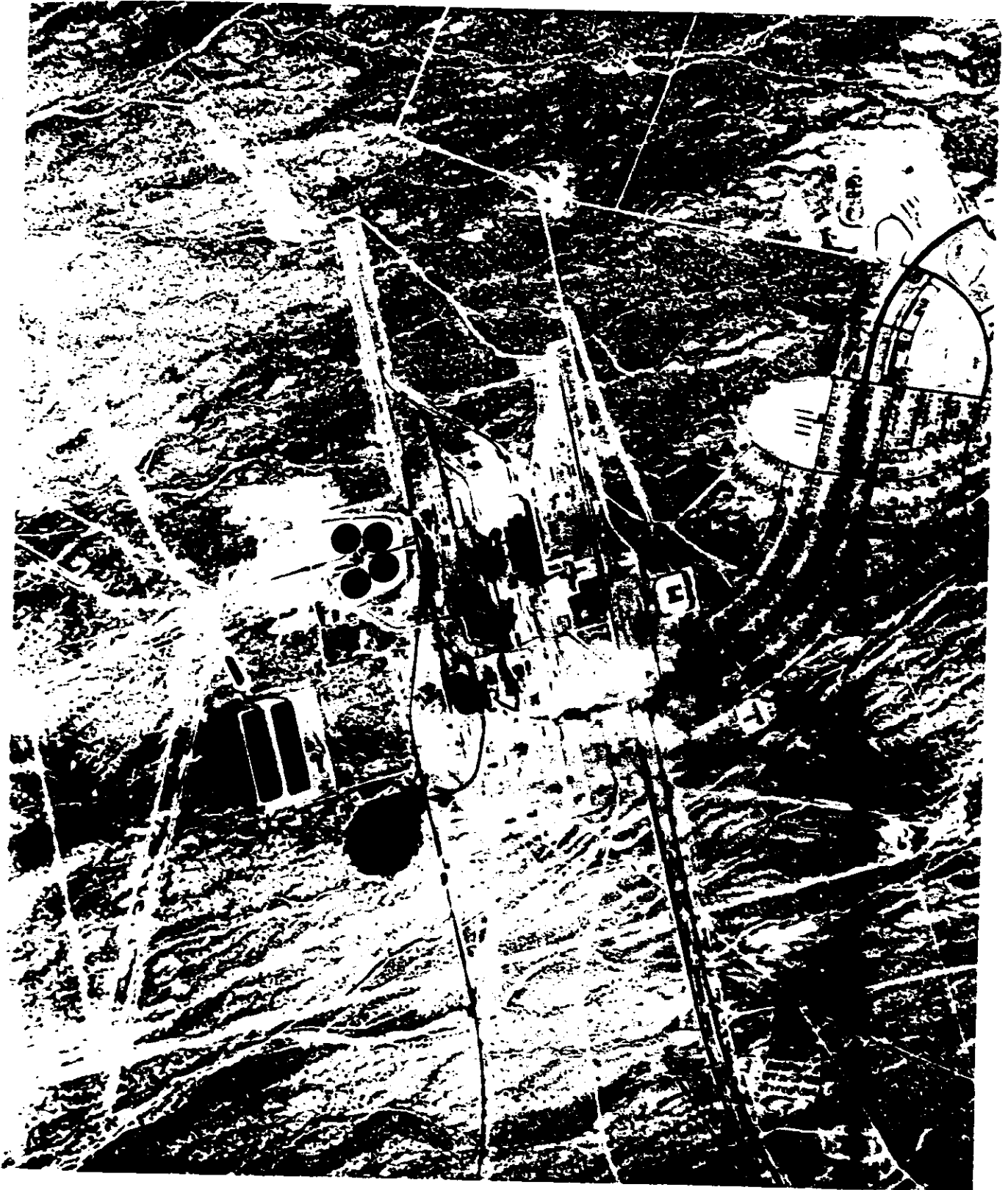
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PART II. FILM

1. Film Processing

This section provides an evaluation of the processing of the original negatives from missions 1021-1 and 1021-2.

a. The stellar and index negative material was processed at the optimum level of development to record imagery for the correlation and mensuration of the primary cameras.

