



United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA 22092

REPORT OF CALIBRATION of Aerial Mapping Camera

August 18, 1992

Camera type: Jena LMK 1000*
Lens type: Jena Lamagon PI/C
Nominal focal length: 153 mm

Camera serial No.: 266613B
Lens serial No.: 7384525C
Maximum aperture: f/4.5
Test aperture: f/4.5

Submitted by: Washington State D.O.T.
Tumwater, Washington

Reference: Washington State Department of Transportation,
purchase order No. F874656, dated July 21, 1992

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type 157-01 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: 152.299 mm

This measurement is considered accurate within 0.005 mm

II. Radial Distortion

Field angle	\bar{D}_c	D_c for azimuth angle			
		0° A-C	90° A-D	180° B-D	270° B-C
degrees	um	um	um	um	um
7.5	3	3	2	3	3
15	4	4	4	4	5
22.7	1	0	1	2	1
30	-3	-4	-3	-2	-4
35	-4	-2	-4	-3	-6
40	3	4	2	3	4

The radial distortion is measured for each of four radii of the focal plane separated by 90° in azimuth. To minimize plotting error due to distortion, a full least-squares solution is used to determine the calibrated focal length. \bar{D}_c is the average distortion for a given field angle. Values of distortion D_c based on the calibrated focal length referred to the calibrated principal point (point of symmetry) are listed for azimuths 0°, 90°, 180° and 270°. The radial distortion is given in micrometers and indicates the radial displacement away from the center of the field. These measurements are considered accurate within 5 um.

* Equipped with Forward Motion Compensation

III. Resolving Power in cycles/mm

Area-weighted average resolution: 77

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial lines	80	95	95	95	95	80	67
Tangential lines	80	80	80	80	80	57	48

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 350 No. 51141A, the 500 No. 51161A and the 550 No. 51185A filters accompanying this camera are within 10 seconds of being parallel. The 500 filter was used for the calibration.

The anti-vignetting coating on the 350 filter has been rubbed off.

V. Shutter Calibration

<u>Indicated shutter speed</u>	<u>Effective shutter speed</u>	<u>Efficiency</u>
1/125	7.00 ms = 1/145 s	73%
1/175	5.00 ms = 1/200 s	73%
1/250	3.50 ms = 1/285 s	73%
1/350	2.43 ms = 1/410 s	73%
1/500	1.75 ms = 1/570 s	73%

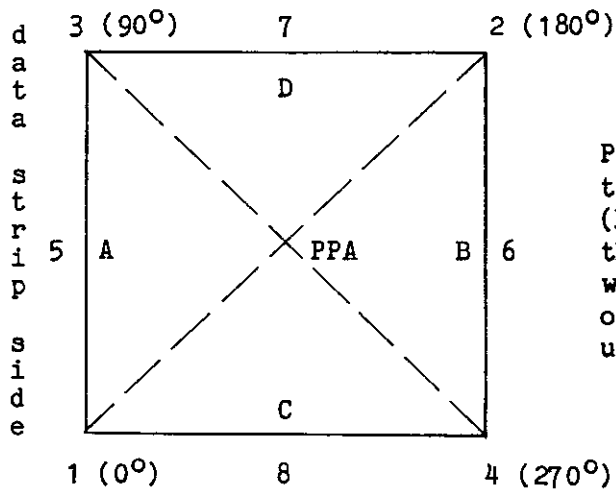
The effective shutter speeds were determined with the lens at aperture f/4.5. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Magazine Platen

The platens mounted in LMK-K 24/120 film magazine No. 266788B and No. 266799B do not depart from a true plane by more than 13 μ m (0.0005 in).

These film magazines are equipped with an identification markers that will register "266788" for magazine No. 266788B, and "266799" for magazine No. 266799B in the film edge for each exposure.

