



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

September 18, 2006

Camera type:	Wild RC20*	Camera serial no.:	5072
Lens type:	Wild Universal Aviogon A4-F	Lens serial no.:	13114
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Air Flight Service
Santa Clara, California

Reference: Air Flight Service purchase order
No. AFS092006-RC20, dated September 18, 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: 152.810 mm

II. Lens Distortion

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

Symmetric radial
distortion parameters

Decentering
distortion parameters

Calibrated
principal point

$$\begin{aligned} K_0 &= -0.4870 \times 10^{-5} \\ K_1 &= -0.1405 \times 10^{-8} \\ K_2 &= 0.1207 \times 10^{-12} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} P_1 &= 0.4400 \times 10^{-8} \\ P_2 &= -0.3314 \times 10^{-6} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} x_p &= -0.002 \text{ mm} \\ y_p &= 0.018 \text{ mm} \end{aligned}$$

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: 86

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	113	113	80	95	95	57
Tangential lines	113	80	80	95	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 filter No. 6941 and the 525 filter No. 6692 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	1742	1728	8.33	1/140	87
1/250	860	863	4.18	1/270	87
1/500	448	450	2.17	1/530	87
1/1000	222	216	1.10	1/1040	87

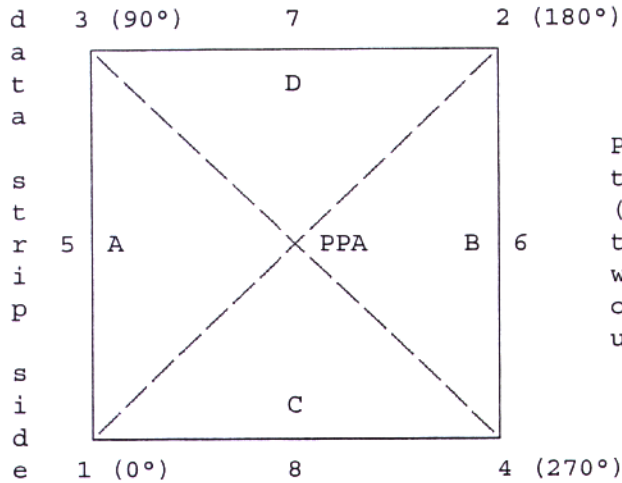
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is described in International Standard ISO 516:1999(E).

VI. Film Platen

The film platen mounted in Wild RC20 drive unit No. 5072-2A 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 "2A" 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.

	X coordinate	Y coordinate
Indicated principal point, corner fiducials	0.011 mm	-0.007 mm
Indicated principal point, midside fiducials	0.014	-0.008
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	-0.002	0.018

Fiducial Marks

1	-105.989 mm	-106.007 mm
2	106.011	105.993
3	-105.982	105.988
4	106.011	-106.007
5	-109.995	-0.008
6	110.016	-0.008
7	0.015	109.985
8	0.012	-110.011

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.814 mm 3-4: 299.805 mm

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

Midside fiducials

5-6: 220.011 mm 7-8: 219.996 mm

Lines joining these markers intersect at an angle of 89° 59' 56"

Corner fiducials (perimeter)

1-3: 211.995 mm 2-3: 211.994 mm

1-4: 212.000 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 282 mm.

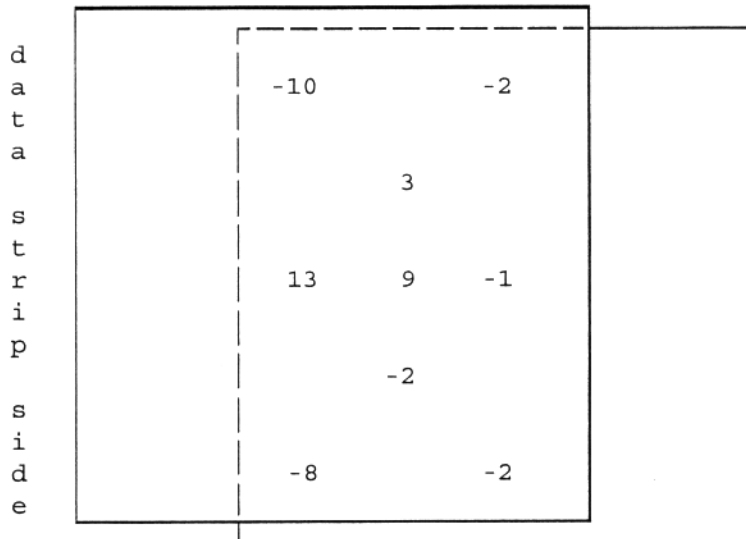
IX. Stereomodel Flatness

FMC Drive Unit No.: 5072-2A

Base/Height ratio: 0.6

Platen ID: 2A

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 μm.

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 calibration report supersedes the previously issued USGS Report No. OSL/2978, dated October 3, 2003.

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