

United States Department of the Interior



U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

November 08, 2007

Camera type: Jena LMK 1015*
Lens type: Jena Lamegon PI/C
Nominal focal Length: 153 mm

Camera serial no.: 266617B
Lens serial no.: 7384529C
Maximum aperture: f/4.5
Test aperture: f/4.5

Submitted by: Aerial Services, Inc.
Cedar Falls, Iowa

Reference: Aerial Services, Inc. purchase order No. 110507da, dated November 5, 2007.

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: 152.587 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (μm)	-1	-2	-4	-5	-4	5
Decentering tangential (μm)	0	0	1	2	3	4

<u>Symmetric radial distortion</u>	<u>Decentering distortion</u>	<u>Calibrated principal point</u>
$K_0 = 0.2890E-04$	$P_1 = 0.1950E-06$	$x_p = -0.006 \text{ mm}$
$K_1 = 0.1136E-07$	$P_2 = -0.1325E-06$	$y_p = 0.006 \text{ mm}$
$K_2 = -0.9367E-12$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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.

* Equipped with Forward Motion Compensation

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 82

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	113	113	95	95	80	67
Tangential Lines	113	113	95	67	80	67	57

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 Jena 350 filter No. 51145A, the 500 filter No. 51163A and the 550 filter No. 51190A accompanying this camera are within 10 seconds of being parallel.

The 500 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 (%)
1/125	2232	2119	7.42	1/160	82
1/175	1541	1510	5.23	1/230	82
1/250	1057	1047	3.69	1/330	82
1/350	763	737	2.57	1/480	82
1/500	546	537	1.85	1/660	82

The effective exposure times were determined with the lens at aperture $f/4.5$. 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 Jena film magazine No. 266787B does not depart from a true plane by more than 13 μ m (0.0005 in).

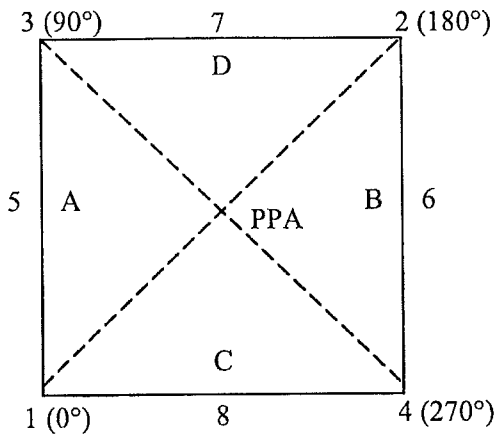
The platen for this film magazine is equipped with an identification marker that will register "266787" in the data strip area for each exposure.

VII. Principal Point and Fiducial Mark Coordinates

d
a
t
a

s
t
r
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p

s
i
d
e



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	.014	-.001
Indicated principal point, midside fiducials	.006	.002
Principal point of autocollimation (PPA)	.000	.000
Calibrated principal point (point of symmetry)	-.006	.006
<u>Fiducial Marks</u>		
1	-109.990	-110.002
2	110.004	109.986
3	-109.998	110.005
4	110.020	-110.002
5	-111.994	.010
6	112.002	-.007
7	.009	111.987
8	.002	-111.992

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2: 311.113 mm	3-4: 311.144 mm
Lines joining these markers intersect at an angle of 90° 00' 08"		
Midside fiducials	5-6: 223.996 mm	7-8: 223.979 mm
Lines joining these markers intersect at an angle of 90° 00' 09"		
Corner fiducials (perimeter)	1-3: 220.007 mm	2-3: 220.001 mm
	1-4: 220.009 mm	2-4: 219.987 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 251 mm.

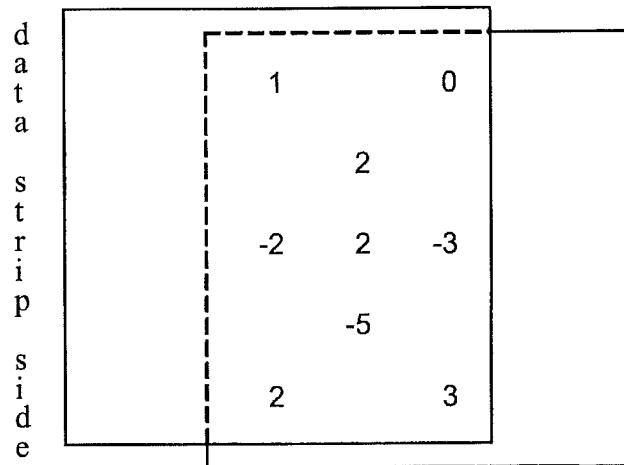
IX. Stereomodel Flatness

FMC Magazine No: 266787B

Base/Height ratio: 0.6

Platen ID: 266787

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: 40

Film: Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3099, dated November 22, 2004.

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