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PREFACE

This manual has been prepared by the National Photographic Interpretation Center with the coordination of the National Reconnaissance Office to provide information for use in planning and exploitation of the products of the [redacted] system.

Information is current as of the date of publication. Some changes may occur in the data presented when engineering or operational philosophy requires a redesign or modification.

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INTRODUCTION

The [redacted] Camera System consists of dual panoramic cameras designed to provide high-resolution, convergent stereo coverage of major portions of the world for search and surveillance requirements. In addition to the dual cameras, the [redacted] contains a mapping camera system consisting of dual stellar cameras and a vertical terrain camera; however, this system will not be operational until the seventh mission. These additional cameras are designed to provide the mapping, charting, and geodetic community with a data base commensurate with its requirements.

PANORAMIC CAMERA SYSTEM

Configuration

The panoramic camera system consists of dual panoramic cameras mounted side by side (Figure 1). The port camera unit looks forward 10° from vertical, and the starboard looks aft 10°, the two forming a 20° stereo convergence angle. (The fwd-looking instrument is designated Camera A; the aft-looking, Camera B). Both units simultaneously scan across track in opposite directions. The forward camera scans the ground from right to left; the aft unit, from left to right.

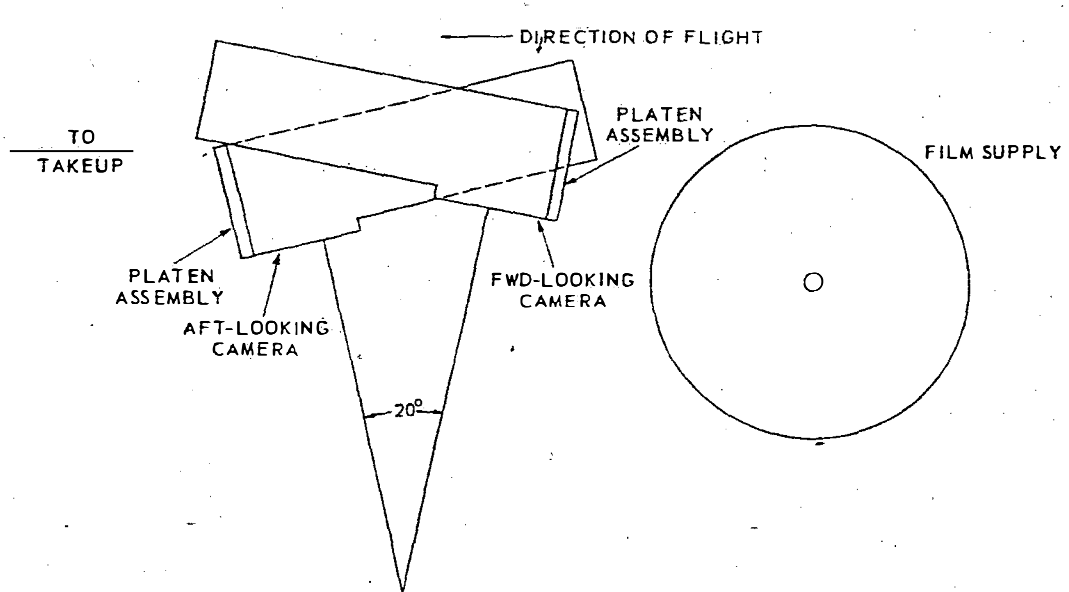

FIGURE 1. PANORAMIC CAMERA ASSEMBLY

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Camera Parameters

	Maximum	Minimum
Scan rate	3.4 rad/sec	1.1 rad/sec
Cycle time	5.6 sec	1.9 sec
Film velocity (at slit)	204 in/sec	66 in/sec
V/h	.054 rad/sec	.018 rad/sec
Exposure time	14 msec	0.4 msec

Optics

The optical train is a catadioptric system consisting of an aspheric corrector plate, a folding mirror, a primary spherical mirror, and a field corrector group (Figure 2).

Optical System Parameters

Effective focal length	60 in
Relative aperture	f/3
Field coverage	2.87° (half angle) 5.73° (full field)
Aperture diameter	20 in
Filter	Wratten 12
Slit length	6.0 in
Slit width	0.08 to 0.91 in
T-number	3.5 max (not including effects of filter)
Optical system	Folded Wright

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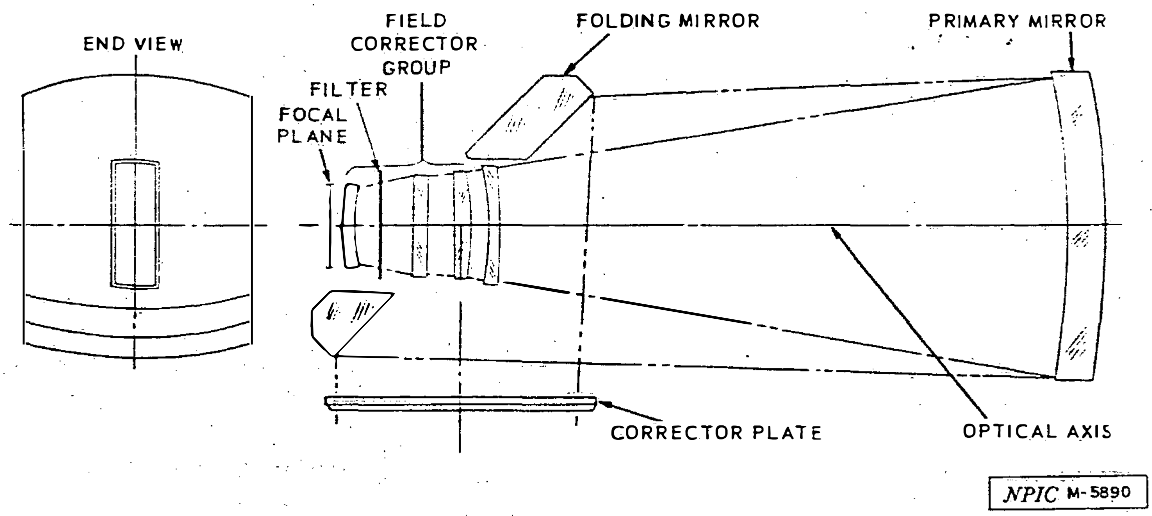

FIGURE 2. PANORAMIC CAMERA OPTICS

Camera Resolution

The specification for the [redacted] camera states: "The resolution of the Sensor Subsystem shall be 139 l/mm or better at scan nadir and at a point on the format determined by zero field angle, and 94 l/mm or better elsewhere, for the operating conditions...specified [sic 30° solar altitude]." Figure 3 illustrates the two sigma low predicted resolution based on the camera design requirements at 2:1 target contrast and 600 foot-Lamberts minimum brightness. Figure 4 translates these resolution values to ground resolved distances from 82 nm. It must be realized that these numbers do not account specifically for haze, nor do they reflect performance at any solar altitude other than that relating to the 600 foot-Lamberts specification (30°).

There will be, as with any camera, losses in performance as solar altitude (brightness) decreases and/or haze increases. Figures 5 and 6 demonstrate the typical performance of a [redacted] camera as a function of scene brightness and for three conditions of field and scan angles.

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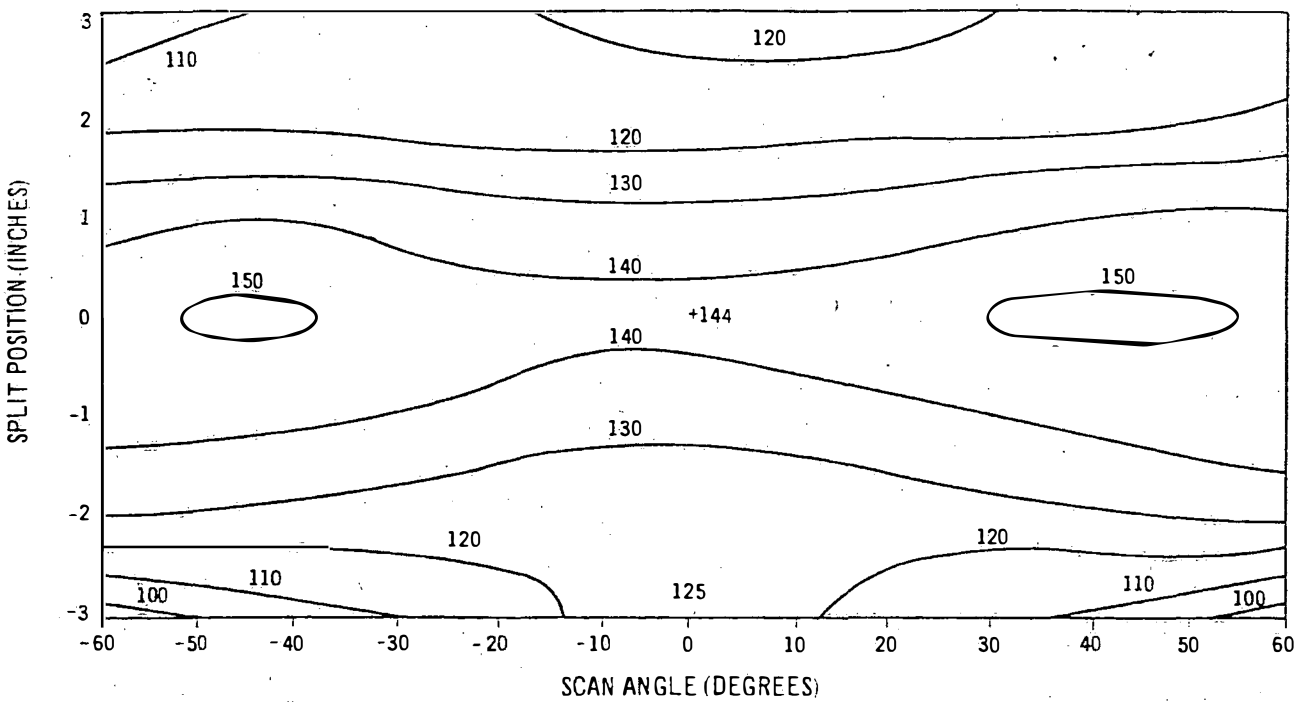

FIGURE 3. PREDICTED 2 SIGMA LOW CAMERA RESOLUTION (L/MM) Based on design requirements

