



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

November 13, 2003

Camera type:	Wild RC30*	Camera serial no.:	5231
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13246
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Tim Tyler Surveying and Mapping
Conway, Arkansas

Reference: Tim Tyler Surveying and Mapping purchase
order No. 11-10-03, dated November 12, 2003.

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: 153.026 mm

II. Lens Distortion

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

Symmetric radial
distortion parameters

Decentering
distortion parameters

Calibrated
principal point

$$\begin{aligned} K_0 &= 0.4556 \times 10^{-4} \\ K_1 &= -0.3618 \times 10^{-8} \\ K_2 &= -0.0012 \times 10^{-15} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} P_1 &= -0.4432 \times 10^{-7} \\ P_2 &= -0.2130 \times 10^{-6} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} x_p &= 0.003 \text{ mm} \\ y_p &= 0.007 \text{ mm} \end{aligned}$$

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.

* Equipped with Forward Motion Compensation

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 102

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	134	134	113	113	95	95
Tangential lines	113	113	113	95	113	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 Wild 420 filter No. 7492 and the 525 filter No. 7485 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	1800	1784	8.24	1/140	86
1/250	924	923	4.32	1/270	86
1/500	467	473	2.19	1/530	86
1/1000	239	238	1.09	1/1070	86

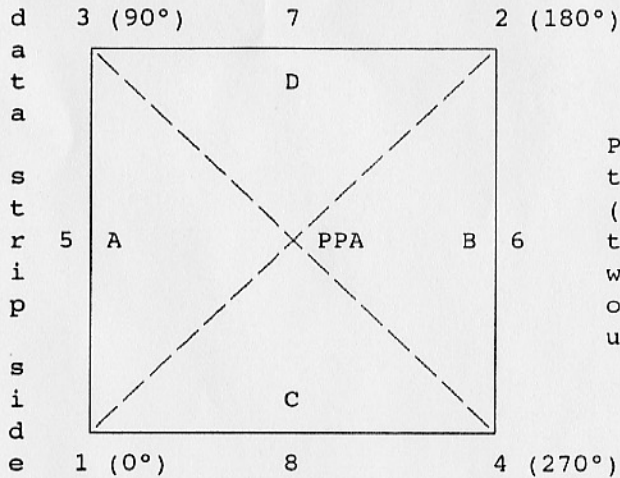
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5231-598 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 "598" 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	0.001 mm
Indicated principal point, midside fiducials	0.000	-0.001
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.003	0.007

Fiducial Marks

1	-105.997 mm	-105.998 mm
2	105.998	106.003
3	-105.997	106.000
4	105.994	-105.998
5	-112.000	-0.001
6	111.996	0.000
7	0.002	112.009
8	-0.002	-112.006

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.811 mm 3-4: 299.805 mm

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

Midside fiducials

5-6: 223.996 mm 7-8: 224.015 mm

Lines joining these markers intersect at an angle of 89° 59' 55"

Corner fiducials (perimeter)

1-3: 211.998 mm 2-3: 211.995 mm
 1-4: 211.991 mm 2-4: 212.001 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 283 mm.

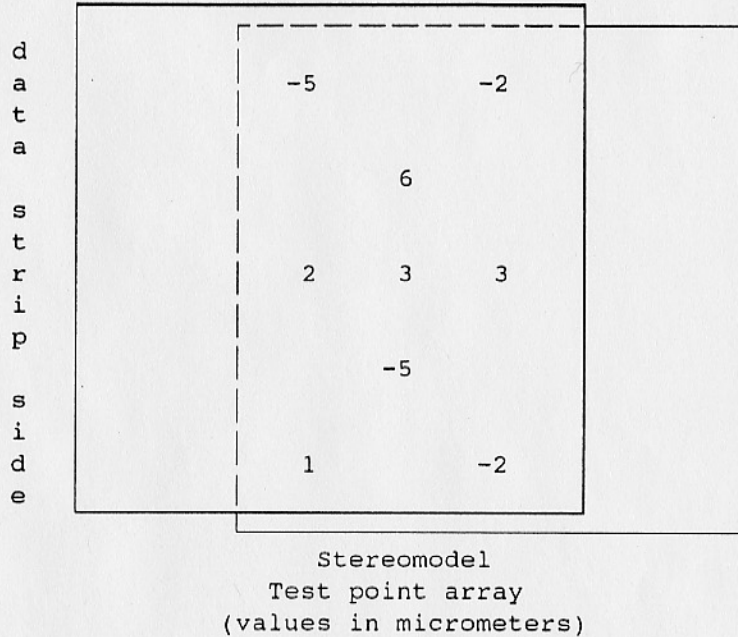
IX. Stereomodel Flatness

FMC Drive Unit No.: 5231-598

Base/Height ratio: 0.6

Platen ID: 598

Maximum angle of field tested: 40°



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 $\pm 5 \mu\text{m}$ from model to model.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 50

Film: Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2705, dated November 20, 2000.

Gregory I. Snyder
Commercial Remote Sensing Project Manager
National Mapping Division