



United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092REPORT OF CALIBRATION
of Aerial Mapping Camera

March 1, 1994

Camera type: Wild RC10
Lens type: Wild Universal Aviogon /4
Nominal focal length: 153 mm

Camera serial no.: 3563
Lens serial no.: 13078
Maximum aperture: f/4
Test aperture: f/4

Submitted by: Leica, Inc.
Rockleigh, New Jersey

Reference: AeroGraphics Corp. purchase order
No. 2939, dated March 1, 1994.

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: 153.024 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	0	0	1	0	-2
15	-1	-1	-1	0	-2
22.7	-2	-2	-2	-3	-3
30	0	-1	-1	1	-1
35	1	3	0	3	0
40	1	3	0	2	0

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.

III. Resolving Power in cycles/mm

Area-weighted average resolution: 83

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	95	95	113	80	95	80	57
Tangential lines	95	80	80	80	95	80	67

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 Wild 420 No. 6374 and the 525 No. 6274 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

<u>Indicated exposure time</u>	<u>Effective exposure time</u>	<u>Efficiency</u>
1/200	5.50 ms = 1/180 s	78%
1/400	2.88 ms = 1/345 s	78%
1/600	1.92 ms = 1/520 s	78%
1/800	1.44 ms = 1/695 s	78%
1/1000	1.15 ms = 1/870 s	78%

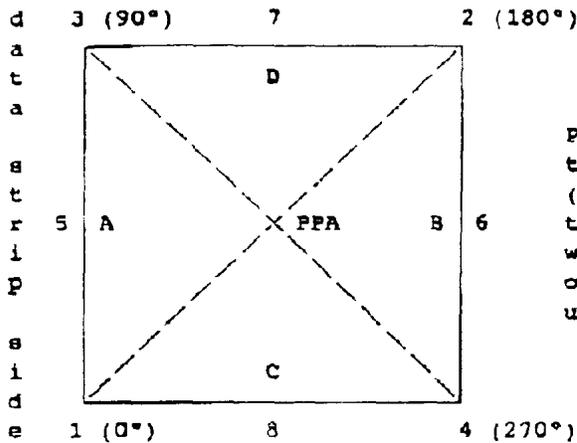
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC10 drive unit No. 3653-387 does not depart from a true plane by more than 13 μ m (0.0005 in).

This camera is equipped with a platen identification marker that will register "387" in the data strip area 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	0.001 mm	0.007 mm
Indicated principal point, midside fiducials	-0.001	0.009
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	-0.003	0.005

Fiducial Marks

1	-106.011 mm	-105.994 mm
2	106.011	106.005
3	-105.990	106.008
4	105.991	-105.994
5	-110.003	0.008
6	110.003	0.009
7	0.005	110.003
8	-0.007	-109.991

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.828 mm 3-4: 299.801 mm

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

Midside fiducials

5-6: 220.006 mm 7-8: 219.994 mm

Lines joining these markers intersect at an angle of 89° 59' 48"

Corner fiducials (perimeter)

1-3: 212.002 mm 2-3: 212.001 mm

1-4: 212.002 mm 2-4: 211.999 mm

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

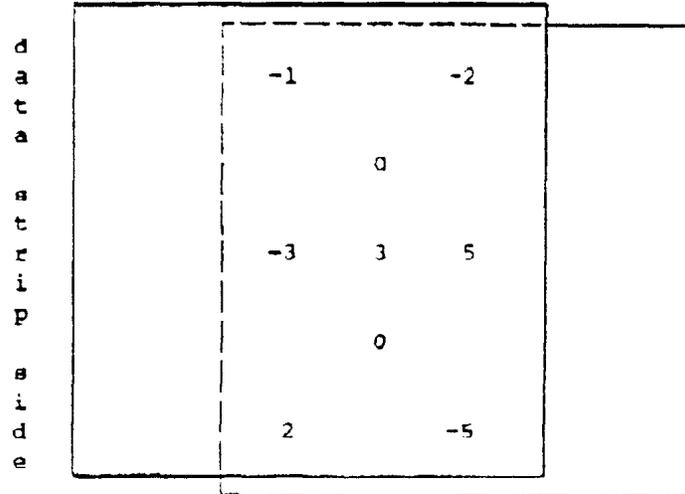
IX. Stereomodel Flatness

Drive unit No.: 3563-387

Base/Height ratio: 0.6

Platen ID: 387

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. Lens/Film Resolving Power 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	48	57	48	48	48	40
Tangential lines	57	40	40	40	48	40	40

This aerial-mapping camera calibration report supersedes the previously issued USGS Report No. OSL/1602, dated February 11, 1991.

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FILM RADIAL DISTORTION, STEREOMODEL FLATNESS AND RESOLVING POWER

Drive unit No.: 3563-387
Platen ID: 387

Base/Height ratio: 0.6
Maximum angle of field tested: 40°

Calibrated Focal Length

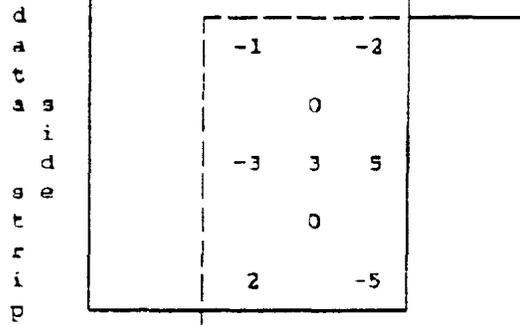
flash plate: 153.024 mm
film: 153.032 mm

IX. 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	2	2	4	3
15	2	2	2	5	0
22.5	2	1	2	3	1
30	1	3	3	2	-3
35	-1	2	-6	2	-2
40	-2	-1	-3	-1	-2

X. Stereomodel Flatness

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.



Stereomodel test point array
(values in micrometers)

XI. Lens/Film Resolving Power in cycles/mm

Area-weighted average resolution:	45							Film: Type 2405
Field angles:	0°	7.5°	15°	22.7°	30°	35°	40°	
Radial Lines	57	48	57	48	48	48	40	
Tangential lines	57	40	40	40	48	40	40	

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/1602, dated February 11, 1991.

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