



# United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
Reston, Virginia 20192

## REPORT OF CALIBRATION of Aerial Mapping Camera

October 6, 2006

Camera type:	Wild RC30*	Camera serial no.:	5368
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13413
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Richard Crouse & Associates, Inc.  
Frederick, Maryland

Reference: Richard Crouse & Associates, Inc. letter of  
Authorization, dated October 10, 2006.

These measurements were made on Agfa glass plates, 0.19 inch thick, with spectroscopic emulsion type APX 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: 153.739 mm

### II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	-2	-5	-5	-4	-1	5
Decentering (um)	0	1	1	2	3	5

#### Symmetric radial distortion parameters

$$\begin{aligned}
 K_0 &= 0.1276 \times 10^{-3} \\
 K_1 &= -0.1051 \times 10^{-7} \\
 K_2 &= 0.3330 \times 10^{-13} \\
 K_3 &= 0.0000 \\
 K_4 &= 0.0000
 \end{aligned}$$

#### Decentering distortion parameters

$$\begin{aligned}
 P_1 &= 0.2788 \times 10^{-6} \\
 P_2 &= -0.1015 \times 10^{-6} \\
 P_3 &= 0.0000 \\
 P_4 &= 0.0000
 \end{aligned}$$

#### Calibrated principal point

$$\begin{aligned}
 x_p &= 0.000 \text{ mm} \\
 y_p &= -0.005 \text{ mm}
 \end{aligned}$$

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 ( $\sigma$ ) of  $\pm 3$  microns.

\* Equipped with Forward Motion Compensation

### III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 109

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	134	134	134	113	95	95
Tangential lines	134	134	113	113	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 420 filter No. 7947 and the 525 filter No. 7930 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 ( $\mu$ sec)	Fall Time ( $\mu$ sec)	$\frac{1}{2}$ width time (ms)	Nom. Speed (sec.)	Efficiency (%)
1/125	1746	1738	8.75	1/130	88
1/250	821	827	4.18	1/270	88
1/500	431	427	2.15	1/530	88
1/1000	227	220	1.09	1/1050	87

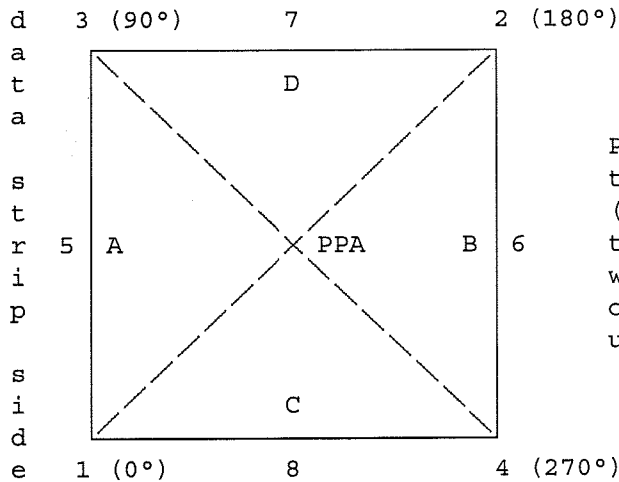
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is described in International Standard ISO 516:1999(E).

### VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5368-756 does not depart from a true plane by more than 13  $\mu$ m (0.0005 in).

This camera is equipped with a platen identification marker that will register "756" 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	0.022 mm	-0.006 mm
Indicated principal point, midside fiducials	0.018	-0.007
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) $x_p, y_p$	0.000	-0.005

Fiducial Marks

1	-105.982 mm	-106.005 mm
2	106.023	105.991
3	-105.972	105.992
4	106.017	-106.005
5	-111.979	-0.004
6	112.023	-0.009
7	0.026	111.995
8	0.011	-112.010

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.814 mm                      3-4: 299.804 mm

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

Midside fiducials

5-6: 224.002 mm                      7-8: 224.005 mm

Lines joining these markers intersect at an angle of 89° 59' 51"

Corner fiducials (perimeter)

1-3: 211.997 mm                      2-3: 211.995 mm

1-4: 212.000 mm                      2-4: 211.996 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 277 mm.

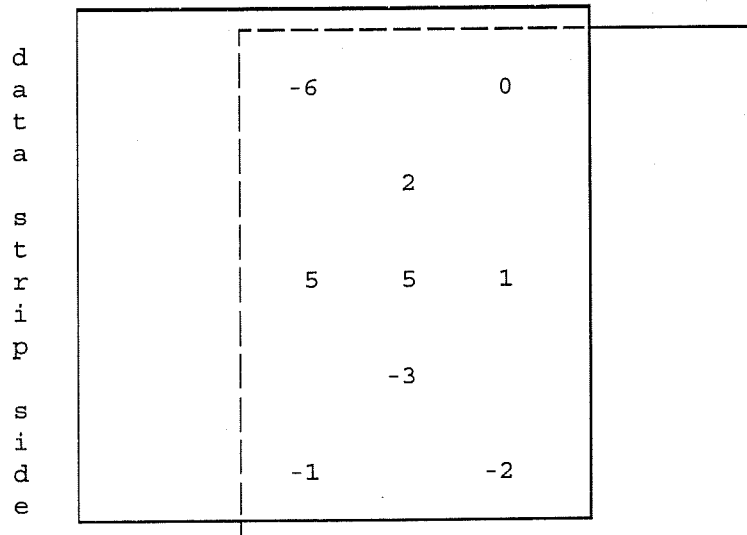
IX. Stereomodel Flatness

FMC Drive Unit No.: 5368-756

Base/Height ratio: 0.6

Platen ID: 756

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 are considered accurate to within 5  $\mu\text{m}$ .

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	57	57	57	57	57	57	48
Tangential lines	57	57	57	57	48	48	40

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2985, dated November 5, 2003.

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