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PHOTOGRAPHIC EVALUATION REPORT MISSION 1031-1

7-14 APRIL 1966

MISSION 1031-2

15-18 APRIL 1966

AUGUST 1966

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TECHNICAL PUBLICATION

PHOTOGRAPHIC EVALUATION REPORT

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NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

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SYNOPSIS

Mission 1031 (J-30) is a two-part satellite reconnaissance mission. The vehicle was programmed to achieve photographic coverage for intelligence purposes. The satellite was launched into a nearly synchronous orbit on 7 April 1966. The first capsule contained 53 photographic passes and was recovered in an air catch on revolution 113, 14 April 1966. The second capsule contained 29 photographic passes and was retrieved in an air catch during revolution 177, 18 April 1966.

The image quality of the photography from the panoramic cameras is generally better than that of Mission 1030. However, approximately 45 percent of the film from both buckets is degraded due to haze and other weather factors. The remaining portion of the mission is generally free of degradations, and some targets are rated as good as any observed in recent missions. Both buckets of Mission 1031 were assigned an MTP rating of 85.

The master (fwd-looking) panoramic camera functioned properly throughout the mission. The slave (aft-looking) panoramic camera functioned properly throughout Mission 1031-1, but an undetermined malfunction prevented the acquisition of any photography record for this camera on Mission 1031-2. The horizon cameras were operational throughout the mission, but due to the absence of photography from the slave camera of Mission 1031-2 the horizon imagery for this portion of the mission is also missing.

The stellar and index cameras of Mission 1031 were operational throughout. The stellar images of both portions are slightly smeared. The shutter of the stellar camera was open during the film transport procedure on the majority of frames in the last 50 percent of Mission 1031-2. The frames exposed during this anomaly are very dense, with approximately 12 stellar images detectable on each frame. Before the malfunction, approximately 20 stellar images could be observed on each frame.

One resolution target was imaged by the master camera on Mission 1031. Poor weather conditions prevailed over the target. A resolution value of 9 feet was read along track and 12 feet was resolved cross track. The target was not recorded by the slave camera.

GENERAL FLIGHT DATA

1. Launch and Recovery Dates

Launch Date, Mission 1031	7 April 1966
Recovery Date, Mission 1031-1	14 April 1966
Recovery Date, Mission 1031-2	18 April 1966

2. Orbital Parameters (Actual)

	Mission 1031-1 (Rev 52)	Mission 1031-2 (Rev 145)
Period	89.550 min	89.388 min
Perigee	104.550 nm	105.494 nm
Apogee	170.390 nm	166.470 nm
Eccentricity	0.00919	0.00853
Inclination Angle	75.072°	75.072°
Perigee Latitude	23.303°N	39.362°N

3. Photographic Operations

	Mission 1031-1	Mission 1031-2
Operational Passes	44	25
Domestic/Operational Passes	1	0
Domestic Passes	7*	3
Engineering Passes	1	1
Total Photographic Passes	53	29
Recovery Revolutions	113	177

*Includes cut and wrap pass

PART I. CAMERA OPERATIONS

1. Master (Fwd-Looking) Panoramic Camera No 184

The master panoramic camera functioned properly throughout the mission. The imagery is of good quality and high resolution. Detriments to the material, caused by the camera operation, are comparable to those of previous missions. These minor degradations include:

a. The usual camera inherent rail scratches are present on both edges of the film. These scratches are outside the format and are continuous throughout the mission.

b. Fine scratches, parallel to the major axis, appear just inside the format at each edge, under the camera number and at the take-up end of most frames. These scratches are also inherent in the camera design and cause very minor degradations to the photographic record.

c. Numerous very fine emulsion scratches are under the binary and at the take-up end of most frames.

d. Fog, caused by the sit period between camera operations, is present on the first and last frame of most passes. This pattern of higher density is generally referred to as film transport. A splash-type fog pattern is present on the next to last frame of most passes. Examples of the fog may be found on pass 17D. A narrow band of fog, parallel to the minor axis, is near the supply end of the fifth frame of most passes of Mission 1031-2. All fog patterns are relative to the solar elevation and to the duration of the sit period between camera operations.

e. The cut and wrap procedure was initiated on pass 111D. Frame 5 was cut clean approximately 10 inches from the take-up end of the frame, and this portion was received in the first recovery capsule. The remaining portion of frame 5 was slightly abraided and scratched. the end of the film from Mission 1031-2 was also abraided and scratched due to film exhaustion.

2. Slave (Aft-Looking) Panoramic Camera No 185

The slave panoramic camera functioned properly throughout Mission 1031-1. Good quality, high resolution photography was acquired, and the imagery is approximately equal to that of the master camera. Due to a camera malfunction, no material was received from the slave camera in the second recovery capsule.

Recovery of the "A" bucket indicated a clean slave payload cut during the cut and wrap procedure. The analysis of the malfunction, according to the camera manufacturer, indicated several facts concerning the failure. The slave instrument failed due to a lack of film cassetting; that is to say, the failure resulted from film accumulating within the slave instrument. The telemetry data indicated that the film was not being removed from the camera system. This resulted in a loss of tension and the subsequent film wrap-up around the metering rollers. This was the first mission to contain a chute to protect the panoramic film during sit periods. It was added to the system to eliminate the light leaks due to the translucent characteristic of the ablative shield. The construction of the chute, its use, and all possible areas of film hang-up in the thrust cone area are under investigation by the camera manufacturer.

Other detrimental features caused by the camera operation which are present on the film record of Mission 1031 are as follows:

a. Continuous scratches, parallel to the edge of the film and outside the format, are present throughout the mission. These scratches are attributed to the rails which support the film during transport.

b. 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.

c. Light leaks caused fog on the first, second, fourth, third from the end, and the last frames of most passes. The fog on the first and last frames is usually referred to as film transport. The fog on the second frame is near the supply end and frequency mark edge. A small band of fog is at the supply end and binary edge of the fourth frame of most passes. The fog on the third frame from the end of most passes is under the binary. The degree of the fog density is relative to the solar elevation and duration of the sit period between camera operations. In most cases, the density is low and causes little degradation, but at times the imagery encompassed by the added density is degraded to the extent that it hampers interpretation.

3. Master Horizon Cameras

The port (supply) and starboard (take-up) horizon cameras were operational throughout the mission. The port horizon imagery is sharp and well-defined, and the arcs are useable for attitude determination. The starboard horizon imagery is veiled on passes 1D through 31D. On the majority of the affected frames, the horizon arcs are very indistinct. After pass 31D, the horizon imagery and arcs are well-defined.

The cause of the veiling has not been determined. However, studies of the anomaly are still being conducted by the camera manufacturer and by NPIC. It is hoped that the correlary data from the Gemini missions will help explain the situation.

The fiducials of both cameras are slightly bloomed, but still useable. A small static discharge was noted at the fiducial nearest the titled edge. Vignetting was minor and did not affect the horizon arcs.

4. Slave Horizon Cameras

The port (take-up) and starboard (supply) horizon cameras were operational throughout Mission 1031-1. The port horizon arcs are sharp and well-defined. The starboard horizon arcs on pass 1D are sharp and well-defined. However, after pass 1D the remaining starboard horizon images are extremely veiled and unsuitable for attitude determination. Other degradations to the horizon images of Mission 1031-1 consisted of intermittent longitudinal emulsion scratches and minor minus density streaks.

Due to the slave panoramic camera malfunction, described in Section 2, Part I, no film was acquired from the slave horizon cameras for Mission 1031-2.

5. Stellar Camera Unit No D83/101/89 (Mission 1031-1)

The stellar camera functioned properly throughout and recorded 419 titled frames. The flare level was low and the film record yielded approximately 20 stellar images per frame. Instead of the optimum point-type images, most images are slightly smeared. This not only causes an increase in attitude reduction time, but the resulting data is not as reliable.

Multi-directional, plus density streaks are present on the first several frames of the stellar formats. The condition is repetitive in each mission and only degrades the first few frames of the mission. The cause of this anomaly is still unknown.

6. Stellar Camera Unit No D86/106/86 (Mission 1031-2)

The stellar camera was operational throughout the mission and recorded 410 titled frames. The first frame is a double exposure. The shutter was open during all or part of the film transport procedure between the normal exposed frames on the last 50 percent of the mission. This resulted in a higher flare level and an associated loss of some previously detectable star images. Approximately 20 stellar images are detected in each frame prior to the malfunction and only 12 thereafter. The malfunction does not seem to have had a significant effect on the shape of the images, which are slightly smeared throughout the take.

The cause of the malfunction has been attributed to excessive friction in the stellar camera shutter. A possible remedy, which is under investigation by the camera manufacturer, is the use of a stronger shutter closing spring.

Severe flare was prominent throughout Mission 1031-2, in addition to the flare which occurred during the camera shutter malfunction. The reason is unknown but it is also under investigation.

The last 13 inches of the stellar material was seriously fogged, possibly due to the cracking of the fiberglass recovery capsule cover.

7. Index Camera Unit No D83/101/89 (Mission 1031-1)

The index camera functioned properly throughout and recorded 419 titled frames. The exposure and processing were good. The imagery is comparable to that of recent missions in this series. The film was very clean throughout with only minor detectable degradations.

8. Index Camera Unit No D86/106/86 (Mission 1031-2)

The index camera was operational throughout the mission and recorded 426 titled frames. Exposure and processing were good except for the double exposure of the first frame. A continuous longitudinal plus density streak is present between the camera number and the frame format on the last 50 frames of the mission. Several random abrasions are present on the last 3 feet of film associated with film supply exhaustion. The last 13 inches of film is seriously fogged, possibly due to the cracking of the fiberglass recovery capsule cover.

A noticeable fall-off in image quality is present at the format edge on each frame. This is probably due to an error in positioning the focal plane for maximum awar. The camera manufacturer is investigating the criterion used for the focus setting.

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 date 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 left wing-up attitude and negative readings indicate right wing-up attitude.

YAW: Rotation of the camera about its vertical axis. Positive readings indicate counterclockwise 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 computed from the scan rate and slit width.

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

PROCESSING LEVEL: The processing level is pertinent to the referenced frame and is extracted from the contractor's processing system.

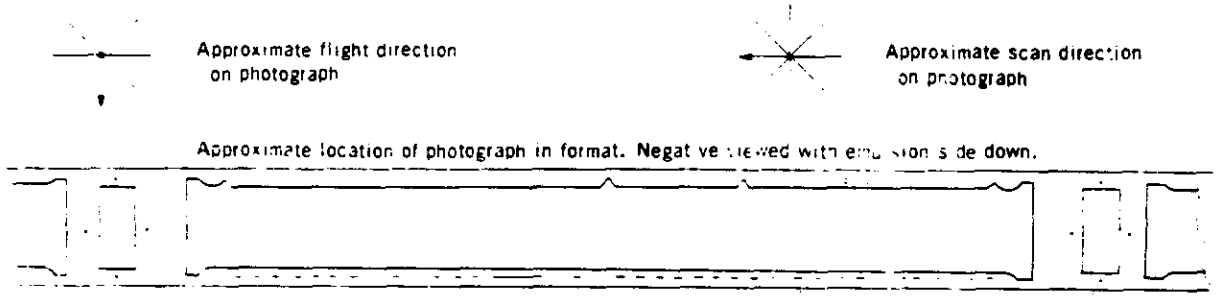
FIGURE 2. VEILED STARBOARD HORIZON IMAGERY, MASTER CAMERA

The starboard horizon imagery of the master camera is veiled on passes 1D through 31D. The horizon arcs, which are affected by the veiling, are very indistinct. This anomaly is illustrated by the following photograph. After pass 31D, the imagery becomes sharp and well-defined.

NPIC K-8831 (8/66)

[redacted]

Camera	Horizon [illegible]
Pass	6D
Frame	61 [illegible]
Date of Photography	8 Apr 6[illegible]
Enlargement Factor	3X
Processing Level	Full



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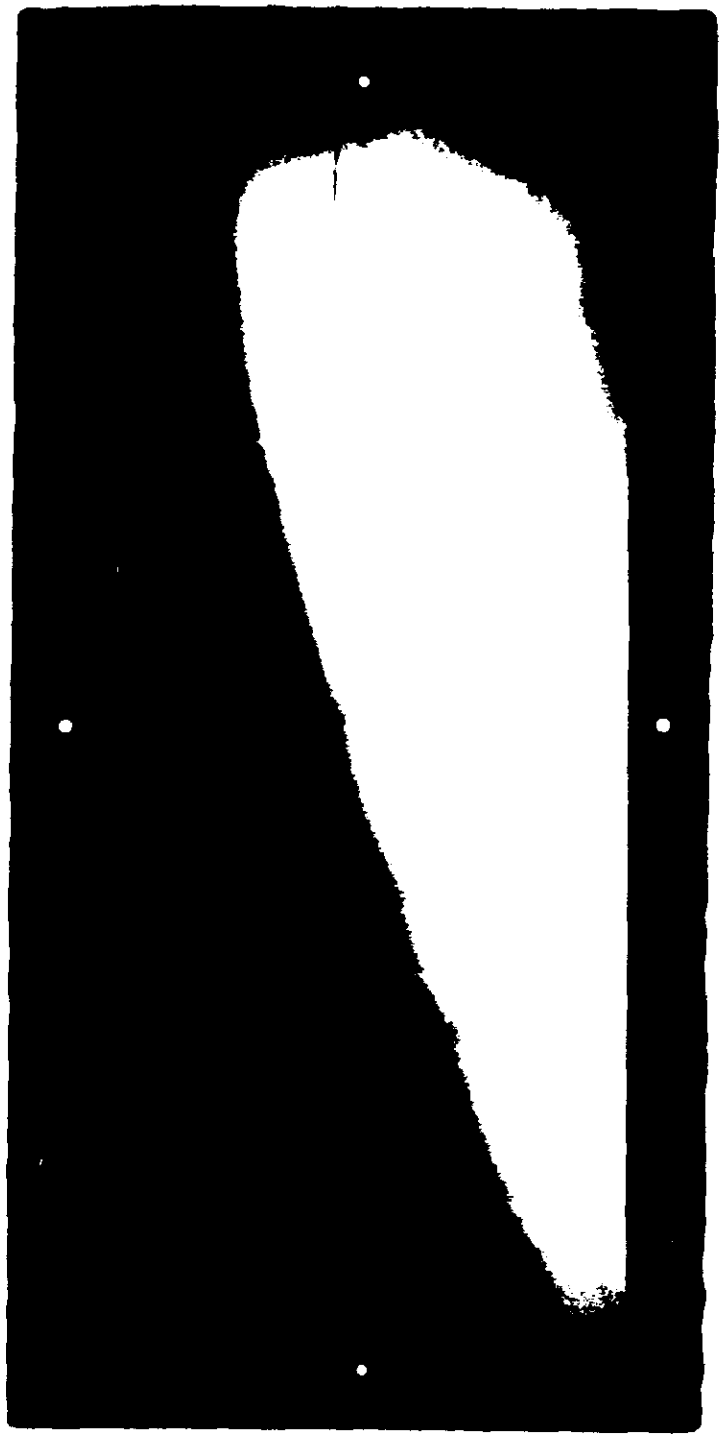

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[redacted]

FIGURE 3. VEILED STARBOARD HORIZON IMAGERY, SLAVE CAMERA

After pass 10, the remaining horizon images from the slave starboard horizon camera appear out-of-focus. The following photograph indicates the severity of the phenomenon.

NPIC K-8833 (8/66)

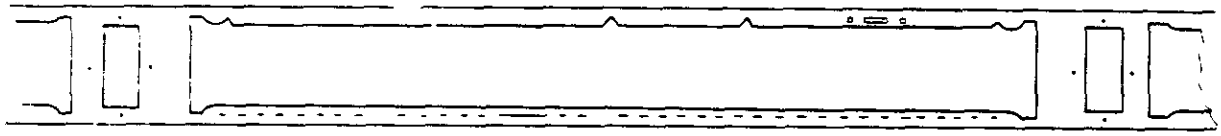
[redacted]

Camera	Horizon Camera
Pass	7D
Frame	10 aft
Date of Photography	8 Apr 66
Enlargement Factor	3X
Processing Level	Full

Approximate flight direction on photograph

Approximate scan direction on photograph

Approximate [illegible] of photograph in format. Negative viewed with emulsion side down.



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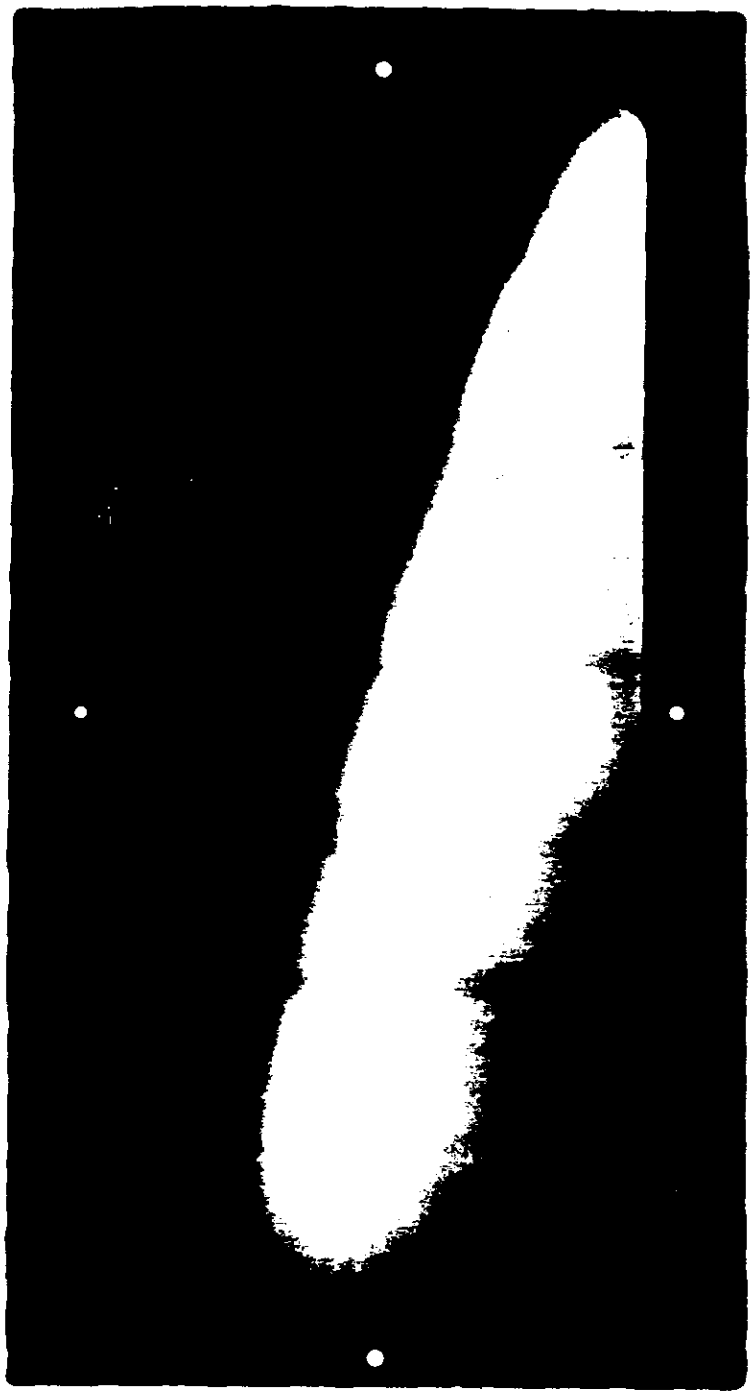
[redacted]



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[redacted]

FIGURE 4. STELLAR PHOTOGRAPH, SHUTTER MALFUNCTION

The stellar camera shutter remained open during all or part of the film transport procedure between the normal exposed frames on the last 50 percent of Mission 1031-2. This resulted in a higher flare level and an associated loss of some previously detectable star images. Approximately 20 stellar images are detected in most frames prior to the malfunction and only 12 thereafter. The malfunction has been attributed to excessive friction in the stellar camera shutter. The photograph is typical of the imagery produced during the malfunction.

