



# United States Department of the Interior

18

GEOLOGICAL SURVEY  
RESTON, VA. 22092

## REPORT OF CALIBRATION of Aerial Mapping Camera

April 28, 1987

Camera type: Zeiss RMK A 15/23  
Lens type: Zeiss Fleogon A2  
Nominal focal length: 153 mm

Camera serial no.: 111679  
Lens serial no.: 112648  
Maximum aperture: f/5.6  
Test aperture: f/5.6

Submitted by: Wyoming State Highway Department  
Cheyenne, Wyoming

Reference: Wyoming State Highway Department purchase order No. 049104,  
dated April 16, 1987.

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type V-F Panchromatic, developed in D-19 at 68° F for 3 minutes with continuous agitation. These photographic plates were exposed on a multicollimator camera calibrator using a white light source rated at approximately 5200K.

### I. Calibrated Focal Length: 153.171 mm

This measurement is considered accurate within 0.005 mm

### II. Radial Distortion

Field angle	$\bar{D}_c$	$D_c$ for azimuth angle			
		0° A-C	90° A-D	180° B-D	270° B-C
degrees	um	um	um	um	um
7.5	-4	-6	-2	-3	-5
15	-6	-7	-4	-5	-8
22.5	-6	-7	-6	-5	-6
30	0	2	-1	1	-2
35	3	4	3	4	2
40	3	5	1	5	2

The radial distortion is measured for each of four radii of the focal plane separated by 90° in azimuth. To minimize plotting error due to distortion, a full least-squares solution is used to determine the calibrated focal length.  $\bar{D}_c$  is the average distortion for a given field angle. Values of distortion  $D_c$  based on the calibrated focal length referred to the calibrated principal point (point of symmetry) are listed for azimuths 0°, 90°, 180° and 270°. The radial distortion is given in micrometers and indicates the radial displacement away from the center of the field. These measurements are considered accurate within 5 um.

### III. Resolving Power in cycles/mm

Area-weighted average resolution: 81.9

Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	134	134	134	113	95	67	67
Tangential lines	134	134	113	95	67	48	40

The resolving power is obtained by photographing a series of test bars and examining the resultant image with appropriate magnification to find the spatial frequency of the finest pattern in which the bars can be counted with reasonable confidence. The series of patterns has spatial frequencies from 5 to 268 cycles/mm in a geometric series having a ratio of the 4th root of 2. Radial lines are parallel to a radius from the center of the field, and tangential lines are perpendicular to a radius.

### IV. Filter Parallelism

The two surfaces of the B No. 114064, the D No. 111434, the KL No. 111493 and the KL-F No. 117322 filters accompanying this camera are within 10 seconds of being parallel. The B filter was used for the calibration.

### V. Shutter Calibration

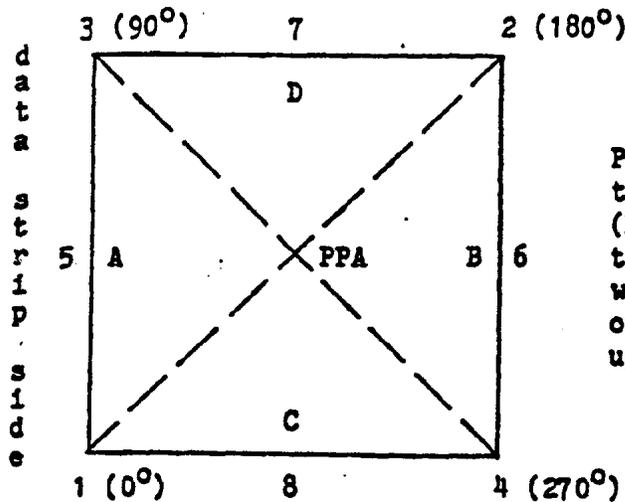
<u>Indicated shutter speed</u>	<u>Effective shutter speed</u>	<u>Efficiency</u>
1/200	4.50 ms = 1/220 s	81%
1/400	2.12 ms = 1/470 s	81%
1/600	1.41 ms = 1/710 s	81%
1/800	1.06 ms = 1/940 s	81%
1/1000	0.80 ms = 1/1250 s	81%

The effective shutter speeds were determined with the lens at aperture  $f/5.6$ . The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

### VI. Magazine Platen

The platen mounted in FK 24/120 film magazine No. 111595 does not depart from a true plane by more than 13  $\mu\text{m}$  (0.0005 in).

VII. Principal Points and Fiducial Coordinates



Positions of all points are referenced to the principal point of autocollimation (PPA) as origin. The diagram indicates the orientation of the reference points when the camera is viewed from the back, or a contact positive with the emulsion up. The data strip is to the left.

	<u>X coordinate</u>	<u>Y coordinate</u>
Indicated principal point, corner fiducials (G)	-0.149 mm	0.090 mm
Indicated principal point, midside fiducials	0.016	0.005
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	0.002	0.016

Fiducial Marks

1	-104.442 mm	-104.436 mm
2	104.230	104.703
3	-104.726	104.312
4	104.734	-104.436
5	-112.982	-0.072
6	113.007	0.082
7	-0.064	112.999
8	0.096	-112.987

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 295.437 mm                      3-4: 295.719 mm

Lines joining these markers intersect at an angle of 90° 02' 00"

Midside fiducials

5-6: 225.989 mm                      7-8: 225.986 mm

Lines joining these markers intersect at an angle of 90° 00' 06"

Corner fiducials (perimeter)

1-3: 208.749 mm                      2-3: 208.956 mm  
 1-4: 209.176 mm                      2-4: 209.140 mm

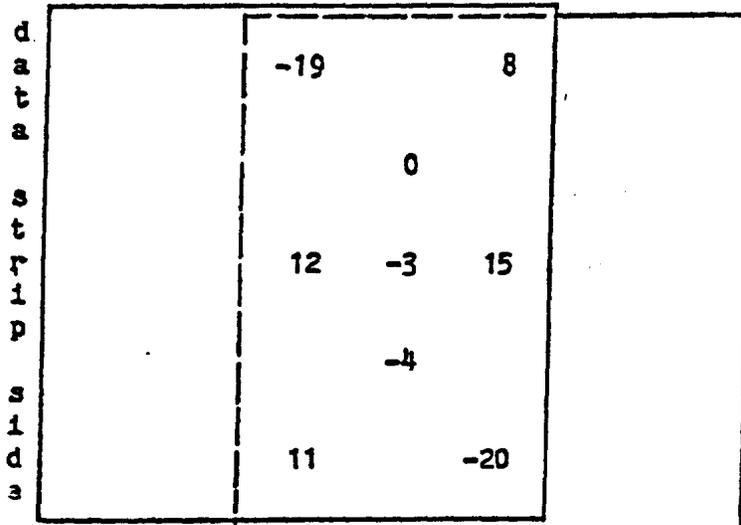
The method of measuring these distances is considered accurate within 0.005 mm.

IX. Stereomodel Flatness

Magazine No.: 111595

Base/Height ratio: 0.6

Maximum angle of field tested: 40°



Stereomodel  
Test point array  
(values in micrometers)

The values shown on the diagram are the average departures from flatness (at negative scale) for two computer-simulated stereomodels based on comparator measurements on contact glass (Kodak Micro-flat) diapositives made from Kodak 2405 film exposures. These measurements are considered accurate within 5  $\mu$ m.

X. Resolving Power in cycles/mm

Area-weighted average resolution: 45.2

Film: Type 2405

Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	67	67	67	67	48	40	34
Tangential lines	67	57	57	57	40	28	24

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. RSAS/900, dated July 25, 1983.

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