



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

November 3, 2005

Camera type:	Zeiss RMK A 15/23	Camera serial no.:	127756
Lens type:	Zeiss Pleogon A2/4	Lens serial no.:	127806
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: James W. Sewall Company
Old Town, Maine

Reference: James W. Sewall Company purchase order
No. 30429, dated October 12, 2005.

These measurements were made on Agfa glass plates, 0.19 inch thick, with spectroscopic emulsion type APX 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: 152.739 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	0	0	-2	-3	-3	3
Decentering (um)	0	0	1	2	3	5

<u>Symmetric radial distortion parameters</u>	<u>Decentering distortion parameters</u>	<u>Calibrated principal point</u>
$K_0 = -0.4016 \times 10^{-5}$	$P_1 = -0.4739 \times 10^{-7}$	$x_p = 0.003 \text{ mm}$
$K_1 = 0.1043 \times 10^{-7}$	$P_2 = -0.2723 \times 10^{-6}$	$y_p = 0.000 \text{ mm}$
$K_2 = -0.7017 \times 10^{-12}$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

The values and parameters for Calibrated Focal Length (CFL), Symmetric Radial Distortion (K_0, K_1, K_2, K_3, K_4), Decentering Distortion (P_1, P_2, P_3, P_4), and Calibrated Principal Point [point of symmetry] (x_p, y_p) were determined through a least-squares Simultaneous Multiframe Analytical Calibration (SMAC) adjustment. The x and y-coordinate measurements utilized in the adjustment of the above parameters have a standard deviation (σ) of ± 3 microns.

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 72

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	95	95	80	95	80	67	57
Tangential lines	95	95	95	80	67	57	48

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 Zeiss B filter No. 127914, the D filter No. 127966, the KL filter No. 127848 and the CF filter (no number) accompanying this camera are within 10 seconds of being parallel. The B filter was used for the calibration.

V. Shutter Calibration

Indicated time (sec)	Rise time (μ sec)	Fall Time (μ sec)	$\frac{1}{2}$ width time (ms)	Nom. Speed (sec.)	Efficiency (%)
1/200	1187	1190	4.13	1/300	82
1/400	570	567	1.93	1/640	82
1/600	371	369	1.27	1/960	82
1/800	276	276	0.94	1/1300	82
1/1000	226	223	0.76	1/1610	82

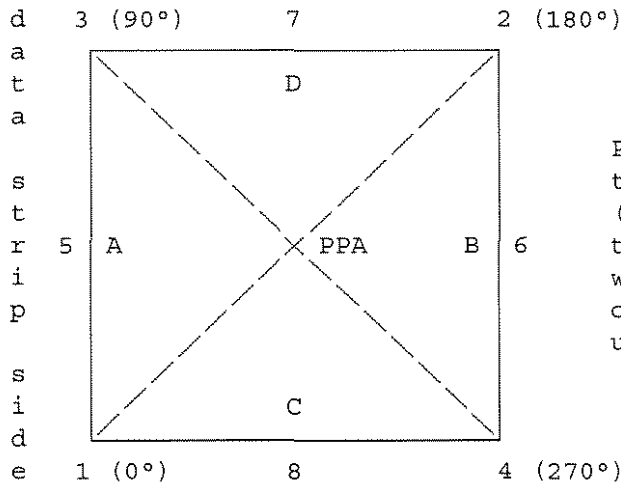
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in International Standard ISO 516:1999(E).

VI. Magazine Platen

The platens mounted in FK 24/120 film magazines No. 110009 and No. 118832 do not depart from a true plane by more than 13 μ m (0.0005 in).

