



United States Department of the Interior

U.S GEOLOGICAL SURVEY
Reston, Virginia

REPORT OF CALIBRATION
of Aerial Mapping Camera

October 4, 1999

Camera type:	Wild RC30*	Camera serial no.:	5319
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13363
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Great Lakes Aerial Survey, Inc.
Sheboygan, Wisconsin

Reference: LH Systems, LLC, purchase order
No. 9018, dated January 6, 1999.

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: 153.472 mm

II. Lens Distortion

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

<u>Symmetric radial Distortion parameters</u>	<u>Decentering Distortion parameters</u>	<u>Calibrated Principal point</u>
$K_0 = 0.5563 \times 10^{-4}$	$P_1 = 0.4662 \times 10^{-7}$	$x_p = 0.002 \text{ mm}$
$K_1 = -0.8206 \times 10^{-8}$	$P_2 = -0.4102 \times 10^{-7}$	$y_p = -0.002 \text{ mm}$
$K_2 = 0.2407 \times 10^{-12}$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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: 114

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	134	134	134	113	113	113
Tangential lines	134	134	113	134	113	95	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 Wild 525 No. 7757 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>
1/125	7.33 ms = 1/125 s	80%
1/250	4.00 ms = 1/250 s	80%
1/500	2.00 ms = 1/500 s	80%
1/1000	1.00 ms = 1/1000 s	80%

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. 5319-701 does not depart from a true plane by more than 13 um (0.0005 in).

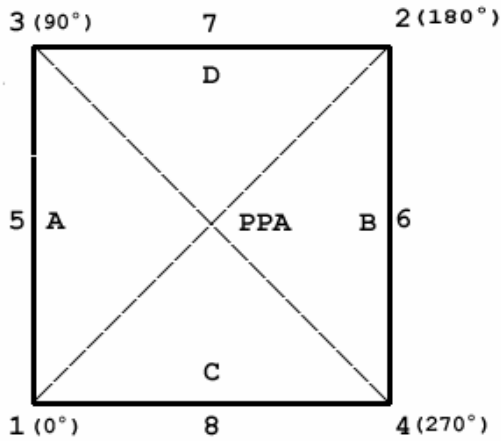
This camera is equipped with a platen identification marker that will register "701" in the data strip area for each exposure.

VII. Principal Points and Fiducial Coordinates

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Positions of all points are reference to the principal points 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	-0.003 mm
Indicated principal point, midside fiducials	0.004	0.000
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt.of sym.) x_p, y_p	0.002	-0.002

Fiducial Marks

1	-105.992 mm	-106.002 mm
2	106.000	105.992
3	-105.994	105.996
4	106.007	-106.002
5	-111.990	0.003
6	112.002	-0.003
7	0.003	111.995
8	0.006	-112.003

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.803 mm 3-4: 299.813 mm

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

Midside fiducials

5-6: 223.993 mm 7-8: 223.999 mm

Lines joining these markers intersect at an angle of 90° 00' 09"

Corner fiducials (perimeter)

1-3: 211.998 mm 2-3: 211.994 mm

1-4: 211.999 mm 2-4: 211.993 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 278 mm.

IX. Stereomodel Flatness

FMC Drive Unit No.: 5319-701

Base/Height ratio: 0.6

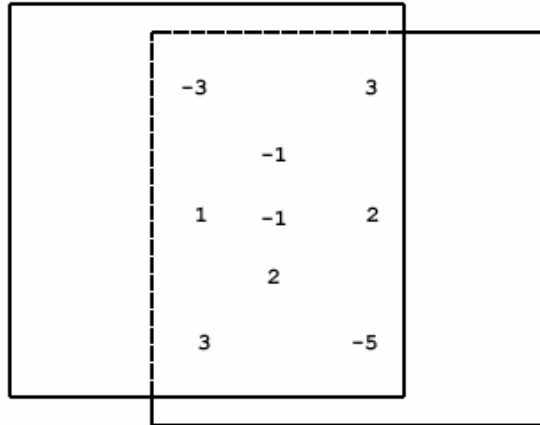
Platen ID: 701

Maximum angle of field tested: 40°

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Maximum: 5
High/Low: 8
Average: 2.33

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 + 5µm from model to model.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 53

Film: Type 2405

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

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GLAS Film Annotation Guide

Film Speed	Location Name
Shutter Speed	Job #
F/ stop	Line #
Filter Factor	Frame #
Exposure Mode	Track : Degrees True
Trigger Mode	Altitude MSL
V/H Ratio	Latitude: dd mm ss.s
End Lap	Longitude: dd mm ss.s
Cycle Interval	(D) = Differential GPS
FMC (Microns)	(N) = No Differential GPS
Voltage	Date: yy/mm/dd
Vacuum	Time: GPS hh:mm:ss
Error Code	
Camera #	