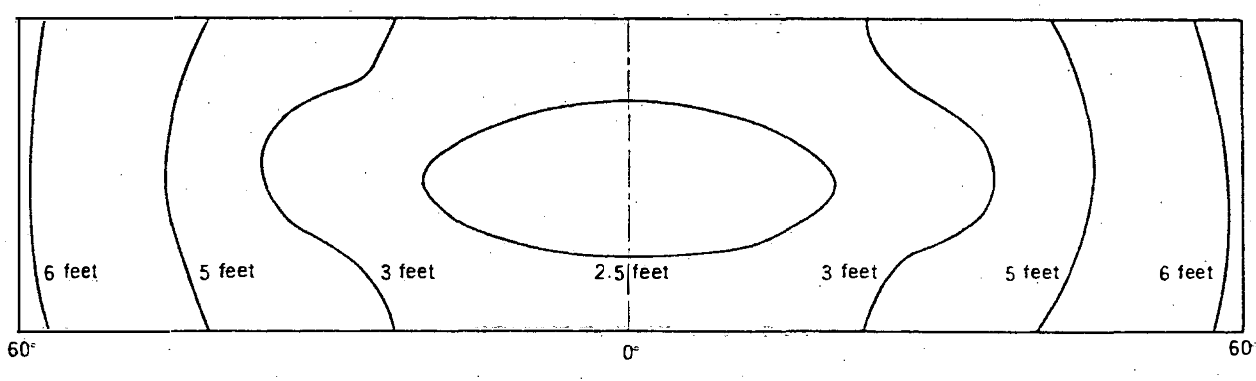

FIGURE 4. PREDICTED 2 SIGMA LOW GROUND RESOLUTION (FT) Based on design requirements at 30° solar altitude and constant 2:1 contrast from 82 nm

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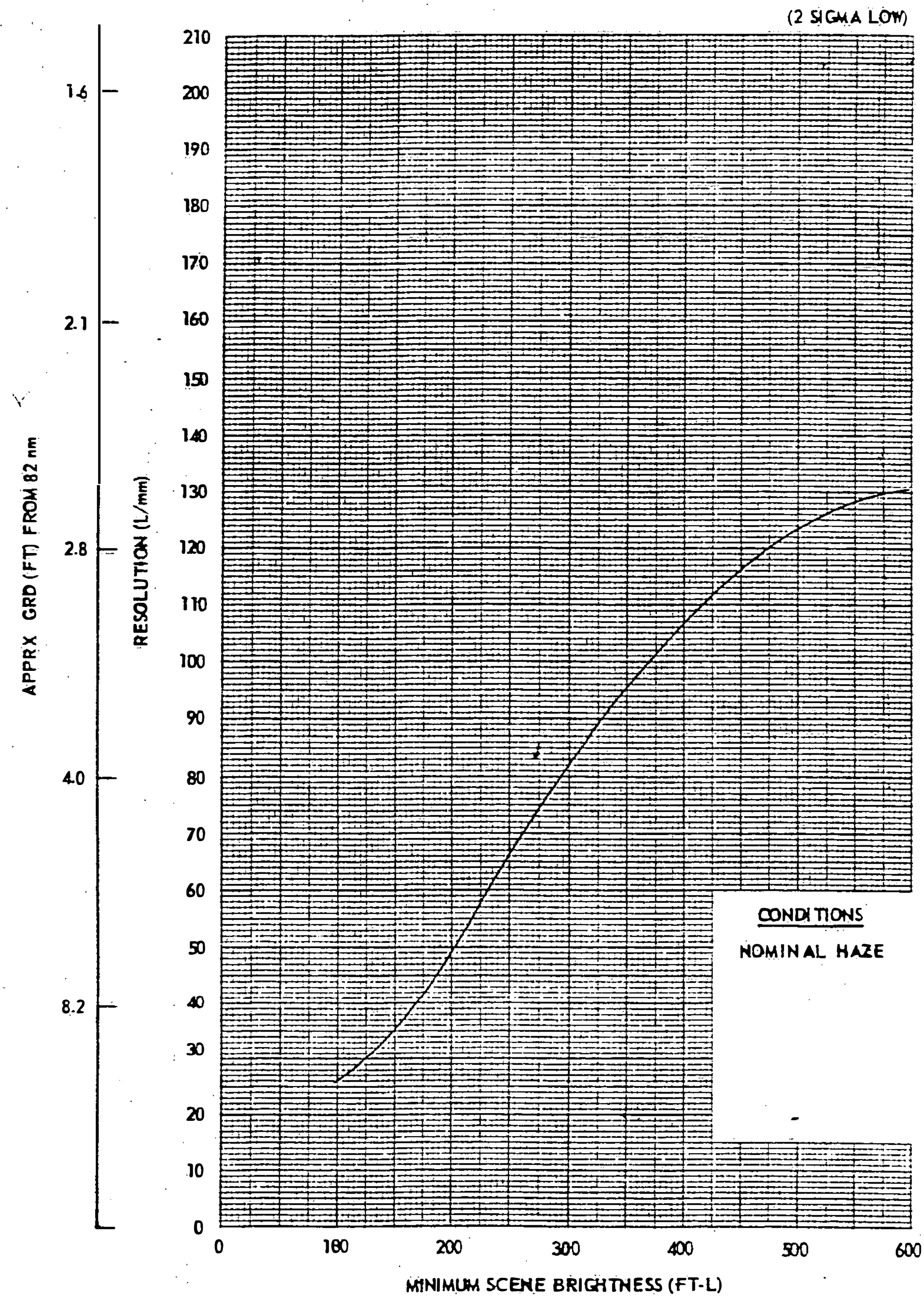

FIGURE 5. PREDICTED GEOMETRIC MEAN RESOLUTION VS. BRIGHTNESS (at nadir)

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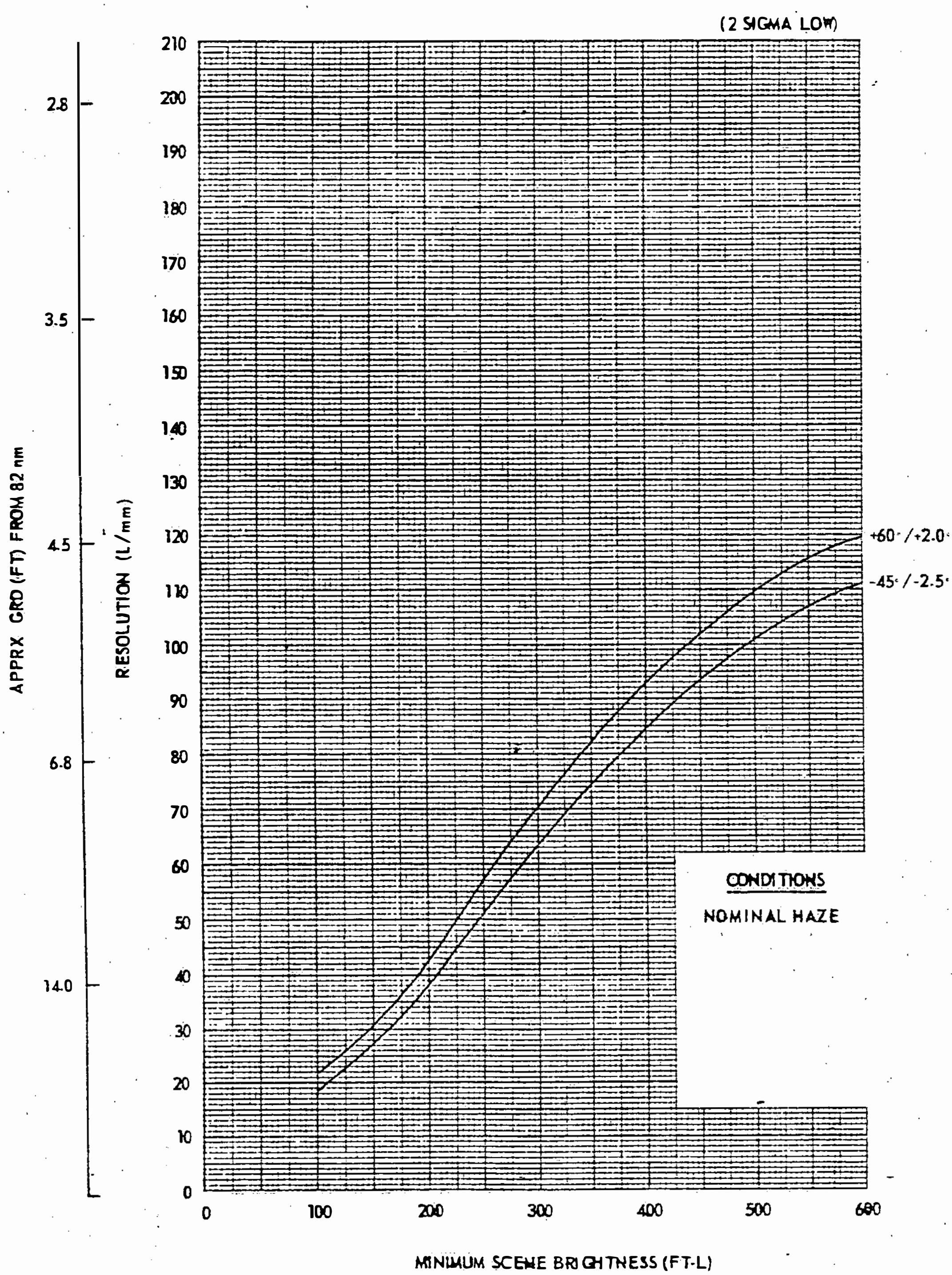

FIGURE 6. PREDICTED GEOMETRIC MEAN RESOLUTION VS. BRIGHTNESS (off axis)

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Coverage

The cameras' constant 20° convergence angle results in a one-half frame overlap between the forward and aft cameras. The aft camera photographic operation lags that of the forward camera by three frames during each start cycle. At the end of each photographic sequence, the forward camera shutter closes first, and the aft camera shutter closes three frames later. Therefore, the trailing half of the first frame of the aft camera and the leading half of the last frame of the fwd camera is monoscopic in every operation. All other imagery is 20° convergent stereoscopic coverage.

