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SAPC 25646
COPY 1 OF 5

18 March 1958
LN142

GK:

Enclosed is a handbook of information for the B Configuration. We have put together in this handbook such information as does not appear in our handbooks, and information which is different from previously published data as a result of the changes which we have incorporated within the last few months. Of particular importance is the change in programming for Mode 1. The programming now incorporated in each configuration is shown in Figure 3.1. As you know, we have also incorporated Modes 2, 3, and 4 which may be selected from the cockpit.

STAT

[redacted]

file BC-200
T & P
Offlet

STAT

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HANDBOOK OF INFORMATION

FOR

FLIGHT PLANNING,

PHOTO INTERPRETATION AND FILM EVALUATION

CAMERA MODEL 73-B

1 MARCH 1958

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TABLE OF CONTENTS

	PAGE
1.0 INTRODUCTION.	1
2.0 FILM DESIGNATION AND FORMAT PRESENTATION.	2
Figure 2.1 Film Designation.	
Figure 2.2 Format Presentation.	
Figure 2.3 Film Transport.	
3.0 PROGRAMMING AND GROUND COVERAGE.	3
Figure 3.1 Mode I Ground Coverage.	
Figure 3.2 Mode 2 Ground Coverage.	
Figure 3.3 Mode 3 Ground Coverage.	
Figure 3.4 Mode 4 Ground Coverage.	
Table 3.5 Lateral Coverage vs. Absolute Altitude in all Modes of Operation.	
4.0 METHODS OF CALCULATING GROUND COVERAGE.	6
4.1 Maximum Lateral Coverage.	6
4.2 Single Vertical Frame Ground Coverage.	7
4.3 Ground Scale.	8
4.4 Coverage Mode I Vertical.	
4.5 Coverage Modes 2, 3, or 4.	8
4.6 Range and Operating Time.	9
4.6.1 Total Operating Time.	9
4.6.2 Total Cycles	9
4.6.3 Range - Flightline Miles.	9
5.0 CAMERA CONTROLS	10

Sanitized Copy Approved for Release 2011/06/27 : CIA-RDP89B00487R000300520001-5

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1.0 INTRODUCTION.

This handbook contains technical information pertaining to the mission capabilities, selective programming, ground coverage, negative presentation, and operating controls of the 73-B Configuration. In defining capabilities, several parameters are taken into consideration. These are operational altitude and speed, modes of operation, film load, and optical properties of the camera. Methods used to calculate the operational characteristics of the Model 73-B Camera are included. Ground coverage is presented diagramatically to show programming, format, maximum lateral distance, distance covered in line of flight, overlap, camera cycling rates, film speeds and total operating time. Film presentation is illustrated graphically to aid in orientation and interpretation. Mechanics pertaining to film transport are included to aid in evaluation of camera operation and negative defects. Camera controls and indicators are described to enable the operator to obtain maximum usefulness of the camera's capabilities.

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2.0 FILM DESIGNATION AND FORMAT PRESENTATION.

The relative orientation of a vertical ground target as it appears on the exposed negative at the platen is shown in Figure 2.1. and 2.1A.

Details of the format presentation and recorded data are shown in Figure 2.2. Film transport path, direction of movement, relative location and spacing of rollers are shown in Figure 2.3.

In addition to end-for-end reversal by the lens, the single reflecting mirror causes the target to appear on the emulsion side of the film negative reversed also from side to side. When matching halves are viewed emulsion up with the data block at the top, the image on a vertical exposure is oriented facing toward the line of flight.

Obliques to the right will be facing twenty-four, forty-nine and seventy-four degrees to the right of the flight path and left obliques will be inclined similarly to the left.

Positive transparencies contact printed emulsion to emulsion are in proper orientation when viewed through the back, emulsion down. Similar contact paper prints will be reversed from right to left. Projection prints on paper can be re-oriented in the enlarger by projecting emulsion to emulsion.

Processed film is designated (9R) for the negative roll covering the right half of the ground image and (9L) for the negative roll covering the left half of the ground image. This is opposite to the actual position of the film roll in the camera.

