



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

September 16, 2008

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

Camera serial no.: 275837
Lens serial no.: 275837E
Maximum aperture: f/4
Test aperture: f/4

Submitted by: Col-East, Inc.
North Adams, MA

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: 152.570 mm

II. Lens Distortion

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

<u>Symmetric radial distortion</u>		<u>Decentering distortion</u>		<u>Calibrated principal point</u>	
K_0	= 0.8441E-04	P_1	= -0.2859E-07	x_p	= 0.000 mm
K_1	= -0.1775E-07	P_2	= -0.1702E-07	y_p	= -0.001 mm
K_2	= 0.7460E-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: 105

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	95	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. 51871, the 490 filter No. 276032 and the 530 filter No. 276025 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 sec)	$\frac{1}{2}$ Width Time (ms)	Nom. Speed (sec)	Efficiency (%)
1/125	923	886	12.99	1/80	96
1/250	448	438	6.47	1/160	96
1/500	223	218	3.20	1/325	96
1/1000	113	103	1.60	1/655	96

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 platens mounted in Jena LMK-K 24/120 film magazines Nos. 273445C, 273495 and 273499 do not depart from a true plane by more than 13 μ m (0.0005 in).

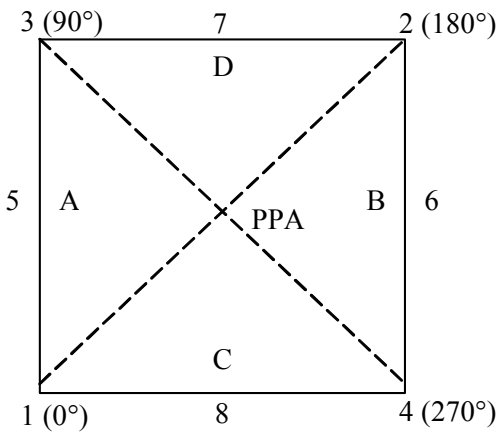
The platens for these film magazines are equipped with identification markers that will register "273445" for magazine No. 273445C, "273495" for magazine No. 273495 and "273499" for magazine No. 273499 in the data strip area for each exposure.

VII. Principal Point and Fiducial Mark Coordinates

d
a
t
a

s
t
r
i
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	0.006	0.002
Indicated principal point, midside fiducials	0.005	0.000
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (point of symmetry)	0.000	-0.001
<u>Fiducial Marks</u>		
1	-109.999	-110.000
2	110.009	110.003
3	-109.993	109.999
4	110.010	-110.000
5	-111.997	0.000
6	111.999	0.000
7	0.008	111.995
8	0.002	-112.006

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2: 311.135 mm	3-4: 311.128 mm
Lines joining these markers intersect at an angle of 90° 00' 04"		
Midside fiducials	5-6: 223.996 mm	7-8: 224.001 mm
Lines joining these markers intersect at an angle of 89° 59' 55"		
Corner fiducials (perimeter)	1-3: 220.000 mm	2-3: 220.001 mm
	1-4: 220.009 mm	2-4: 220.003 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 254 mm.

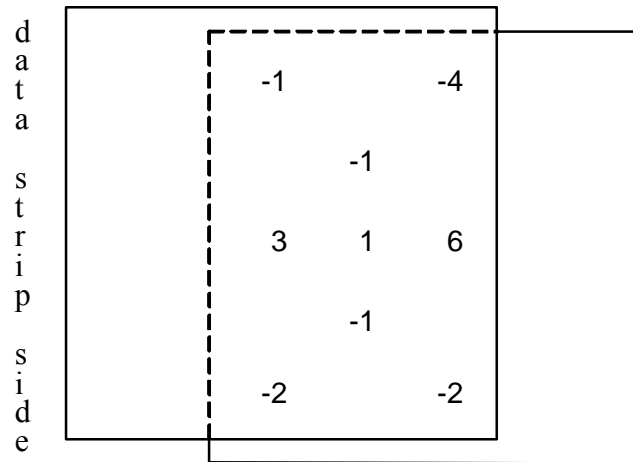
IX. Stereomodel Flatness

FMC Magazine No: 273445C

Base/Height ratio: 0.6

Platen ID: 273445

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: 46

Film: Type 2405

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

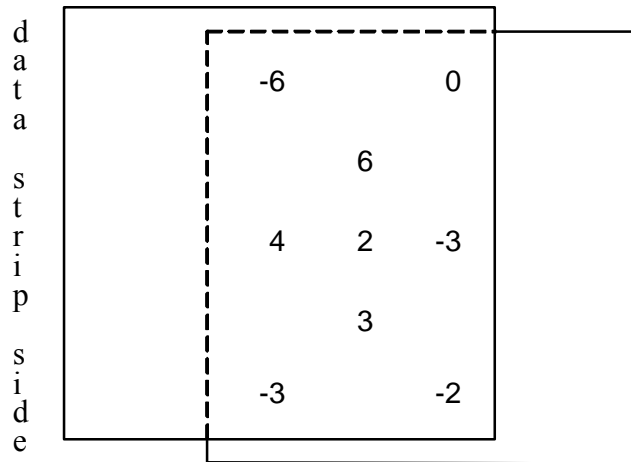
IX. Stereomodel Flatness

FMC Magazine No: 273495

Base/Height ratio: 0.6

Platen ID: 273495

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: 29

Film: Type 2405

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

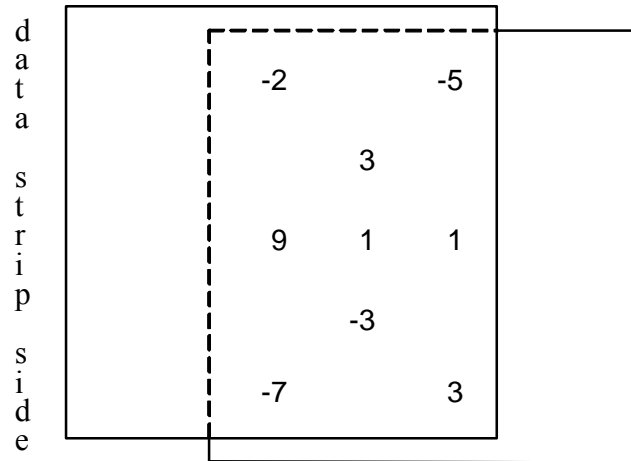
IX. Stereomodel Flatness

FMC Magazine No: 273499

Base/Height ratio: 0.6

Platen ID: 273499

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: 28

Film: Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3171, dated September 9, 2005.

Michael G. Benson
Remote Sensing Technologies Project Manager
Geography Discipline