An average mission provides approximately 24 million square nautical miles of stereoscopic coverage. Other coverage statistics, as computed at an 82nm altitude, are given below:

Lateral Ground Coverage in nm/Frame

		Scan Center			
		0°	±15°	±30°	±45°
Scan Sector	30°	45	48	62	102
	60°	96	107	150	
	90°	169	198		
	120°	300			

In-Track Ground Coverage in nm/Frame

Scan Angle	Coverage (nm)
0°	8.5
±15°	8.8
±30°	9.9
±45°	12.4
±60°	18.7

Area Ground Coverage in nm²/Frame

		Scan Center			
		0°	±15°	±30°	±45°
Scan Sector	30°	383	432	634	1.368
	60°	863	1.017	1.800	
	90°	1.652	2.231		
	120°	3.599			

1 nm = 6.076.115 feet

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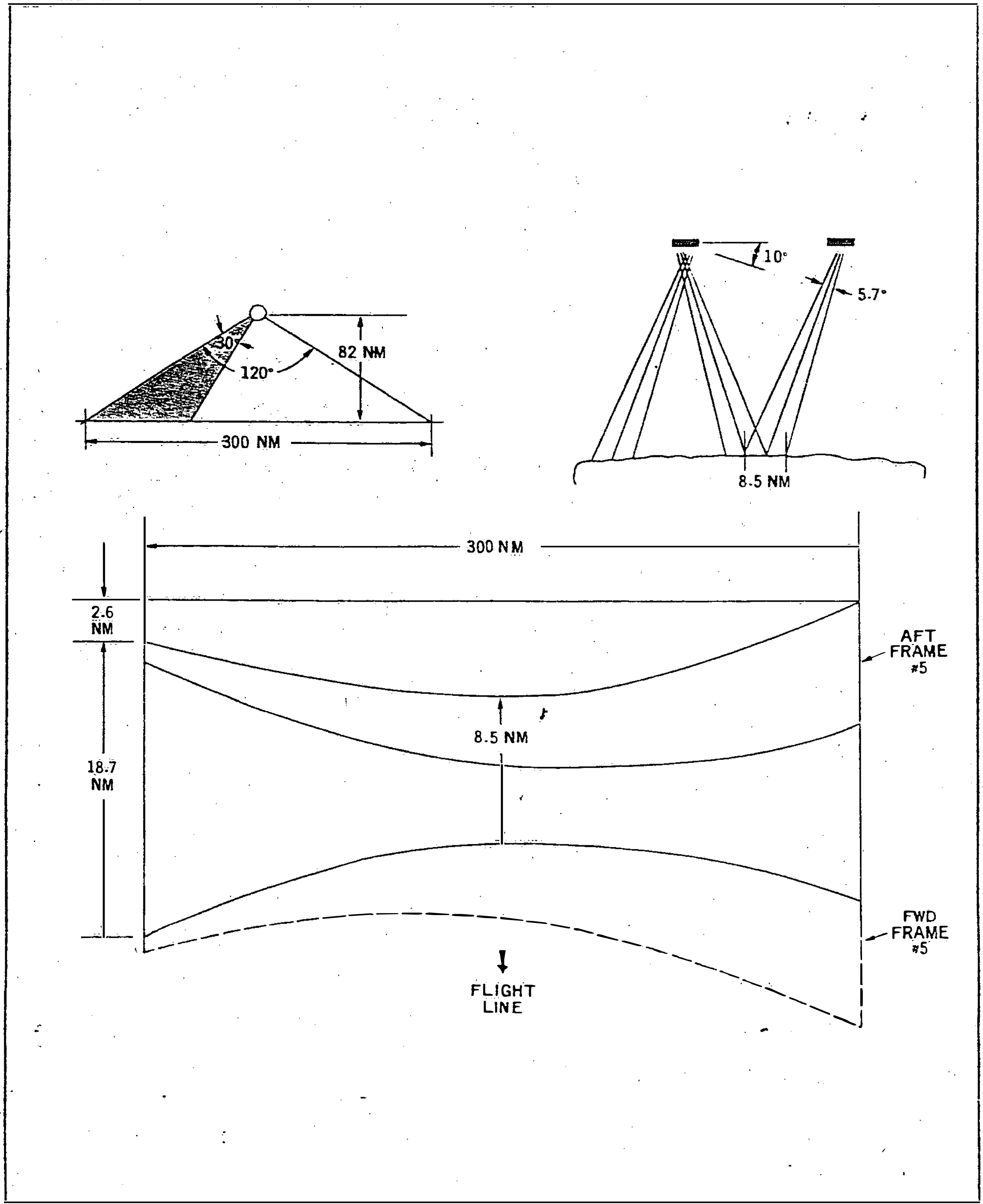

FIGURE 7. SCAN COVERAGE

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Modes of Operation

The [redacted] panoramic cameras operate in any single commanded mode (scan center and swath width) throughout an operation. A photographic operation is measured from the time the shutter of the forward camera opens to the time the shutter of the aft camera closes. A 25- to 70-second delay is required between operations at different scan centers, swath widths, or optical bar rotation rates.

A scan sector of 30°, 60°, 90°, or 120° can be programmed for any one camera operation (Figure 8). The programmed scan sector can be centered at 0°, ±15°, ±30°, or ±45° across the flight track (Figure 9).

Scan Center

		45°L	30°L	15°L	0°	15°R	30°R	45°R
Scan Sector	30°	X	X	X	X	X	X	X
	60°		X	X	X	X	X	
	90°			X	X	X		
	120°				X			

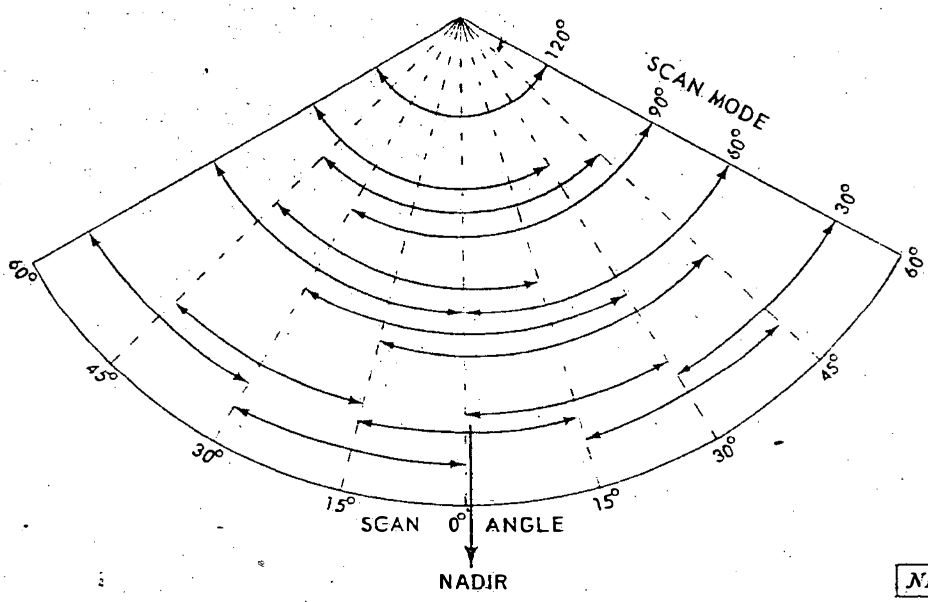

FIGURE 9. MODES AND SCAN ANGLES

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Format

The format length is dependent on the particular scan sector being used, but the image width is a constant 6.0 inches. Sizes range as follows:

Scan Sector	Format Length (ft)
30°	2.62
60°	5.24
90°	7.86
120°	10.48

Film

Data

The film supply capacity for each camera is 104,000 feet of ultra thin base (UTB) 1414 film 6.6 inches wide. Data for this film are as follows:

Main Camera Data

	Fwd and Aft (ft)	Total (ft)
Film Load	104,000	208,000
Frames		
Minimum	8,000	16,000
Maximum	32,000	64,000
Average	18,360	36,720

The exposed film is retrieved in four buckets, each containing approximately 52,000 feet of film (26,000 ft/camera). The buckets contain nearly equal footage but recovery sequences may not have equal time spans.

Approximately 15.6 percent of the film is used for interframe and interoperation spacing. This varies according to the philosophy of operation and can be as low as 8 percent or as high as 18 percent.

Camera operations are conducted in the various available modes in order to maximize collection efficiency considering available accesses, priorities, weather, special requirements, etc. The distributions below represent the number of operations in each mode and the corresponding percentage of film consumed for a simulated "typical" mission. Actual missions can be expected to vary from these figures depending on the specific conditions which pertain to each flight.

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Number of Camera Operations

		Scan Sector			
		30°	60°	90°	120°
Scan Center	0°	16	31	16	90
	±15°	42	19	35	
	±30°	55	84		
	±45°	178			
Total		291	134	51	90
% of Total		51	24	9	16

Percent of Film Consumed

		Scan Sector			
		30°	60°	90°	120°
Scan Center	0°	1	3	3	51
	±15°	1	3	9	
	±30°	3	13		
	±45°	13			
Total		18	19	12	51

Exposure

Film exposure ranges from 0.4 to 14 milliseconds.* It is controlled by the slit width, which is adjustable between 0.080 and 0.910 inch with an accuracy of ±0.015 inch or ±5 percent, whichever is greater. The slit width can be adjusted in increments of 8 percent of the previous setting, with only one increment adjustment during the transport recycle between frames. The slit width is independently controlled for each camera.

Recorded Data

The panoramic camera contains several items of recorded data which are of importance to the exploitation system (Figure 10). These items include scan angle marks, time track recording, and start of frame and start of operation marks.

Scan Angle Marks

These are 381-micrometer (micron) diameter dots spaced at 5.24-inch intervals along the format edges to reference universal grid orientation and reporting. They are optically recorded during exposure at 5° intervals along both edges of the film. The cross-track distance between scan angle marks varies slightly because the film velocity is modulated to correct for cross-track components of image motion.

Time Recording

Time Track. Time marks, 381-micrometer-diameter dots, are recorded at .002 second intervals on the non-titled edge of the film. This 500 cycle/second time track is used to determine the film velocity at the slit.

*Over the entire Vx/h range.