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FILM DESIGNATION - MODE 1

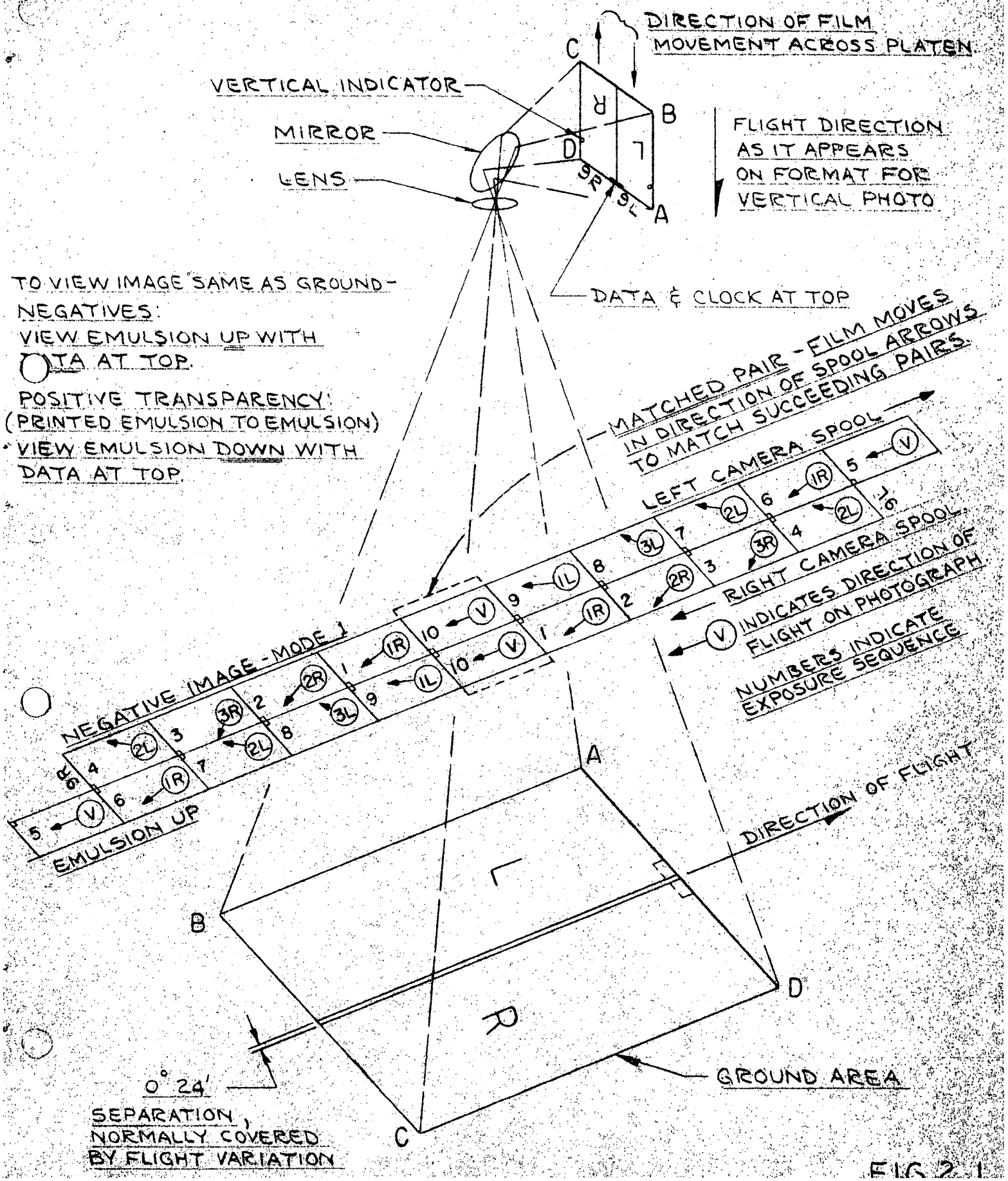

FIG 2.1

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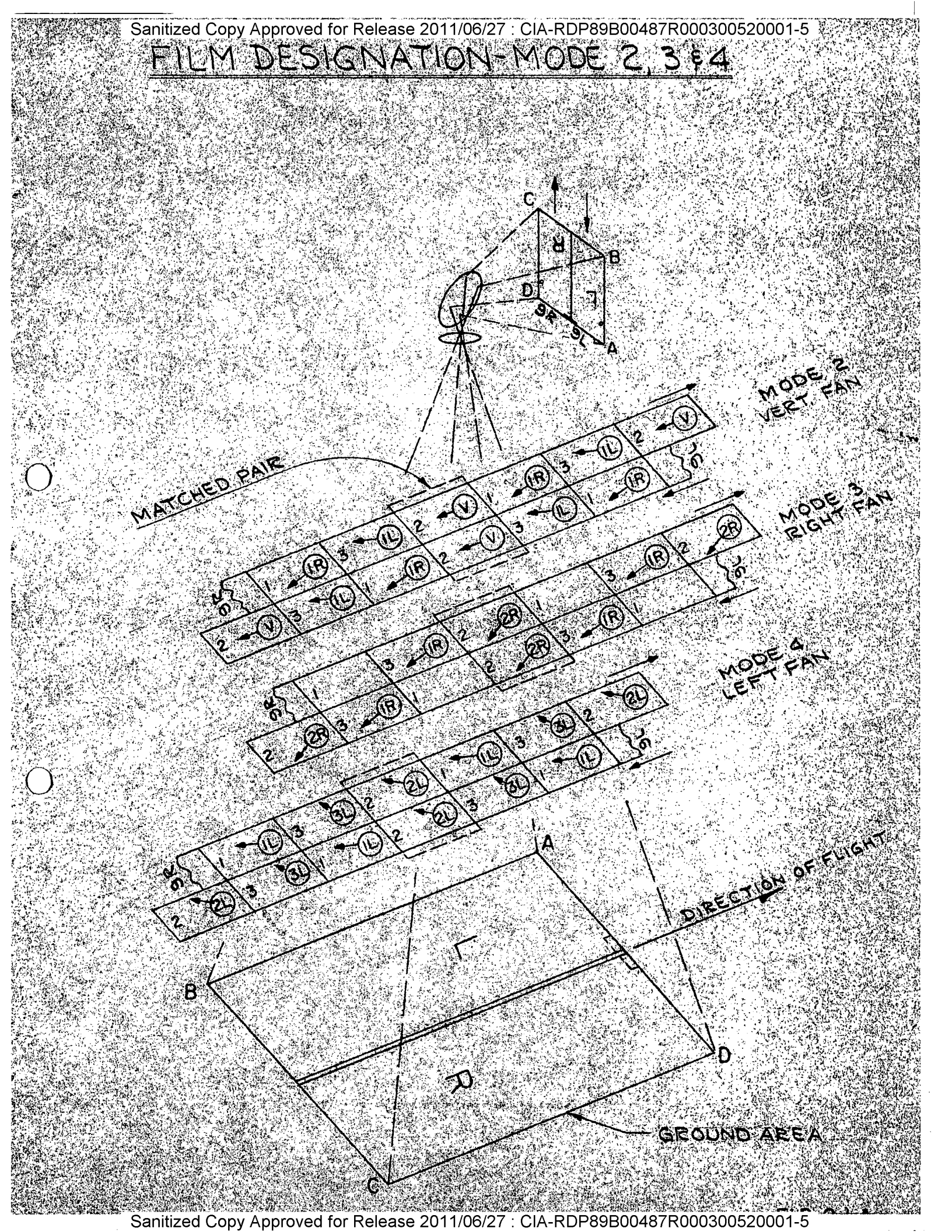
FILM DESIGNATION-MODE 2, 3 & 4



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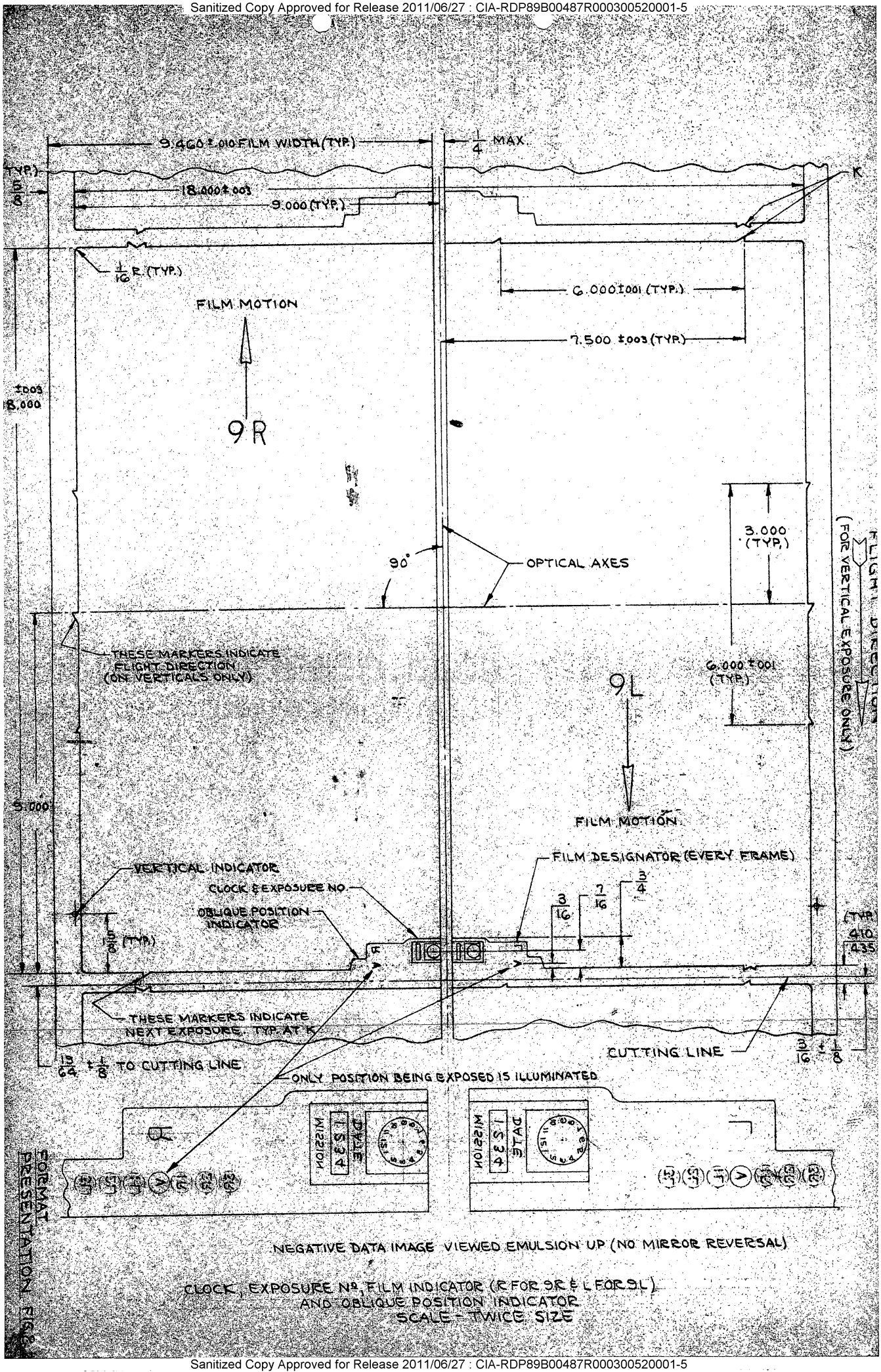

