



United States Department of the Interior



GEOLOGICAL SURVEY
RESTON, VA 22092

REPORT OF CALIBRATION of Aerial Mapping Camera

July 13, 1990

Camera type:	Jena LMK 2000*	Camera serial no.:	271826C
Lens type:	Jena Lamagon PI/D	Lens serial no.:	7390036D
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: E. Coyote Enterprises, Inc.
Mineral Wells, Texas

Reference: E. Coyote Enterprises, Inc., purchase
order No. 2679, dated July 6, 1990.

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type V-F 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: 152.754 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	-2	-1	-2	-2	-3
15	-2	-2	-3	-1	-3
22.5	0	0	2	-2	0
30	3	4	4	3	1
35	2	2	1	1	2
40	-1	-1	-2	0	-1

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: 96

Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	113	113	113	113	113	95	95
Tangential lines	113	113	113	95	80	80	80

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 405 No. 51870, the 490 No. 51877 and the 530 No. 51884 filters accompanying this camera are within 10 seconds of being parallel. The 490 filter was used for the calibration.

V. Shutter Calibration

<u>Indicated shutter speed</u>	<u>Effective shutter speed</u>	<u>Efficiency</u>
1/125	8.50 ms = 1/120 s	68%
1/250	4.00 ms = 1/250 s	68%
1/500	2.00 ms = 1/500 s	68%
1/1000	1.05 ms = 1/950 s	68%

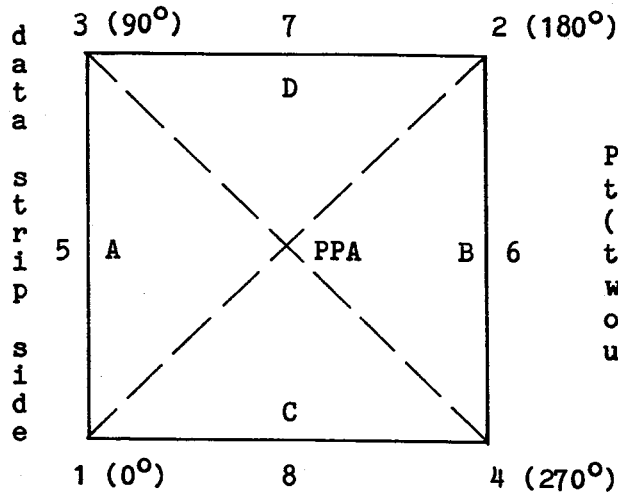
The effective shutter speeds were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Magazine Platen

The platens mounted in LMK-K 24/120 film magazines No. 271892 and No. 271895 do not depart from a true plane by more than 13 um (0.0005 in).

These film magazines are equipped with identification markers that will register "271892" for magazine No. 271892 and "271895" for magazine No. 271895 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	-0.002 mm	-0.006 mm
Indicated principal point, midside fiducials	0.002	0.000
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	0.001	0.005

Fiducial Marks

1	-109.997 mm	-110.006 mm
2	110.000	110.000
3	-110.005	109.998
4	109.999	-110.006
5	-112.006	-0.002
6	111.998	0.001
7	0.000	111.998
8	0.004	-112.007

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 311.129 mm 3-4: 311.133 mm

Lines joining these markers intersect at an angle of 89° 59' 56"

Midside fiducials

5-6: 224.004 mm 7-8: 224.005 mm

Lines joining these markers intersect at an angle of 90° 00' 01"

Corner fiducials (perimeter)

1-3: 220.004 mm 2-3: 220.005 mm
 1-4: 219.996 mm 2-4: 220.006 mm

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

IX. Stereomodel Flatness

Magazine No.: 271892

Base/Height ratio: 0.6

Magazine ID: 271892

Maximum angle of field tested: 40°

d a t a s t r i p s i d e	-2	2	
	-3		
	2	-3	4
	2		
	2	-4	

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 μm .

X. Resolving Power in cycles/mm

Area-weighted average resolution: 47

Film: Type 2405

Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	67	57	57	57	48	48	40
Tangential lines	67	57	57	48	40	40	34

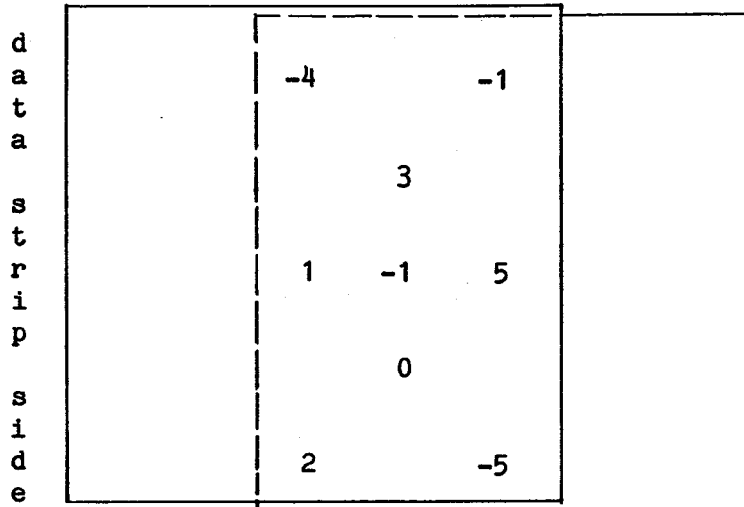
IX. Stereomodel Flatness

Magazine No.: 271895

Base/Height ratio: 0.6

Magazine ID: 271895

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 um.

X. Resolving Power in cycles/mm

Area-weighted average resolution: 46

Film: Type 2405

Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	57	57	57	48	48	48	40
Tangential lines	57	57	57	48	40	40	34

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