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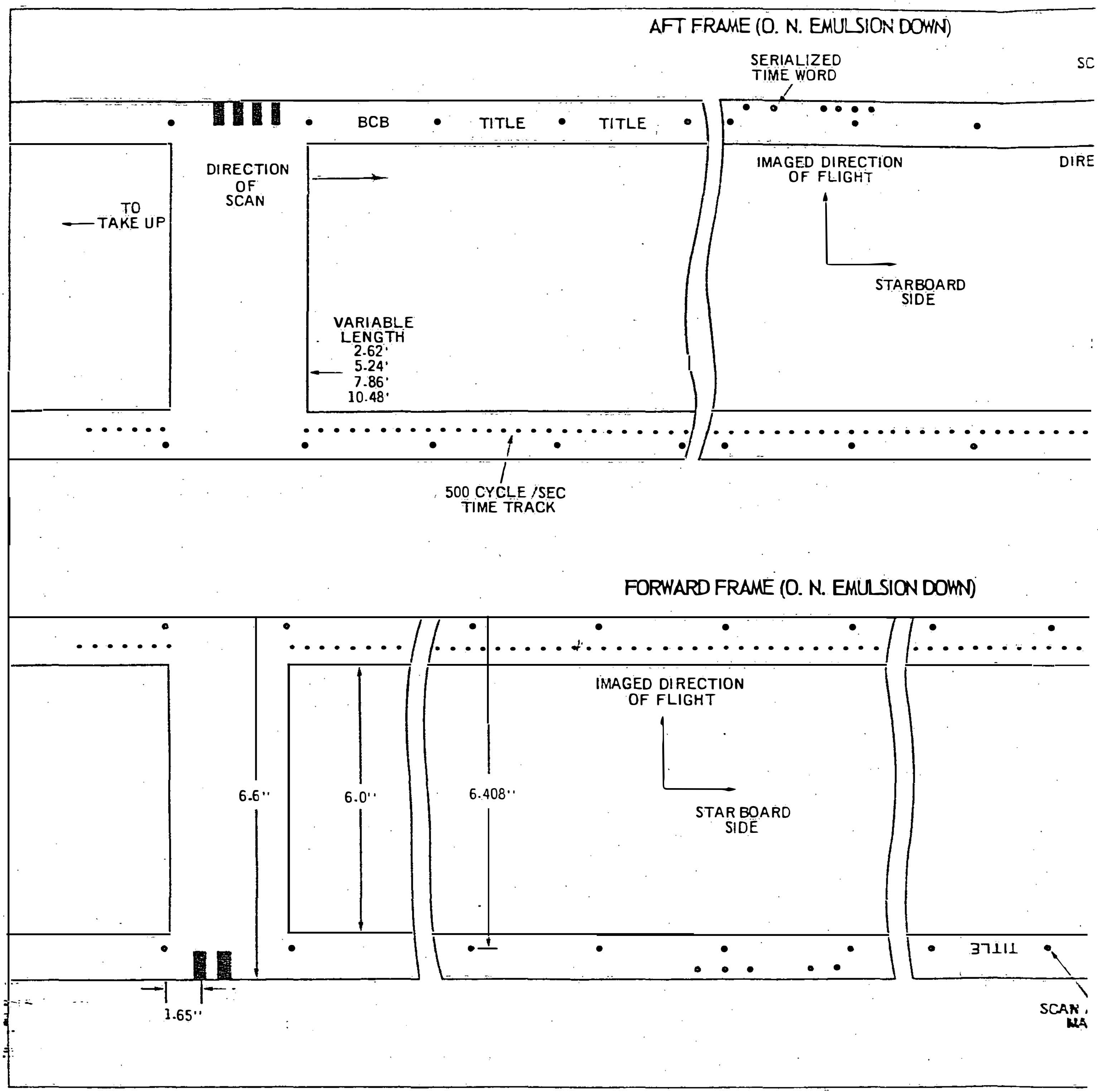

FIGURE 10. PANORAMIC CAMERA FORMAT DIAGRAM

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Time word. A vehicle time is recorded 5° after the start of scan but is not imaged until the center of scan. This time is imaged as a serialized time word beginning at the center of format on the titled edge of the frame. The time word consists of 35 bits imaged in the following manner:

First bit after scan center	Index
Next 24 bits	200 msec clock
Next 8 bits	1 msec clock
Next bit	Parity
Last bit	Index

The following is a list of binary values in milliseconds:

Least significant bit nearest the supply end of the format	1
	2
	4
	8
	16
	32
	64
	128
	200
	400
	800
	1,600
	3,200
	6,400
	12,800
	25,600
	51,200
	102,400
	204,800
	409,600
	819,200
	1,638,400
	3,276,800
	6,553,600
	13,107,200
	26,214,400
	52,428,800
	104,857,600
	209,715,200
	419,430,400
	838,860,800
Most significant bit nearest the center of scan	1,677,721,600

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The time word is used as a backup system if the ephemeris data are not available. The time track and the serialized time word are variable in spacing since they are recorded at different film speeds on each frame. NPIC has prepared a template (Figure 11) used to read the time word at varying film speeds.

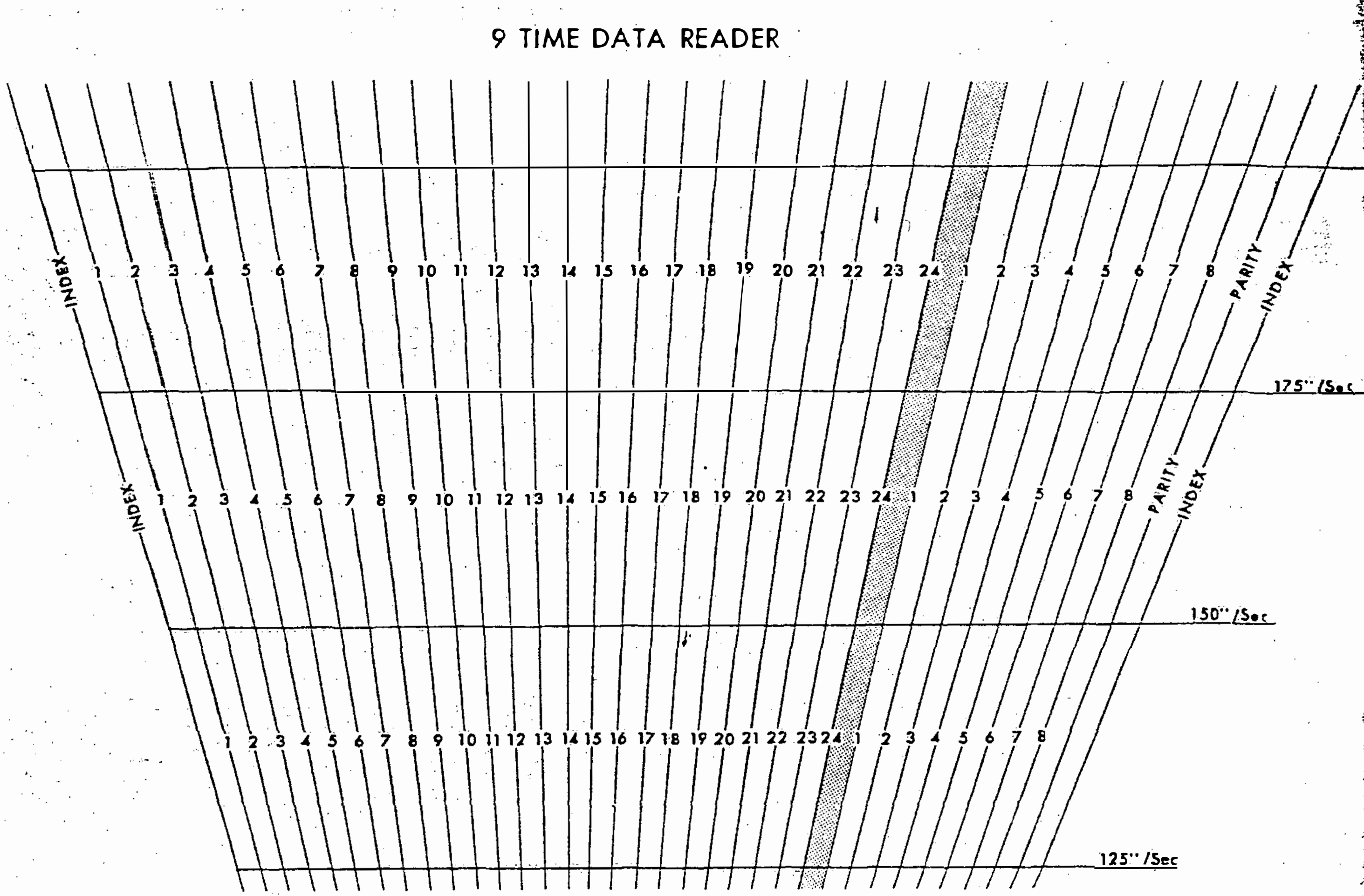

FIGURE 11. TIME WORD TEMPLATE

Start of Frame and Operation Indicators

The beginning of each frame is indicated by two marks (0.25 x 0.30 inches) imaged on the film edge in the space preceding the frame.

The beginning of an operation is signified by four marks preceding the first frame of the operation.

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Titling Data

The following data are optically titled on the original negative:

Binary code block (machine-readable code to identify frame number)
Mission number
Bucket number
Acquisition date
Camera designator (fwd or aft)
Classification (TOP SECRET [redacted] for all frames plus Noforn identification when required)
Revolution number
Scan center
Scan mode:
- 1M = 30°
- 2M = 60°
- 3M = 90°
- 4M = 120°

Operation number
Frame number

In addition, scan angle marks are optically titled numerically for identification and reporting ease. The signed, two-digit numbers are placed after the first and just prior to every third scan angle mark thereafter (every 15°) with one exception: the last scan angle mark of each frame is not titled. The scan angle marks on a forward 120° scan are titled from -60 to +60; whereas on the aft, the scan angle marks are titled from +60 to -60. Any other scan center/scan width combination is titled as a segment of the 120° scan (see Figure 12 for a visual presentation of scan angle mark titling).

An example of the frame titling is portrayed in Figure 13.