NEGATIVE DATA IMAGE VIEWED EMULSION UP (NO MIRROR REVERSAL)

CLOCK, EXPOSURE Nº, FILM INDICATOR (R FOR 9R & L FOR 9L)
AND OBLIQUE POSITION INDICATOR
SCALE - TWICE SIZE

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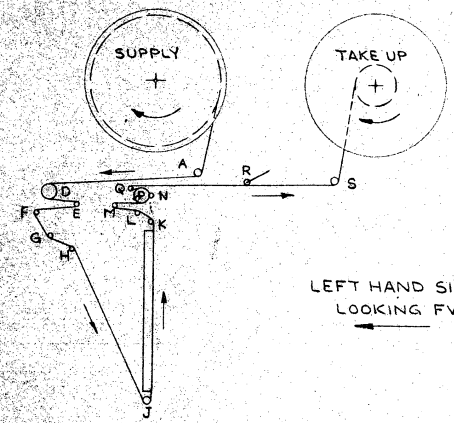
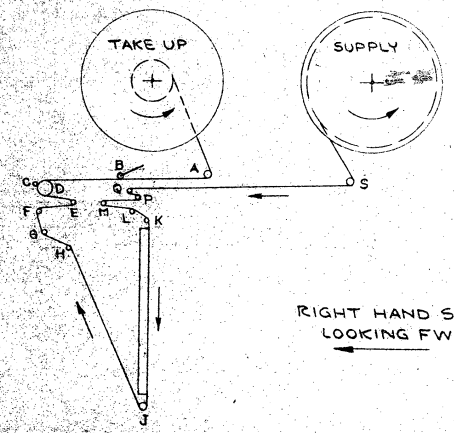


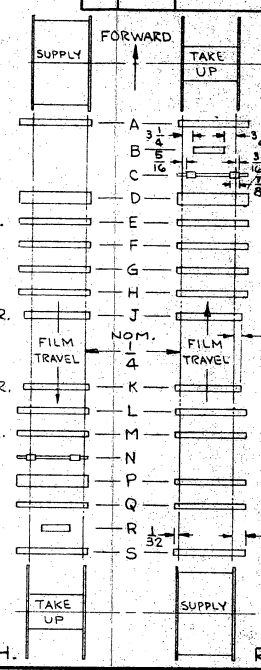
LEFT HAND SIDE LOOKING FWD.



RIGHT HAND SIDE LOOKING FWD.

FIG 2.3 A

TANGENT DIM. BETWEEN ROLLERS L.H.	R.H.	ROLLER DIA.	ROLLER NAME
	$8\frac{1}{8}$	.734	IDLER
$15\frac{5}{8}$			
	$7\frac{1}{2}$		
$\frac{1}{2}$ TO $2\frac{13}{16}$	$2\frac{13}{16}$ TO $\frac{1}{2}$	1.466	IDLER
$1\frac{1}{8}$ TO $3\frac{7}{16}$	$3\frac{7}{16}$ TO $1\frac{1}{8}$	.484	IDLER-SHFL.
$3\frac{3}{16}$	$3\frac{3}{16}$	.484	IDLER
$2\frac{3}{4}$	$2\frac{3}{4}$	.484	IDLER
$17\frac{13}{16}$	$17\frac{13}{16}$	.484	IDLER
		.734	PLATEN-LWR.
$19\frac{15}{16}$	$19\frac{15}{16}$		
$1\frac{3}{16}$	$1\frac{3}{16}$	.484	PLATEN-UPR.
$3\frac{7}{16}$ TO $1\frac{1}{8}$	$1\frac{1}{8}$ TO $3\frac{7}{16}$	.484	IDLER
		.484	IDLER-SHFL.
$2\frac{13}{16}$ TO $\frac{1}{2}$	$\frac{1}{2}$ TO $2\frac{13}{16}$	.500	PRESSURE
$\frac{3}{4}$	$1\frac{1}{2}$	1.466	METERING
$13\frac{3}{4}$	$20\frac{3}{4}$	.484	IDLER
		.500	SENSOR
		.734	IDLER



CHG.	DATE	REVISION	APP.
A	10/17/57	GENERAL REVISION	

NEXT ASSEM.	FILM ROLLERS-EVALUATION DATA CAMERA MODEL 73 B
SCALE NONE	NAME
REQ.	
DEC. ANG. FRACT.	MATERIAL
TOL. UNLESS SPECIFIED	DATE 9-25-57 DRAWN R.W. CHECKED APPROVED
[redacted]	FIG. 2.3 DRAWING NO.

DIETERICH/POST CLEARPRINT NO. 1020

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3.0 PROGRAMMING AND GROUND COVERAGE.

The camera is capable of taking a photograph in each of seven positions of its lens, rotatable horizon to horizon across the line of flight. These positions are prime vertical, 24° 30' right and left from vertical, (low oblique), 49° right and left from vertical (medium oblique), and 73° 30' right and left from vertical (high oblique).