NPIC K-8834 (8/66)

MISSION 1031-2

Stellar Frame Numbers	Correlates with Fwd-Looking Pass	Camera 184 Frame
298	153D	18
299	159D	3
300	159D	10
Date of Photography	17 Apr 66	
Enlargement Factor	2X	
Exposure Time	2 seconds	

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[redacted]

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FIGURE 5. INDEX PHOTOGRAPH, GOOD QUALITY

This photograph is indicative of the normal good-quality imagery that is within the capabilities of the index cameras used in the "J" systems. It is included in this report not only as an example of the good quality of Mission 1031-1 but for a comparison with the index photography of Mission 1031-2.

NPIC K-8835 (8/66)

MISSION 1031-1

Index Frame Number	17
Correlates with:	
Fwd-Looking Camera	184
Pass	6D
Frame	48
Date of Photography	8 Apr 66
Enlargement Factor	2.5X
Exposure Time	1/500 second

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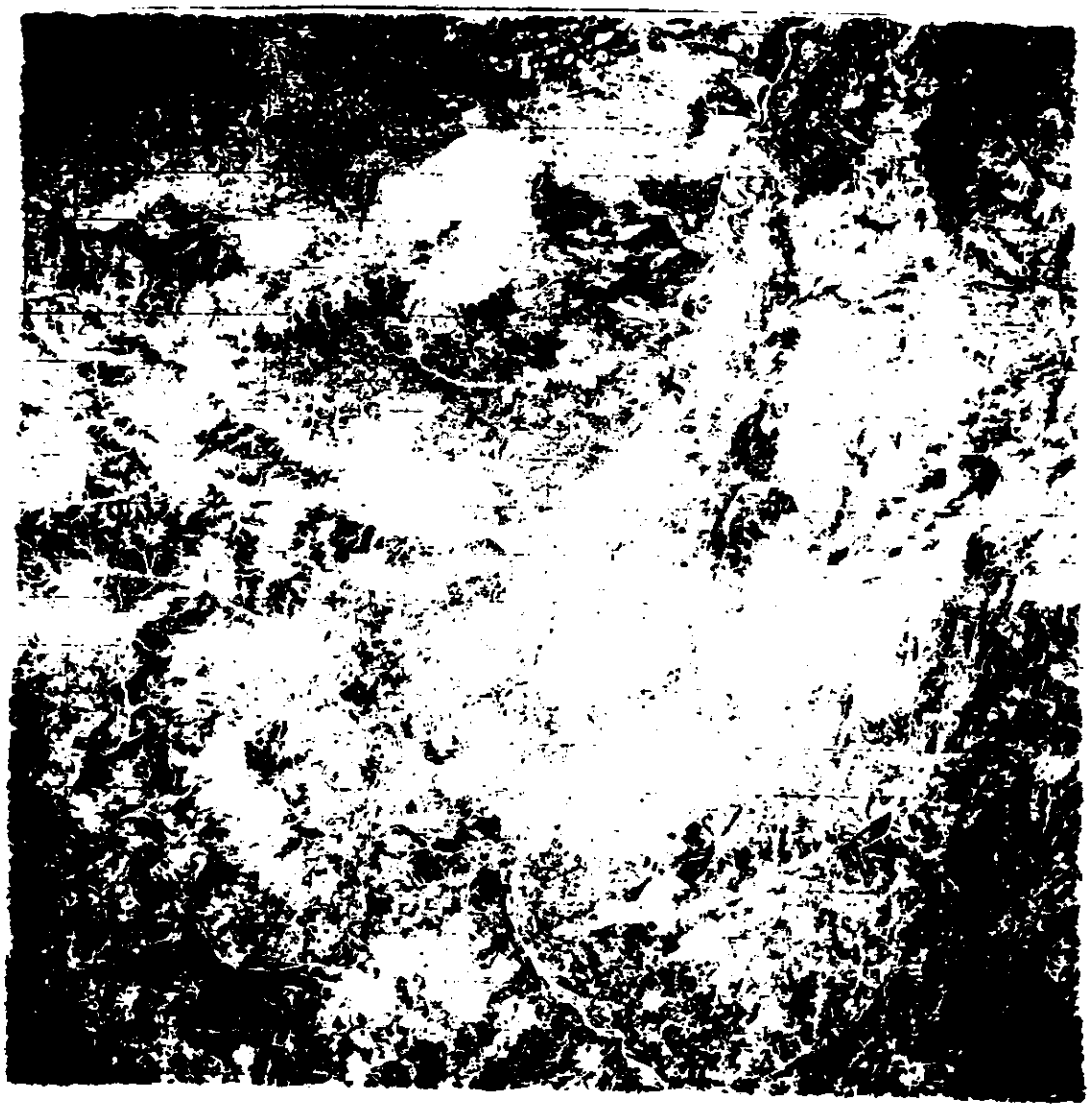
[redacted]



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[redacted]

FIGURE 6. INDEX PHOTOGRAPHY, IMAGE FALL-OFF

The following photograph was exposed by the index camera on Mission 1031-2. Evidently, the camera was focused for the center of the lens instead of the normal procedure of focusing for maximum awar. A noticeable amount of image sharpness fall-off toward the edge of the format results from this anomaly.

Figure 5 is included in this report for a comparison with the following photograph.

MISSION 1031-2

Index Frame Number	203
Correlates with:	
Fwd-Looking Camera	184
Pass	149D
Frame	1
Date of Photography	17 Apr 66
Enlargement Factor	2.5X
Exposure Time	1/500 second

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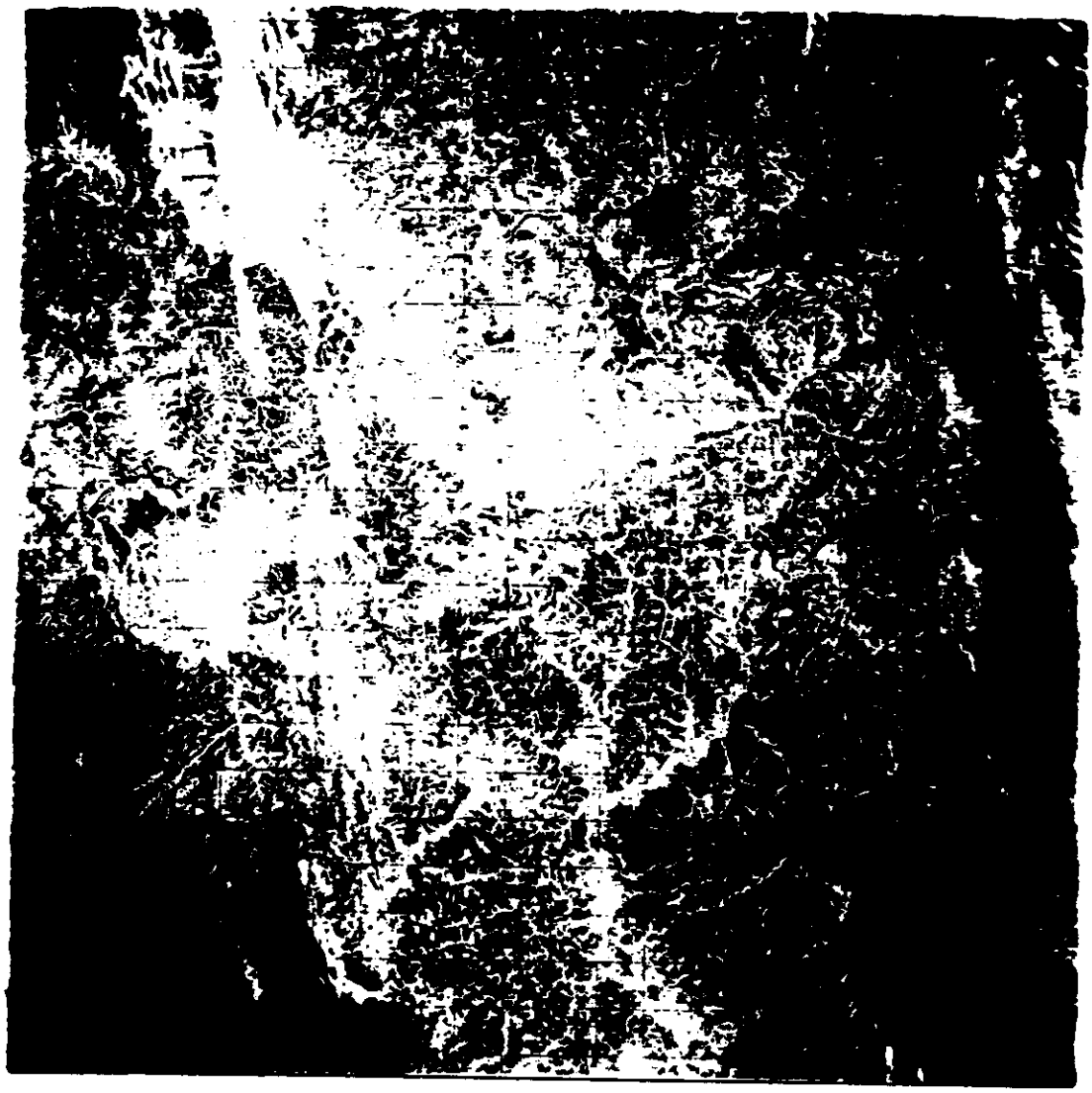
[redacted]



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9. Associated Equipment

The associated equipment generally operated satisfactorily. However, several problems were encountered in the binary reduction procedure. After an examination of the clock correlation data and the binary clock time imaged on the film, it was established that the vehicle clock suddenly gained time between passes 65D and 68D. The passes affected by this jump were 68D, 69D, 71D and 72D. By the beginning of pass 74D, the clock drifted back to normal and agreed with the correlation data furnished. A similar anomaly occurred again between passes 143D and 151D. In order to correct the discontinuity caused by the anomaly, NPIC interpolated a pair of new clock interrogation values for revolutions 67/68 and 147/148.

The binary read-out was accomplished by machine on a duplicate positive. Listed below is an itemized list of the problems confronted:

Mission 1031-1

Fwd

Pass 11D - Binary missing on frames 24 and 34 (index lights were on).
Pass 37D - Number 29 light was faint on frames 1 - 5.
Pass 39D - Number 18 light was faint on frame 36.
Pass 48D - Number 29 light was faint on frame 1.
Pass 50D - Number 29 light was faint on frames 1 and 26.
Pass 52D - Number 29 light was faint throughout the pass.
Pass 68D - Number 29 light was faint on frames 1 - 5.
Pass 103D - Binary missing on frame 33.

Aft

Pass 6D - Number 27 light was faint throughout the pass.
Pass 8D - Number 27 light was faint throughout the pass.
Pass 37D - Number 16 light was faint on frame 10.
Pass 104D - Number 27 light was faint throughout the pass.

Mission 1031-2

Fwd

Pass 130D - Number 22 light was faint on frames 22 and 23.
Pass 133D - Number 22 light was faint throughout the pass.
Pass 149D - Number 29 light was faint throughout the pass.
Pass 151D - Number 29 light was faint throughout the pass.
Pass 162D - Number 29 light was faint throughout the pass.
Pass 163D - Number 29 light was faint throughout the pass.

In addition to the problems listed above, some of the binary lights were missing on several frames in the mission due to film misalignment during the original duplicating procedure.

PART II. FILM

1. Film Footage

Listed below is the processed film footage from the cameras used in Mission 1031.

Camera	Mission 1031-1	Mission 1031-2
Master (Fwd-Looking) Panoramic No 184	8,136	7,871
Slave (Aft-Looking) Panoramic No 185	8,133	*
Stellar No D83/101/89	51	NA
Stellar No D86/106/86	NA	47
Index No D83/101/89	97	NA
Index No D86/106/86	NA	91

2. Frame Totals

Following is the number of titled frames received from the cameras used in Mission 1031.

Camera	Mission 1031-1	Mission 1031-2
Master (Fwd-Looking) Panoramic No 184	2,944	2,980
Slave (Aft-Looking) Panoramic No 185	2,930	*
Stellar No D83/101/89	419	NA
Stellar No D86/106/86	NA	410
Index No D83/101/89	419	NA
Index No D86/106/86	NA	426

*Not applicable due to the absence of photography acquired by the slave camera in Mission 1031-2.

NA - Not Applicable.

3. Film Processing

This section provides an evaluation of the processing, exposure, density, contrast, and special printing of the original negative.

a. Infrared densitometry was used in an attempt to determine the optimum levels of development for the panoramic material from Mission 1031. Three separate levels of development are afforded by the Trenton Processor which was used in processing the panoramic material. The levels of development available and the percentage of film processed at each level are given below.

[redacted]

	Mission 1031-1		Mission 1031-2	
Development Level	Master	Slave	Master	Slave
Primary	18	15	7.6	*
Intermediate	34	43	53.2	*
Full	48	42	39.2	*

*Not applicable due to the absence of photography acquired by the slave camera in Mission 1031-2.

The stellar and index records were adequately processed at one development level employing a Trenton and EH-6A Processor, respectively.

b. The filter/slit width combination used on Mission 1031 provided adequate exposure except where low solar elevations prevailed. A Wratten 23A filter combined with a 0.225 inch slit width was employed by the master panoramic camera for the first time. The new filter enabled the slit width to be reduced from the more common 0.250 inch slit width in an attempt to minimize the effects of vibrations and IMC errors. The slave camera employed the Wratten 21 filter with a 0.150 inch slit width.

The characteristics of the Wratten 21 and 23A filters used in this mission and the Wratten 25 filter which has been used in the master camera of previous missions are listed at the end of Part II.

The exposure of the index camera photography was generally adequate. However, as usual, where low solar elevations prevailed the density was less than optimum and in areas of high reflectivity, such as snow-covered terrain, the density is often higher than desired. The stellar camera photography was adequately exposed to detect stellar images.

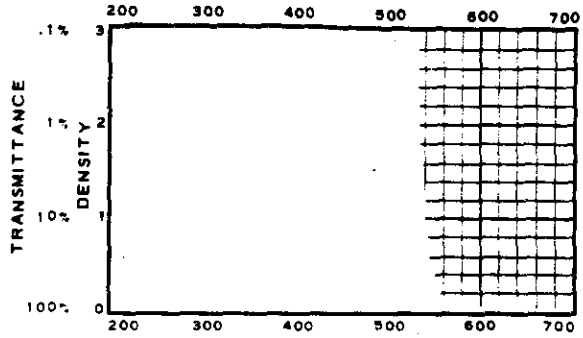
c. The "J" camera system provides the intelligence community with photographic coverage of large land masses from various portions of the world. Although this type of coverage is desired, it also presents numerous problems in obtaining the optimum exposure and density of the original negative. Numerous attempts are made throughout the acquisition, processing, and reproduction procedures to obtain maximum value from the mission. Exposure and processing level changes are being made when deemed necessary. However, the variables encountered in obtaining the finished original negative are such that exposure and processing changes are not sufficient. In the reproduction stage, various printing levels are used to improve the value of the photography. Special printing is required when the range of the negative of an individual can is such that 2 levels of printing duplicate positives are required for greater intelligence value to be obtained from the original negative. Included below are the number of processing level changes and special prints made on the original negative from Mission 1031.

[redacted]

	Processing Level Changes	Special Prints
Mission 1031-1 Fwd	70	17
Mission 1031-1 Aft	60	15
Mission 1031-2 Fwd	46	9

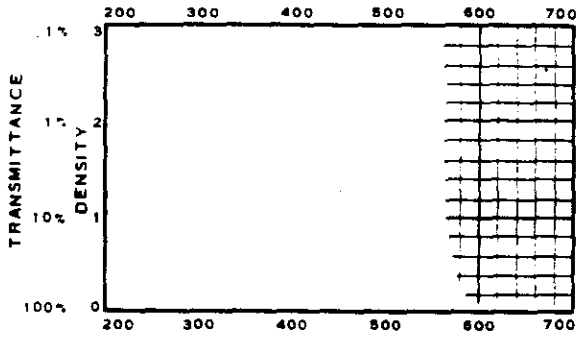
4. Physical Film Degradations

The majority of the physical film degradations on the original negative are covered under the respective cameras in Part I. In general, the photographic record is relatively clean. However, minor degradations consisting of intermittent pinholes, slight abrasions, and scratches are present. The most severe degradation is the longitudinal intermittent scratch present throughout the slave camera record of Mission 1031-1. The scratches are possibly caused by the interference of the film chute which is located in the "A" bucket recovery system. As a precautionary measure, future film chutes have been designed with additional film clearance.



