



# United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
Reston, Virginia 20192

## REPORT OF CALIBRATION of Aerial Mapping Camera

January 29, 2003

Camera type:	Zeiss RMK A 21/23	Camera serial no.:	115734
Lens type:	Zeiss Toparon	Lens serial no.:	116220
Nominal focal length:	210 mm	Maximum aperture:	f/5.6
		Test aperture:	f/5.6

Submitted by: Keystone Aerial Surveys, Inc.  
Philadelphia, Pennsylvania

Reference: Keystone Aerial Surveys, Inc. purchase  
order No 0049, dated January 24, 2003.

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type 157-01 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: 208.107 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	-4	-6	-5	-2
15	-5	-5	-6	-6	-5
22.7	-1	0	-1	1	-2
30	4	4	4	4	4

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. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 64

Field angle:	0°	7.5°	15°	22.7°	30°
Radial Lines	82	82	82	82	58
Tangential lines	82	82	69	58	35

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 3 to 195 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 Zeiss B filter No. 116612, the B (60%) filter No. 116623, the C-F filter No. 115956 and the KL filter No. 116636 accompanying this camera are within 10 seconds of being parallel. The B filter, No. 116612, was used for the calibration.

**Note:** The antivignetting coating on the C-F filter has been abraded to an unacceptable degree.

### V. Shutter Calibration

Indicated time (sec)	Rise time ( $\mu$ sec)	Fall Time ( $\mu$ sec)	$\frac{1}{2}$ width time (ms)	Nom. Speed (sec.)	Efficiency (%)
1/200	647	649	3.69	1/300	89
1/400	340	342	1.92	1/590	89
1/600	234	237	1.33	1/850	89
1/800	175	174	1.02	1/1100	89
1/1000	157	156	0.89	1/1260	89

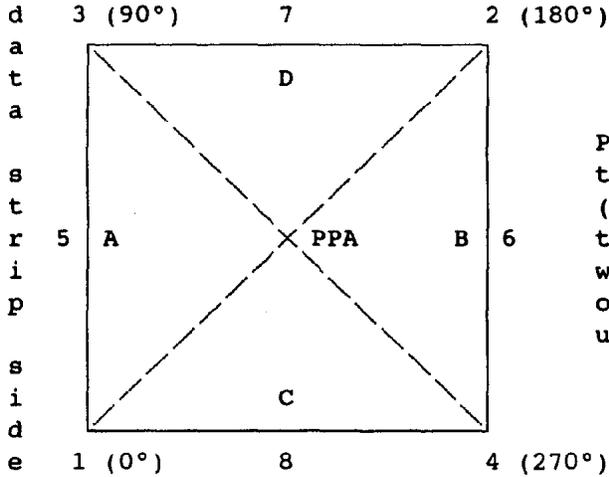
The effective exposure times were determined with the lens at aperture f/5.6. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

### VI. Magazine Platen

The platens mounted in FK 24/120 film magazines No. 118778 and No. 129820 do not depart from a true plane by more than 13  $\mu$ m (0.0005 in).

The platens for these film magazines are equipped with an identification marker that will register "CZ047" for magazine No. 118778, and "CZ063" for magazine No. 129820 in the data strip area for each exposure.

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	0.010 mm	-0.001 mm
Indicated principal point, midside fiducials	0.023	-0.004
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	-0.004	-0.012

Fiducial Marks

1	-103.936 mm	-103.943 mm
2	103.948	103.933
3	-103.917	103.916
4	103.963	-103.943
5	-112.988	-0.009
6	113.024	0.001
7	0.011	113.002
8	0.034	-112.996

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 293.986 mm      3-4: 293.972 mm

Lines joining these markers intersect at an angle of 90° 00' 15"

Midside fiducials

5-6: 226.012 mm      7-8: 225.998 mm

Lines joining these markers intersect at an angle of 90° 00' 12"

Corner fiducials (perimeter)

1-3: 207.859 mm      2-3: 207.865 mm

1-4: 207.899 mm      2-4: 207.876 mm

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2420, dated March 18, 1998.

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