There are four selectable patterns of ground coverage, automatically programmed by the camera at the selection of the pilot. These are designated Modes 1, 2, 3 and 4. Mode I is a full transverse sweep of the lens through the seven positions defined above to give coverage from horizon to horizon. (See Figure 3.1) Modes 2, 3 and 4 are three position sweeps through the vertical, right oblique, and left oblique positions respectively. (See Figures 3.2, 3.3 and 3.4) All sweeps start from the extreme right and program to the left. In detail, Mode 2 covers right low oblique, vertical, and left low oblique in that order. Mode 3 covers right high, right medium and right low oblique. Mode 4 covers left low, left medium and left high oblique in that order. Ground coverage vs. absolute altitude in all modes of operation is shown in Table 3.5.

Image motion compensation (IMC) is obtained in all modes by rocking the optical elements as a unit about an axis parallel to the pitch axis of the aircraft. All modes have a fixed IMC rate of .012 radians per second.

Photograph are taken in an order which provides fifty percent forward overlap for full stereo coverage and sufficient side lap for full single coverage. The lens total angular coverage is 28° 04', side to side and fore and aft over an eighteen by eighteen inch square format.

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3.0 (cont.)

The less than half degree separation of the film down the center of the format is amply covered from one photograph to the next by the normal deviation of the aircraft from a true flight path.

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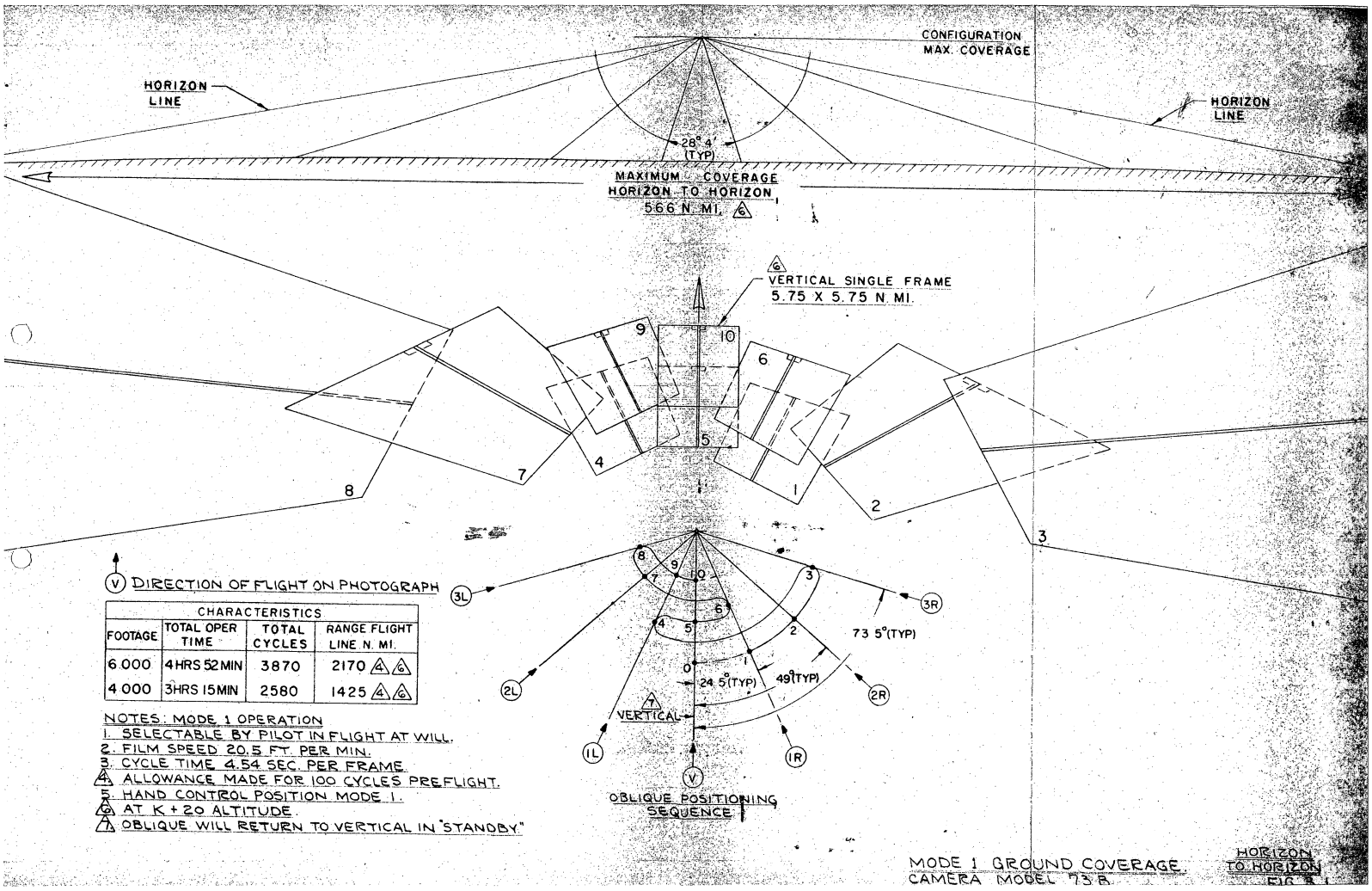

CHARACTERISTICS			
FOOTAGE	TOTAL OPER TIME	TOTAL CYCLES	RANGE FLIGHT LINE N. MI.
6.000	4 HRS 52 MIN	3870	2170 4 6
4.000	3 HRS 15 MIN	2580	1425 4 6

NOTES: MODE 1 OPERATION
1. SELECTABLE BY PILOT IN FLIGHT AT WILL.
2. FILM SPEED 20.5 FT. PER MIN.
3. CYCLE TIME 4.54 SEC. PER FRAME.
4. ALLOWANCE MADE FOR 100 CYCLES PREFLIGHT.
5. HAND CONTROL POSITION MODE 1.
6. AT K + 20 ALTITUDE.
7. OBLIQUE WILL RETURN TO VERTICAL IN "STANDBY."

MODE 1 GROUND COVERAGE
CAMERA MODEL 73 B.

HORIZON TO HORIZON
FIG. 1

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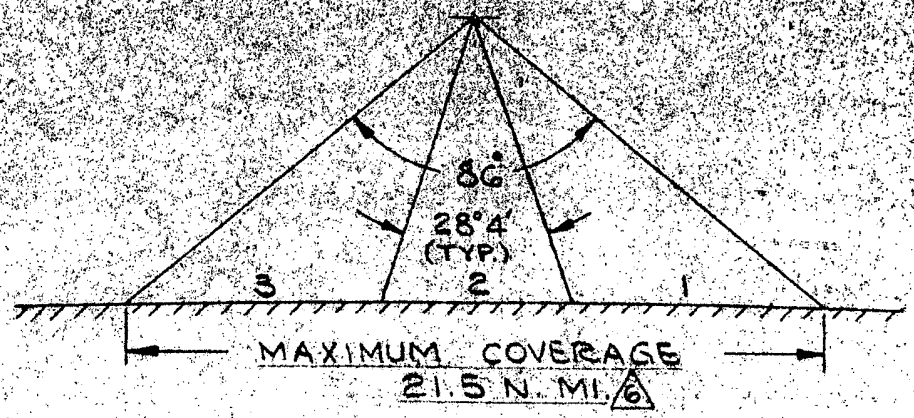