b. Infrared densitometry was used to determine the optimum level of development needed for the various portions of the master and slave records. Sixty-four processing level changes were required on the master and 51 changes were required on the slave of Mission 1021-1. Twelve processing level changes were required on the master and 75 changes were required on the slave of Mission 1021-2. The percentage of film processed at each level was:

<u>Development Level</u>	<u>Mission 1021-1</u>		<u>Mission 1021-2</u>	
	<u>Master</u>	<u>Slave</u>	<u>Master</u>	<u>Slave</u>
Primary	15%	14%	53%	13%
Intermediate	38%	39%	25%	41%
Full	47%	47%	22%	46%

2. Special Printing

Fourteen parts of the master and 19 parts of the slave film required special printing on Mission 1021-1. Two parts of the master and 3 parts of the slave required special printing on Mission 1021-2. Special printing is required when the range of the negative is such that 2 levels of printing for duplicate positives are required to provide greater intelligence value from the original negative.

3. Film Degradations

The most severe degradation was the anomaly which caused the film to come out of the rails on pass 85D, frame 11 of the master camera (See Part I, Section 1). There is a manufacturing splice approximately 8.0 inches from the take-up end of frame 11, pass 85D. Approximately 2.0 inches from the splice, the film is separated from the frequency-mark edge toward the center of the film. Part of the separation had the characteristics of a cut rather than a tear.

At the cut/tear, the film was creased and folded. Through the inspection of the original negative it was concluded that a cut existed in the film when it was transported into the platen area prior to exposure. Because of the cut, the film slipped from the rails. The tension exerted by the camera induced tearing of the film at that point. The camera continued to operate throughout the mission, but the film jammed on pass 102D, frame 7. This resulted in a premature termination of the master camera record. The film was severely degraded beginning on frame 11, pass 85D. That and all subsequent frames were out-of-focus and contained severe base scratches 0.25 inches from and parallel to each film edge. Various longitudinal scratches, emulsion lifts, emulsion cracks, abrasions, and plus and minus density streaks occur intermittently throughout this portion of the film. Other degradations preceding this anomaly include:

- a. Pinholes and minus density comets appear intermittently throughout.
- b. The usual minor abrasions and scratches appear intermittently throughout.
- c. A severe base scratch ranging 0.3 to 0.9 inches from the titled edge is present on pass 25D, frames 39-43 and throughout passes 26D, 27D, and 30D of the fwd camera.
- d. Numerous longitudinal scratches are located on the supply end of pass 21D, frame 55 fwd. Severe irregular scratches are present on pass 32D, frame 2 fwd, and pass 69D, frame 4 fwd.
- e. Pass 6D, frame 11 aft was torn across the format, seriously degrading the imagery. This evidently occurred after the film left the processing site.
- f. A plus density scratch located approximately 0.85 inches from the titled edge, varying in length from 0.4 inches to being almost continuous, is present on pass 81D, frame 1, through pass 154D, frame 67 of the fwd camera.
- g. Titling was less than optimum in that the title was blocked up on numerous occasions. Also the titling was frequently transferred to adjacent areas of the film during wind-up. Examples appear on passes 26D, frames 5 through 25 aft, 42D, frames 1 through 68 fwd, and 93D, frames 1 through 57 fwd.



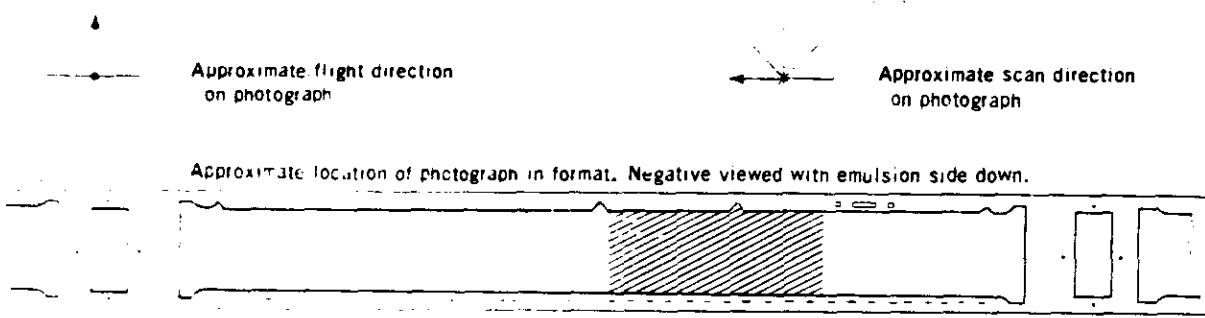
FIGURE 8. PRINT OF CUT AND SPLICE WHICH CAUSED FILM TO COME OUT OF THE RAILS

Note the well-defined line where the film was folded and cut. This caused the film to slip from the rails and induced tearing.