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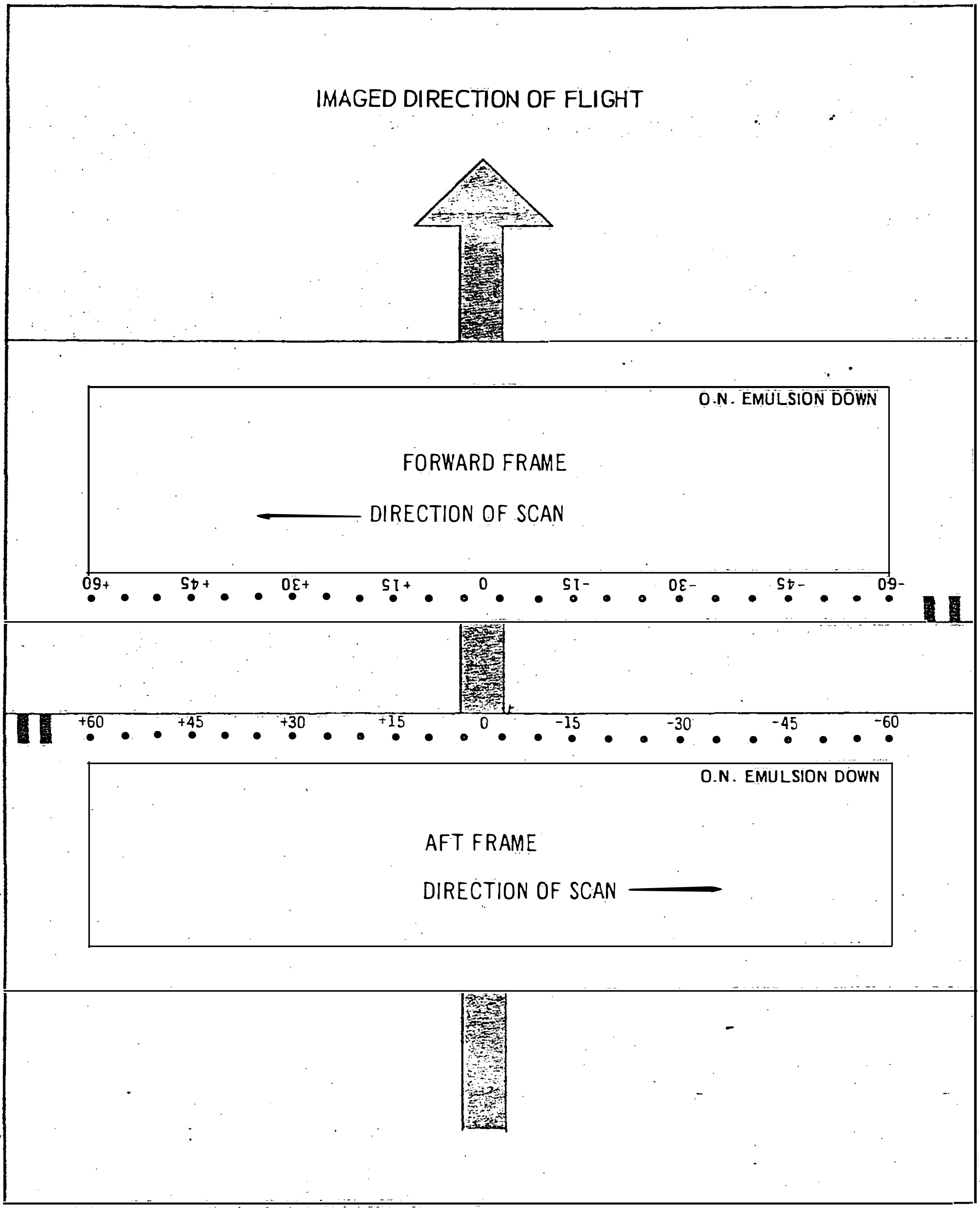

FIGURE 12. SCAN MARK TITLING

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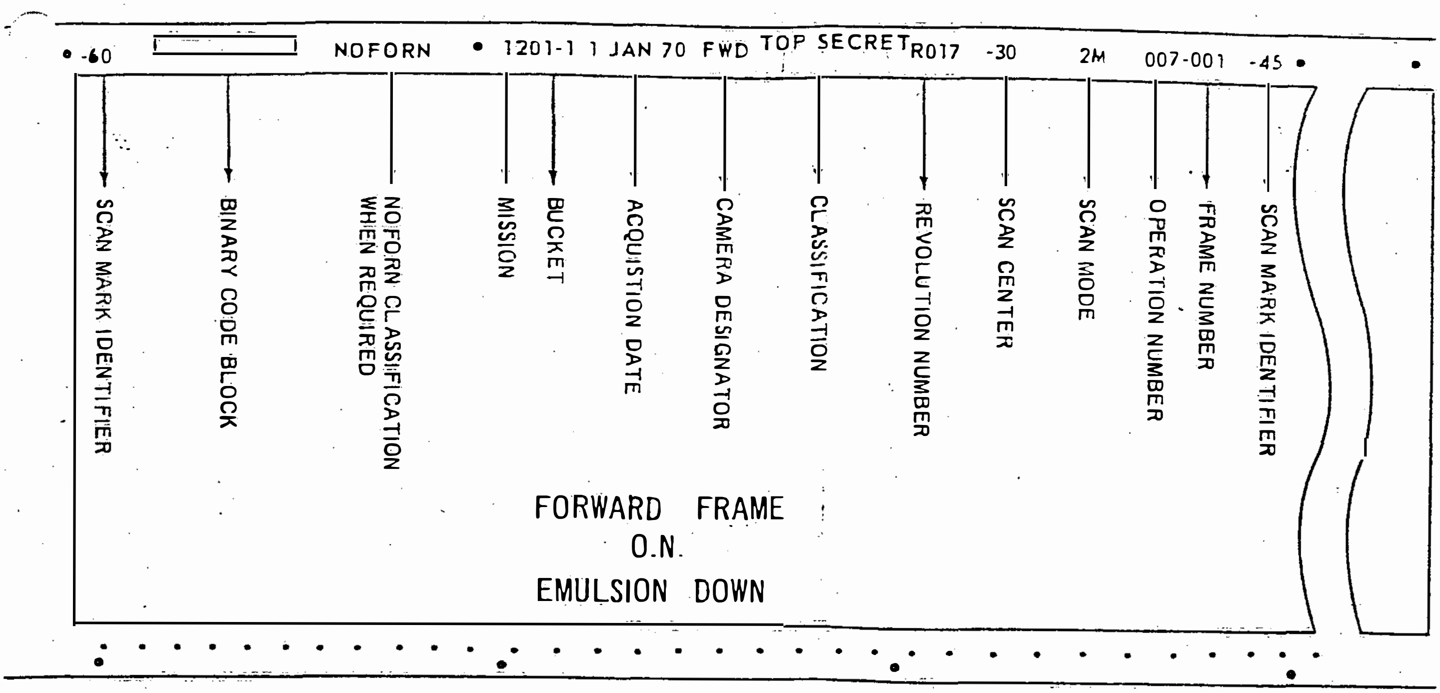

FIGURE 13. TITLING INFORMATION

Ephemeris Information

A complete ephemeris, known as a Mission Profile Report (MPR), will be available on a daily basis within NPIC several days prior to the arrival of the film from each recovery bucket. It provides the data for the mensuration data base as well as the target information necessary for exploitation.

This ephemeris is as accurate as the tracking system used in developing the orbital parameters and includes the data listed below:

Data	Frequency
1. Mission number	Report
2. Vehicle number	Report
3. Vehicle/ephemeris identification	Report
4. Camera parameters (fwd and aft)	Report
a. Film type	
b. Filter	
c. Focal length	
5. Slit calibration (fwd and aft)	Report
6. Time correlation parameters	Report
7. MPR initial ephemeris conditions	Report
8. MPR physical constants	Report

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Data	Frequency
9. A 20-point ephemeris	Revolution
a. Time of node	
b. Longitude of node	
c. Time of ephemeris points	
d. X,Y,Z components of vehicle position	
e. X,Y,Z components of vehicle velocity	
f. X,Y,Z components of inertial acceleration	
10. Operation information	Operation
a. Date	
b. First/last frame reference time	
c. Scan sector (width)	
d. Scan center	
e. Latitude and longitude of operation corners	
11. Frame information	Frame
a. Frame number	
b. Current revolution	
c. Operation number	
d. Optical bar (A or B)	
e. System time of frame reference point, 5 degrees after start of scan, (FRT)	
f. Vehicle time in octal	
g. Commanded Vy/h	
h. Commanded Vx/h	
i. Computed Vx/h	
j. Commanded optical bar rotation rate	
k. Computed optical bar rotation rate	
l. Slit calibration	
m. Commanded film speed	
n. Computed film speed	
o. Latitude and longitude of nadir at FRT	
p. Latitude and longitude of frame reference point which complies with FRT	
q. Vehicle inertial velocity at FRT	
r. Ground track velocity at FRT	
s. Vehicle inertial azimuth at FRT	
t. Ground track azimuth at FRT	
u. Sun elevation at FRT	
v. Sun azimuth at FRT	
w. Vehicle altitude	
x. Vehicle flight path angle at FRT	
y. Latitude and longitude of the frame corners	
z. Frame target acquisition data	
(1) Target ID	

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Data	Frequency
(2) Framing state of target	
(a) FF - Completely in frame	
(b) FI - Center in frame, edge intersects frame boundary	
(c) MI- Center in margin, edge intersects frame boundary	
(d) OI - Center outside margin, edge intersects frame boundary	
(e) MO - Target completely inside margin area between frame boundary and frame edge	
(3) X,Y coordinates of target on frame	
(4) Latitude, longitude, altitude and diameter of the target	
12. Orbit adjust parameters	Event
13. Classification	Page

In addition, an operation performance summary will be provided after each bucket. This summary includes not only some of the information presented in the MPR but also the following:

1. Total film consumption for the bucket
2. Film consumption per operation
   a. Exposed
   b. Interframe
3. Interoperation spacing
4. The amount and percentage of film rated good per operation
5. Vehicle attitude for each frame
6. Vehicle attitude rates for each frame
   a. Mean
   b. Minimum
   c. Maximum
7. Frame length
8. Length of the frame rated good
9. The percentage of the frame which meets specifications with regard to dynamic motions that affect resolution during exposure
10. The scan angle for each target

Image Motion Compensation

Compensation for image motion is accomplished by a combination of film movement and platen rotation. To compensate for the motion caused by the scanning optics, the film is transported at a velocity proportional to the optical bar scan rate. To compensate for the forward motion of the vehicle, the angle of film movement in the lateral plane is continually changed. This skew angle is varied by platen rotation as a function of scan angle.

