



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

November 18, 2008

Camera type:	Zeiss RMK A 15/23	Camera serial no.:	137491
Lens type:	Zeiss Pleogon A2/4	Lens serial no.:	137519
Nominal focal Length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4
Submitted by:	Southern Resources Mapping Corporation Northport, Alabama		

Reference:

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: 153.528 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (µm)	0	0	-1	-1	-1	1
Decentering tangential (µm)	0	1	1	2	4	5

<u>Symmetric radial distortion</u>	<u>Decentering distortion</u>	<u>Calibrated principal point</u>
$K_0 = -0.5056E-05$	$P_1 = 0.1112E-07$	$x_p = -0.010 \text{ mm}$
$K_1 = 0.4787E-08$	$P_2 = -0.3169E-06$	$y_p = 0.020 \text{ mm}$
$K_2 = -0.3052E-12$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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: 92

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	159	159	113	95	95	80	80
Tangential Lines	159	159	113	95	95	67	67

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 clear filter (no number) and the "B" filter No. 127914 accompanying this camera are within 10 seconds of being parallel. The "B" filter was used for the calibration.

V. Shutter Calibration

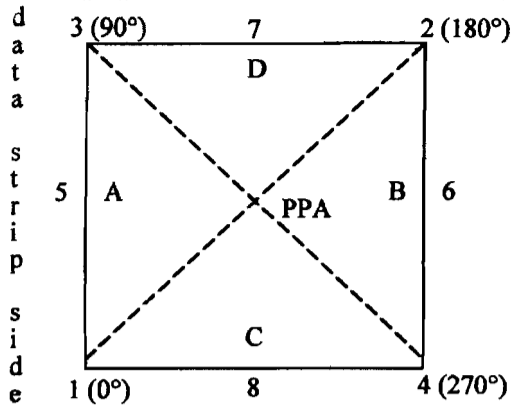
Indicated Time (sec)	Rise Time (μ sec)	Fall Time (μ sec)	$\frac{1}{2}$ Width Time (ms)	Nom. Speed (sec)	Efficiency (%)
1/200	462	461	4.40	1/240	93
1/400	232	239	2.25	1/470	93
1/600	166	166	1.53	1/700	93
1/800	114	111	1.06	1/1010	93
1/1000	96	90	0.89	1/1200	94

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 described in International Standard ISO 516:1999(E).

VI. Magazine Platen

The platen mounted in Zeiss FK 24/120 film magazine No. 111611 does not depart from a true plane by more than 13 μ m (0.0005 in).

VII. Principal Point and Fiducial Mark 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 (mm)</u>	<u>Y coordinate (mm)</u>
Indicated principal point, corner fiducials	-0.002	0.000
Indicated principal point, midside fiducials	-0.010	0.004
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (point of symmetry)	-0.010	0.020

Fiducial Marks

1	-103.966	-103.940
2	103.939	103.917
3	-103.925	103.935
4	103.924	-103.940
5	-113.015	0.019
6	112.987	-0.011
7	0.020	112.985
8	-0.040	-112.969

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2: 293.989 mm	3-4: 293.961 mm
Lines joining these markers intersect at an angle of	90° 00' 11"	
Midside fiducials	5-6: 226.003 mm	7-8: 225.955 mm
Lines joining these markers intersect at an angle of	89° 59' 32"	
Corner fiducials (perimeter)	1-3: 207.875 mm	2-3: 207.864 mm
	1-4: 207.890 mm	2-4: 207.857 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 240mm with a 10 mm filter thickness. Additional filter thickness will increase entrance pupil distance by 0.34 X added thickness.

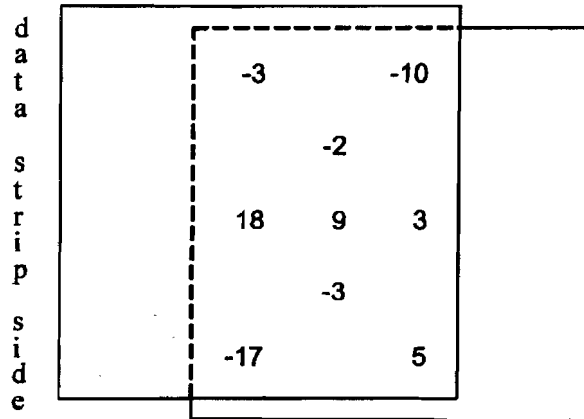
IX. Stereomodel Flatness

Magazine No: 111611

Base/Height ratio: 0.6

Platen ID:

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 Agfa Avitone P3P 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: 42

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	57	57	48	48	48	40	34
Tangential Lines	57	57	48	40	40	40	28

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3148, dated June 10, 2005.

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Geography Discipline