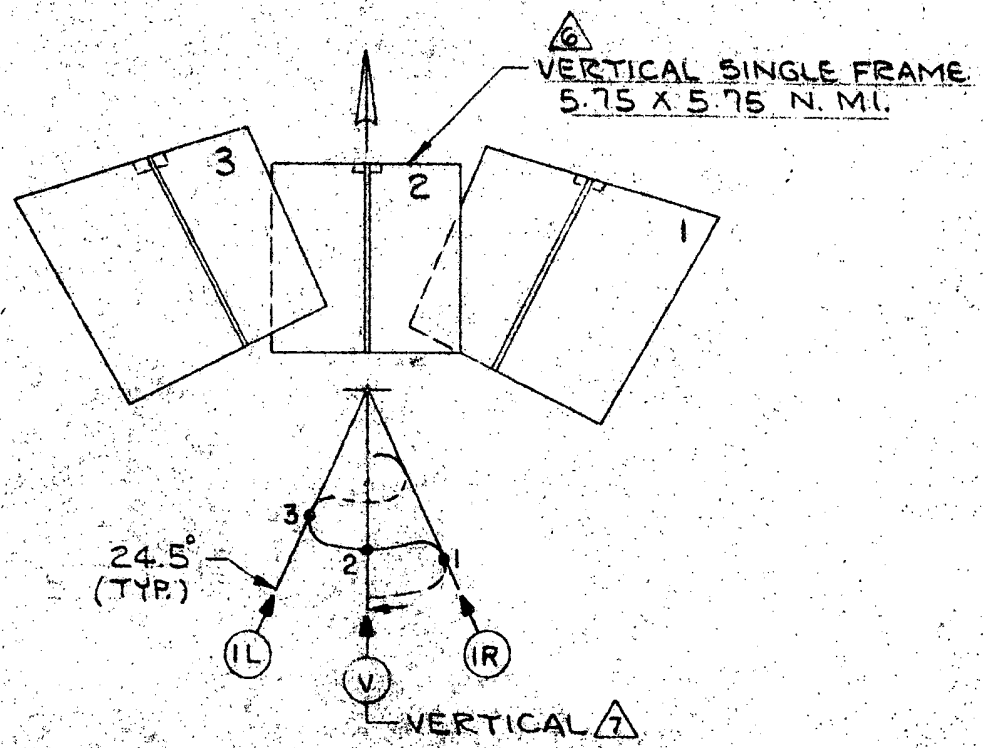

OBLIQUE POSITIONING SEQUENCE

V DIRECTION OF FLIGHT ON PHOTOGRAPH

CHARACTERISTICS			
FOOTAGE	TOTAL OPER. TIME	TOTAL CYCLES	RANGE-FLIGHT LINE N. MI.
6,000	8 HRS.	3800	3540 4 6
4,000	5 HRS. 30 MIN.	2530	2330 4 6

NOTES: MODE 2 OPERATION

1. SELECTABLE IN FLIGHT AT WILL.
2. FILM SPEED 12.5 FT. PER MIN.
3. CYCLE TIME 7.57 SEC. PER FRAME.
4. ALLOWANCE MADE FOR 100 CYCLE PREFLIGHT
5. HAND CONTROL POSITION MODE 1, 2 OR 3
6. AT K+20 ALTITUDE.
7. OBLIQUE WILL RETURN TO VERTICAL IN "STANDBY".

MODE 2 GROUND COVERAGE-VERTICAL FAN CAMERA MODEL 73B

FIG 3.2

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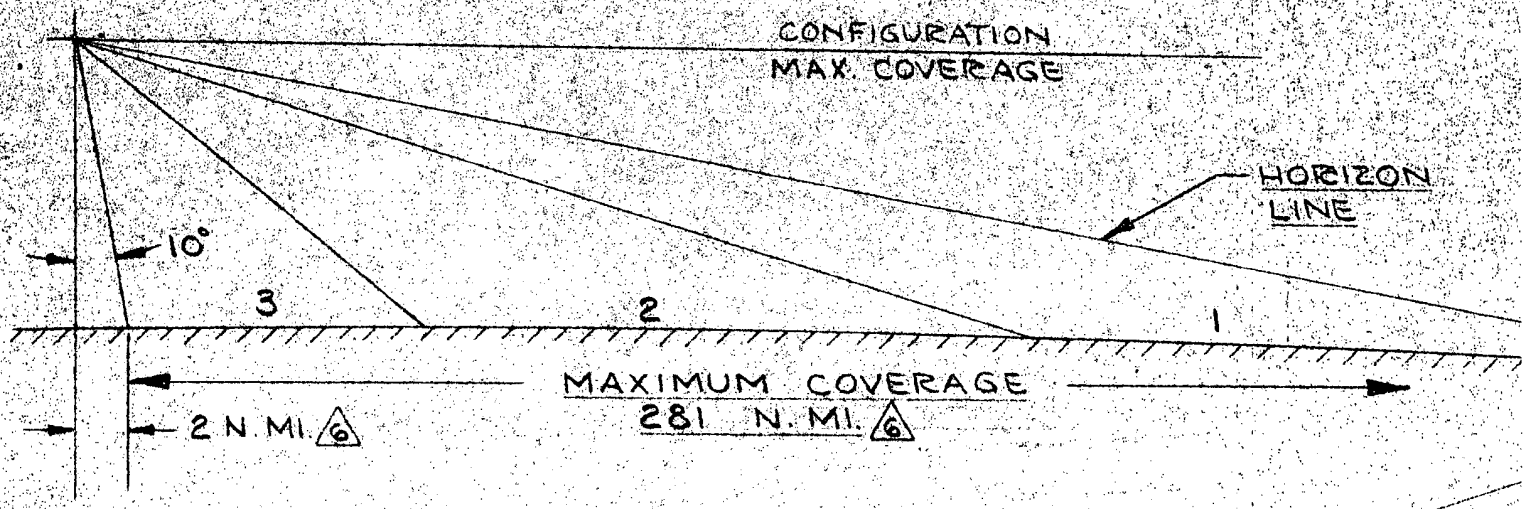