NPIC K-5529 (12/65)

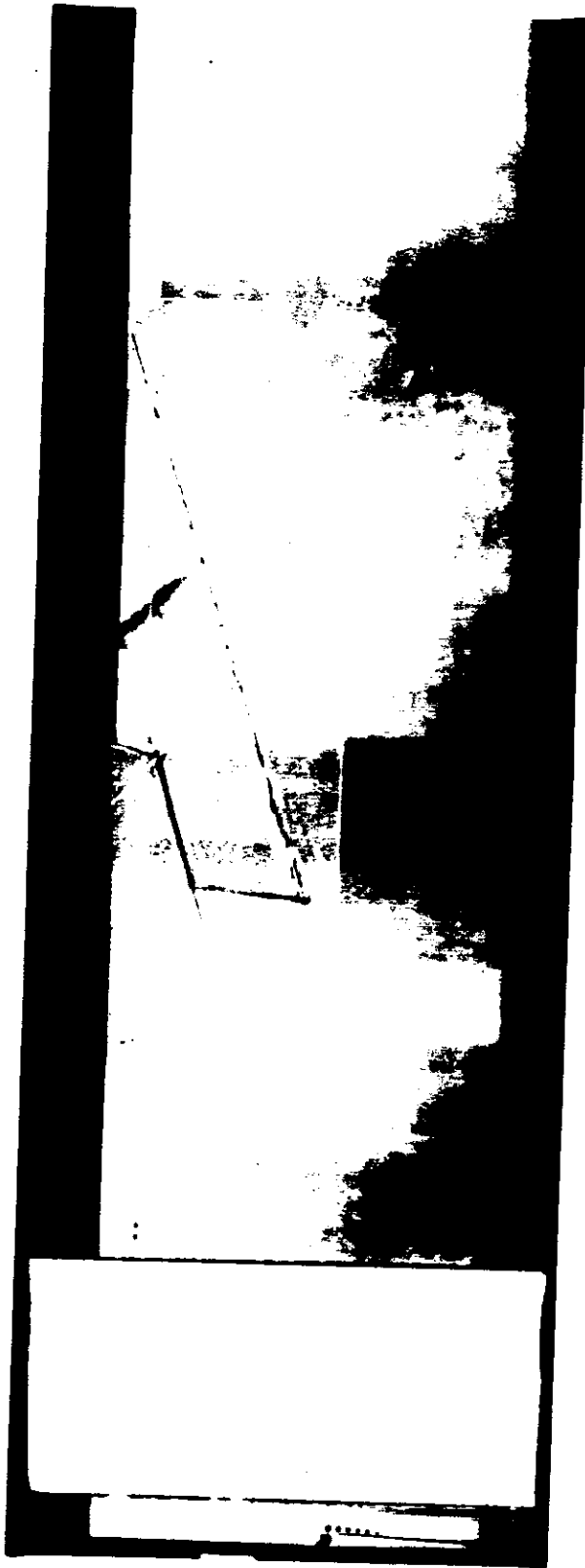
- 10a -

Camera . . . . . 166  
Pass . . . . . 85D  
Frame . . . . . 11 aft  
Date of Photography . . . . . 24 May 65  
Universal Grid Coordinates . . . . . 46 - 65  
Enlargement Factor . . . . . Contact  
Geographic Coordinates . . . . . 53-08N 104-38E  
Altitude (feet). . . . . 708,620  
Camera:  
Pitch . . . . . -14°39'  
Roll . . . . . -0°06'  
Yaw . . . . . Not Determined  
Local Sun Time . . . . . 817  
Solar Elevation . . . . . 36°36'  
Solar Azimuth . . . . . 106°  
Exposure (fractions of second) . . . . . 1/334  
Processing Level . . . . . Full  
Vehicle Azimuth . . . . . 156°14'



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FIGURES 9 AND 10. COMPARISON OF FWD AND AFT PHOTOGRAPHY AFTER THE  
CUT AND SPLICE

Due to the cut and splice the film came out of the rails, causing  
the aft material to be out of focus and severely degraded.

