

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

September 10, 2015

Camera type:	Jena LMK 2015*	Camera serial no.:	275839E
Lens type:	Jena Lamegon PI/E	Lens serial no.:	275839E
Nominal focal Length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Aerial Surveys International
Watkins, CO

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: 152.492 mm

II. Lens Distortion

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

<u>Symmetric radial distortion</u>	<u>Decentering distortion</u>	<u>Calibrated principal point</u>
$K_0 = 0.7823E-04$	$P_1 = 0.5838E-07$	$x_p = -0.009$ mm
$K_1 = -0.1867E-07$	$P_2 = -0.2253E-06$	$y_p = -0.005$ mm
$K_2 = 0.8911E-12$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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: 103

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	134	113	113	113	95	95
Tangential Lines	134	134	113	95	113	80	95

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 405 filter No. 275568, 490 filter No. 276002 and the 530 filter No. 52028 accompanying this camera are within 10 seconds of being parallel. The 490 filter was used for the calibration.

V. Shutter Calibration

Indicated Time (sec)	Rise Time (μ sec)	Fall Time (μ)	$\frac{1}{2}$ Width Time (ms)	Nom. Speed (sec)	Efficiency (%)
1/125	2372	2220	9.10	1/130	84
1/250	1808	1611	6.80	1/170	84
1/500	819	839	3.40	1/350	85
1/1000	450	433	1.69	1/710	84

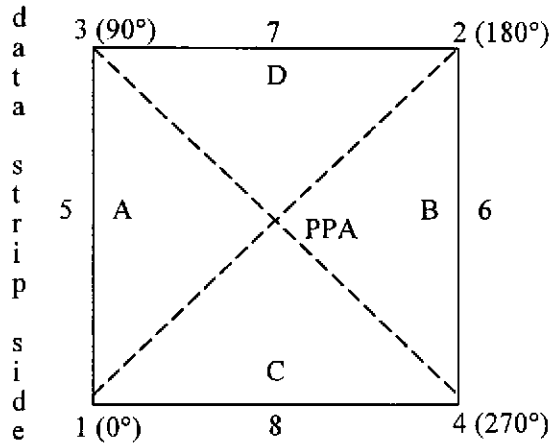
The effective exposure times were determined with the lens at aperture $f/4$. The method is considered accurate within 3 percent. The technique used is described in International Standard ISO 516:1999(E).

VI. Magazine Platen

The platen mounted in Jena LMK-K 24/120 film magazine No. 271902 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 "271902" in the data strip area for each exposure.

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	0.000	-0.015
Indicated principal point, midside fiducials	-0.003	-0.012
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (point of symmetry)	-0.009	-0.005
<u>Fiducial Marks</u>		
1	-110.006	-110.014
2	110.011	109.988
3	-109.993	109.990
4	109.987	-110.014
5	-112.003	-0.009
6	111.993	-0.015
7	0.007	111.989
8	-0.012	-112.023

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2: 311.140 mm	3-4: 311.115 mm
Lines joining these markers intersect at an angle o 89° 59' 56"		
Midside fiducials	5-6: 223.996 mm	7-8: 224.012 mm
Lines joining these markers intersect at an angle o 89° 59' 48"		
Corner fiducials (perimeter)	1-3: 220.004 mm	2-3: 220.004 mm
	1-4: 219.993 mm	2-4: 220.001 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 241mm.

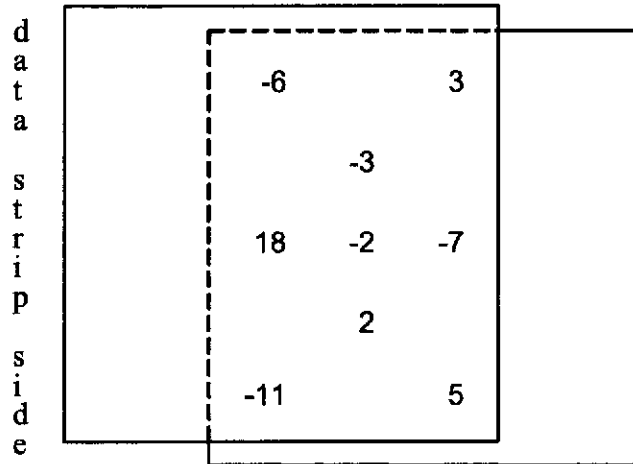
IX. Stereomodel Flatness

FMC Magazine No: 271902

Base/Height ratio: 0.6

Platen ID: 271902

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 Agfa Aviphot Pan 200 film exposures. These measurements are considered accurate to within 5 μm.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 46

Film: Pan 200

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3545, dated December 15, 2010.

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Climate and Land Use Change