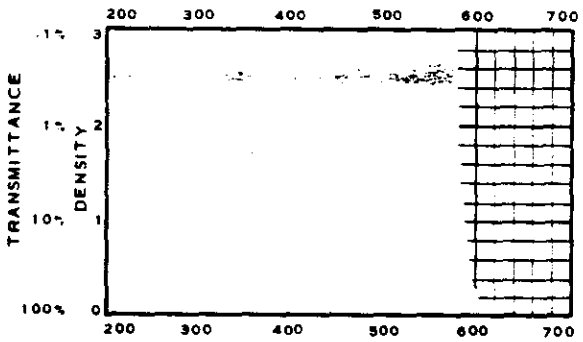
21

STABILITY: CBB



23A

STABILITY: BAB



25
(A)

STABILITY: AAA

PART III. IMAGE QUALITY

1. Photographic Interpretation (PI Suitability)

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. Details in the highlight areas, as well as details in the shadow areas, are readily detectable. Observation of small objects and a high order of mensuration are made possible by the consistently superior 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 or highlight areas. Detection and identification of small objects are possible but accuracy of mensuration is limited by the fall-off in image quality and the less-than-optimum contrast that prevails.

Poor: Camera-induced degradations or weather limitations severely reduce the effectiveness of the photography. Definition of edges and corners are not well-defined. 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.

2. PI Suitability, Mission 1031

Mission 1031 was launched into a nearly synchronous orbit and approximately the same land mass was covered by every 16th orbit. This resulted in multiple coverage of some targets while other programmed targets were missed altogether. The photo interpreter's view of this coverage by Mission 1031 is that the disadvantages caused by the missed targets at times outweighed the advantages afforded by the multiple coverage.

Mission 1031 was the first system to utilize the delay circuit for elimination of mono photography. This circuit delays both the start-up and shut-down of the slave camera for 12 seconds following the start-up and shut-down of the master camera. As a result of the delay circuit, much of the photography which would normally have been mono is afforded the added advantage of stereo coverage.

The PI suitability of this mission is good. Some of the targets covered by Mission 1031 were rated by the photo interpreters as good as any observed in recent mission. The photo interpreters and the PET team considered the overall quality of Mission 1031 slightly superior to Mission 1030.

Although the PI suitability is good, Mission 1031, like Mission 1030, contains an overall reduction in quality due to atmospheric conditions. The affect of atmospherics on the individual targets is well represented by the large number of poor and fair quality ratings assigned by the photo interpreters. Although some of these ratings are due to the usual low solar elevations and obliquity angles, the majority are caused by haze. In an attempt to discover the reason for the fair and poor quality ratings, 200 targets were randomly selected and analyzed. Listed below are the number of targets analyzed, the PI rating under which they fall, and the number of targets affected by each contributing factor.

Number of Targets in Each Category Which Affected the PI Rating

Total Targets Analyzed	PI Rating Good	Fair	Poor	Haze	Heavy Clouds	Scattered Clouds	Semi-Darkness	Snow	Obliquity
200	11	102	87	83	22	19	41	15	9

FIGURE 7. GOOD PI SUITABILITY TARGET

FIGURE 8. STEREO COVERAGE OF GOOD PI SUITABILITY TARGET

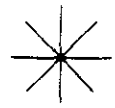
Stereo coverage was obtained on the following two photographs during pass 22D. The photo interpreters assigned the target a good quality rating. This same area was photographed one day later in stereo on pass 38D and is illustrated in Figures 9 and 10. Similar parameters were experienced on both passes, but the target on pass 38D was assigned a poor quality rating. The target on both passes is located within the satisfactory limits of the film format, but at different coordinates. The varying locations could contribute to the different quality ratings.

Microdensitometric traces of this target area are located in Appendix B.

[redacted]

	FIGURE 7	FIGURE 8
Camera	Master	Slave
Pass	22D	22D
Frame	17 Fwd	19 Aft
Date of Photography	9 Apr 66	9 Apr 66
Universal Grid Coordinates	23.2 - 9.8	68.2 - 14.7
Enlargement Factor	20X	20X
Geographic Coordinates	25-49N 104-32E	25-48N 104-29E
Altitude (feet)	646,812	645,630
Local Sun Time	1357	1357
Solar Elevation	56°12'	56°12'
Solar Azimuth	119°	119°
Exposure (fractions of second)	1/252	1/400
Processing Level	Full	Intermediate
Vehicle Azimuth	166°25'	166°34'

Approximate flight direction on photograph



Approximate scan direction on photograph

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

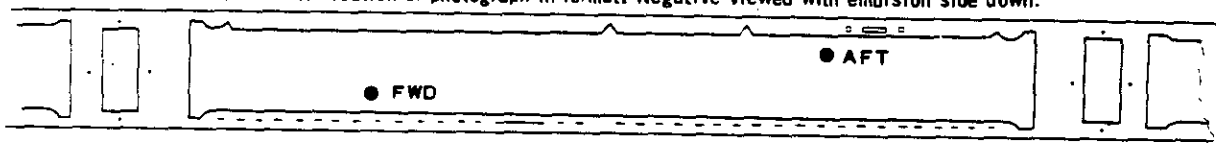


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FIGURE 9. POOR PI SUITABILITY TARGET

FIGURE 10. STEREO COVERAGE OF POOR PI SUITABILITY TARGET

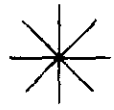
The target on the following 2 photographs was assigned a poor quality rating by the photo interpreter. The same target was photographed during pass 22D and the photo interpreter assigned it a good quality rating. For a comparative analysis, see Figures 7 and 8.

Microdensitometric traces of this target area are located in Appendix B.

[redacted]

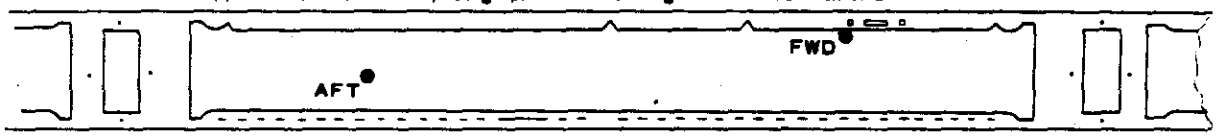
	FIGURE 9	FIGURE 10
Camera	Master	Slave
Pass	38D	38D
Frame	60 fwd	61 aft
Date of Photography	10 Apr 66	10 Apr 66
Universal Grid Coordinates	66.5 - 14.6	24.3 - 11.4
Enlargement Factor	20X	20X
Geographic Coordinates	25-17N 103-08E	25-28N 103-02E
Altitude (feet)	642,662	641,898
Local Sun Time	1346	1346
Solar Elevation	59°02'	58°59'
Solar Azimuth	121°	121°
Exposure (fractions of second)	1/280	1/424
Processing Level	Full	Full
Vehicle Azimuth	166°30'	166°37'

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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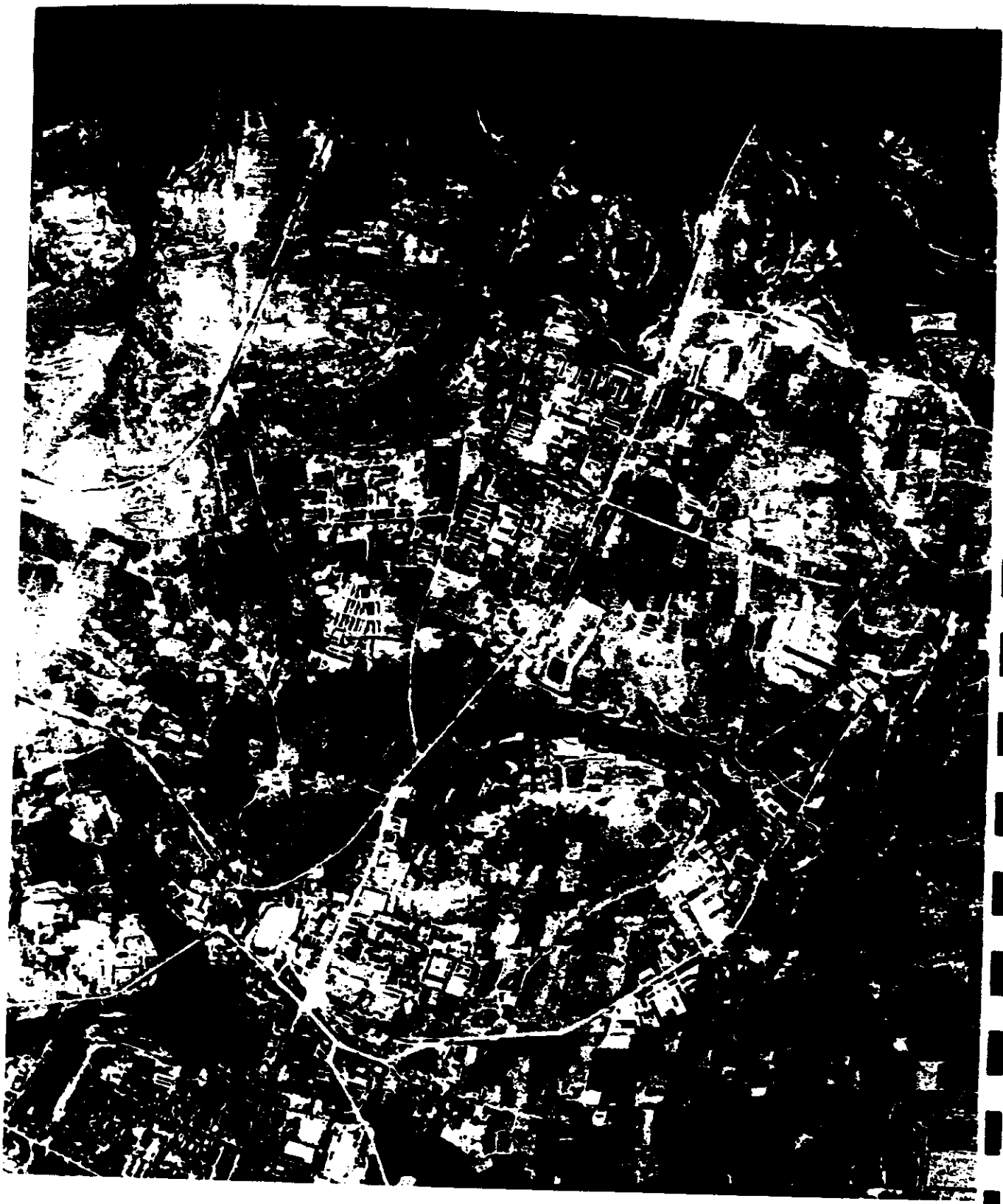

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3. Mission Information Potential (MIP)

The MIP is an arbitrary number, not limited by terminal values, which is subjectively assigned to the panoramic photography of a mission and which compares it to the other missions. It is meant to be a measure of the camera's maximum capability for recording information, discounting adverse atmospheric conditions, minimum solar elevations, camera malfunctions, or other factors which reduce the quality of the photography.

The MIP is based on the best photography found in a mission, even though the photography may be limited to a few frames. Since these frames are considered to be the best in the mission, they do not indicate the overall success, average quality, or general interpretability of the photography.

Criteria for selection of the MIP frame:

a. Eliminate all portions of the mission affected by system malfunctions.

b. Select frames which are free of clouds or atmospheric attenuation.

c. Eliminate the first 10 frames and last frame of a pass as these may be affected by incorrect scan speed.

d. Select frames that are in a continuous strip of approximately 10 cloud-free frames, as cloud shadows from weather fronts are cast for great distances.

e. Determine from the horizon cameras that the panoramic photography is not affected by apparent vehicle perturbations.

f. Select targets that are near the center of the format and on frames as close as possible to perigee for scale purpose and to eliminate obliquity.

g. Select frames having near optimum solar elevation.

h. Select a high contrast target (preferably an airfield) and compare the target to a previous mission which has been given an MIP rating.

4. MIP Mission 1031

Fwd frame 136 of pass 103D was selected as the MIP frame for Mission 1031-1. It was assigned an MIP rating of 85. Coverage of the same area was provided by the slave camera on frame 138. The detail discernible in both photographs is good but it was felt that the frame from the master camera was slightly better.

Fwd frame 52 of pass 166D was selected as the MIP frame for Mission 1031-2. This frame was also assigned an MIP rating of 85. The detail discernible in this photograph is nearly identical to the MIP frame for Mission 1031-1. Stereo coverage of the MIP frame of Mission 1031-2 is not available because of the absence of film from the slave camera in Mission 1031-2.

Due to the nearly synchronous orbit of Mission 1031, the availability of targets normally chosen for MIP frames was limited. However, it was felt that the quality of the MIP frames of Mission 1031 was equivalent to that of past missions assigned an MIP rating of 85. The airfields in the MIP frame of bucket A and a select group of buildings in the MIP frame of bucket B provide sharp, high-contrast edges which are applicable for micro-densitometric studies.

FIGURE 11. MIP PHOTOGRAPHY, FWD-LOOKING CAMERA, MISSION 1031-1

FIGURE 12. PHOTOGRAPHY OF MIP AREA, AFT-LOOKING CAMERA, MISSION 1031-1

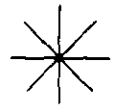
The following photographs, from both panoramic cameras, provide stereo coverage of the MIP area. The detail discernible in both photographs is good. However, it was felt that the material from the master (fwd-looking) camera was slightly better. Thus, the MIP area was selected from the master camera film.

A Wratten 23A filter in conjunction with a 0.225 inch slit width was employed by the master camera for the first time. The combination of the Wratten 23A filter and the 0.225 inch slit width could account for the subtle improvement of the master camera film over the slave camera film. The slave camera incorporates a Wratten 21 filter with a 0.150 inch slit width. Characteristics of the Wratten 21, 23A, and 25 are included in this report in Part II, section 3B.

[redacted]

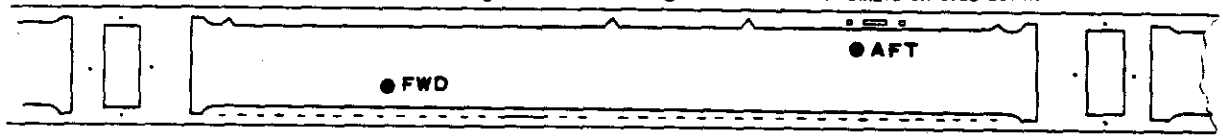
	FIGURE 11	FIGURE 12
Camera	Master	Slave
Pass	103D	103D
Frame	136 fwd	138 aft
Date of Photography	14 Apr 66	14 Apr 66
Universal Grid Coordinates	25.3 - 11.0	66.0 - 13.3
Enlargement Factor	20X	20X
Geographic Coordinates	41-32N 70-04E	41-31N 70-01E
Altitude (feet)	651,372	649,897
Local Sun Time	1228	1228
Solar Elevation	57°03'	57°04'
Solar Azimuth	166°	166°
Exposure (fractions of second)	1/296	1/446
Processing Level	Intermediate	Intermediate
Vehicle Azimuth	162°18'	162°37'

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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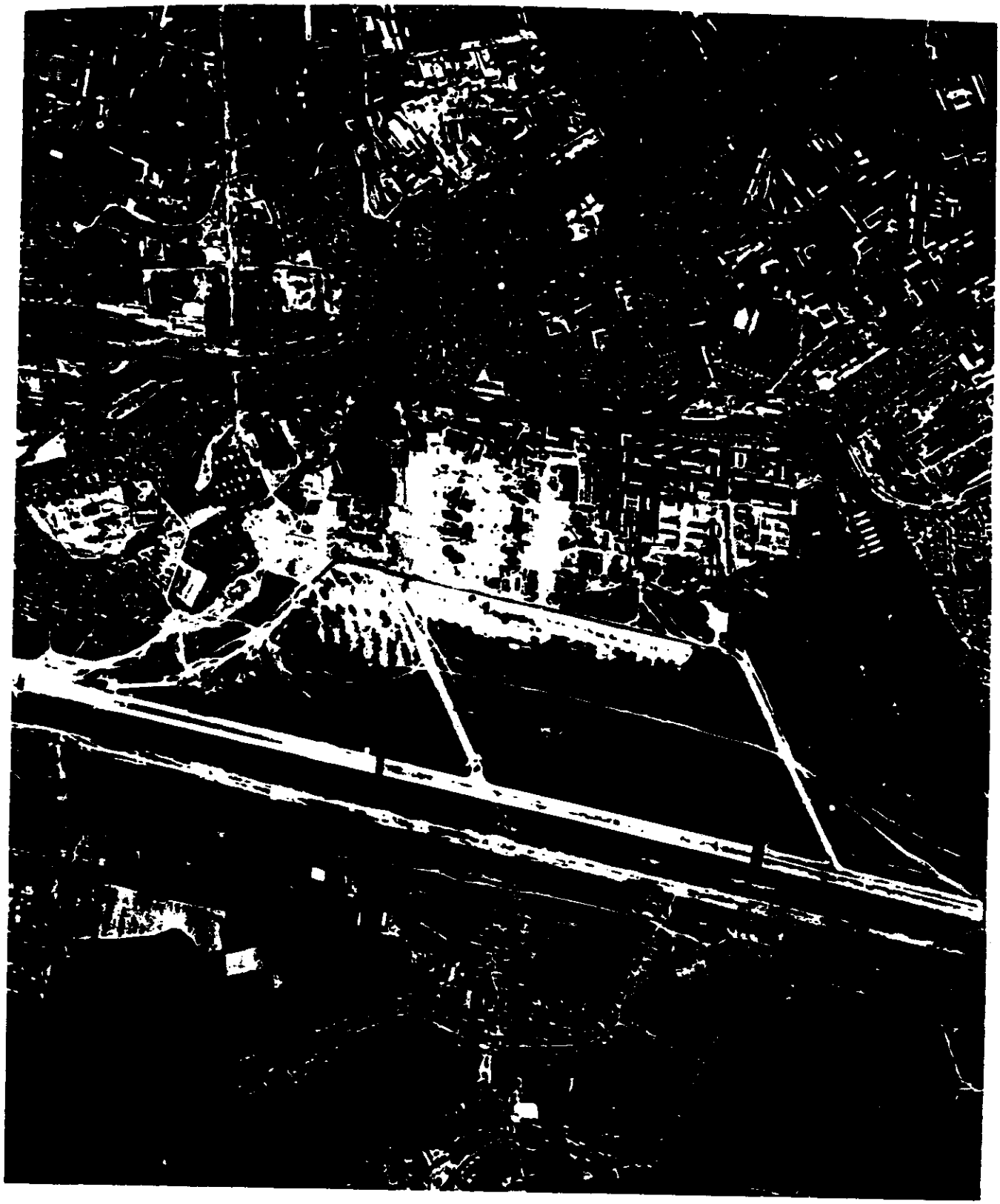

