



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

October 10, 2002

Camera type:	Wild RC30*	Camera serial no.:	5360
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13402
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Surdex Corporation
Chesterfield, Missouri

Reference: Surdex Corporation purchase order
No. 2667, dated October 9, 2002.

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: 153.517 mm

II. Lens Distortion

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

Symmetric radial distortion parameters

Decentering distortion parameters

Calibrated principal point

$$\begin{aligned}
 K_0 &= 0.6397 \times 10^{-4} \\
 K_1 &= -0.1379 \times 10^{-7} \\
 K_2 &= 0.5948 \times 10^{-12} \\
 K_3 &= 0.0000 \\
 K_4 &= 0.0000
 \end{aligned}$$

$$\begin{aligned}
 P_1 &= 0.1190 \times 10^{-6} \\
 P_2 &= 0.1787 \times 10^{-6} \\
 P_3 &= 0.0000 \\
 P_4 &= 0.0000
 \end{aligned}$$

$$\begin{aligned}
 x_p &= 0.006 \text{ mm} \\
 y_p &= -0.005 \text{ mm}
 \end{aligned}$$

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 (σ) of ± 3 microns.

* Equipped with Forward Motion Compensation

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 114

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	159	159	159	134	113	113	95
Tangential lines	159	134	134	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 No. 7914, and the 525 No. 7928 filters 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	1716	1694	8.26	1/140	87
1/250	880	880	4.30	1/270	87
1/500	443	436	2.17	1/530	87
1/1000	231	230	1.11	1/1040	87

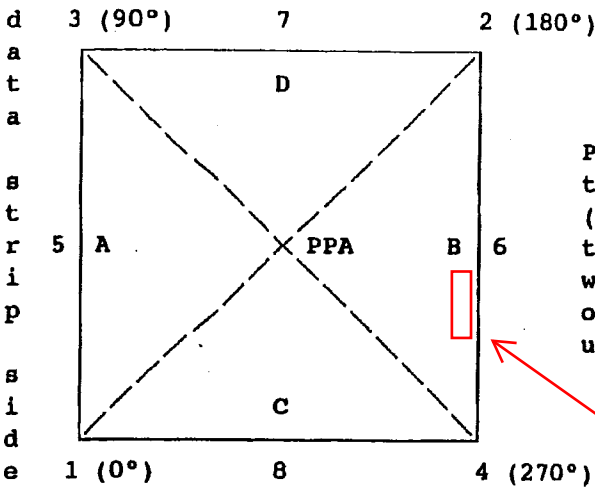
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5360-753 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 "753" 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.

Lens ID tab

	<u>X coordinate</u>	<u>Y coordinate</u>
Indicated principal point, corner fiducials	0.006 mm	0.006 mm
Indicated principal point, midside fiducials	0.005	0.009
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.006	-0.005

Fiducial Marks

1	-105.994 mm	-105.992 mm
2	106.006	106.002
3	-105.993	106.004
4	106.005	-105.992
5	-111.996	0.010
6	112.007	0.007
7	0.007	112.004
8	0.003	-111.989

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.809 mm 3-4: 299.808 mm

Lines joining these markers intersect at an angle of 90° 00' 04"

Midside fiducials

5-6: 224.002 mm 7-8: 223.992 mm

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

Corner fiducials (perimeter)

1-3: 211.995 mm 2-3: 211.999 mm

1-4: 211.999 mm 2-4: 211.994 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.

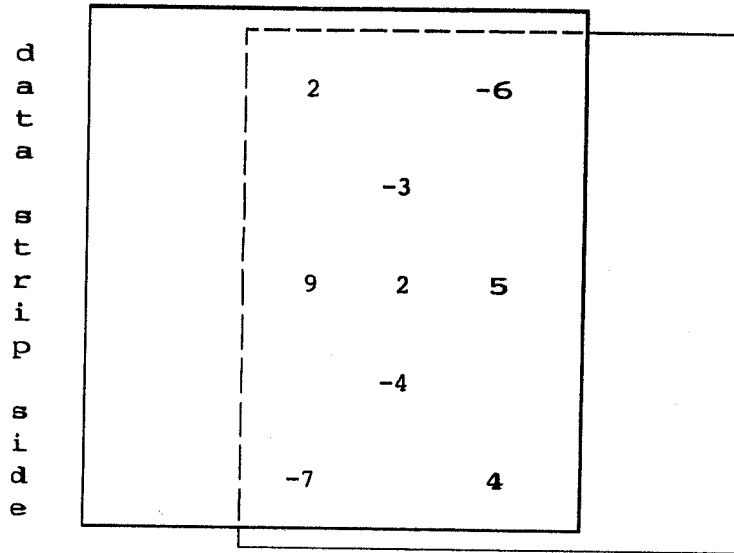
IX. Stereomodel Flatness

FMC Magazine No.: 273390C

Base/Height ratio: 0.6

Platen ID: 273390

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. Lens/Film Resolving Power in cycles/mm

Area-weighted average resolution: 44

Film: Type 2405

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

Note: This camera calibration page (5a of 5) supersedes the previous page (5 of 5) as it was retested on November 15, 2002, after repair work was done on the platen of FMC Magazine No. 273390C.

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