The platens for these film magazines are equipped with identification markers that will register "CZ400" for magazine No. 110009, and "CZ359" for magazine No. 118832 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	0.008 mm
Indicated principal point, midside fiducials	-0.001	0.003
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.003	0.000

Fiducial Marks

1	-103.915 mm	-103.920 mm
2	103.914	103.954
3	-103.925	103.917
4	103.923	-103.920
5	-113.002	-0.001
6	112.998	0.008
7	-0.008	112.976
8	0.007	-112.985

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 293.946 mm 3-4: 293.934 mm

Lines joining these markers intersect at an angle of 89° 59' 42"

Midside fiducials

5-6: 226.000 mm 7-8: 225.961 mm

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

Corner fiducials (perimeter)

1-3: 207.838 mm 2-3: 207.838 mm

1-4: 207.838 mm 2-4: 207.874 mm

The method of measuring these distances is considered accurate within 0.003 mm

Note: For GPS applications, the nominal entrance pupil distance from the focal plane is 240 mm with a 10 mm filter thickness. Additional filter thickness will increase entrance pupil distance by 0.34 X added thickness.

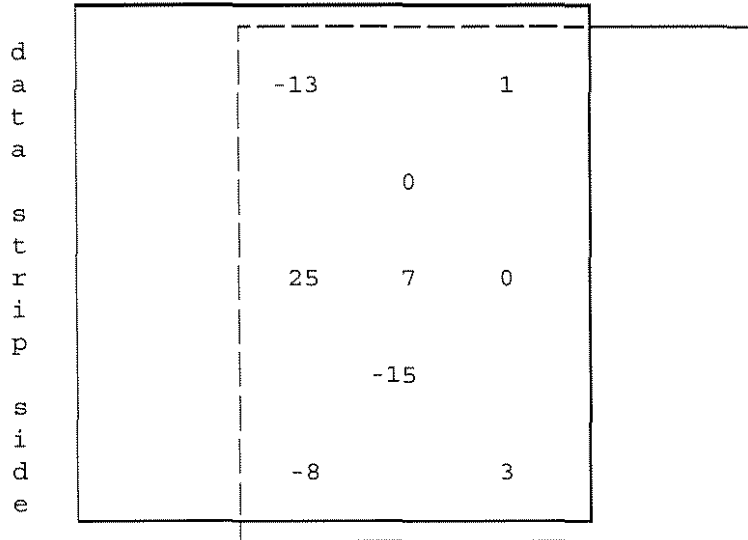
IX. Stereomodel Flatness

Magazine No.: 110009

Base/Height ratio: 0.6

Platen ID: CZ400

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 stereo models. The values are based on comparator measurements on Kodak 4425 copy film made from Kodak 2405 film exposures. These measurements are considered accurate to within 5 μm .

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 36

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	48	48	48	40	40	34	24
Tangential lines	48	48	48	40	34	28	24

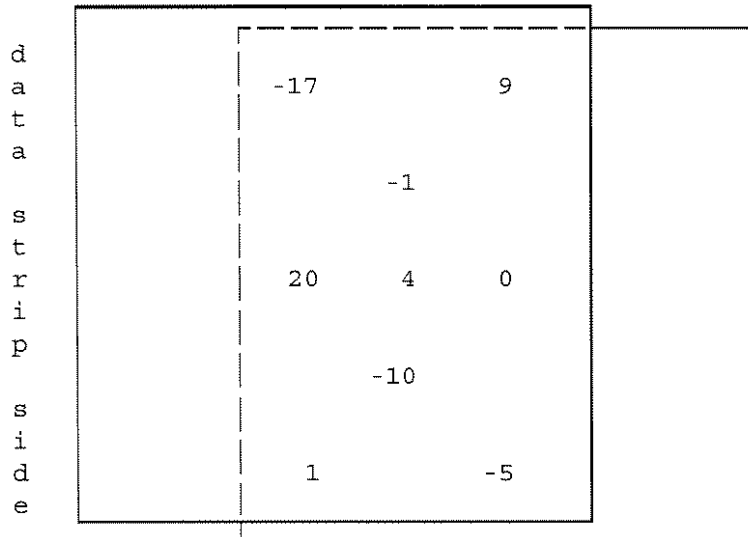
IX. Stereomodel Flatness

Magazine No.: 118832

Base/Height ratio: 0.6

Platen ID: CZ359

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 stereo models. The values are based on comparator measurements on Kodak 4425 copy film made from Kodak 2405 film exposures. These measurements are considered accurate to within 5 μm.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 35

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	48	48	48	40	40	34	24
Tangential lines	48	48	40	34	34	28	24

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2881, dated November 6, 2002.

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Geography Discipline