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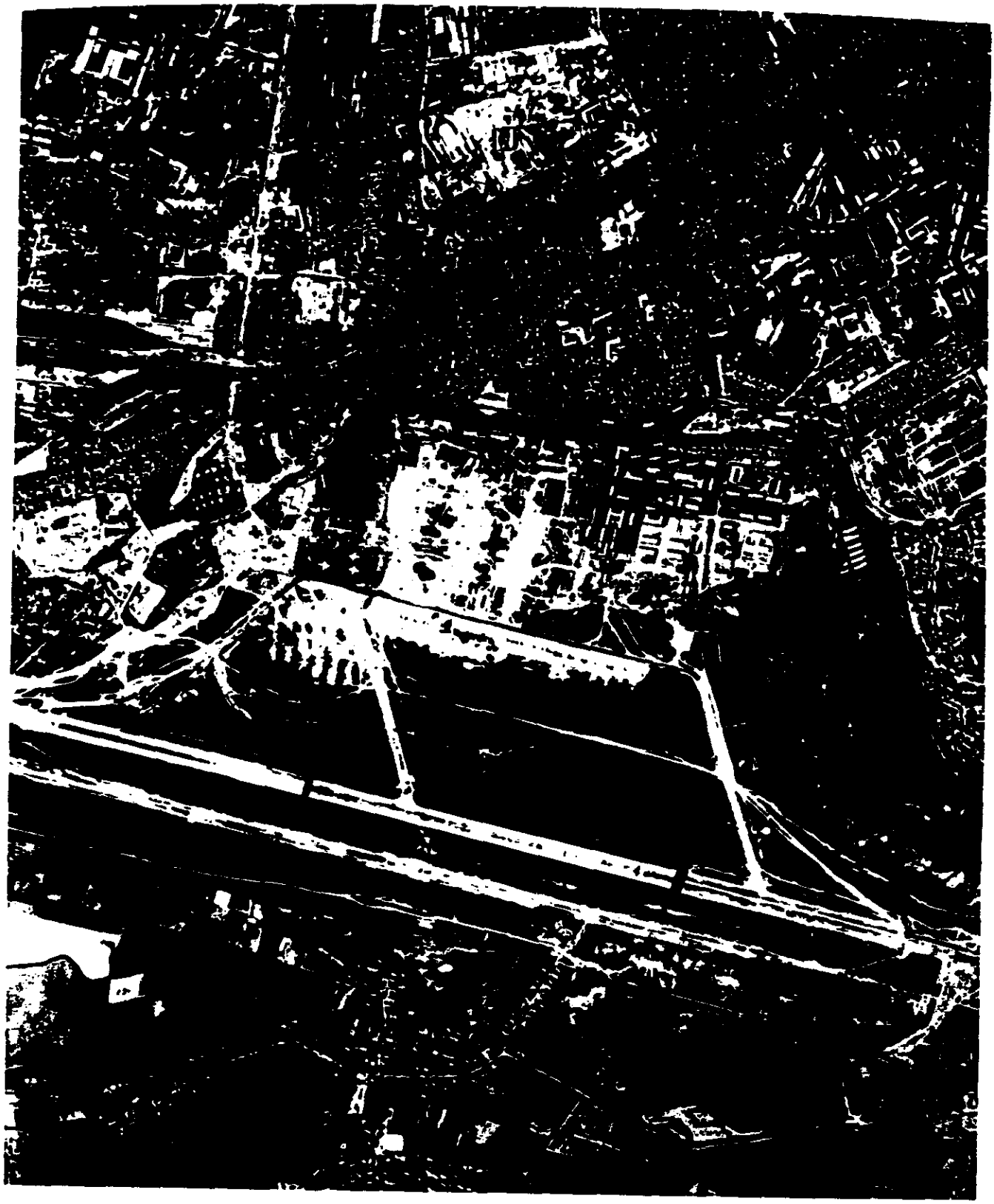

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FIGURE 13. MIP PHOTOGRAPH, FWD-LOOKING CAMERA, MISSION 1031-2

Due to the nearly synchronous orbit of Mission 1031, the number of targets normally available for MIP areas was limited. However, the quality of the following photograph is comparable to MIP areas of past missions. Thus, it was selected as the MIP area of Mission 1031-2 and assigned a rating of 85.

NPIC K-6843 (8/66)

FIGURE 13

Camera	Master
Pass	166D
Frame	52 fwd
Date of Photography	18 Apr 66
Universal Grid Coordinates	38.0 - 13.0
Enlargement Factor	20X
Geographic Coordinates	55-12N 081-21E
Altitude (feet)	659,756
Local Sun Time	1112
Solar Elevation	44°14'
Solar Azimuth	164°
Exposure (fractions of second)	1/286
Processing Level	Full
Vehicle Azimuth	154°47'

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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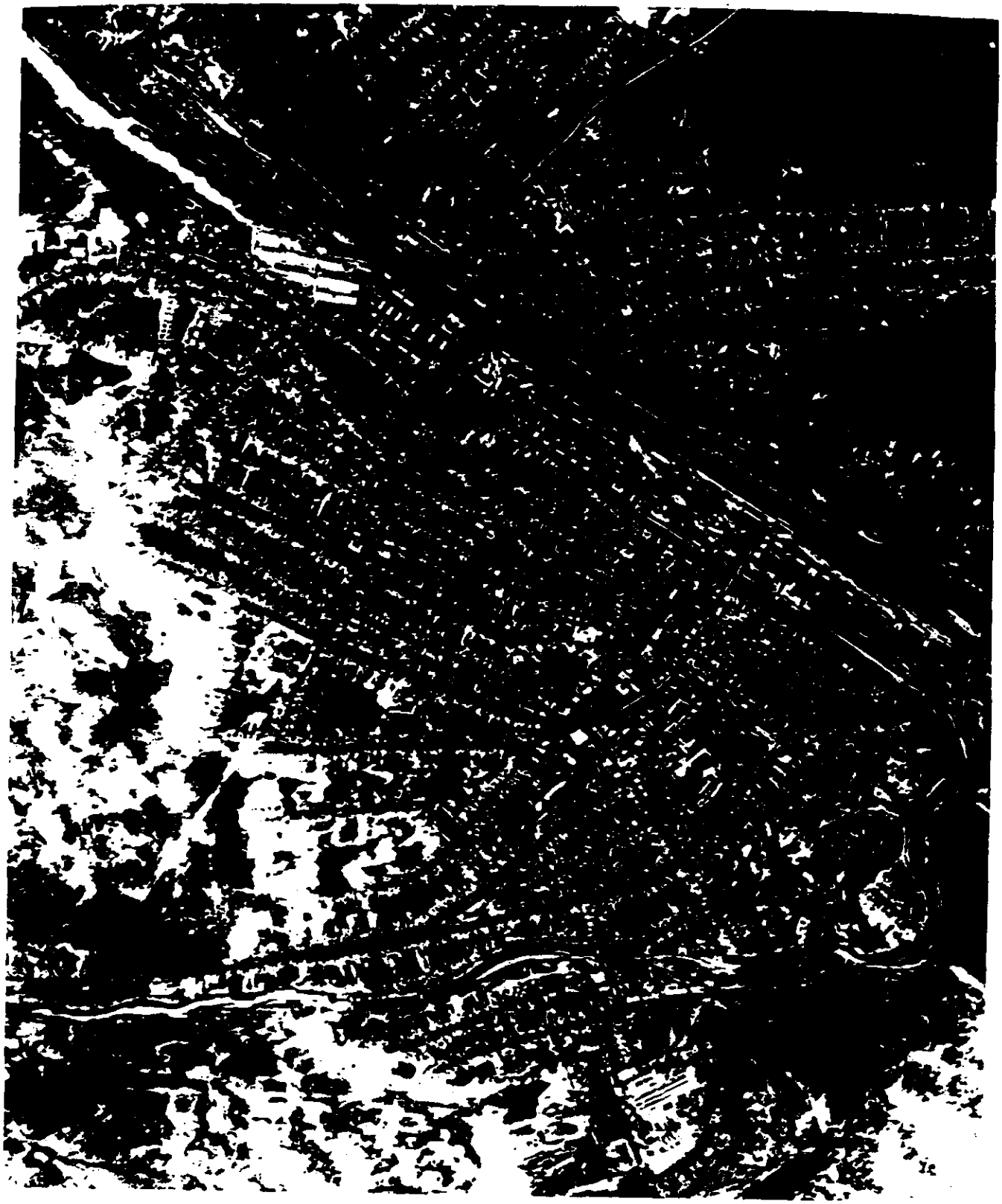

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5. Analysis of Resolution Target

Only one resolution target was imaged during Mission 1031. Poor weather conditions prevailed over it. A resolution value of 9 feet was read along track and 12 feet was resolved cross track. The target was covered by the master camera only.

The following data gives the location of the target within the photography and the system parameters which influence the resolution of the target.

RESOLUTION TARGET DATA

Location	Fort Huachuca
Target:	
Type	Medium Contrast "T"
Camera	Master
Pass	159D
Frame	15 fwd
Universal Grid Coordinate	22.2 - 11.6
Date of Photography	17 Apr 66
Geographic Coordinate	31-51N 109-29W
Vehicle Altitude (ft)	634,730
Vehicle Azimuth	165°11'
Local Sun Time	1158
Solar Elevation	68°40'
Exposure	1/292
Resolution - Original Negative:	
Flight Direction	9 Feet
Scan Direction	12 Feet
Processing Level	Full

6. Horizon Imagery Report

Veiling in the starboard horizon camera images of Mission 1031 causes a soft, out-of-focus appearance. This makes attitude reduction extremely difficult, and the derived data is not completely reliable. Vehicle attitude is normally determined from the stellar/index system and compared with the attitude derived from the horizon camera film. If the stellar index system fails, the attitude is solely dependent upon the horizon camera images. Sharp and well-defined horizon arcs become mandatory for dependable attitude derivations. Although the stellar/index system was operational throughout Mission 1031 and the attitude obtained is reliable, the veiling condition remains a serious problem. It has become a common occurrence on most missions. At present, very few conclusive explanations have been offered, but examinations are being conducted at NPIC and various other installations in an attempt to discover the possible causes of the anomaly.

For a more thorough report on the veiled horizon images, see the Photographic Evaluation Report on Mission 1029.

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APPENDIX A. SYSTEM SPECIFICATIONS

1. Cameras

	Master Pan	Master Take-Up Horizon	Master Supply Horizon	Slave Pan	Slave Take-Up Horizon	Slave Supply Horizon	Mission 1031-1 Stellar	Mission 1031-1 Index	Mission 1031-2 Stellar	Mission 1031-2 Index
Camera No	184	N/A	N/A	185	N/A	N/A	D83/101/89	D83/101/89	D86/106/86	D86/106/86
Reseau No	N/A	N/A	N/A	N/A	N/A	N/A	89	101	86	106
Lens Serial No	1872435	12859	12867	1452435	12872	12832	10777	820188	11507	819195
Slit Width	.225	N/A	N/A	.150	N/A	N/A	N/A	N/A	N/A	N/A
Aperture	3.5	8.0	6.3	3.5	6.3	8.0	1.8	4.5	1.8	4.5
Exposure Time (Sec)	1/250 Avg.	1/100	1/100	1/400 Avg.	1/100	1/100	2.0	1/500	2.0	1/500
Filter (Wratten)	23A	25	25	21	25	25	None	21	None	21
Focal Length (mm)	609.577	55.00	55.00	609.602	55.00	54.90	84 Nom	38.55	84 Nom	38.56
Film Length (ft)	16,000	N/A	N/A	16,000	N/A	N/A	75	135	75	135
Splices	4	N/A	N/A	5	N/A	N/A	None	None	None	None
Emulsion	241-8-3-11-3-6	241-8-3-11-3-6	241-8-3-11-3-6	241-8-3-11-3-6	241-8-3-11-3-6	241-8-3-11-3-6	124-35-12-5	106-13-10-5	124-35-12-5	106-13-10-5
Film Type	3404	3404	3404	3404	3404	3404	3401	3400	3401	3400
Resolution Data (L/mm)										
Static										
High Contrast	242	209	209	243	209	209	*	72 (Awar)	*	72 (Awar)
Low Contrast	143	*	*	145	*	*	*	*	*	*
Dynamic										
I High Contrast	185	*	*	199	*	*	*	*	*	*
I Low Contrast	117	*	*	120	*	*	*	*	*	*
P High Contrast	157	*	*	167	*	*	*	*	*	*
P Low Contrast	114	*	*	115	*	*	*	*	*	*

N/A Not Applicable.
* Not Available.

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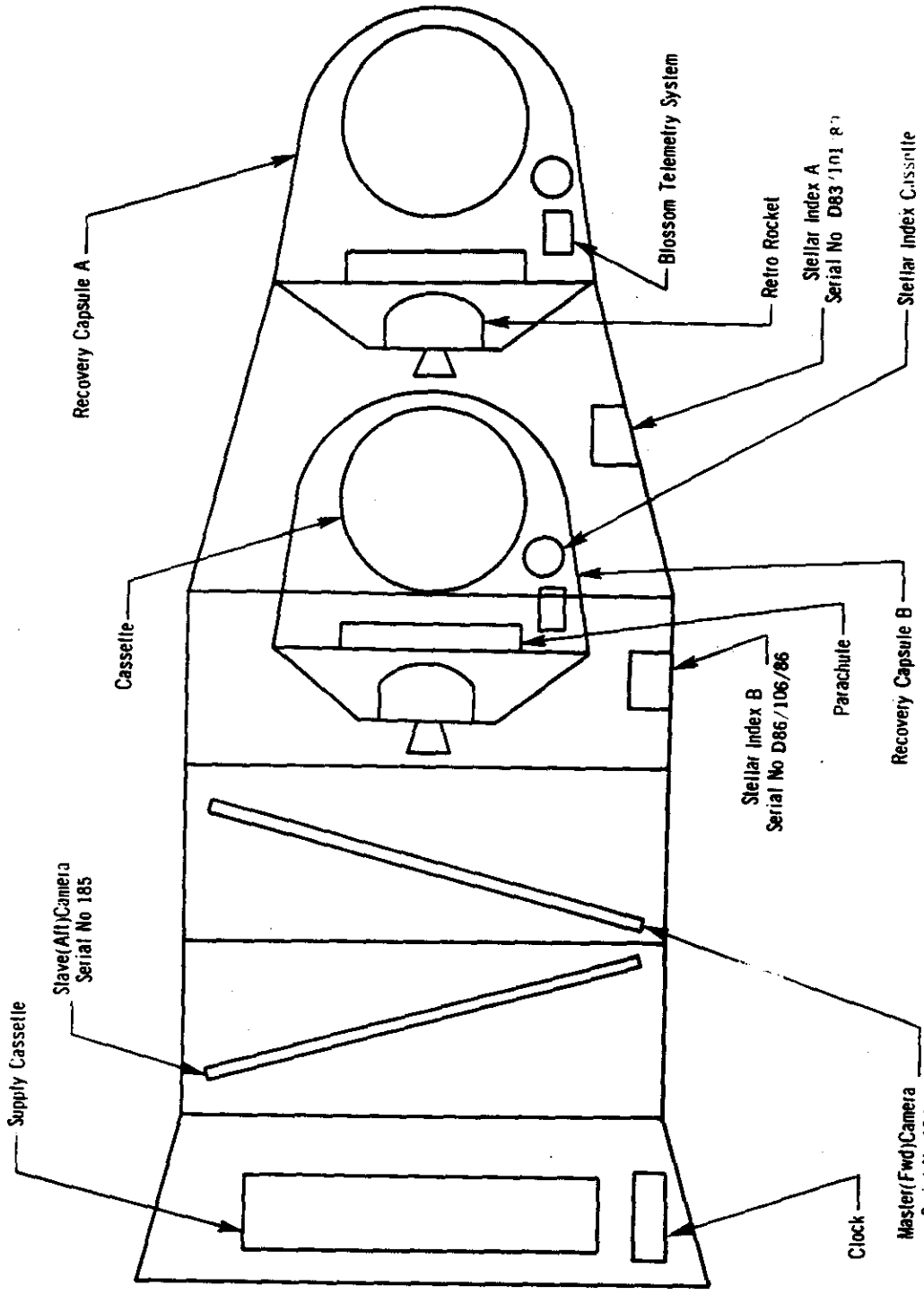
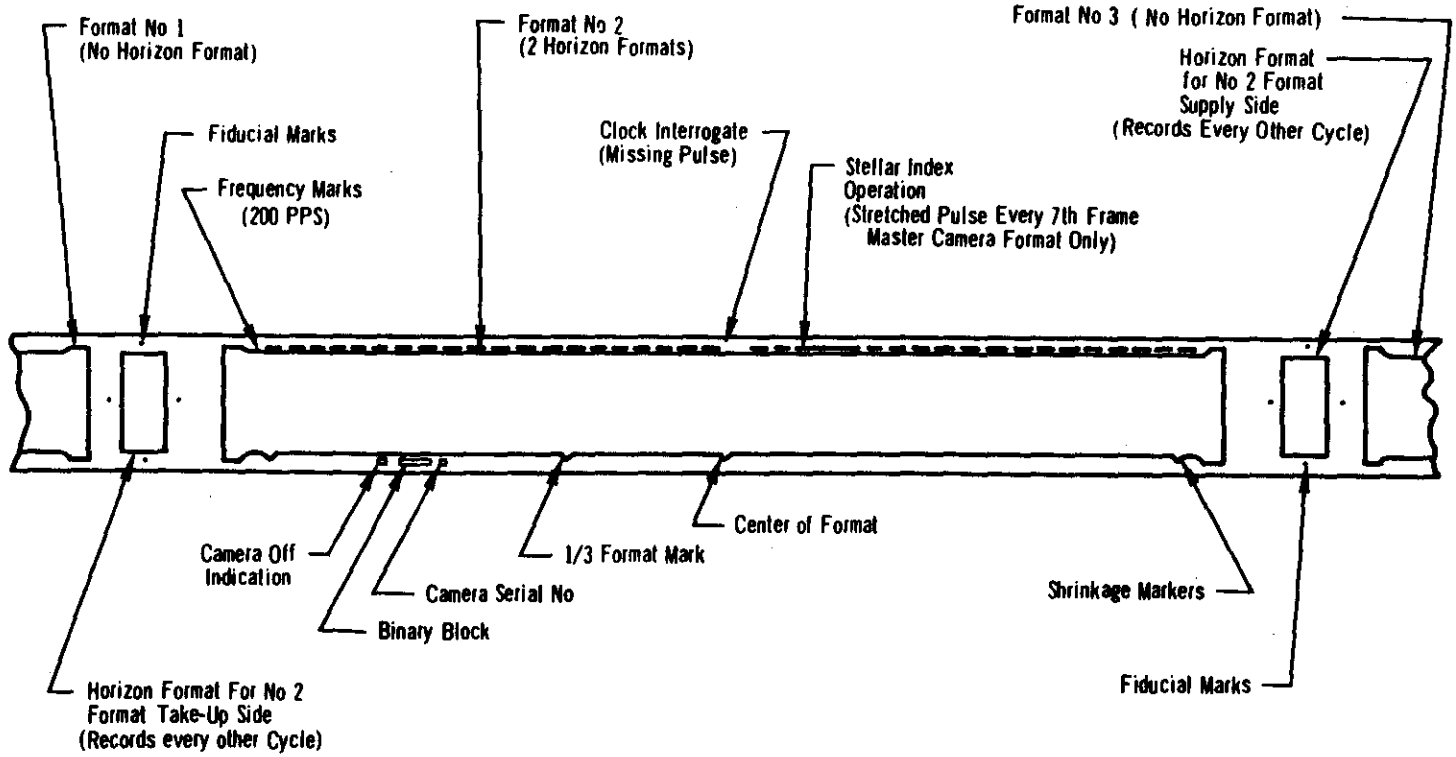
2. VEHICLE CONFIGURATION AND EQUIPMENT LAYOUT



