



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, VirginiaREPORT OF CALIBRATION
of Aerial Mapping Camera

August 15, 2001

Camera type:	Wild RC30*	Camera serial no.:	5109
Lens type:	Wild Universal Aviogon A4-F	Lens serial no.:	13138
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Great Lakes Aerial Survey, Inc.
Sheboygan, WisconsinReference: Great Lakes Aerial Survey, Inc. purchase
order No. 0801, dated August 15, 2001.

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: 152.840 mmII. Lens Distortion

Field Angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	-1	-2	-1	1	2	-2
Decentering (um)	0	0	0	1	1	1

<u>Symmetric radial</u> <u>Distortion parameters</u>	<u>Decentering</u> <u>Distortion parameters</u>	<u>Calibrated</u> <u>Principal point</u>
$K_0 = 0.7048 \times 10^{-4}$	$P_1 = 0.2134 \times 10^{-7}$	$x_p = 0.003 \text{ mm}$
$K_1 = -0.1717 \times 10^{-7}$	$P_2 = 0.6452 \times 10^{-7}$	$y_p = -0.003 \text{ mm}$
$K_2 = 0.8361 \times 10^{-12}$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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 or 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: 90

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	134	113	80	113	95	67
Tangential lines	134	113	95	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 7750, and the Wild 525 No. 7757 filters accompanying this camera are within 10 seconds of being parallel. The 525 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	1688	1683	7.48	1/160	86%
1/250	889	876	3.99	1/290	86%
1/500	469	460	2.07	1/560	86%
1/1000	240	238	1.07	1/1090	86%

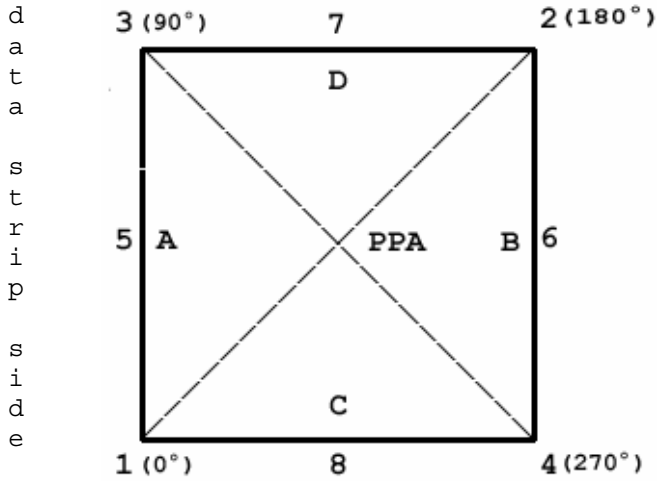
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972 (R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5109-502 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 "502" 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 (PPS) 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	0.011 mm	0.002 mm
Indicated principal point, midside fiducials	0.011	0.001
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt.of sym.) x_p, y_p	0.003	-0.003
<u>Fiducial Marks</u>		
1	-105.989 mm	-105.993 mm
2	106.009	105.996
3	-105.984	106.002
4	106.000	-105.993
5	-109.990	0.005
6	109.999	-0.002
7	0.018	110.000
8	0.004	-110.001

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.804 mm 3-4: 299.799 mm

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

Midside fiducials

5-6: 219.989 mm 7-8: 220.001 mm

Lines joining these markers intersect at an angle of 89° 59' 53"

Corner fiducials (perimeter)

1-3: 211.995 mm 2-3: 211.993 mm
 1-4: 211.989 mm 2-4: 211.989 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 282 mm.

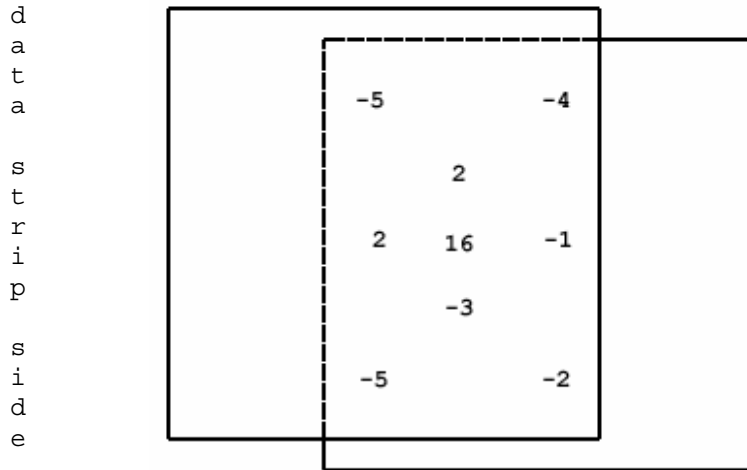
IX. Stereomodel Flatness

FMC Drive Unit No.: 5109-502

Base/Height ratio: 0.6

Platen ID: 502

Maximum angle of field tested: 40°



Stereomodel
Test point array
(values in micrometers)

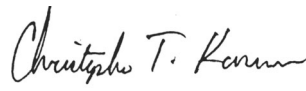
The values shown on the diagram are the average departures from flatness (at negative scale) for two computer-simulated stereo models. The values are based on comparator measurements on contact glass (Kodak Micro-flat) diapositives made from Kodak 2405 film exposures. These measurements can vary by as much as + 5um from model to model.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 43 Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	57	57	48	40	48	48	40
Tangential lines	57	48	40	40	40	40	34

This aerial mapping camera report supersedes the previously issued USGS Report No. OSL/2470, dated August 11, 1998.

for 
John J. Lenart
Chief, Technology Operations Section
National Mapping Division

GLAS Film Annotation Guide

Film Speed

Shutter Speed

F/ stop

Filter Factor

Exposure Mode

Trigger Mode

V/H Ratio

End Lap

Cycle Interval

FMC (Microns)

Voltage

Vacuum

Error Code

Camera #

Location Name

Job #

Line #

Frame #

Track : Degrees True

Altitude MSL

Latitude: dd mm ss.s

Longitude: dd mm ss.s

(D) = Differential GPS

(N) = No Differential GPS

Date: yy/mm/dd

Time: GPS hh:mm:ss