VII. Principal Points and Fiducial 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</u>	<u>Y coordinate</u>
Indicated principal point, corner fiducials	0.006 mm	-0.006 mm
Indicated principal point, midside fiducials	0.007	-0.002
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	0.006	-0.010

Fiducial Marks

1	-109.990 mm	-110.002 mm
2	110.010	109.999
3	-109.989	109.995
4	109.998	-110.002
5	-111.998	-0.004
6	112.004	0.000
7	0.014	111.993
8	0.000	-112.002

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 311.128 mm 3-4: 311.116 mm

Lines joining these markers intersect at an angle of 89° 59' 55"

Midside fiducials

5-6: 224.002 mm 7-8: 223.996 mm

Lines joining these markers intersect at an angle of 89° 59' 43"

Corner fiducials (perimeter)

1-3: 219.997 mm 2-3: 220.000 mm

1-4: 219.988 mm 2-4: 220.001 mm

The method of measuring these distances is considered accurate within 0.005 mm.

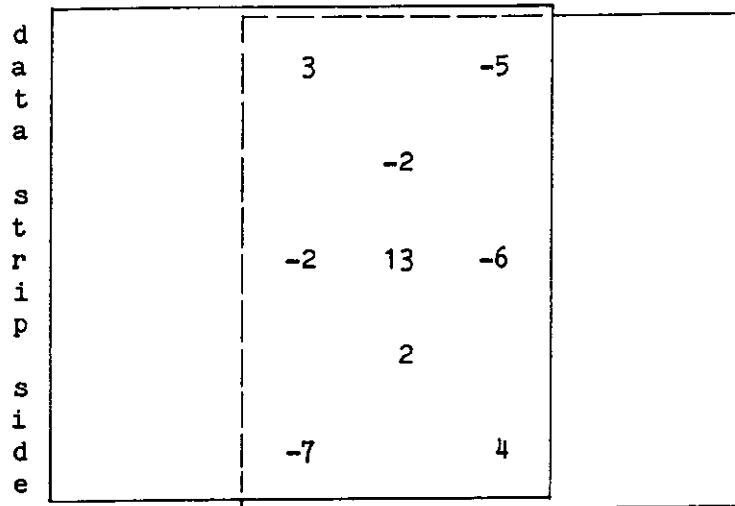
IX. Stereomodel Flatness

Magazine No.: 266788B

Base/Height ratio: 0.6

Platen ID: 266788

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 stereomodels based on comparator measurements on contact glass (Kodak Micro-flat) diapositives made from Kodak 2405 film exposures. These measurements are considered accurate within 5 μ m.

X. Resolving Power in cycles/mm

Area-weighted average resolution: 39

Film: Type 2405

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

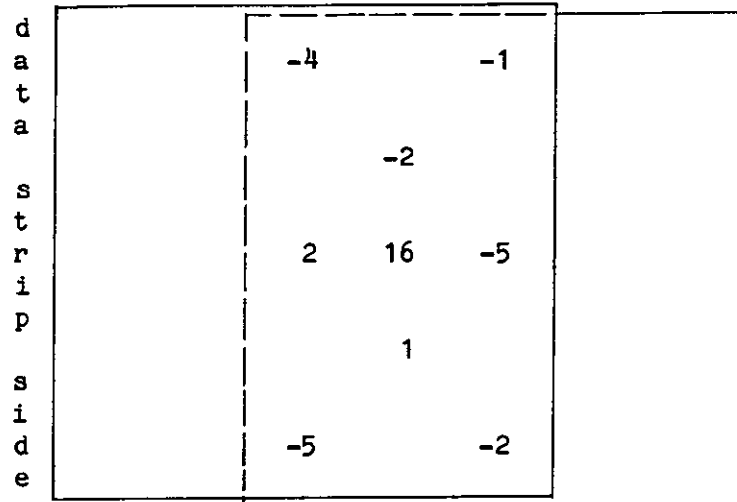
IX. Stereomodel Flatness

Magazine No.: 266799B

Base/Height ratio: 0.6

Platen ID: 266799

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 stereomodels based on comparator measurements on contact glass (Kodak Micro-flat) diapositives made from Kodak 2405 film exposures. These measurements are considered accurate within 5 μ m.

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This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/1313, dated January 29, 1988.

Bradish F. Johnson

Bradish F. Johnson
Chief, Optical Science Laboratory
National Mapping Division