3. PANORAMIC FILM FORMAT CONFIGURATION



Master(Fwd)Panoramic Camera No 184
Viewed With Negative Emulsion Down
Direction of Film Transport ←
Direction of Scan →
Direction of Vehicle Motion ↓

Slave(Aft)Panoramic Camera No 185
Viewed With Negative Emulsion Down
Direction of Film Transport ←
Direction of Scan →
Direction of Vehicle Motion ↑

NPIC K-8845/66

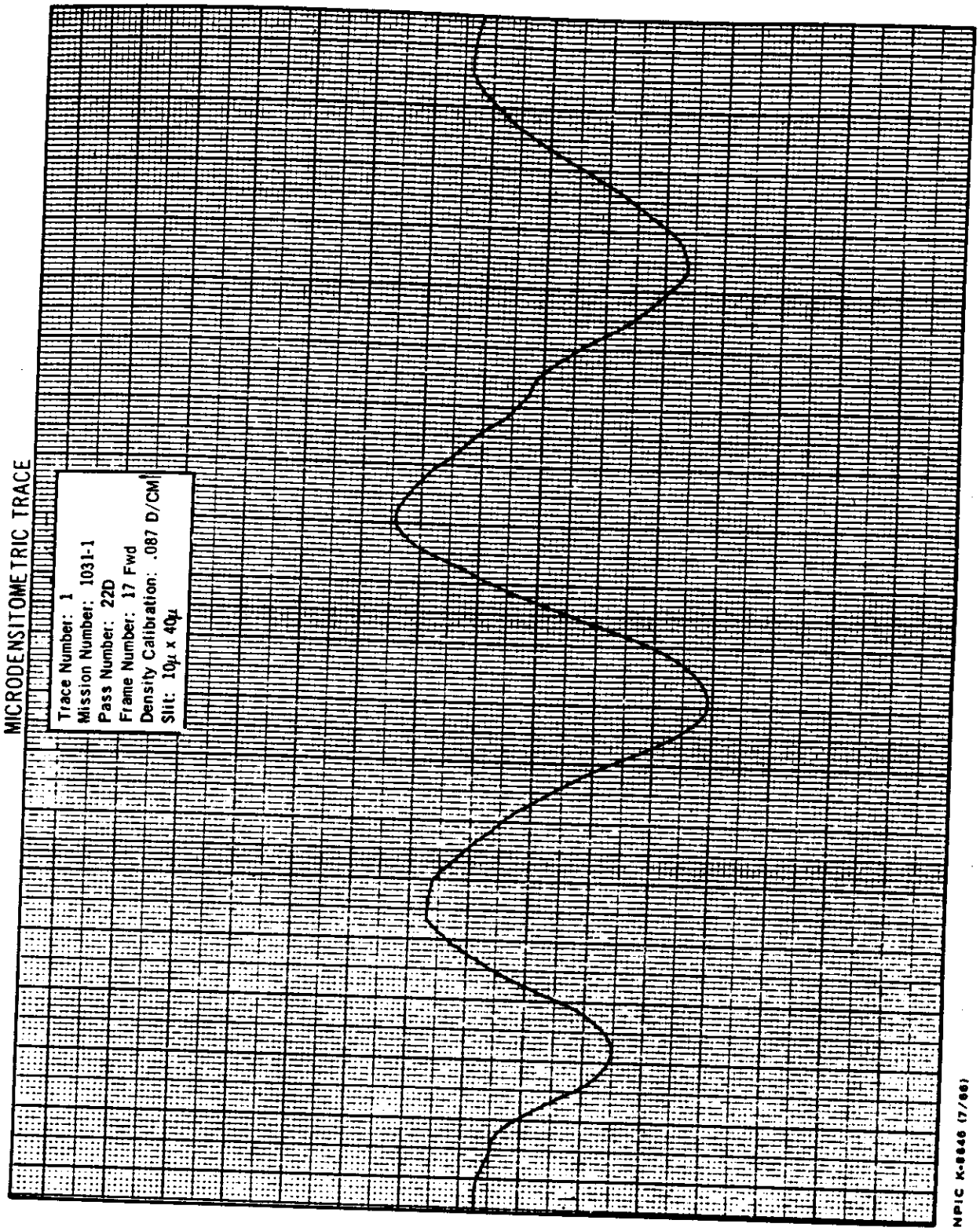
APPENDIX B. MICRODENSITOMETRY

This section is intended to provide a more objective analysis of the imagery from the fwd and aft-looking cameras of Mission 1031-1. The target selected for the following microdensitometric traces was photographed in stereo on passes 22D and 38D. The target on pass 22D received a good quality rating by the PI whereas the target on pass 38D was assigned a poor quality rating.

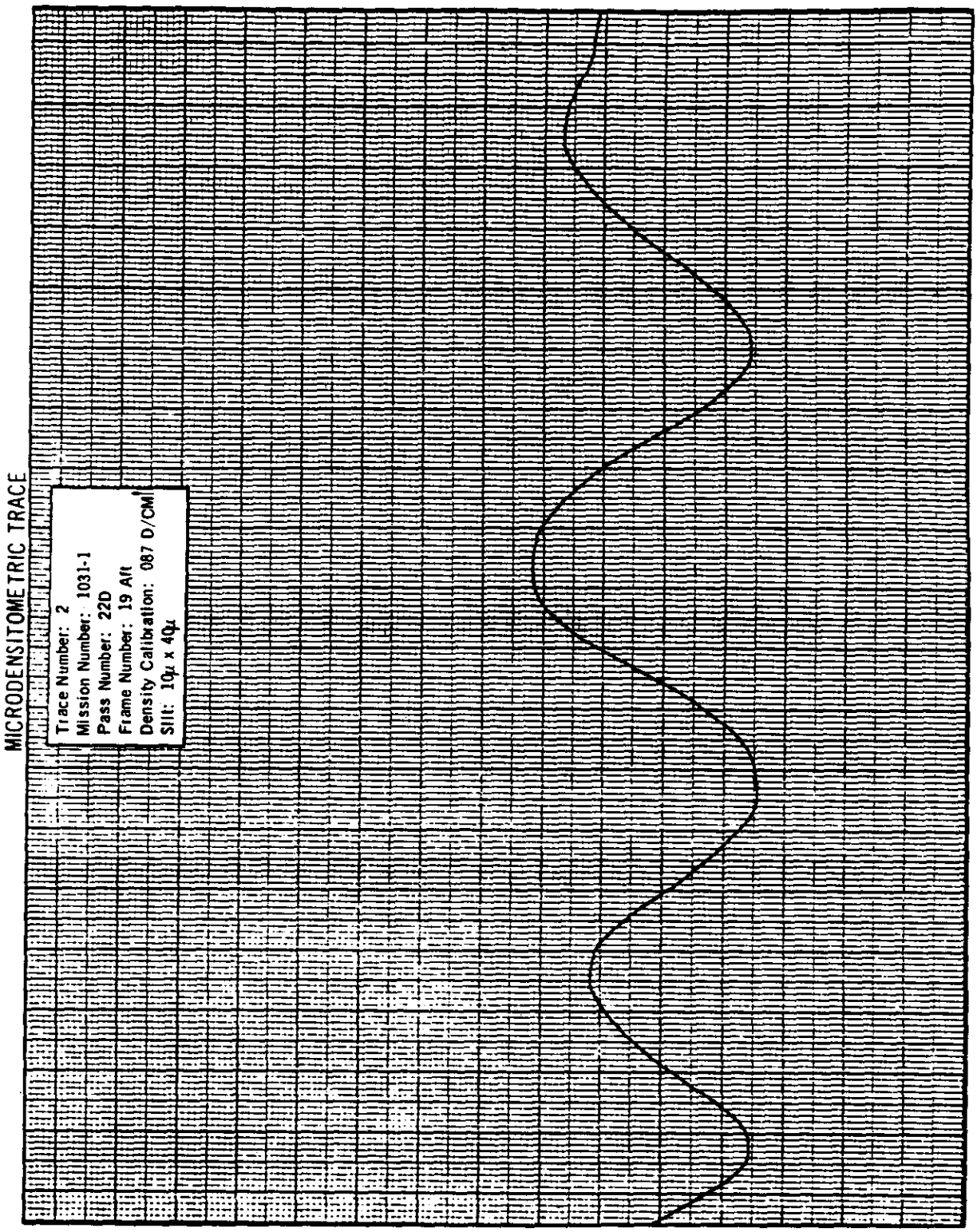
The target was recorded on frame 17 fwd (19 aft) of pass 22D and frame 60 fwd (61 aft) of pass 38D. A row of buildings was selected from each target and a microdensitometric trace was made on three of the buildings from each of the four frames. The three buildings are approximately parallel, and the microdensitometer slit was aligned parallel to the first building for each trace.

The instrument used for the trace comparison was a Joyce-Lobel Double-Beam Automatic Recording Microdensitometer, Model Mark IIIC. The parameters on the instrument were kept the same for all traces. The ratio between distance (abscissa) on the trace to distance on the film is 1000:1, a 10 by 40 micron effective aperture was used, and the maximum ordinate range was 1.60 density with a slope of 0.087 density per centimeter of pen deflection.

A direct comparison of the 4 microdensity traces was made with emphasis on the steepness of the density gradients that represent the edges of the buildings. The conclusions regarding the traces are: The traces show that the contrast is lower in pass 38D than in 22D as indicated by the smaller changes in density across the buildings. By laying a straight edge along the density gradients between building and background, it can be shown that the forward-looking camera produced steeper gradients on both passes than the aft-looking camera. Also, the imagery from pass 22D has steeper gradients than that in pass 38D. The steeper gradients indicate that the edges of these buildings are sharper.

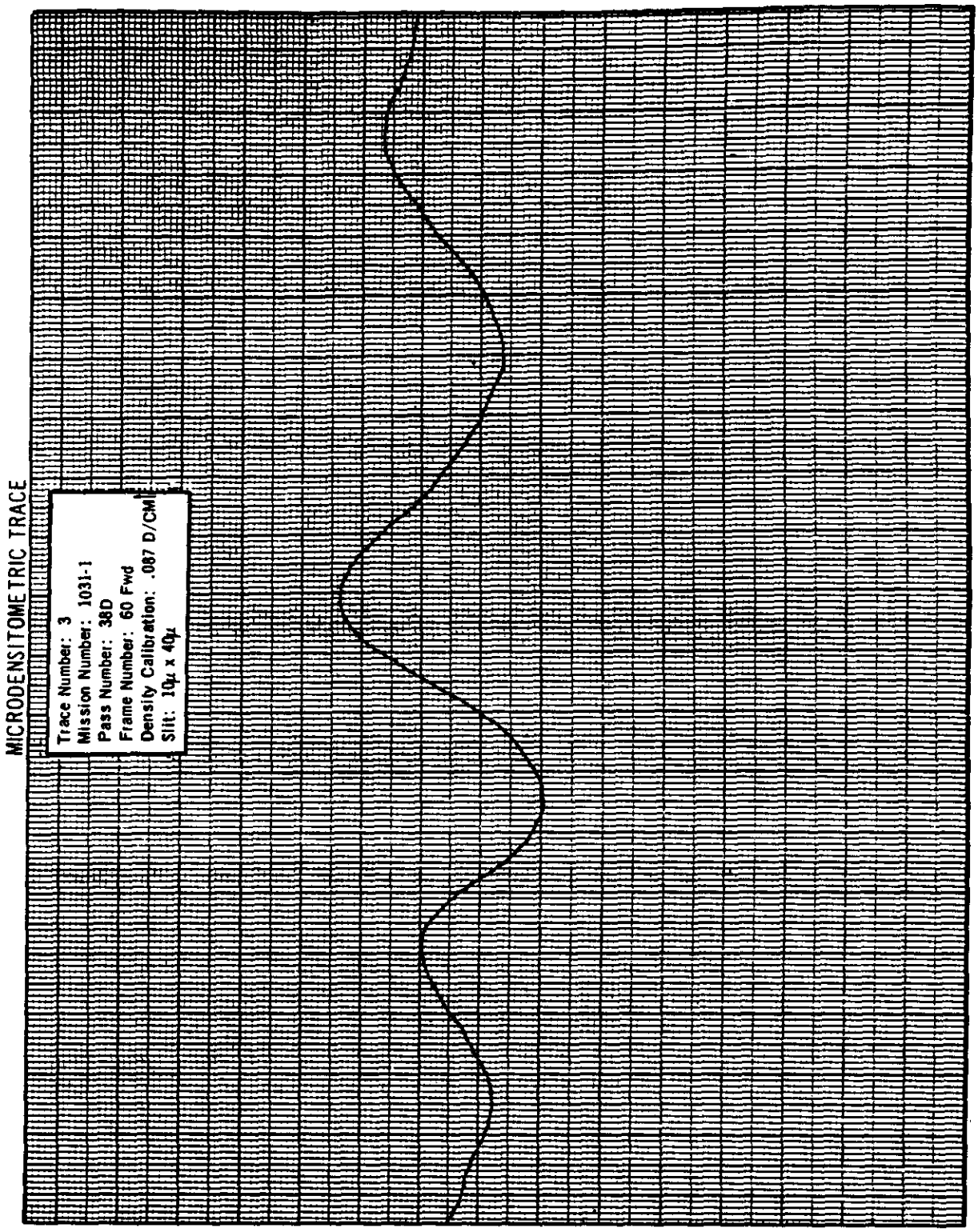

MICRODENSITOMETRIC TRACE
Trace Number: 1
Mission Number: 1031-1
Pass Number: 22D
Frame Number: 17 Fwd
Density Calibration: .087 D/CM
Slit: 10μ x 40μ
NPIC K-8846 (7/66)

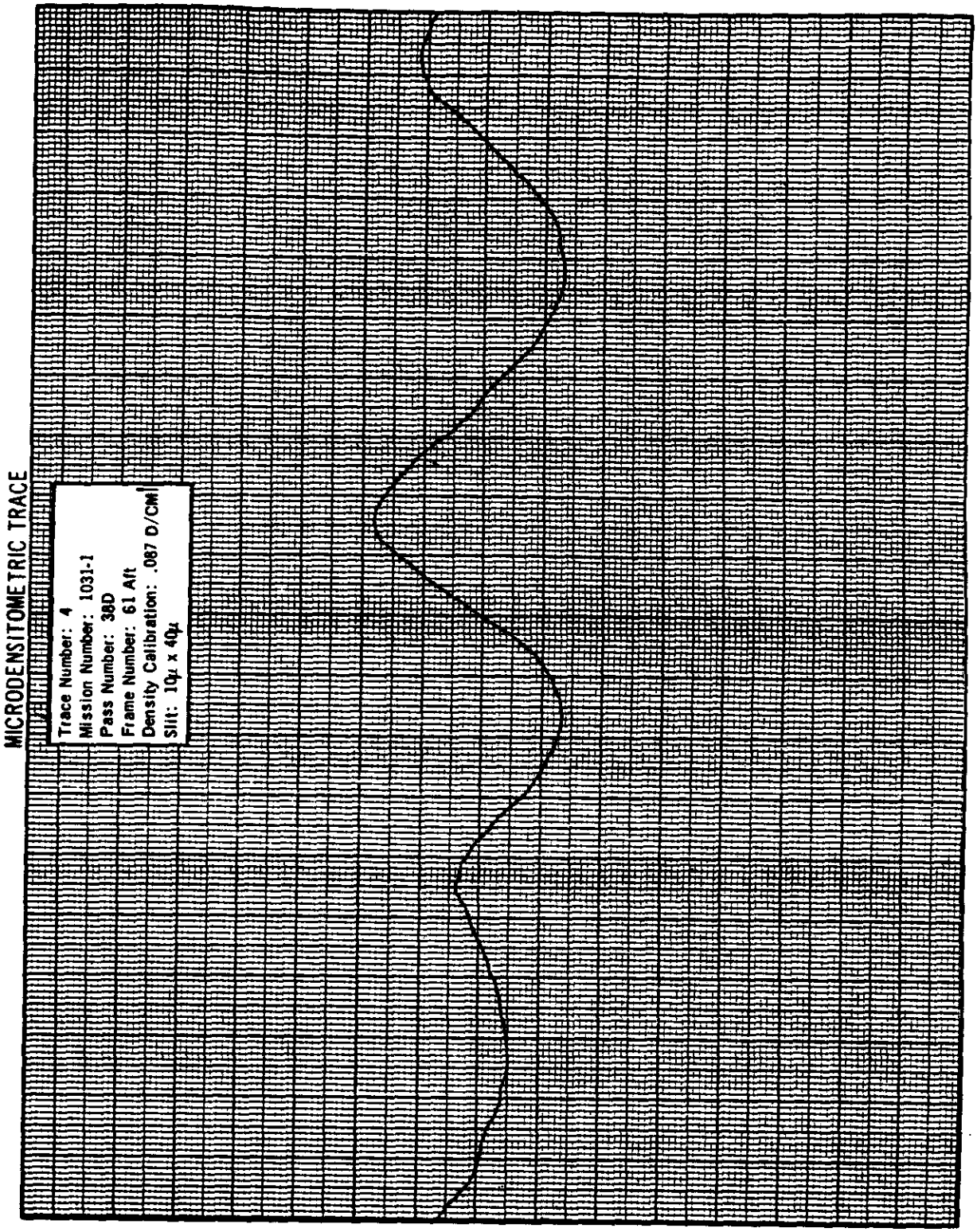
[redacted]



NPIC K-8647 (7/88)

[redacted]


MICRODENSITOMETRIC TRACE
Trace Number: 3
Mission Number: 1031-1
Pass Number: 38D
Frame Number: 60 Fwd
Density Calibration: .087 D/CM
Slit: 10μ x 40μ
NPIC K-8848 (7/68)



NPIC K-8848 (7/86)

[redacted]

APPENDIX C. DENSITY READINGS

The following density readings were measured on the stellar and index camera film of Mission 1031. They were made with a McBeth Quantalog Densitometer, Model EP 1000, with an ET 20 attachment and a 0.5mm aperture.