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Film Velocity

The film velocity, having a maximum velocity of 204 inches per second, is programmed as a function of the velocity/height ratio and is directly tied to the optical bar's rotation. The film velocity past the slit is synchronous with the angular scan rate within a small tolerance. The film velocity is modulated by 0.25 percent to correct for cross-track components of image motion.

Photographic Sequence (Operation)

At the initiation of a photographic sequence the camera system is turned on. This involves turning on power, updating commands such as V/h, slit width, etc., and starting the optical bars (OB), supply takeup spools, and platen oscillation.

At the beginning of a photographic operation, the forward camera shutter opens three frames ahead of the aft shutter to provide stereo/coverage for all photography.

Once the system is up to constant speed the photographic operation begins. Both platens accelerate to OB velocity about 10° ahead of the first point in the scan at which photography could begin. Film velocity is accelerated and is at operating speed at the time the platens start to accelerate. At the end of the 10° the platen and OB are rotating synchronously. Both platens continue to rotate through the full 120° sector. They then stop and reverse direction to reposition the platens for the next frame. After completion of a frame, the film is stopped, reversed, and accelerated again for the next frame.

At the end of a photographic sequence the forward camera shutter is closed first; the aft camera lags by three frames. The film is reversed and a sufficient quantity of exposed film is rewound onto the supply spools to take care of the accelerating period during the next start. The camera system is then turned off.

Attitude Control Device

Attitude from the vehicle attitude system is tape recorded during each panoramic frame and read-out to the ground stations during the mission. The two sigma accuracy of the attitude data is approximately 12 arc minutes. This data is available to interested users; however, it will be part of the MPR package beginning with flight 5. This data may not correspond with the data from the mapping camera stellar photographs due to the possible structural deflections between the horizon sensors and the mapping camera.

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Frame Calibration

NPIC calibrates the recorded data on the forward and aft frames for each mission. The calibration information is used in postflight analysis, mission performance analysis, mensuration programs, and other associated activities. The results of this calibration are sent to the community. The calibration provides the following information (Figure 14):

1. Dimensions of scan angle marks
2. In-track/cross-track distances between scan angle marks
3. Angles between adjacent and opposite scan angle marks
4. Film speed
5. Frame lengths
6. Distance between individual marks of start of frame and start of operation indicators
7. Distance between center of density of start of frame and start of operation indicators to first scan mark

The variances or standard deviations for each of the items measured are provided. The format and method of dissemination are presently being established by the Reports Control Manual Committee.

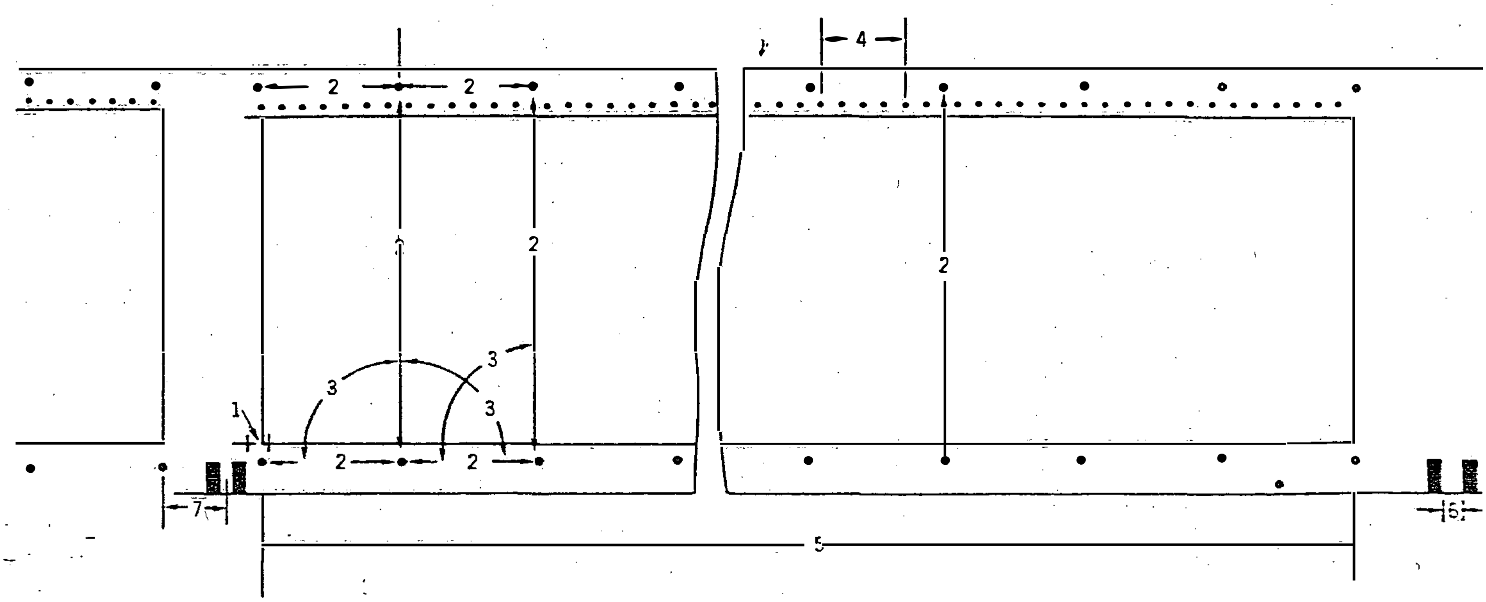

FIGURE 14. FRAME CALIBRATION

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[redacted] Grid Instructions

The Universal Reference Grid (URG) will be used by all exploitation organizations in reporting positions of intelligence targets on [redacted] film. Directions for its use are as follows:

1. With the titled edge up, place the grid over the film with the zero point (X-0, Y-0) on the untitled edge:

2. Align the grid so that the X-0 line is in line with the nearest titled (numbered) scan angle mark to the left of the target, and place the Y-0 line along the bottom edge of the imagery.

3. Read and report coordinates in the following manner:

   a. First, record the camera operation number.

   b. Second, record the frame number.

   c. Third, record the sequential number (i.e., 1 through 8) assigned to the titled scan angle mark aligned with the X-0 line.

   d. Fourth, read right for "X" coordinates, up for "Y" coordinates, and record these readings after the sequential number.

   e. Example: For camera operation 101, frame 022, using the second titled scan angle mark with an "X" reading of 25.5 and a "Y" reading of 10.8, the URG coordinate would be 101/022/2/25.5, 10.8.

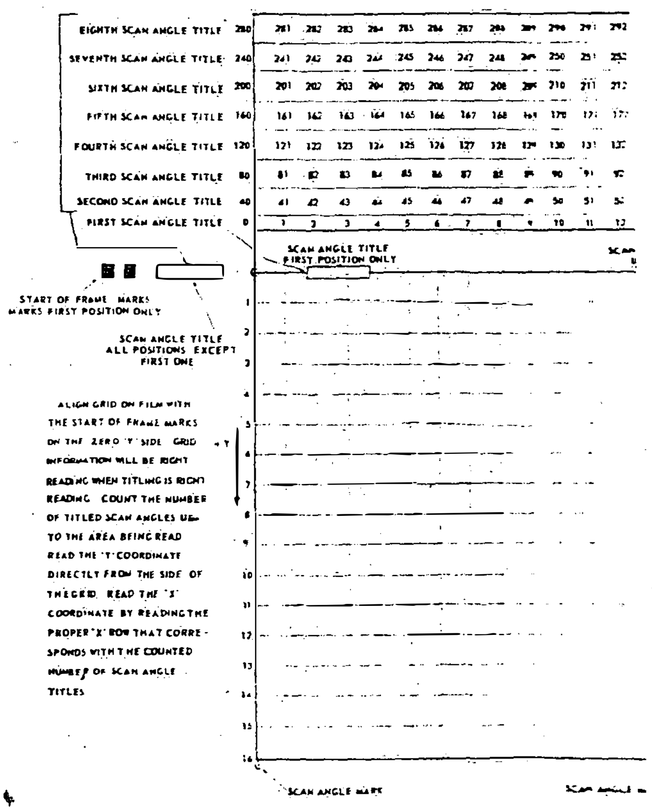
   f. Note: The "X" coordinate should never exceed 39.9 cm.

This system of reporting film position coordinates is different from that contained in the MPR. However, it is compatible with the MPR as demonstrated by the following conversion table:

"X" Coord

URG System Titled Scan Angle/X Coord.	MPR Syste
1/00-39.9	0- 39.9
2/00-39.9	40- 79.9
3/00-39.9	80-119.9
4/00-39.9	120-159.9
5/00-39.9	160-199.9
6/00-39.9	200-239.9
7/00-39.9	240-279.9
8/00-39.9	280-319.9

A special centimeter grid has been developed to utilize grid, as shown in the example on Figure 15.



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"X" Coord

URG System	MPR System
Titled Scan Angle/X Coord.	
1/00-39.9	0- 39.9
2/00-39.9	40- 79.9
3/00-39.9	80-119.9
4/00-39.9	120-159.9
5/00-39.9	160-199.9
6/00-39.9	200-239.9
7/00-39.9	240-279.9
8/00-39.9	280-319.9

"Y" Coord

URG System	MPR System
0	16
1	15
2	14
3	13
4	12
5	11
6	10
7	9
8	8
9	7
10	6
11	5
12	4
13	3
14	2
15	1
16	0

cial centimeter grid has been developed to utilize the MPR reported target positions. Directions for its use are explained on each shown in the example on Figure 15.