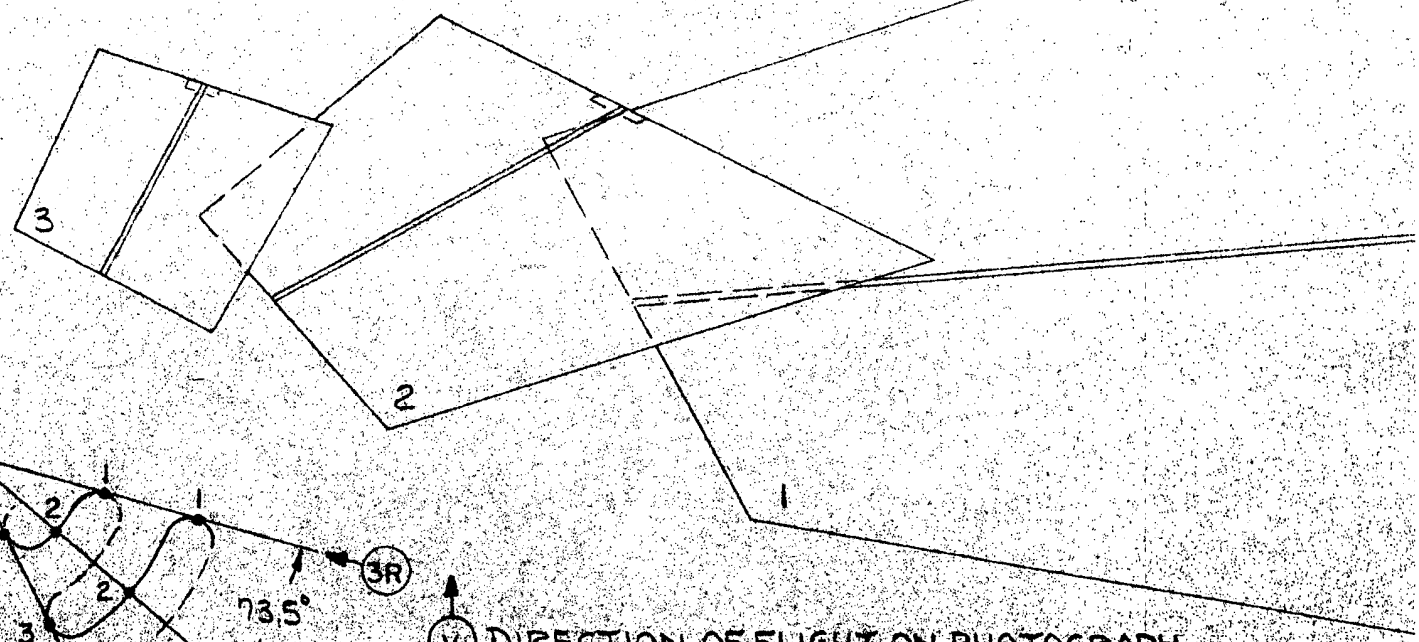

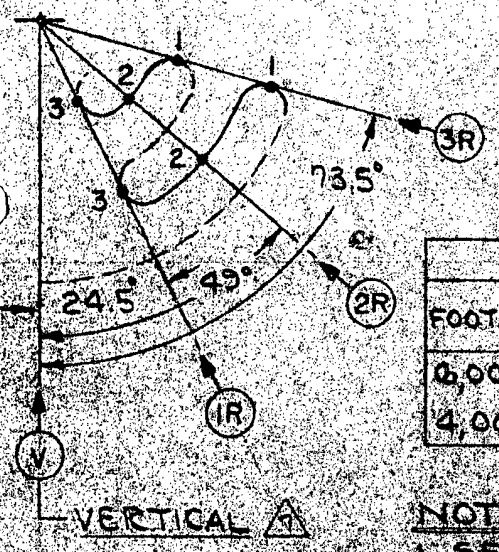

V DIRECTION OF FLIGHT ON PHOTOGRAPH

CHARACTERISTICS			
FOOTAGE	TOTAL OPER. TIME	TOTAL CYCLES	RANGE FLIGHT LINE N. MI.
6,000	8 HRS.	3800	3540 4 6
4,000	5 HRS. 30 MIN.	2530	2330 4 6

NOTES: MODE 3 OPERATION

1. SELECTABLE IN FLIGHT AT WILL
2. FILM SPEED 12.5 FT. PER MIN.
3. CYCLE TIME 7.57 SEC. PER FRAME
4. ALLOWANCE MADE FOR 100 CYCLE PREFLIGHT
5. HAND CONTROL POSITION MODE 1, 2 OR 3
6. AT K + 20 ALTITUDE
7. OBLIQUE WILL RETURN TO VERTICAL IN "STANDBY"

MODE 3 GROUND COVERAGE - RIGHT FAN
CAMERA MODEL 73 B

FIG. 3.3

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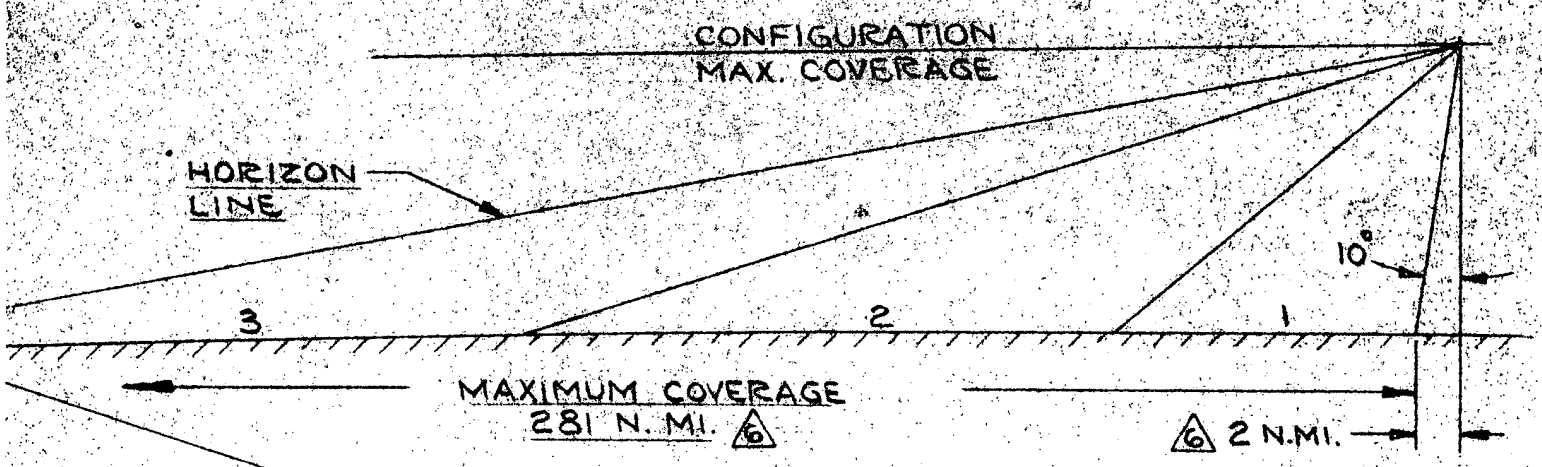