Included at the end of each series of values are the averages and ranges of the densities from each stellar and index camera film record.

[redacted]

Stellar Camera Mission 1031-1

Pass	Frame	Dmax	Dmin	Delta	Gross Fog
1D	1	0.50	0.17	0.33	0.16
	2	2.55	0.17	2.38	0.16
5D	3	0.64	0.17	0.47	0.16
	10	1.13	0.17	0.96	0.16
6D	11	0.68	0.17	0.51	0.16
	26	0.50	0.17	0.33	0.16
7D	27	0.71	0.17	0.54	0.16
	38	0.68	0.17	0.51	0.16
8D	39	0.75	0.17	0.58	0.16
	47	0.68	0.17	0.51	0.16
10D	50	0.62	0.17	0.45	0.16
	55	0.65	0.17	0.48	0.16
11D	56	0.62	0.17	0.45	0.16
	61	0.78	0.17	0.61	0.16
14D	62	0.49	0.17	0.32	0.16
	64	0.45	0.17	0.28	0.16
16D	65	0.56	0.17	0.39	0.16
	66	0.58	0.17	0.41	0.16
17D	67	0.50	0.17	0.33	0.16
	69	0.60	0.17	0.43	0.16
22D	70	0.71	0.17	0.54	0.16
	86	1.71	0.17	1.54	0.16
23D	87	0.55	0.17	0.38	0.16
	88	0.50	0.17	0.33	0.16
27D	89	0.60	0.17	0.43	0.16
	93	0.56	0.17	0.39	0.16
28D	94	0.61	0.17	0.44	0.16
	99	0.69	0.17	0.52	0.16
30D	100	0.50	0.17	0.33	0.16
	102	0.48	0.17	0.31	0.16
31D	103	0.60	0.17	0.43	0.16
	106	0.69	0.17	0.52	0.16
32D	107	0.60	0.17	0.43	0.16
	108	0.62	0.17	0.45	0.16
37D	109	0.53	0.17	0.36	0.16
	124	0.58	0.17	0.41	0.16
38D	125	0.69	0.17	0.52	0.16
	137	0.75	0.17	0.58	0.16
39D	138	0.62	0.17	0.45	0.16
	150	0.82	0.17	0.65	0.16
41D	151	0.60	0.17	0.43	0.16
	155	0.57	0.17	0.40	0.16
43D	156	0.62	0.17	0.45	0.16
	161	0.64	0.17	0.47	0.16

Stellar Camera Mission 1031-1

Pass	Frame	Dmax	Dmin	Delta	Gross Fog
48D	162	0.50	0.17	0.33	0.16
	163	0.43	0.17	0.26	0.16
49D	164	0.51	0.17	0.34	0.16
	171	0.83	0.17	0.66	0.16
50D	172	0.70	0.17	0.53	0.16
	176	0.80	0.17	0.63	0.16
52D	177	0.63	0.17	0.46	0.16
	182	0.70	0.17	0.53	0.16
54D	183	0.80	0.17	0.63	0.16
	189	0.77	0.17	0.60	0.16
55D	190	0.53	0.17	0.36	0.16
	200	0.70	0.17	0.53	0.16
56D	201	0.53	0.17	0.36	0.16
	209	0.72	0.17	0.55	0.16
61D	210	0.55	0.17	0.38	0.16
	211	0.58	0.17	0.41	0.16
62D	212	0.48	0.17	0.31	0.16
	214	0.43	0.17	0.26	0.16
65D	215	0.78	0.17	0.61	0.16
	221	0.85	0.17	0.68	0.16
68D	228	0.68	0.17	0.51	0.16
	233	0.58	0.17	0.41	0.16
69D	234	0.65	0.17	0.48	0.16
	244	0.48	0.17	0.31	0.16
71D	245	0.70	0.17	0.53	0.16
	261	0.51	0.17	0.34	0.16
72D	262	0.64	0.17	0.47	0.16
	269	0.82	0.17	0.65	0.16
74D	270	0.62	0.17	0.45	0.16
	281	0.81	0.17	0.64	0.16
79D	282	0.68	0.17	0.51	0.16
	284	0.60	0.17	0.43	0.16
84D	285	0.75	0.17	0.58	0.16
	292	0.84	0.17	0.67	0.16
86D	293	0.74	0.17	0.57	0.16
	301	0.68	0.17	0.51	0.16
87D	302	0.73	0.17	0.56	0.16
	335	1.09	0.17	0.92	0.16
93D	336	0.68	0.17	0.51	0.16
	338	0.77	0.17	0.60	0.16
95D	339	0.92	0.17	0.75	0.16
	341	0.80	0.17	0.63	0.16
97D	342	0.88	0.17	0.71	0.16
	345	0.88	0.17	0.71	0.16

Stellar Camera Mission 1031-1

Pass	Frame	Dmax	Dmin	Delta	Gross Fog
100D	346	0.73	0.17	0.56	0.16
	351	0.63	0.17	0.46	0.16
101D	352	0.82	0.17	0.65	0.16
	358	0.67	0.17	0.50	0.16
102D	359	0.72	0.17	0.55	0.16
	364	0.68	0.17	0.51	0.16
103D	365	0.74	0.17	0.57	0.16
	389	1.10	0.17	0.93	0.16
104D	390	0.88	0.17	0.71	0.16
	406	0.88	0.17	0.71	0.16
105D	407	0.72	0.17	0.55	0.16
	418	0.73	0.20	0.53	0.17
111D	419	0.82	0.20	0.62	0.17
Average		0.70	0.17	0.53	0.16
Range		0.43-2.55	0.17-0.20	0.28-2.55	0.16-0.17

Stellar Camera Mission 1031-2

Pass	Frame	Dmax	Dmin	Delta	Gross Fog
113D	1	2.25	1.20	1.05	0.12
114D	2	1.80	0.49	1.31	0.12
	10	1.80	0.45	1.35	0.12
116D	11	1.58	0.33	1.25	0.12
	33	1.87	0.47	1.40	0.12
117D	34	2.15	0.45	1.70	0.12
	66	1.96	0.53	1.43	0.12
118D	67	1.95	0.54	1.41	0.12
	91	2.52	0.68	1.84	0.12
120D	94	2.03	0.61	1.42	0.12
	99	2.00	0.61	1.39	0.12
127D	100	2.04	0.44	1.60	0.15
	101	2.01	0.60	1.41	0.16
130D	102	2.45	0.70	1.75	0.16
	109	2.65	0.91	1.74	0.16
131D	110	2.45	0.83	1.62	0.16
	117	2.45	0.88	1.57	0.16
133D	118	2.32	0.86	1.46	0.16
	141	2.48	0.88	1.60	0.16
134D	142	2.33	0.83	1.50	0.16
	166	2.57	0.87	1.70	0.16
135D	167	2.41	0.90	1.51	0.16
	183	2.98	1.14	1.84	0.17
136D	184	2.22	0.75	1.47	0.17
	189	2.27	0.75	1.52	0.17
143D	190	2.48	0.83	1.65	0.17
	192	2.61	0.87	1.74	0.17
146D	193	2.60	0.85	1.75	0.17
	202	2.85	1.18	1.67	0.17
149D	203	2.19	0.83	1.36	0.17
	231	2.63	1.12	1.51	0.17
150D	232	2.67	1.07	1.60	0.17
	254	2.93	1.23	1.70	0.17
151D	255	2.39	1.04	1.35	0.17
	280	2.92	1.14	1.78	0.17
152D	281	2.81	1.08	1.73	0.17
	295	2.71	1.07	1.64	0.17
153D	296	2.72	1.22	1.50	0.17
	298	2.90	1.23	1.67	0.17
159D	299	2.50	1.04	1.46	0.17
	300	2.55	1.01	1.54	0.17
162D	301	2.68	1.11	1.57	0.17
	312	2.90	1.23	1.67	0.17
163D	313	2.73	1.11	1.62	0.17

Stellar Camera Mission 1031-2

Pass	Frame	Dmax	Dmin	Delta	Gross Fog
	329	2.76	1.18	1.58	0.17
164D	330	2.70	1.13	1.57	0.17
	340	2.80	1.11	1.69	0.17
165D	341	2.46	0.98	1.48	0.17
	367	2.62	1.05	1.57	0.17
166D	368	2.84	1.23	1.61	0.17
	384	2.94	1.24	1.70	0.17
167D	385	2.64	1.02	1.62	0.17
	406	2.88	1.35	1.53	0.32
168D	407	2.87	1.23	1.64	0.23
	423	N/R	N/R	N/R	N/R
169	424	N/R	N/R	N/R	N/R
	426	N/R	N/R	N/R	N/R
Average		2.47	0.92	1.55	0.16
Range		1.58-2.98	0.33-1.35	1.05-1.84	0.12-0.32

INDEX CAMERA MISSION 1031-1

		Limiting				Terrain		
Pass	Frame	Dmax	Dmin	Delta	Gross Fog	Dmax	Dmin	Delta
1D	1	1.56	0.52	1.04	0.06	0.53	0.52	0.01
	2	1.65	0.37	1.28	0.06	0.37	0.37	0.00
5D	3	1.65	1.08	0.57	0.06	1.65	1.08	0.57
	10	1.37	0.63	0.74	0.06	1.37	0.63	0.74
6D	11	1.67	1.06	0.61	0.06	1.67	1.06	0.61
	26	1.56	0.60	0.96	0.06	0.82	0.60	0.22
7D	27	1.63	0.55	1.08	0.06	1.63	0.55	1.08
	38	2.00	0.90	1.10	0.06	1.65	0.90	0.75
8D	39	1.45	0.80	0.65	0.06	1.45	0.80	0.65
	47	1.46	0.72	0.74	0.06	1.46	0.72	0.74
10D	50	1.25	0.11	1.14	0.06	1.25	0.11	1.14
	55	1.57	0.68	0.85	0.06	1.34	0.68	0.66
11D	56	1.00	0.78	0.22	0.06	1.00	0.78	0.22
	61	1.93	0.28	1.65	0.06	0.75	0.28	0.47
14D	62	1.84	0.35	1.49	0.06	0.84	0.35	0.49
	64	1.86	0.28	1.58	0.06	0.92	0.28	0.54
16D	65	1.50	0.25	1.25	0.06	--	--	--
	66	1.42	0.18	1.24	0.06	--	--	--
17D	67	1.48	0.67	0.81	0.06	1.48	0.67	0.81
	69	1.60	0.86	0.74	0.06	0.90	0.86	0.04
22D	70	1.90	1.05	0.85	0.06	--	--	--
	86	1.15	0.30	0.85	0.06	1.00	0.30	0.70
23D	87	1.13	0.53	0.60	0.06	1.13	0.53	0.60
	88	1.49	0.55	0.94	0.06	1.49	0.55	0.94
27D	89	1.89	0.20	1.69	0.06	1.30	0.74	0.56
	93	1.70	0.45	1.25	0.06	1.20	0.45	0.75
28D	94	1.57	0.80	0.77	0.06	1.57	0.80	0.77
	99	1.75	0.95	0.80	0.06	1.75	0.95	0.80
30D	100	1.85	0.25	1.60	0.06	0.65	0.25	0.40
	102	1.78	0.25	1.53	0.06	0.85	0.25	0.60
31D	103	1.95	0.33	1.62	0.06	0.95	0.33	0.62
	106	2.10	0.25	1.85	0.06	0.93	0.25	0.68
32D	107	1.87	0.25	1.62	0.06	--	--	--
	108	1.50	0.18	1.32	0.06	--	--	--
37D	109	1.40	0.40	1.00	0.06	1.40	0.40	1.00
	124	1.65	0.30	1.35	0.06	--	--	--
38D	125	1.74	0.73	1.01	0.06	1.30	0.73	0.57
	137	1.90	0.52	1.38	0.06	--	--	--
39D	138	1.70	0.45	1.25	0.06	1.68	0.45	1.23
	150	1.93	0.85	1.08	0.06	--	--	--

		Limiting Terrain						
Pass	Frame	Dmax	Dmin	Delta	Gross Fog	Dmax	Dmin	Delta
41D	151	1.70	0.38	1.32	0.06	0.80	0.38	0.42
	155	1.50	0.58	0.92	0.06	0.93	0.58	0.35
43D	156	1.75	1.05	0.70	0.06	--	--	--
	161	1.75	0.90	0.85	0.06	1.00	0.90	0.10
48D	162	1.75	0.15	1.60	0.06	--	--	--
	163	1.40	0.15	1.25	0.06	--	--	--
49D	164	1.45	0.73	0.72	0.06	1.00	0.73	0.27
	171	1.90	0.50	1.40	0.06	1.18	0.50	0.68
50D	172	1.65	0.90	0.75	0.06	--	--	--
	176	1.73	0.95	0.78	0.06	1.70	0.95	0.75
52D	177	1.62	0.99	0.63	0.06	1.29	0.99	0.30
	182	1.80	0.97	0.83	0.06	--	--	--
54D	183	1.82	1.02	0.80	0.06	--	--	--
	189	1.57	0.50	1.07	0.06	0.99	0.50	0.49
55D	190	1.23	0.57	0.66	0.06	1.02	0.57	0.45
	200	1.90	0.67	1.23	0.06	1.90	0.67	1.23
56D	201	1.20	0.29	0.91	0.06	1.20	0.29	0.91
	209	1.90	0.45	1.45	0.06	1.37	0.45	0.92
61D	210	1.50	0.40	1.10	0.06	0.85	0.40	0.45
	211	1.35	0.31	1.04	0.06	0.87	0.31	0.56
62D	212	1.82	0.22	1.60	0.06	0.98	0.23	0.75
	214	1.70	0.17	0.53	0.06	1.50	0.27	1.23
65D	215	1.74	0.98	0.76	0.06	1.74	0.98	0.76
	221	1.83	0.53	1.30	0.06	1.83	0.98	0.85
68D	228	1.58	0.23	1.35	0.06	1.27	0.23	1.04
	233	1.97	0.62	1.35	0.06	--	--	--
69D	234	1.68	0.95	0.73	0.06	1.25	0.95	0.30
	244	1.83	0.33	1.50	0.06	1.50	0.33	1.17
71D	245	1.52	0.50	1.02	0.06	1.42	0.50	0.92
	261	1.34	0.20	1.14	0.06	0.60	0.24	0.36
72D	262	1.57	0.23	1.34	0.06	0.77	0.23	0.54
	269	1.62	0.47	1.15	0.06	1.11	0.47	0.64
74D	270	1.70	0.94	0.76	0.06	1.02	0.94	0.08
	281	1.98	0.67	1.31	0.06	1.03	0.67	0.36
79D	282	1.83	0.45	1.38	0.06	1.38	0.45	0.93
	284	1.74	0.67	1.07	0.06	1.30	0.67	0.63
84D	285	1.57	0.70	0.87	0.06	1.57	0.70	0.87
	292	1.60	0.40	1.20	0.06	1.60	0.40	1.20
86D	293	1.95	0.60	1.35	0.06	1.95	0.60	1.35
	301	1.67	0.72	0.95	0.06	--	--	--

