



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

March 7, 2000

Camera type:	Wild RC10	Camera serial no.:	2957
Lens type:	Wild Universal Aviogon I	Lens serial no.:	UAg I 6069
Nominal focal length:	153 mm	Maximum aperture:	f/5.6
		Test aperture:	f/5.6

Submitted by: Air Flight Service
Santa Clara, California

Reference: Air Flight Service purchase order
No. 7412, dated March 2, 2000.

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: 152.007 mm

II. Lens Distortion

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

Symmetric radial
distortion parameters

Decentering
distortion parameters

Calibrated
principal point

$$\begin{aligned} K_0 &= 0.9185 \times 10^{-4} \\ K_1 &= -0.2211 \times 10^{-7} \\ K_2 &= 0.1066 \times 10^{-11} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} P_1 &= -0.3729 \times 10^{-7} \\ P_2 &= 0.1196 \times 10^{-6} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} x_p &= 0.004 \text{ mm} \\ y_p &= -0.006 \text{ mm} \end{aligned}$$

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	113	134	67	57	80	67	24
Tangential lines	113	113	67	48	57	67	40

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 No. 5673 and the 525 No. 5643 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

Note: The antivignetting coating on the 420 AV2x filter No. 5673 has been abraded to an unacceptable degree.

V. Shutter Calibration

<u>Indicated exposure time</u>	<u>Effective exposure time</u>	<u>Efficiency</u>
1/200	5.00 ms = 1/200 s	79%
1/400	2.38 ms = 1/420 s	79%
1/600	1.58 ms = 1/630 s	79%
1/800	1.19 ms = 1/840 s	79%
1/1000	0.95 ms = 1/1055 s	79%

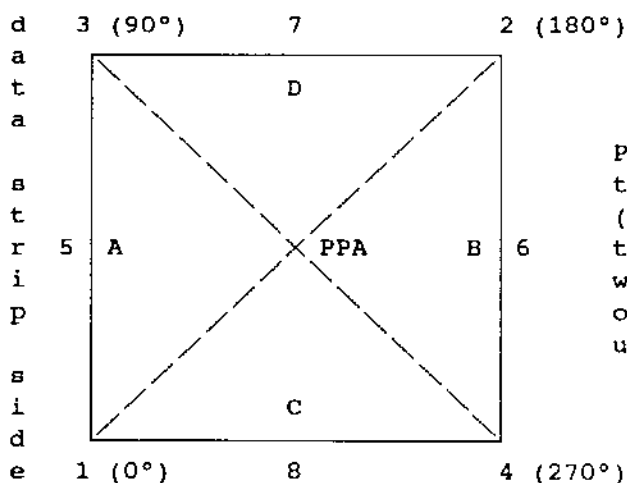
The effective exposure times were determined with the lens at aperture f/5.6. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC10 drive unit No. 2957-333 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 "333" 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	0.005 mm	0.007 mm
Indicated principal point, midside fiducials	0.008	0.006
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.004	-0.006

Fiducial Marks

1	-105.995 mm	-105.990 mm
2	106.009	106.010
3	-105.992	106.000
4	106.007	-105.990
5	-109.998	-0.001
6	109.997	0.014
7	0.009	110.008
8	0.007	-109.987

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.816 mm 3-4: 299.806 mm

Lines joining these markers intersect at an angle of 90° 00' 06"

Midside fiducials

5-6: 219.996 mm 7-8: 219.995 mm

Lines joining these markers intersect at an angle of 89° 59' 45"

Corner fiducials (perimeter)

1-3: 211.990 mm 2-3: 212.001 mm

1-4: 212.002 mm 2-4: 212.000 mm

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

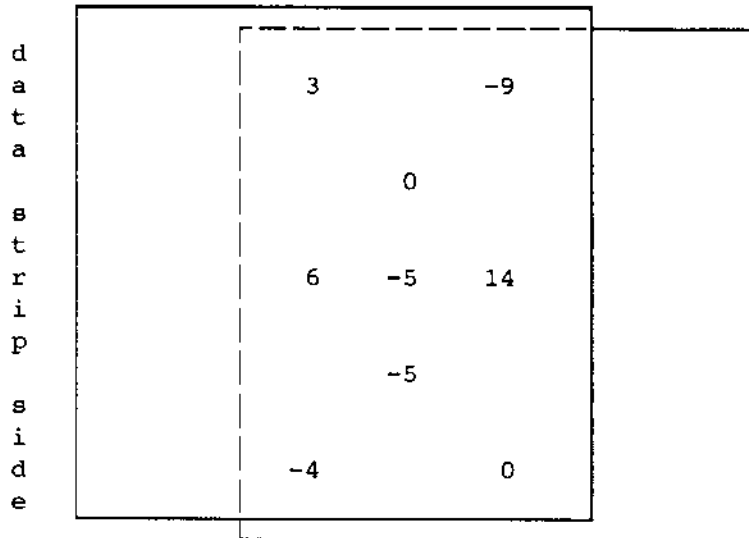
IX. Stereomodel Flatness

Drive unit No.: 2957-333

Base/Height ratio: 0.6

Platen ID: 333

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 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: 34

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	57	48	40	28	40	40	20
Tangential lines	57	48	34	34	34	34	24

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2314, dated April 23, 1997.

Frank C. Maccue

Frank C. Maccue
Chief, Optical Science Laboratory
National Mapping Division