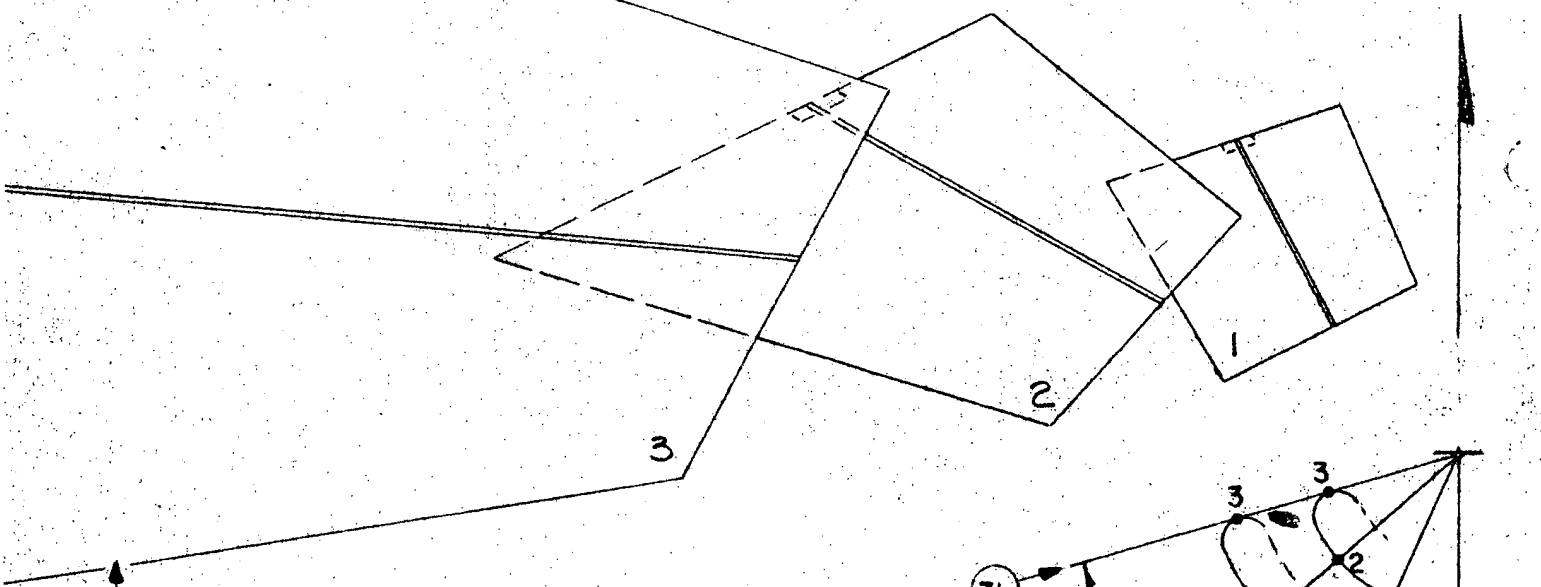

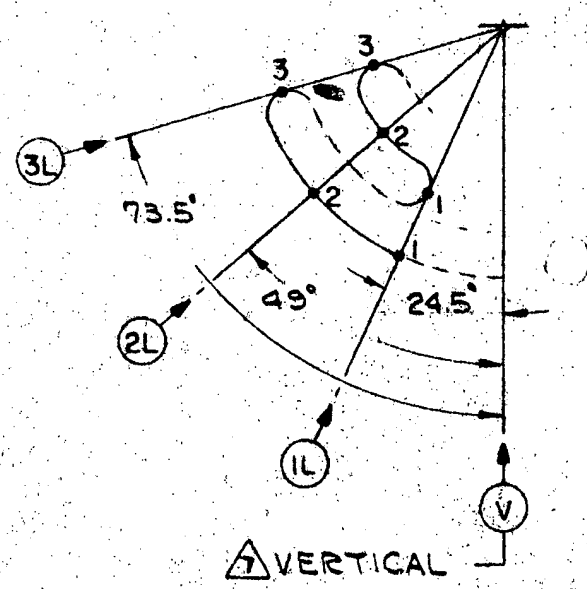

V DIRECTION OF FLIGHT ON PHOTOGRAPH

CHARACTERISTICS			
FOOTAGE	TOTAL OPER. TIME	TOTAL CYCLES	RANGE FLIGHT LINE N. MI.
6,000	8 HRS.	3800	3540 4 6
4,000	5HRS 30 MIN.	2530	2330 4 6

NOTES: MODE 4 OPERATION
1. SELECTABLE IN FLIGHT AT WILL.
2. FILM SPEED 12.5 FT. PER MIN.
3. CYCLE TIME 7.57 SEC. PER FRAME
4. ALLOWANCE MADE FOR 100 CYCLE PREFLIGHT
5. HAND CONTROL POSITION MODE 1, 2 OR 3
6. AT K + 20 ALTITUDE
7. OBLIQUE WILL RETURN TO VERTICAL IN "STANDBY"

MODE 4 GROUND COVERAGE - LEFT FAN.
CAMERA MODEL 73 R

FIG. 3.4

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TABLE 3.5

Camera Mod. 73 B Lateral Ground Coverage vs Absolute Altitude in all Modes of Operation

Altitude	Single Vertical Frame Nautical Miles	Mode 1 N. M.	Mode 2	Mode 3 & 4
K + 30	6.58	605	24.6	301
K + 29	6.50	602	24.3	299
K + 28	6.42	598	23.9	297
K + 27	6.34	594	23.6	295
K + 26	6.25	590	23.3	293
K + 25	6.17	586	23.0	291
K + 24	6.08	582	22.7	289
K + 23	6.01	578	22.4	287
K + 22	5.93	574	22.1	285
K + 21	5.84	570	21.8	283
K + 20	5.75	565	21.5	281
K + 19	5.67	560	21.2	279
K + 18	5.58	557	20.9	277
K + 17	5.51	554	20.6	275
K + 16	5.42	550	20.3	273
K + 15	5.34	545	20.0	270
K + 14	5.26	542	19.6	268
K + 13	5.18	537	19.3	267
K + 12	5.09	533	19.0	265
K + 11	5.02	528	18.7	263
K + 10	4.93	523	18.4	261
K + 9	4.85	520	18.1	259
K + 8	4.77	515	17.8	257
K + 7	4.68	512	17.5	255
K + 6	4.60	506	17.2	252
K + 5	4.52	502	16.9	250
K + 4	4.44	498	16.6	248
K + 3	4.36	492	16.3	245
K + 2	4.27	488	16.0	243
K + 1	4.19	483	15.6	240
K + 0	4.11	478	15.3	238
K - 1	4.03	473	15.1	235
K - 2	3.95	468	14.7	233
K - 3	3.87	464	14.4	231
K - 4	3.79	458	14.1	228
K - 5	3.70	454	13.8	226

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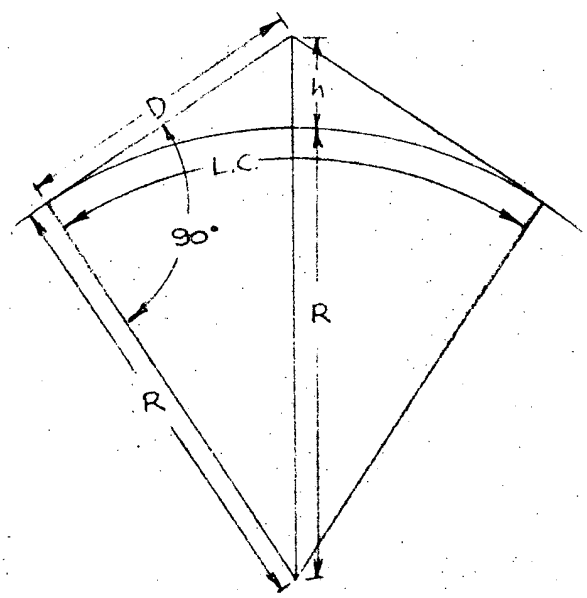
4.0 METHODS OF CALCULATING GROUND COVERAGE

4.1 Maximum Lateral Coverage

The maximum lateral ground coverage is the horizon to horizon distance on the earths surface which is limited by the line of sight from the camera at altitude to the point of tangency on the earths surface. This distance may be determined as follows:



L.C. = Lateral Ground Coverage N. Mi.
D = Distance from camera to point of tangency on earths surface.
R = Radius of earth 3958.89 mi. (Sta.)
h = altitude in feet.