		Limiting Terrain						
Pass	Frame	Dmax	Dmin	Delta	Gross Fog	Dmax	Dmin	Delta
87D	302	1.72	0.33	1.39	0.06	1.72	0.33	1.39
	335	2.08	0.80	1.28	0.06	2.08	0.80	1.28
93D	336	1.59	0.76	0.83	0.06	--	--	--
	338	1.62	0.73	0.89	0.06	--	--	--
95D	339	1.53	0.53	1.00	0.06	1.08	0.53	0.55
	341	1.95	0.41	1.54	0.06	1.23	0.41	0.82
97D	342	1.67	0.98	0.69	0.06	1.67	0.98	0.69
	345	1.84	0.57	1.27	0.06	1.84	0.57	1.27
100D	346	1.67	0.54	1.13	0.06	1.00	0.54	0.46
	351	1.50	0.19	1.31	0.06	--	--	--
101D	352	1.60	0.70	0.90	0.06	1.60	0.70	0.90
	358	1.70	0.29	1.41	0.06	1.48	0.69	0.79
102D	359	1.72	1.05	0.67	0.06	1.72	1.05	0.67
	364	2.00	0.70	1.30	0.06	2.00	0.70	1.30
103D	365	1.58	0.47	1.11	0.06	1.58	0.47	1.11
	389	2.07	0.67	1.40	0.06	2.07	0.67	1.40
104D	390	1.81	1.10	0.71	0.06	--	--	--
	406	1.83	0.58	1.25	0.06	1.10	0.58	0.52
105D	407	1.88	0.20	1.68	0.06	1.88	0.49	1.39
	418	1.78	0.45	1.33	0.06	0.85	0.45	0.40
111D	419	2.05	0.40	1.65	0.06	1.45	0.40	1.05
Average		1.69	0.56	1.13	0.06	1.29	0.57	0.72
Range		1.00-2.10	0.11-1.10	0.22-1.85	0.06-0.06	0.37-2.08	0.11-1.08	0.00-1.40

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		Limiting				Terrain		
Pass	Frame	Dmax	Dmin	Delta	Gross Fog	Dmax	Dmin	Delta
113D	1	2.08	1.18	1.90	0.06	--	--	--
114D	2	1.68	0.82	0.86	0.06	--	--	--
	10	1.95	0.35	1.60	0.06	1.28	0.35	0.93
116D	11	1.52	0.75	0.77	0.06	1.52	0.75	0.77
	33	1.64	0.37	1.27	0.06	--	--	--
117D	34	1.73	0.85	0.88	0.06	--	--	--
	66	2.00	0.40	1.60	0.06	1.00	0.40	0.60
118D	67	1.69	0.98	0.71	0.06	1.69	0.98	0.71
	91	2.20	1.05	1.15	0.06	1.55	1.05	0.50
120D	94	2.15	0.41	1.74	0.06	0.94	0.41	0.53
	99	1.45	0.33	1.12	0.06	1.18	0.33	0.85
127D	100	2.23	0.55	1.68	0.06	1.53	0.55	0.97
	101	2.10	0.62	1.48	0.06	1.43	0.62	0.81
130D	102	1.78	1.00	0.78	0.06	1.78	1.00	0.78
	109	1.97	0.89	1.08	0.06	1.97	0.89	1.08
131D	110	1.64	0.90	0.74	0.06	1.64	0.90	0.74
	117	1.82	1.00	0.82	0.06	1.82	1.00	0.82
133D	118	1.54	0.60	0.94	0.06	1.54	0.60	0.94
	141	1.93	0.18	1.75	0.06	0.80	0.60	0.20
134D	142	1.63	0.62	1.01	0.06	1.63	0.62	1.01
	166	1.95	0.83	1.12	0.06	1.38	0.83	0.55
135D	167	1.68	0.38	1.30	0.06	1.52	0.38	1.14
	183	2.12	0.92	1.20	0.06	--	--	--
136D	184	1.78	0.41	1.37	0.06	1.00	0.41	0.59
	189	1.55	1.00	0.55	0.06	--	--	--
143D	190	2.12	0.78	1.34	0.06	1.42	0.95	0.47
	192	1.97	1.05	0.92	0.06	1.08	1.05	0.03
146D	193	1.73	1.44	0.29	0.06	1.73	1.44	0.29
	202	1.90	0.88	1.02	0.06	1.90	1.38	0.52
149D	203	1.26	0.59	0.67	0.06	1.26	0.59	0.67
	231	1.49	0.59	0.90	0.06	1.49	0.92	0.57
150D	232	1.63	0.70	0.93	0.06	1.63	0.70	0.93
	254	2.12	0.84	1.28	0.06	1.10	0.84	0.26
151D	255	1.30	0.96	0.34	0.06	--	--	--
	280	2.09	0.84	1.25	0.06	2.09	0.84	1.25
152D	281	1.74	1.05	0.69	0.06	1.74	1.05	0.69
	295	1.82	0.60	1.22	0.06	--	--	--
153D	296	1.74	0.44	1.30	0.06	0.67	0.44	0.23
	298	1.83	0.48	1.35	0.06	0.98	0.48	0.50
159D	299	1.89	0.63	1.26	0.06	1.37	0.63	0.74
	300	2.00	0.62	1.38	0.06	1.33	0.62	0.71
162D	301	1.73	0.97	0.76	0.06	1.73	0.97	0.76

		Limiting Terrain						
Pass	Frame	Dmax	Dmin	Delta	Gross Fog	Dmax	Dmin	Delta
	312	1.90	0.38	1.52	0.06	1.18	0.38	0.80
163D	313	1.60	0.76	0.84	0.06	1.60	0.76	0.84
	329	1.78	0.35	1.43	0.06	--	--	--
164D	330	1.78	0.40	1.38	0.06	0.99	0.40	0.59
	340	2.05	0.20	1.85	0.06	--	--	--
165D	341	1.80	0.43	1.37	0.06	1.55	0.43	1.12
	367	1.66	0.36	1.30	0.06	--	--	--
166D	368	1.74	0.43	1.31	0.06	1.74	0.43	1.31
	384	1.94	0.63	1.31	0.06	1.19	0.63	0.56
167D	385	1.60	0.18	1.42	0.06	--	--	--
	406	2.00	0.48	1.52	0.06	1.12	0.48	0.64
168D	407	1.83	1.13	1.70	0.06	--	--	--
	423	2.05	1.10	0.95	0.82	1.38	1.10	0.28
169D	424	2.25	1.35	0.90	1.10	2.25	1.35	0.90
	426	2.80	2.60	0.20	2.50	2.80	2.60	0.20
Average		1.84	0.73	1.11	0.06	1.46	0.77	0.69
Range		1.26-2.80	0.18-2.60	0.20-1.90	0.06-2.50	0.80-2.80	0.33-2.60	0.20-1.31

*Not included in average due to fog caused by film run out.

APPENDIX D. CLOUD COVER ANALYSIS

1. Introduction

This study represents a statistical analysis of the cloud cover on the photography of Mission 1031. The basis of this study is the cloud cover data for each quarter segment of every individual frame of photography. The data is obtained by analysts specifically trained in estimating cloud cover by designated categories.

Five cloud categories have been formulated for use in this photography (Reference, Table 1). These categories allow for the wide latitude of cloud cover conditions commonly found on a frame of this photography. Note in Table 1 that a mean cloud percentage value has been calculated for each category for use in determining a combined cloud cover percentage for all operational passes of the mission.

The occurrence of each cloud category within an operational pass is expressed as a percentage of 100 and appears in Table 2. Each percentage is a ratio of the number of occurrences of a given cloud cover category to the total number of cloud observations in a photo pass. For example: if the number of category 1 occurrences in a given pass is 200 out of a total of 1000 (250 frames x 4 quarters), all categories combined, then 20 percent of the pass would be classed as category 1.

Also a cloud cover percentage per pass is included in the last column of Table 2 under "Cloud Cover % Per Pass." This value is determined by the summation of the products of category percentage in each pass and the mean cloud percentage for that category as established in Table 1. For example: if it is determined that the following percentages exist in a given pass:

20% Category 1
15% Category 2
30% Category 3
25% Category 4
10% Category 5

Then, by using the mean cloud percentage established in Table 1 the following computations are made:

$$
\begin{aligned}
0.20 \times 5.0 &= 1.00\% \\
0.15 \times 17.5 &= 2.63\% \\
0.30 \times 38.0 &= 11.40\% \\
0.25 \times 75.0 &= 18.75\% \\
0.10 \times 100.0 &= \underline{10.00\%} \\
&\quad 43.78\%
\end{aligned}
$$

Hence, 43.8 percent of this pass is cloud covered.

TABLE 1

CLOUD COVER CATEGORIES

Category Number	Percent of Cloud Cover	Description	Mean Cloud Percentage
1	Less than 10%	Clear	5%
2	10% - 25%	Small Scattered Clouds	17.5%
3	26% - 50%	Large Scattered Clouds	38%
4	51% - 99%	Broken or Connected Clouds	75%
5	100%	Complete Overcast	100%

2. Cloud Cover Data

a. Mission 1031-1

Pass Number	1	2	3	4	5	Cloud Cover % Per Pass
1D	0.0	0.0	0.0	83.9	16.1	79.0
5D	65.6	5.4	8.0	21.0	0.0	23.0
6D	54.9	5.1	10.8	21.0	8.2	31.7
7D	53.7	4.5	7.2	34.6	0.0	32.2
8D	53.2	9.1	8.3	27.0	2.4	30.1
10D	32.3	19.5	26.2	22.0	0.0	31.5
11D	24.4	26.1	13.3	34.5	1.7	38.4
14D	7.1	9.5	10.7	72.7	0.0	60.6
16D	3.6	7.1	19.6	69.7	0.0	61.1
17D	76.1	3.6	3.6	16.7	0.0	18.3
22D	18.8	14.5	30.6	32.2	3.9	43.2
23D	94.3	3.8	1.9	0.0	0.0	6.1
27D	85.0	4.3	5.0	5.7	0.0	11.2
30D	19.7	15.8	17.1	47.4	0.0	45.8
32D	40.0	10.0	25.0	21.7	3.3	32.8
37D	89.4	2.9	2.5	5.2	0.0	9.8
38D	29.2	5.9	6.5	42.1	16.3	52.8
39D	60.8	2.7	8.2	26.1	2.2	28.4
41D	24.4	17.3	28.8	29.5	0.0	37.3
43D	12.5	12.5	18.4	34.2	22.4	57.9
48D	76.6	6.7	10.0	6.7	0.0	13.8
49D	49.5	10.5	19.5	20.5	0.0	27.1
50D	100.0	0.0	0.0	0.0	0.0	5.0
52D	17.1	3.7	8.5	70.7	0.0	57.8
54D	11.4	17.9	26.6	31.1	13.0	50.1
55D	100.0	0.0	0.0	0.0	0.0	5.0
56D	37.7	2.4	6.3	53.6	0.0	44.9
61D	0.0	0.0	33.3	66.7	0.0	62.7
62D	69.4	15.3	15.3	0.0	0.0	12.0
65D	76.6	7.8	4.7	10.9	0.0	15.2
68D	52.3	2.0	3.1	42.6	0.0	36.1
69D	20.7	15.1	16.4	47.8	0.0	45.8
71D	67.4	10.7	11.6	10.3	0.0	17.4
72D	29.7	6.0	8.2	54.8	1.3	48.1
74D	39.2	2.1	3.0	55.4	0.3	45.3
84D	77.9	5.6	6.0	10.5	0.0	15.0
86D	50.8	6.9	12.9	29.4	0.0	30.7
87D	45.6	5.4	12.2	33.4	3.4	36.3

Pass Number	1	2	3	4	5	Cloud Cover % Per Pass
97D	76.7	8.3	2.5	12.5	0.0	15.6
100D	19.5	6.7	12.2	61.6	0.0	53.0
101D	17.0	11.5	17.5	52.0	2.0	50.5
102D	100.0	0.0	0.0	0.0	0.0	5.0
103D	58.8	9.0	14.0	18.1	0.1	23.5
104D	0.0	1.7	6.1	67.4	24.8	78.0
105D	7.8	6.6	25.6	53.1	6.9	58.0
	46.7*	7.1*	11.4*	31.4*	3.4*	34.9*

b. Mission 1031-2

Pass Number	1	2	3	4	5	Cloud Cover % Per Pass
114D	49.3	9.7	6.7	34.3	0.0	32.4
116D	48.4	4.7	8.9	29.3	8.7	37.3
117D	46.5	12.6	12.5	28.4	0.0	30.6
118D	33.1	1.8	3.1	55.3	6.7	51.3
120D	43.4	11.9	16.7	28.0	0.0	31.6
130D	100.0	0.0	0.0	0.0	0.0	5.0
131D	100.0	0.0	0.0	0.0	0.0	5.0
133D	33.5	4.0	5.5	44.1	12.9	50.4
134D	70.1	5.2	7.8	14.1	2.8	20.8
135D	24.8	1.8	2.0	40.3	31.1	63.6
136D	17.4	5.8	16.9	59.9	0.0	53.2
146D	100.0	0.0	0.0	0.0	0.0	5.0
149D	28.0	4.3	5.6	39.9	22.2	56.4
150D	46.5	9.9	12.2	29.9	1.5	32.6
151D	20.2	3.3	5.0	63.8	7.7	59.0
152D	4.4	2.6	6.5	54.3	32.2	76.1
153D	2.3	4.5	5.7	62.5	25.0	74.9
162D	68.7	1.8	5.1	24.4	0.0	24.0
163D	56.1	2.5	5.8	35.0	0.6	32.3
164D	22.6	6.3	12.5	58.6	0.0	50.9
165D	40.5	5.2	13.2	26.5	14.6	42.4
166D	37.8	4.8	21.9	34.7	0.8	37.9
167D	23.2	12.2	26.9	32.6	5.1	43.1
168D	0.0	0.4	5.8	64.1	29.7	80.0
169D	90.0	10.0	0.0	0.0	0.0	6.3
	40.4*	5.2*	9.0*	36.4*	9.0*	42.7**

*Average percentage by category for mission.
**Overall mission cloud cover percentage.

APPENDIX E. MISSION COVERAGE STATISTICS

1. Summary of Plottable Photographic Coverage, Mission 1031-1

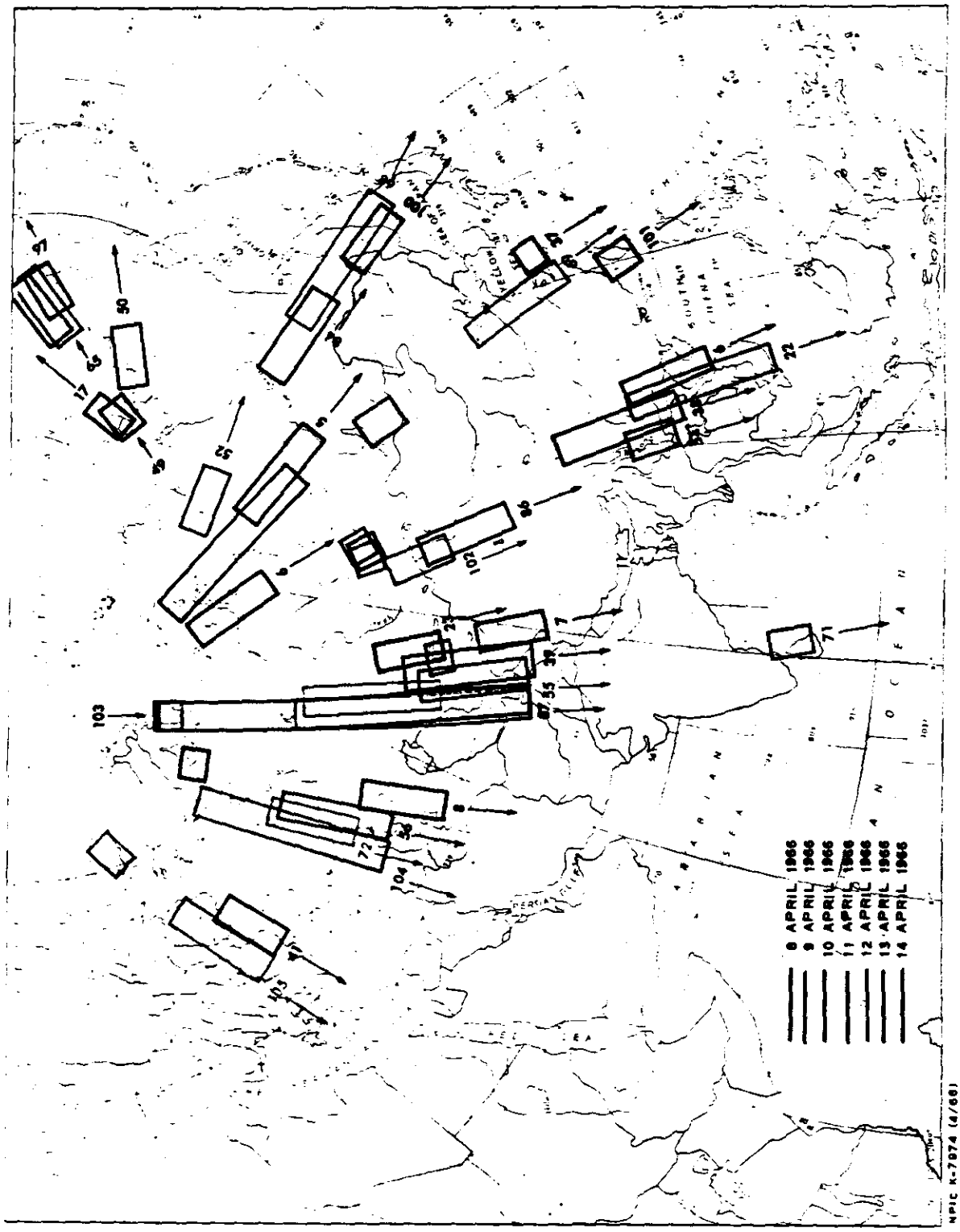
	Forward Camera		Aft Camera		Totals	
Country	Linear nm	Square nm	Linear nm	Square nm	Linear nm	Square nm
USSR	15,385	2,538,244	15,321	2,525,088	30,706	5,063,332
China	2,979	452,714	3,022	459,038	6,001	911,752
Canada	793	110,634	793	110,634	1,586	221,268
N Vietnam	593	59,260	593	59,260	1,186	118,520
Bolivia	396	64,944	396	64,944	792	129,888
Libya	377	58,058	377	58,058	754	116,116
Poland	369	61,254	369	61,254	738	122,508
Mexico	363	51,232	374	52,948	737	104,180
Niger	362	55,064	367	55,064	729	110,128
Mauritania	278	42,812	282	43,428	560	86,240
Mongolia	240	39,840	240	39,840	480	79,680
Congo	225	34,650	225	34,650	450	69,300
S Vietnam	215	32,680	215	32,680	430	65,360
Rumania	198	32,868	189	31,374	387	64,242
Laos	187	28,510	187	28,510	374	57,020
Taiwan	185	12,124	185	12,124	370	24,248
Ceylon	164	7,448	164	7,448	328	14,896
Morocco	149	22,946	151	23,254	300	46,200
Ghana	149	22,648	144	21,888	293	44,536
Brazil	136	22,304	136	22,304	272	44,608
Peru	129	21,156	129	21,156	258	42,312
Upper Volta	112	17,024	108	16,416	220	33,440
Ivory Coast	112	17,024	108	16,416	220	33,440
Afghanistan	109	18,022	90	14,868	199	32,890
Alaska US	87	2,520	87	2,520	174	5,040
India	82	1,216	82	1,216	164	2,432
Cambodia	72	10,944	72	10,944	144	21,888
Cameroon	64	9,856	64	9,856	128	19,712
Mali	62	9,548	62	9,548	124	19,096
Kashmir	62	10,070	60	9,738	122	19,808
Czechoslovakia	57	9,462	53	8,798	110	18,260
Hungary	57	9,462	53	8,798	110	18,260
Spanish Sahara	48	7,392	50	7,700	98	15,092
Pakistan	47	7,802	25	4,150	72	11,952
Algeria	32	4,928	33	5,082	65	10,010