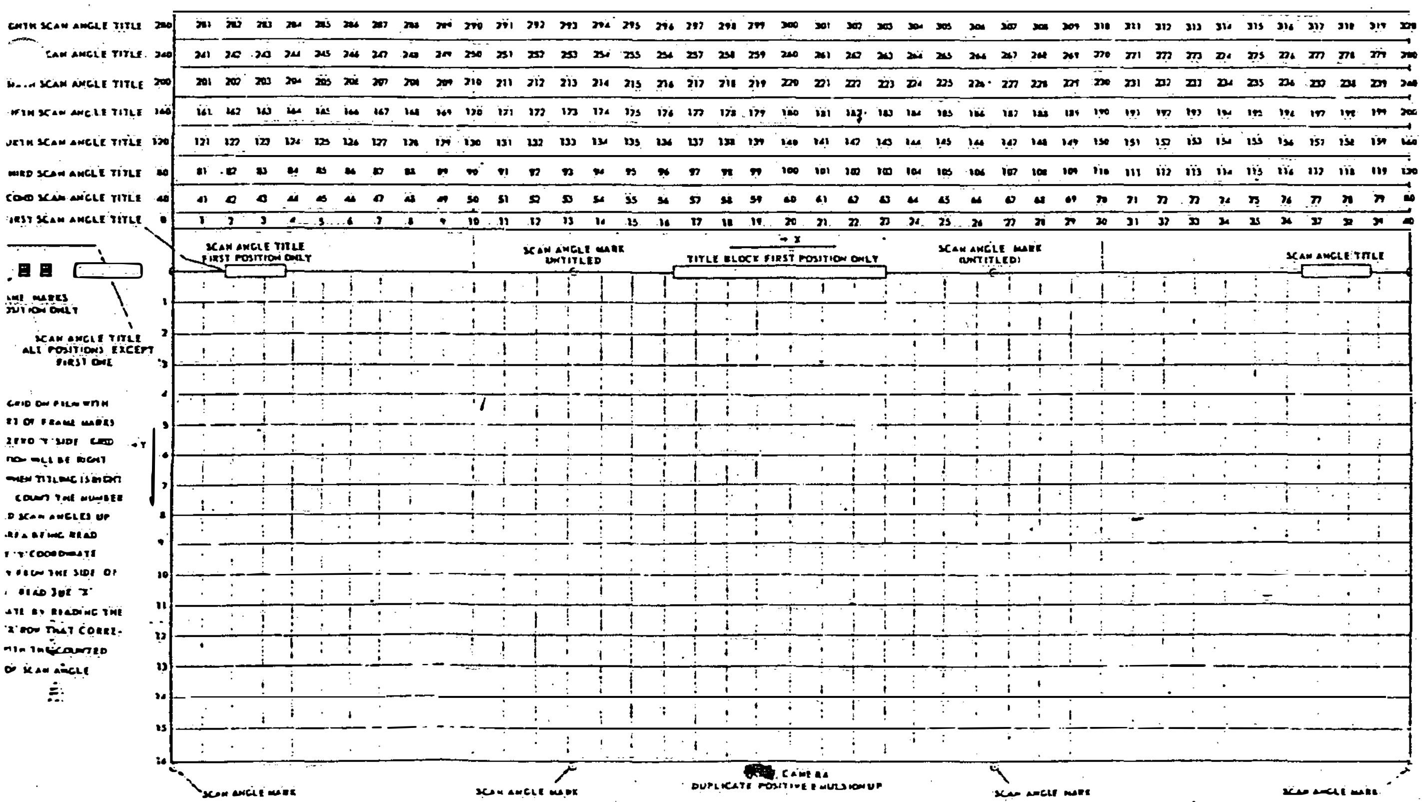

FIGURE 15. GRID

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MAPPING CAMERA SYSTEM

This system is designed to provide accurate attitude, timing, and calibrated imagery to establish a data base suitable for the production of 1:50,000 scale maps and other topographic products and to support point positioning to an accuracy better than 450 feet horizontal (c e .90) and 300 feet vertical (90% assurance) with respect to the World Geodetic System. The mapping camera system is operated separately from the panoramic camera system, whose search and surveillance requirements should remain relatively stable.

According to operational requirements, it is possible that the conjugate imagery could be as much as 100 percent or as little as nothing between the terrain camera and the panoramic cameras.

The stellar and terrain film load will be retrieved in a separate recovery vehicle approximately one day after the recovery of the fourth panoramic film vehicle.

Configuration

The mapping camera system is composed of a vertical terrain camera (Figure 16), with a 12-inch focal length lens, and twin stellar cameras (Figure 17), with 10-inch focal length lenses.

Stellar Camera System

Terrain and stellar cameras operate simultaneously, with the mid-points of terrain and stellar exposures coincident within 4 milliseconds.

The stellar cameras are pointed 45° aft and 7.5° up from the horizontal to increase the accuracy of pitch determination and to reduce sun and albedo problems in recording stars. The two stellar cameras operate as a unit, recording both a left and a right exposure of a portion of the stellar field at each shutter-open command.

The stellar cameras contain 1,800 feet of film to provide 2,000 stellar pairs per mission--one stellar pair per terrain photograph. The format is a 110mm by 70mm web of film. The cycle spacing is 10.8 inches.

There are four fixed fiducials on the format for alignment. A 10mm grid is superimposed on the format for calibration and mensuration purposes. This grid consists of intersections only and is pre-flashed by a luminescent panel on the back of the shutter (Figure 18).

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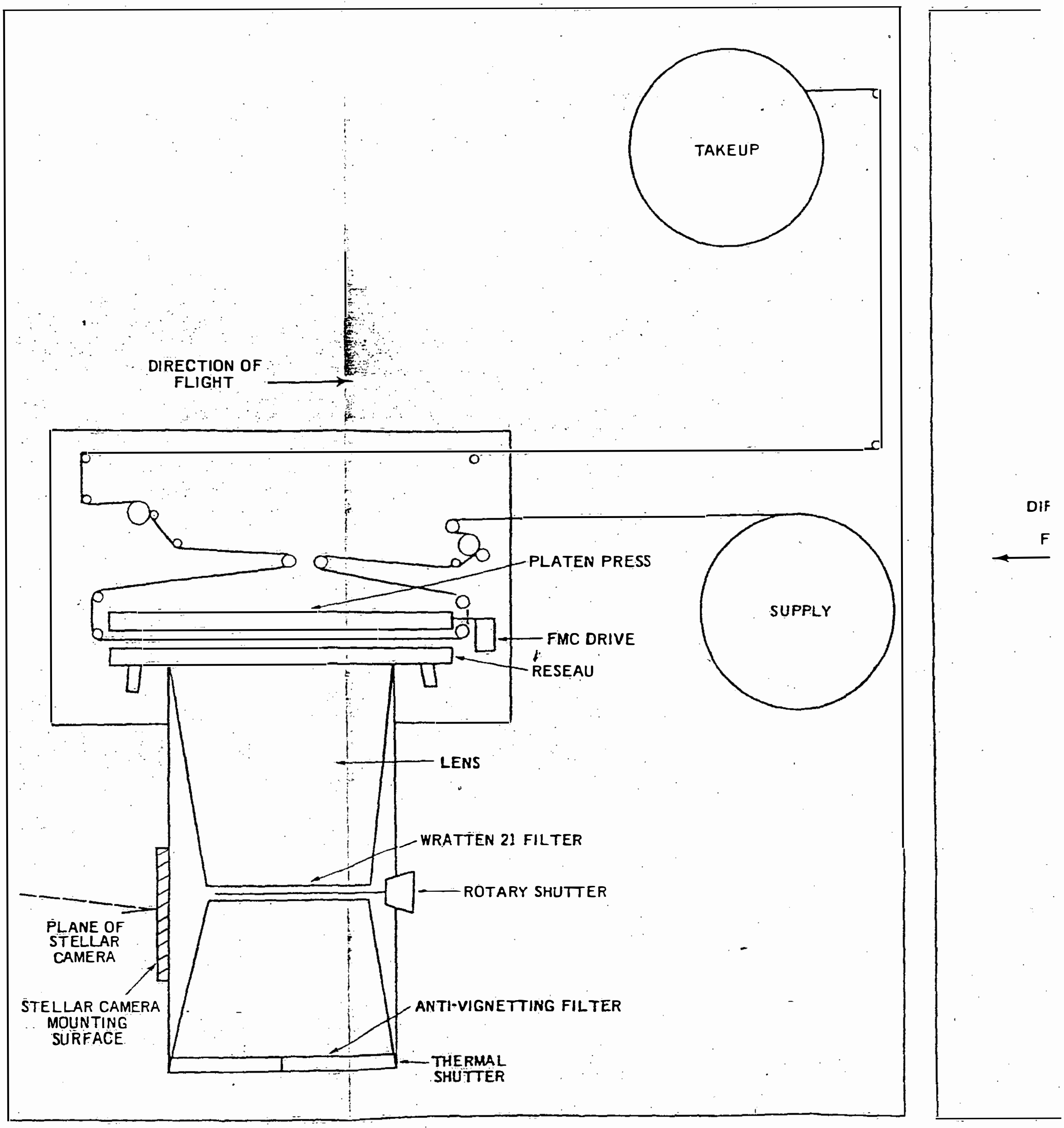

FIGURE 16. TERRAIN CAMERA ASSEMBLY (SIDE VIEW)

