



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

December 16, 2010

Camera type: Jena LMK 2015*
Lens type: Jena Lamegon PI/E
Nominal focal Length: 153 mm

Camera serial no.: 275839E
Lens serial no.: 275839E
Maximum aperture: f/4
Test aperture: f/4

Submitted by: Aerial Surveys International, LLC
 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: 152.490 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (μm)	-1	-2	-2	0	1	2
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	= 0.6704E-04	P_1	= -0.1053E-06	x_p	= -0.010 mm
K_1	= -0.1155E-07	P_2	= -0.2283E-06	y_p	= 0.007 mm
K_2	= 0.3964E-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

<u>Field angle:</u>	<u>0°</u>	<u>7.5°</u>	<u>15°</u>	<u>22.7°</u>	<u>30°</u>	<u>35°</u>	<u>40°</u>
Radial Lines	113	134	113	113	113	95	95
Tangential Lines	113	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 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

<u>Indicated Time</u> <u>(sec)</u>	<u>Rise Time</u> <u>(μ sec)</u>	<u>Fall Time</u> <u>(μ sec)</u>	<u>½ Width Time</u> <u>(ms)</u>	<u>Nom. Speed</u> <u>(sec)</u>	<u>Efficiency</u> <u>(%)</u>
1/125	1044	1038	11.75	1/90	94
1/250	463	468	5.43	1/195	95
1/500	244	244	2.74	1/385	94
1/1000	121	115	1.39	1/760	95

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. 273410C does not depart from a true plane by more than 13 μm (0.0005 in).

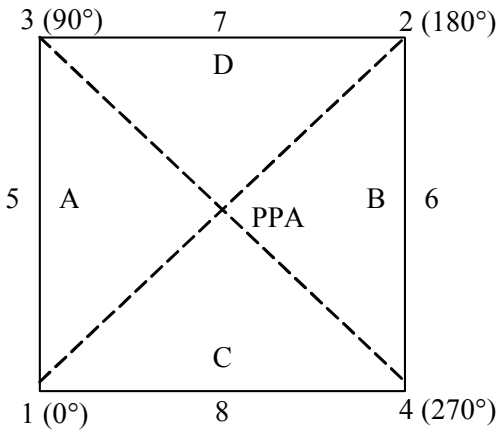
The platen for this film magazine is equipped with an identification marker that will register "273410" in the data strip area for each exposure.

VII. Principal Point and Fiducial Mark Coordinates

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a
t
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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	-0.004	-0.010
Indicated principal point, midside fiducials	-0.004	-0.008
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (point of symmetry)	-0.010	0.007

Fiducial Marks

1	-110.009	-110.011
2	110.006	109.996
3	-110.000	109.993
4	109.989	-110.011
5	-112.009	-0.008
6	111.994	-0.008
7	0.003	111.993
8	-0.011	-112.021

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2: 311.143 mm	3-4: 311.122 mm
Lines joining these markers intersect at an angle of	89° 59' 57"	
Midside fiducials	5-6: 224.003 mm	7-8: 224.013 mm
Lines joining these markers intersect at an angle of	89° 59' 47"	
Corner fiducials (perimeter)	1-3: 220.004 mm	2-3: 220.007 mm
	1-4: 219.997 mm	2-4: 220.007 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.

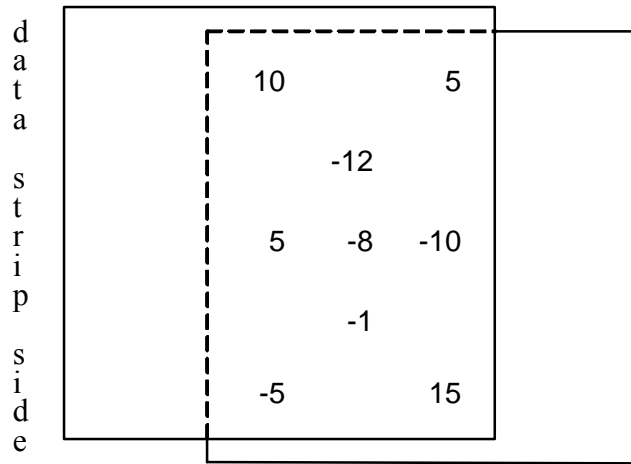
IX. Stereomodel Flatness

FMC Magazine No: 273410C

Base/Height ratio: 0.6

Platen ID: 273410

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: 45

Film: Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3217, dated February 15, 2006.

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