



United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

May 5, 2004

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

Camera serial no.: 2337
Lens serial no.: 1045
Maximum aperture: f/5.6
Test aperture: f/5.6

Submitted by: Hauts-Monts, Inc.
Beauport, Quebec, Canada

Reference: Hauts-Monts, Inc. letter of authorization
dated April 30, 2004.

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: 153.228 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	6	10	9	1	-7	-10
Decentering (um)	0	0	1	2	3	4

Symmetric radial
distortion parameters

$$\begin{aligned}K_0 &= -0.3408 \times 10^{-3} \\K_1 &= 0.5753 \times 10^{-7} \\K_2 &= -0.1943 \times 10^{-11} \\K_3 &= 0.0000 \\K_4 &= 0.0000\end{aligned}$$

Decentering
distortion parameters

$$\begin{aligned}P_1 &= 0.1175 \times 10^{-7} \\P_2 &= -0.2375 \times 10^{-6} \\P_3 &= 0.0000 \\P_4 &= 0.0000\end{aligned}$$

Calibrated
principal point

$$\begin{aligned}x_p &= 0.000 \text{ mm} \\y_p &= 0.007 \text{ mm}\end{aligned}$$

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 of 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.

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 62

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	95	95	95	57	80	80	14
Tangential lines	95	67	57	48	67	67	34

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 filter No. 5593 filters accompanying this camera are within 10 seconds of being parallel. This 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 (%)
1/200	1318	1330	4.55	1/270	81
1/400	667	672	2.30	1/530	81
1/600	436	455	1.50	1/820	81
1/800	330	339	1.11	1/1110	81
1/1000	289	287	0.91	1/1380	80

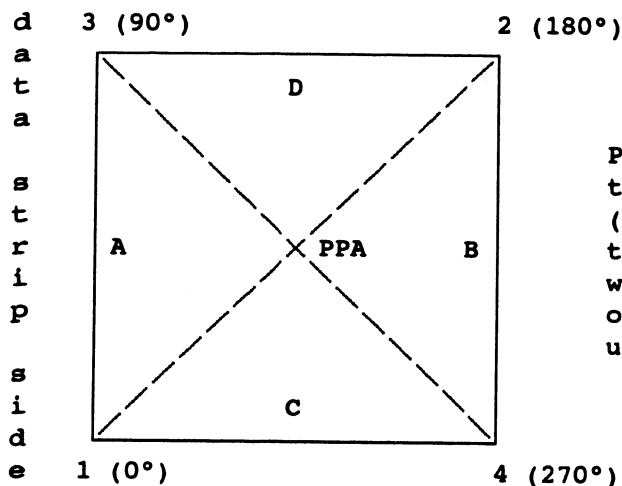
The effective exposure times were determined with the lens at aperture f/5.6. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC10 drive unit No. 2337-229 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 "229" 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	-0.003 mm	-0.009 mm
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.000	0.007

Fiducial Marks

1	-105.993 mm	-106.006 mm
2	106.001	106.002
3	-106.015	105.982
4	106.015	-106.006

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.814 mm 3-4: 299.826 mm

Lines joining these markers intersect at an angle of 90° 00' 13"

Corner fiducials (perimeter)

1-3: 211.988 mm 2-3: 212.008 mm
1-4: 212.015 mm 2-4: 212.007 mm

The method of measuring these distances is considered accurate within 0.003 mm

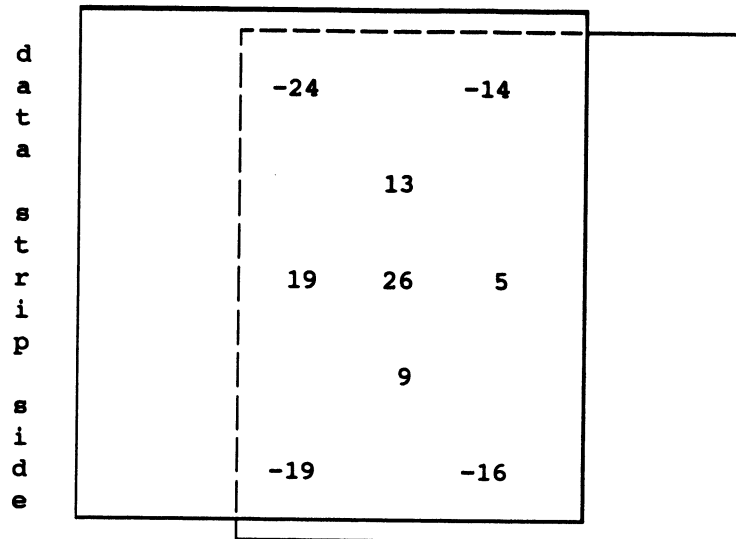
IX. Stereomodel Flatness

Drive unit No.: 2337-229

Base/Height ratio: 0.6

Platen ID: 229

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 Kodak 4425 copy film made from Kodak 2405 film exposures. These measurements can vary by as much as $\pm 5 \mu\text{m}$ from model to model.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 32

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	40	40	40	34	40	40	14
Tangential lines	40	34	28	28	34	28	24

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