Assume D = 1/2 L.C. within practical limits

$$R^2 + D^2 = (R+h)^2$$

$$D^2 = (R+h)^2 - R^2$$

$$D^2 = R^2 + 2Rh + h^2 - R^2$$

$$D^2 = h\,(2R+h)$$

$$D = \sqrt{h\,(2R+h)}$$

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$$D = \sqrt{\frac{2 \times R + \frac{h\ ft}{5280}}{5280}} \times \sqrt{h\ ft}\ mi.$$

Since $\frac{h}{5280}$ is a small number

$$D = \sqrt{\frac{2R}{5280}} \times \sqrt{h\ ft.}\ mi.$$

$$= \sqrt{\frac{2 \times 3959}{5280}} \times \sqrt{h\ ft.}\ mi.$$

$$\underline{D = 1.228 \sqrt{h\ ft.}\ mi.\ (Sta.)}$$

Expressed in nautical miles

$$D = .868 \times 1.228 \sqrt{h\ ft.} = \underline{1.068 \sqrt{h.\ ft.}\ N.\ Mi.}$$

$$L.C. = 2 \times 1.228 \sqrt{h\ ft.}\ Sta.\ Mi. = \underline{2.456 \sqrt{h\ ft.}\ Sta.\ Mi.}$$

$$L.C. = .868 \times 2.456 \sqrt{h\ ft.}\ N.\ Mi. = 2.135 \sqrt{h\ ft.}\ N.\ Mi.$$

Example: $h = 70000$

$$2.135 \sqrt{70000} = 565\ N.\ Mi.$$

Distance at other altitudes are shown in Table 3.5

4.2 Single Vertical Frame Ground Coverage

$$C = \frac{W \times h}{f \times 6076.1}$$

C = coverage in nautical miles.

W = Width of format (inches).

h = Height above terrain (feet).

f = Focal length (inches).

Example:

$$C = \frac{18 \times 70000}{36} \times \frac{N\ Mi.}{6076.1} = 5.75\ N.\ Mi.$$

Coverage at other altitudes is shown in Table 3.5

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4.3 Ground Scale

The scale of a vertical photograph is the ratio between focal length and altitude.

S = Scale of photograph as a function.

f = Focal length of lens (inches).

h = Height or altitude above terrain (feet).

Example:

$$S = \frac{36}{12 \times 70000} = \frac{1}{23,300}$$

4.4 Mode 2 Vertical Coverage

In Mode 2 the determination of lateral coverage is based on scale layouts verified by flight results. By these methods an equivalent half angle of view of 18.5° is obtained.

Therefore:

Lateral coverage Mode 2 = $\frac{2 \times (\text{Alt. ft.}) \tan 43°}{6076}$

Example: L.C. = $\frac{2(70000).934}{6076}$ = 21.5 N. Mi.

Coverage at other altitudes is shown in Table 3.5.

4.5 Modes 3 or 4 Coverage

Coverage in Modes 3 or 4 is considered to be half the lateral coverage in Mode 1 less the distance from vertical. Coverage is shown in Table 3.5.

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4.6 Range and Operating Time

Known Factors:

Capacity C_1 = 6000 ft. film

C_2 = 4000 ft. film

Mode 1 film speed V_{f_1} = 20.5 ft. per min.

Mode 2 " " V_{f_2} = 12.5 ft. per min.

Mode 1 cycle interval (C.I.) = 4.54 sec.

Mode 2 " " (C.I.) = 7.57 sec.

Linear coverage per (C.I.) with 50% overlap = 5.75 x 50% = 2.875 N. Mi. at K + 20 alt.

4.6.1 Total Operating Time

Total operating time = $\frac{C}{V_f}$ min.

Example: 6000 ft. Mode 1 total operating time = $\frac{C}{V_f} = \frac{6000}{20.5}$ = 293.0 min.

4.6.2 Total Cycles

Total number of cycles = $\frac{\text{total operating time x 60}}{\text{cycle interval}}$

Example: 6000 ft. Mode 1 total cycles = $\frac{293 \times 60}{4.54}$ = 3870 cycles

4.6.3 Range - Flightline Miles

Range flightline Nautical Miles with 50% overlap = $\frac{(\text{total cycles - preflight cycle}) \times \text{linear coverage per frame}}{\text{number of cycles between vertical frame}}$

Example: Range - Flightline (N. Mi.) = $\frac{(3870 - 100)}{5} \times 2.875$ = 2170 N. Mi.

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B CONFIGURATION

5.1. **Camera Controls and Indicators.**

Mode Switch Position	Indicator Lights On	Framing Interval	Camera Operation
Off	- -	- -	All Power Off Camera
Standby	- -	- -	Master camera power solenoid energized. Note: Camera must be turned to Standby for 30 seconds before turning OFF to permit completion of cycle program.
1	D	4.5 sec.	Horizon to horizon coverage.
2	B, D	7.6 sec.	Vertical triple fan; 24-1/2° left vertical, 24-1/2° right.
3	C, D	7.6 sec.	Right triple fan; 73-1/2° right, 49° right, 24-1/2° right.
4	A, D	7.6 sec.	Left triple fan; 24-1/2° left, 49° left, 73-1/2° left.

5.2. **Shutter.**

Single fixed speed of 1/150 sec ±20% TOT. Efficiency 65% at f/10, 75% at f/16, 75% at f/22.

5.3. **Aperture.**

Maximum lens aperture is f/10. A choice of additional fixed Waterhouse stops, f/16 or f/22, may be inserted in the shutter during preflight preparation.

5.4. **Filters.**

The lens contains an integral, interference type yellow filter deposited on one of the lens elements. This filter has a filter-factor equivalent to Wratten 12.

A red filter can be mounted in a filter holder in front of the lens.

The red filter in combination with the integral yellow filter has a filter -factor equivalent to Wratten 25A.

5.5. **Film Rate.**

4.86 minutes per 100 ft. in Mode 1.
8.1 minutes per 100 ft. in Modes 2, 3, and 4.

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