NPIC K-5830 (12/65)

NPIC K-5831 (12/65)

- 10c -

Figure 9

Figure 10

Camera . . . . .	167	166
Pass . . . . .	86D	86D
Frame. . . . .	72 fwd	81 aft
Date of Photography. . . . .	24 May 65	24 May 65
Universal Grid Coordinates . . . . .	57.8 - 13.2	33.5 - 9.6
Enlargement Factor . . . . .	10X	10X
Geographic Coordinates . . . . .	21-13N 094-44E	21-13N 094-44E
Altitude (feet). . . . .	665,202	665,202
Camera:		
Pitch . . . . .	15°14'	15°14'
Roll. . . . .	-0°15'	-0°15'
Yaw . . . . .	Not Determined	Not Determined
Local Sun Time . . . . .	907	907
Solar Elevation. . . . .	51°14'	51°26'
Solar Azimuth. . . . .	83°	83°
Exposure (fractions of second) . . . . .	1/252	1/361
Processing Level . . . . .	Full	Full
Vehicle Azimuth. . . . .	167°4'	167°15'

—●— Approximate flight direction  
on photograph



Approximate scan direction  
on photograph

Approximate location of photograph in format. Negative viewed with emulsion side down.



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FIGURES 11 AND 12. EXAMPLE OF DEGRADED PHOTOGRAPHY DUE TO THE CUT  
AND SPLICE

These photographs illustrate the abrasions parallel to the film  
edge and the out of focus condition.

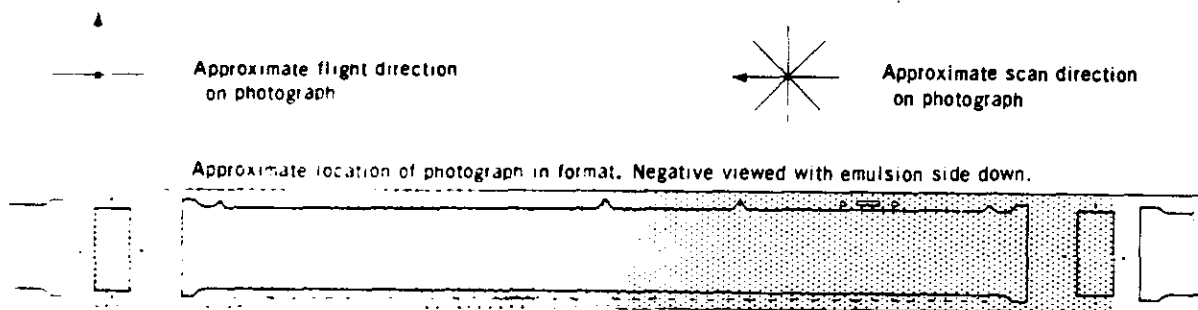
NPIC K-5832 (12/65)

NPIC K-5833 (12/65)

- 10e -



Camera . . . . . 166  
Pass . . . . . 95D  
Frame. . . . . 17 aft  
Date of Photography. . . . . 24 May 65  
Universal Grid Coordinates . . . . . Not Applicable  
Enlargement Factor . . . . . Contact  
Geographic Coordinates . . . . . 33-27N 012-28W  
Altitude (feet). . . . . 670,736  
Camera:  
Pitch . . . . . Not Applicable  
Roll. . . . . Not Applicable  
Yaw . . . . . Not Applicable  
Local Sun Time . . . . . Not Applicable  
Solar Elevation. . . . . Not Applicable  
Solar Azimuth. . . . . Not Applicable  
Exposure (fractions of second) . . . . . Not Applicable  
Processing Level . . . . . Intermediate  
Vehicle Azimuth. . . . . Not Applicable



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0 95 017 D

S. AFT 1021-2 24 MAY 65 TOP SECRET

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