Japan	21	1,826	21	1,826	42	3,652
Argentina	20	3,280	20	3,280	40	6,560
Chad	18	2,736	18	2,736	36	5,472
Norway	17	2,958	17	2,958	34	5,916
Ifni	16	503	17	503	33	1,006
Gabon	16	2,464	16	2,464	32	4,928
UN Central African Rep	16	2,464	16	2,464	32	4,928
Sweden	4	696	4	696	8	1,392
TOTAL	25,003	3,923,587	24,935	3,907,921	49,938	7,831,508
Continental US	269	41,964	270	42,120	539	84,084
GRAND TOTAL	25,272	3,965,551	25,205	3,950,041	50,477	7,915,592

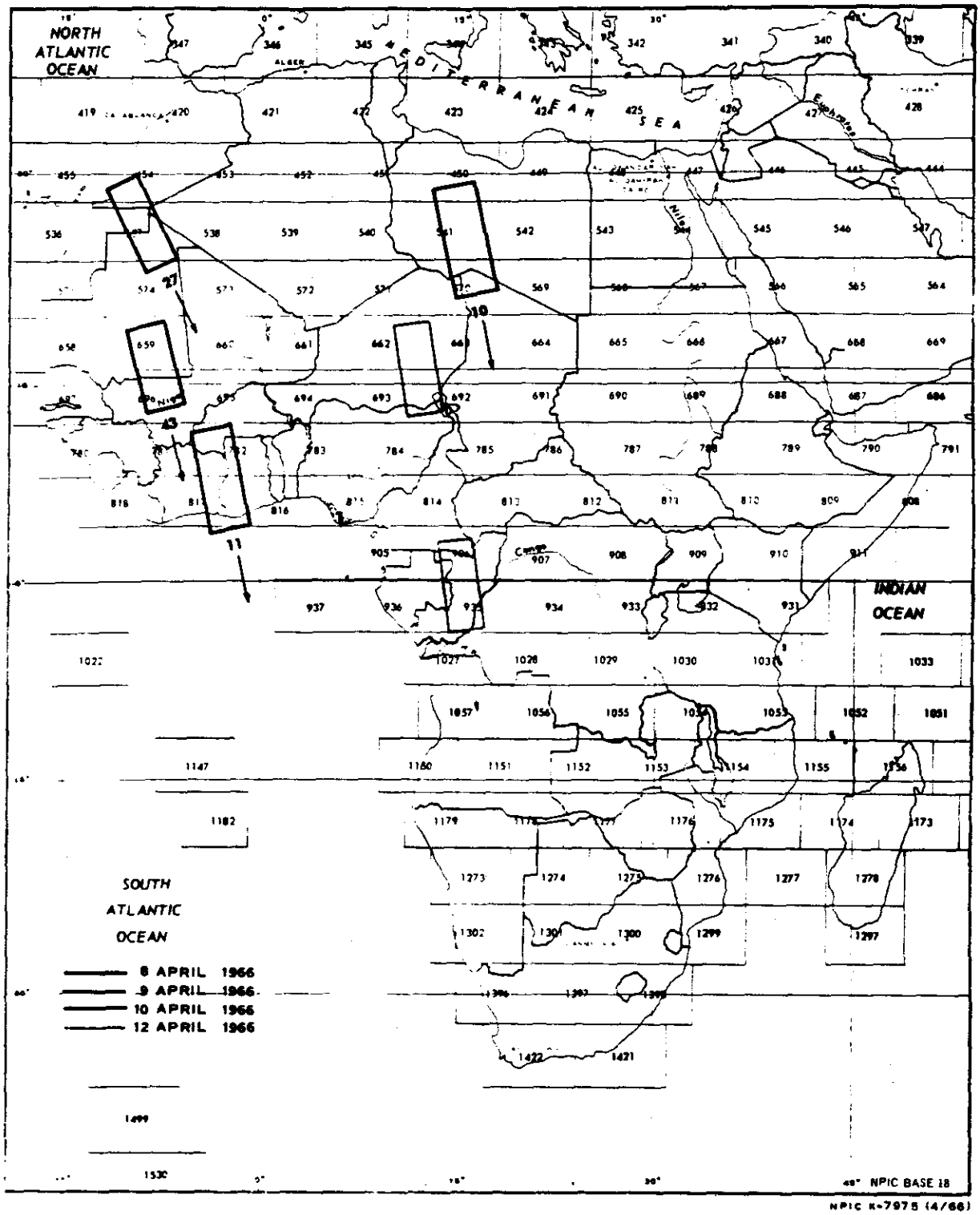
[redacted]

	Forward Camera		Totals	
Country	Linear nm	Square nm	Linear nm	Square nm
USSR	13,956	2,358,874	13,956	2,358,874
China	6,598	1,058,494	6,598	1,058,494
Taiwan	226	9,440	226	9,440
Afghanistan	187	29,920	187	29,920
Mongolia	174	28,368	174	28,368
Philippines	124	4,408	124	4,408
E Germany	74	12,876	74	12,876
Poland	70	11,684	70	11,684
India	59	9,440	59	9,440
Czechoslovakia	41	6,806	41	6,806
Sudan	41	6,232	41	6,232
Mexico	22	3,432	22	3,432
Finland	19	3,306	19	3,306
Alaska US	10	1,700	10	1,700
Pakistan	6	960	6	960
TOTAL	21,607	3,545,940	21,607	3,545,940
Continental US	450	70,200	450	70,200
GRAND TOTAL	22,057	3,616,140	22,057	3,616,140

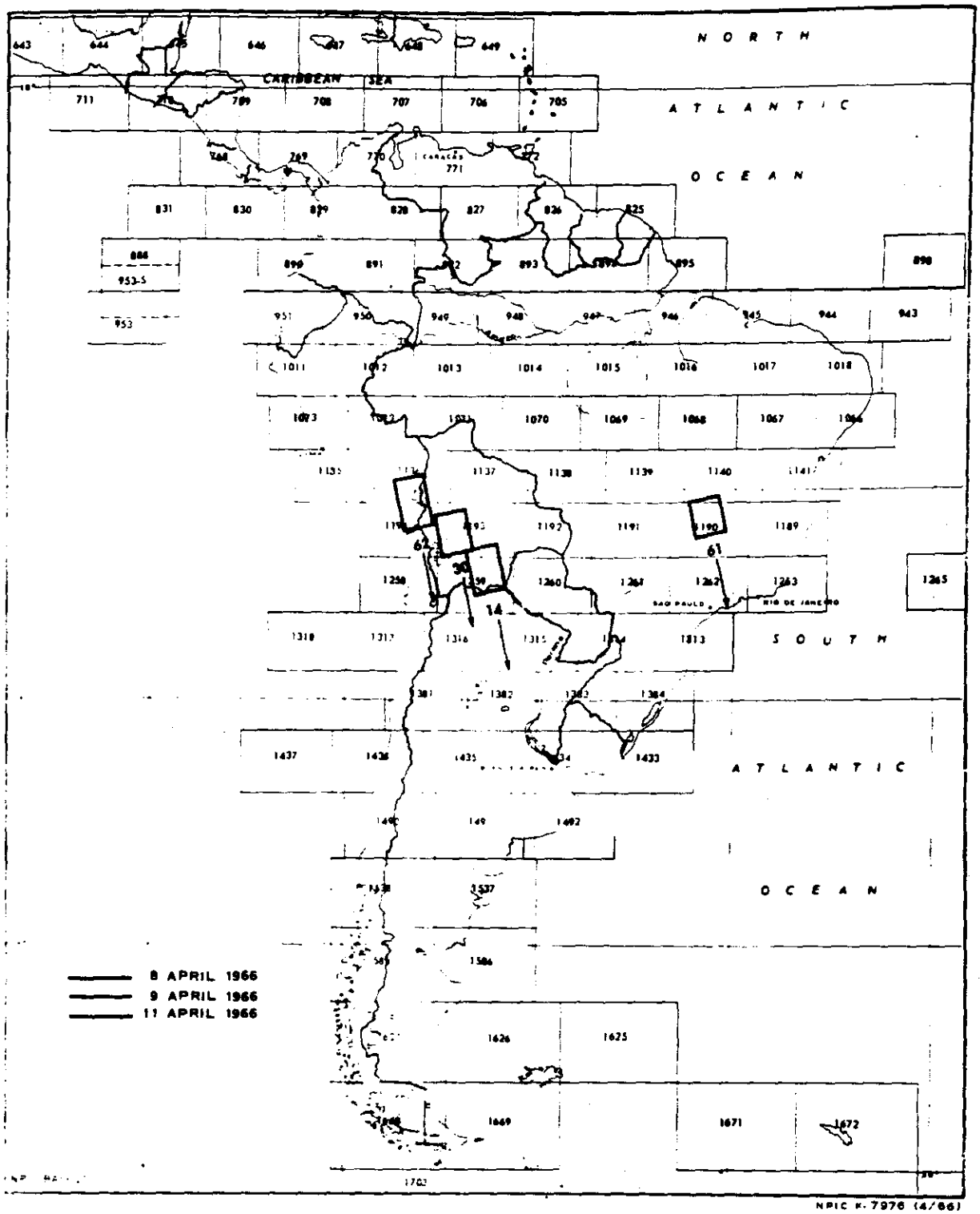
[redacted]



APPROXIMATE TRACK OF MISSION 1031-1, 8-14 APRIL 1966 OVER USSR, FAR AND MIDDLE EAST.



APPROXIMATE TRACK OF MISSION 1031-1, 8-14 APRIL 1966 OVER AFRICA.



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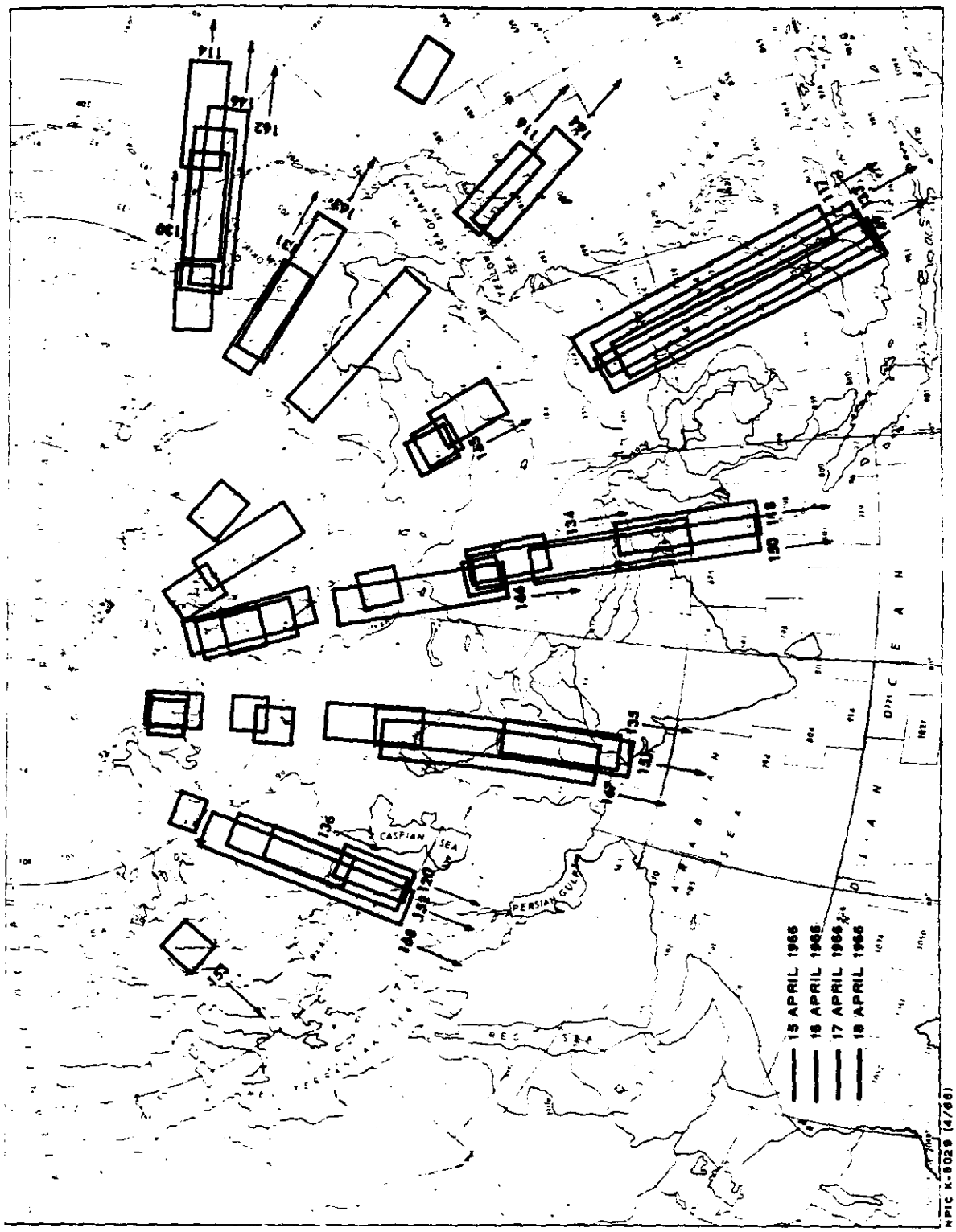

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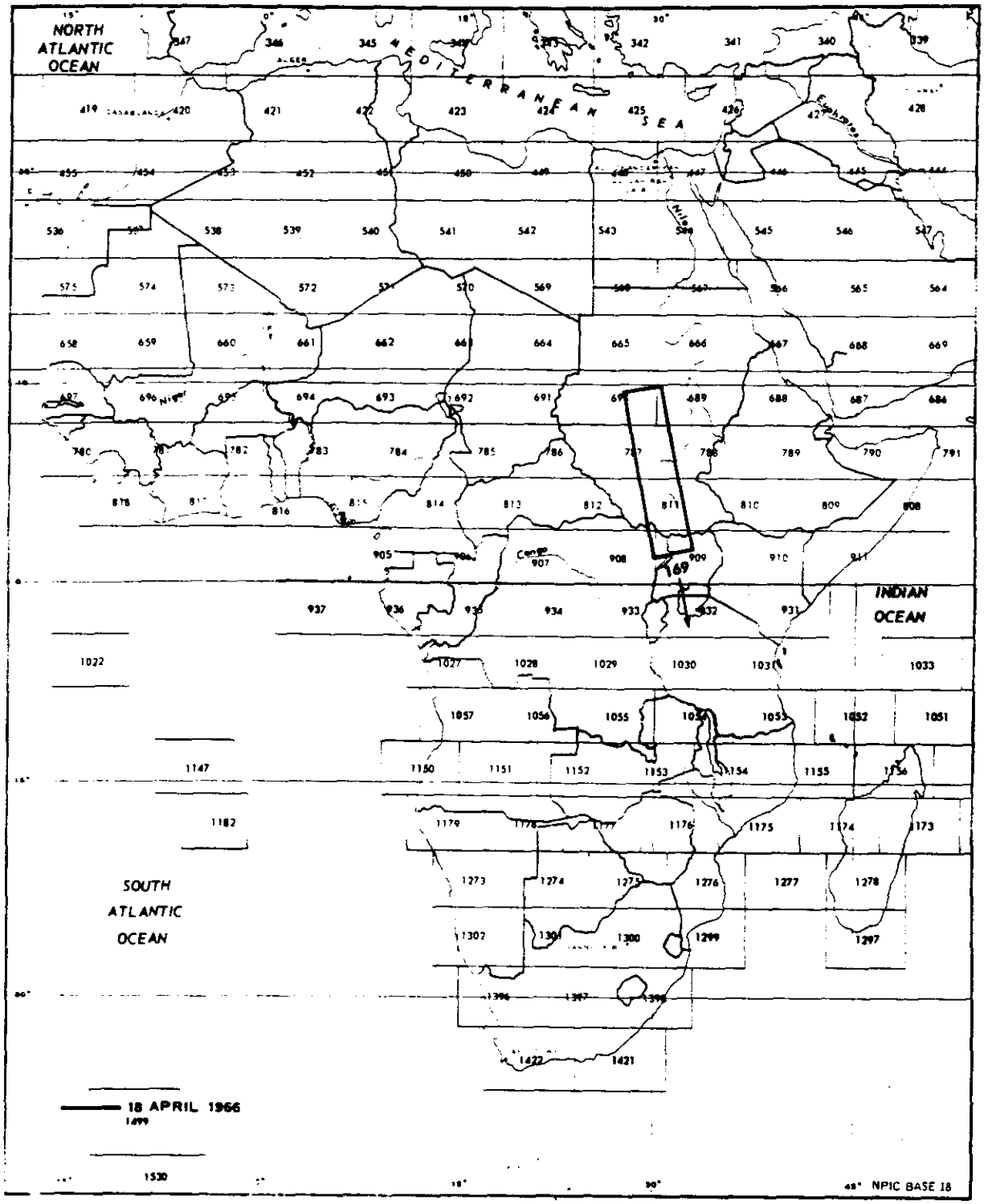

APPROXIMATE TRACK OF MISSION 1031-2, 15-18 APRIL 1966 OVER AFRICA.