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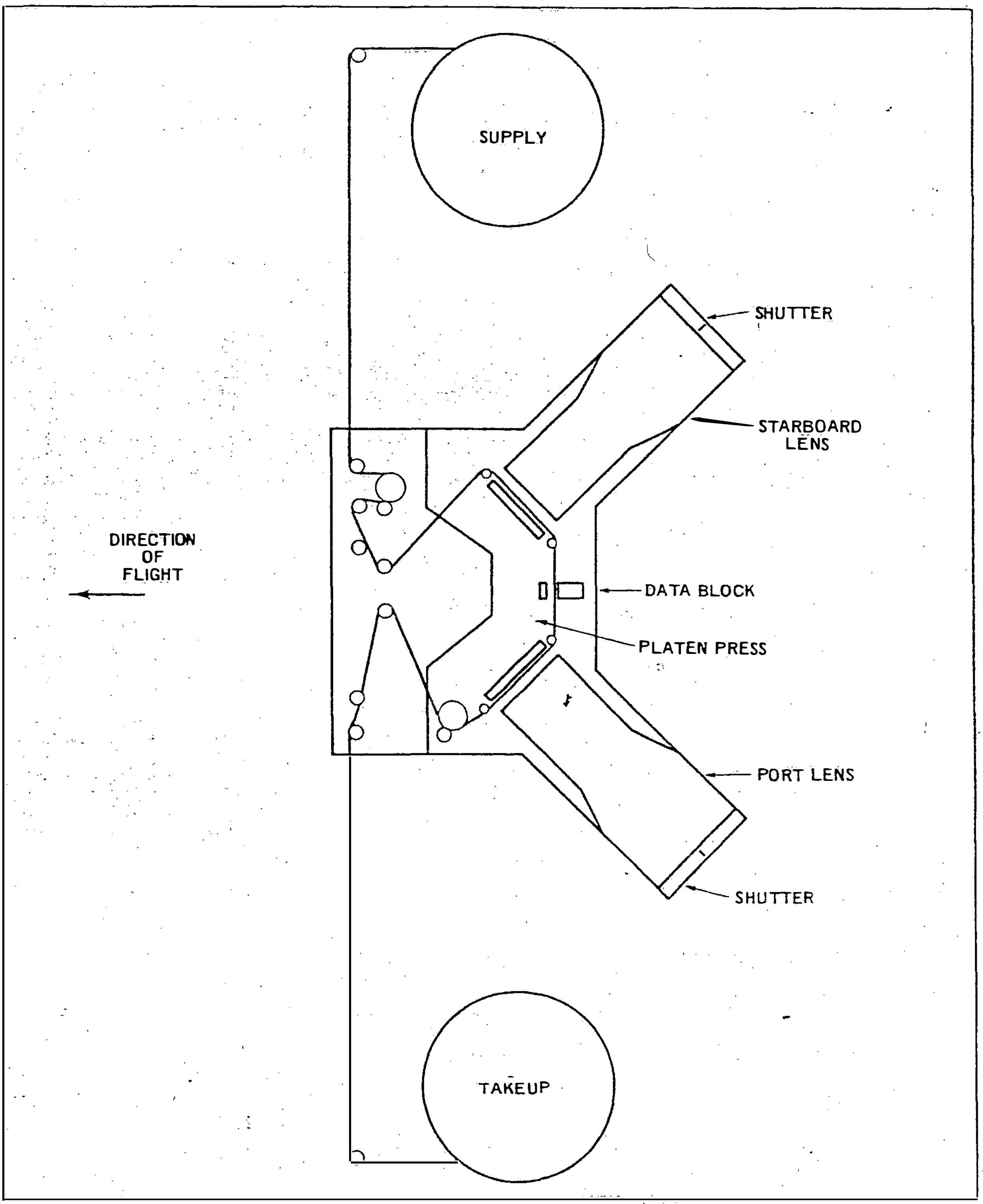

FIGURE 17. STELLAR CAMERA ASSEMBLY

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Terrain Camera

The terrain camera contains 3,200 feet of 9.5-inch-wide film with a 19.25-inch cycle spacing. This will provide approximately two thousand 9- x 18-inch frames per mission.

The camera can operate in 10, 70, or 78 percent overlap modes. The 78 percent overlap mode can only be used for altitudes higher than 100 nm. Each frame covers approximately 7,565 square nm at an 82 nm altitude.

The camera has a cycle range of 7.9 to 80 seconds to provide proper overlap and forward motion compensation for altitudes between 80 and 240 nm.

The terrain format contains a 10mm spaced reseau. The reseau consists of 10-micrometer-wide lines, 2.5 mm long, at each intersection over the entire format as shown in Figure 16. The format also contains four fiducials which are flashed at terrain mid-exposure.

The terrain camera has forward motion compensation (FMC) for all velocity/height ratios between .0155 and .0566 radians/second with an accuracy of .00032 radians/second. Reseau velocity varies from .186 to .679 inches/second depending on commanded velocity/height. The forward motion compensation corrects for orbital rates within the altitude envelope of 80 to 240 nm.

The terrain camera provides a resolution of 50 lines/mm on axis with no point in the format less than 34 lines/mm.

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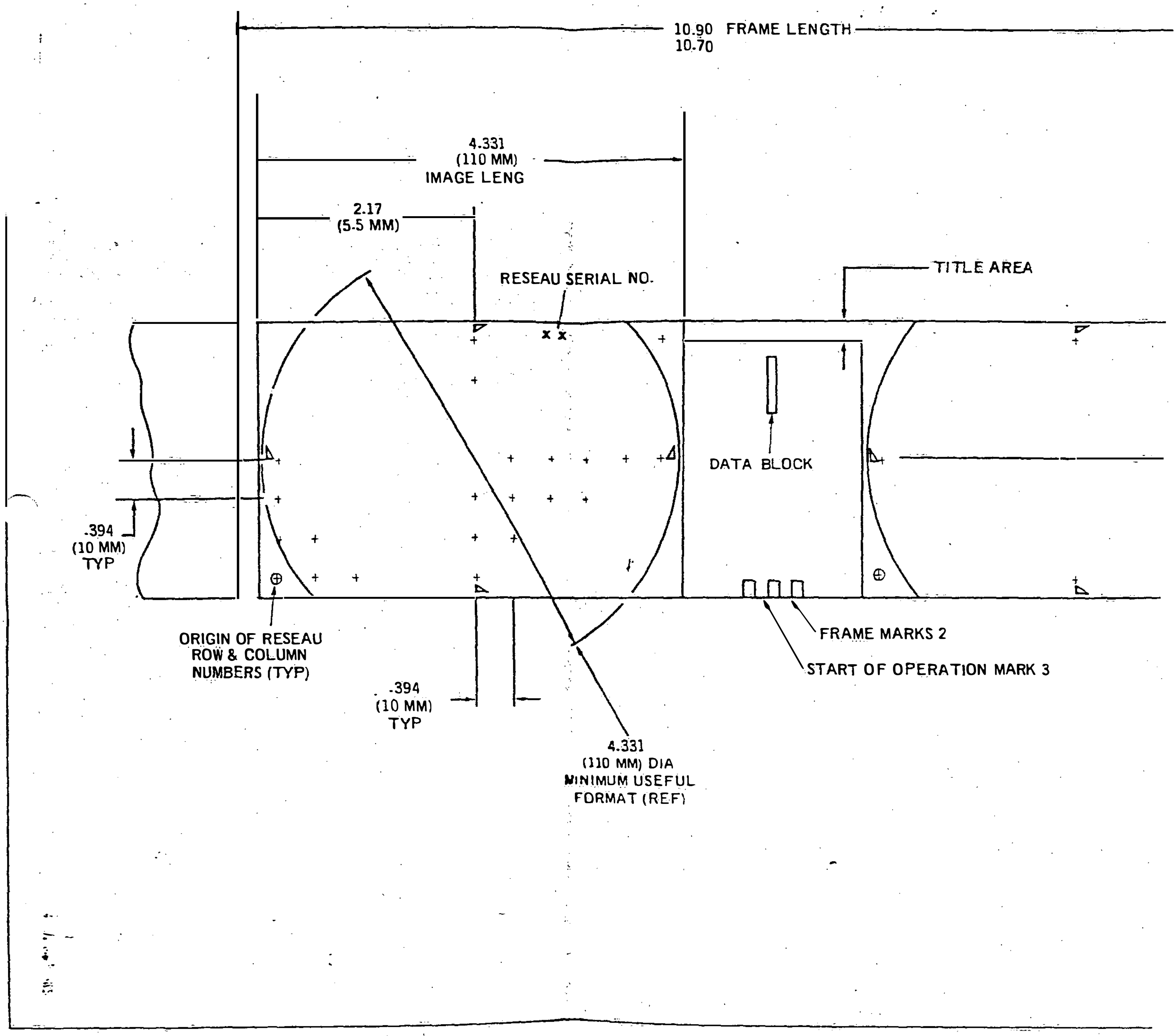

FIGURE 18. STELLAR FORMAT

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Stellar/Terrain Camera Data

	Terrain	Stellars
Focal length	12 in	10 in
Aperture	f/6 (2.0 in)	f/2 (5.0 in)
Points	Vertical	7.5° above horizontal
Port		left 45° aft
Starboard		right 45° aft
Film load	9.5 in x 3,200 ft	70 mm x 1,800 ft (Single web)
Film type	3400	3401
Resolution	50 lines/mm on axis 34 lines/mm minimum	6th magnitude stars
Frames	2,000	2,000 pairs
Format size	9 in x 18 in rectangle	70 mm x 110 mm
FMC	Moving platen (V/h control)	None
Filter	Wratten 21	None
Reseau	10 mm	10 mm
Fiducials	4	4
Exposure	3,6,12 msec	200 msec
T/Number	T/14 ($\lambda = .58\,\mu$ — $.72\,\mu$)	T/2.7

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Recorded Data

The stellar data block, located between frames of the stellar pair, provides the following information:

1. Vehicle time at mid-exposure to 1.0 msec accuracy
2. Camera time of port stellar shutter one-half open
3. Camera time of port stellar shutter one-half closed
4. Camera time of terrain mid-exposure to 0.1 m sec accuracy
5. Serial number
6. V/h input command
7. Terrain exposure input command
8. Overlap command
9. Index bit

The terrain data block contains the following information:

1. Vehicle time at mid-exposure to 1.0 msec accuracy
2. Camera time of starboard stellar shutter one-half open
3. Camera time of starboard stellar shutter one-half closed
4. Camera time of terrain mid-exposure to 0.1 msec accuracy
5. Serial number
6. V/h input command
7. Terrain exposure input command
8. Overlap command
9. Index bit

These data blocks are standard DOD diode array recordings.

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Ephemeris Information

A daily ephemeris, developed for the stellar/terrain camera system, contains all the data necessary for exploitation except the targeting information.

Data	Frequency
1. Camera ID (terrain & stellar)	Report
2. Lens serial numbers	Report
3. Date of photography	Report
4. Time correlation parameters	Report
5. Focal lengths	Report
6. Filter	Report
7. Film type for each camera	Report
8. A 20-point ephemeris	
a. XYZ components of vehicle position	
b. XYZ components of vehicle velocity	
c. XYZ components of inertial acceleration	Revolution
9. Operation information	Operation
a. Exposure overlap mode	
b. Latitude and longitude of four corners of total area photographed by the terrain camera (includes mono coverage at beginning and end of operation)	
10. Frame information	Frame
a. Time at center of format	
b. Latitude and longitude of nadir	
c. Rev and operation number	
d. Frame number	
e. Solar elevation	
f. Altitude	
g. Inertial velocity	
h. Ground track velocity	
i. Ground track azimuth	
j. Commanded FMC rate	
k. Right ascension and declination of each stellar axis	
11. DMU firings and special events	Event
12. Classification	Page

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