



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

January 11, 2005

Camera type:	Wild RC20*	Camera serial no.:	5075
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13407
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Selkirk Remote Sensing Ltd.
Richmond, British Columbia, Canada

Reference: Selkirk Remote Sensing Ltd. purchase order No. 2576,
dated January 4, 2005. Signed by Ms. Ann Williams.

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: 153.334 mm

II. Lens Distortion

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

Symmetric radial distortion parameters

$$\begin{aligned} K_0 &= -0.1499 \times 10^{-4} \\ K_1 &= 0.3774 \times 10^{-8} \\ K_2 &= -0.1788 \times 10^{-12} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

Decentering distortion parameters

$$\begin{aligned} P_1 &= 0.6969 \times 10^{-7} \\ P_2 &= -0.3844 \times 10^{-7} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

Calibrated principal point

$$\begin{aligned} x_p &= 0.001 \text{ mm} \\ y_p &= 0.002 \text{ mm} \end{aligned}$$

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: 107

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	159	134	113	113	95	95
Tangential lines	134	134	134	113	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 525 filter No. 7944 accompanying this camera are within 10 seconds of being parallel. This 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	1584	1598	8.12	1/140	88
1/250	832	832	4.25	1/270	88
1/500	426	422	2.14	1/530	88
1/1000	222	219	1.08	1/1060	88

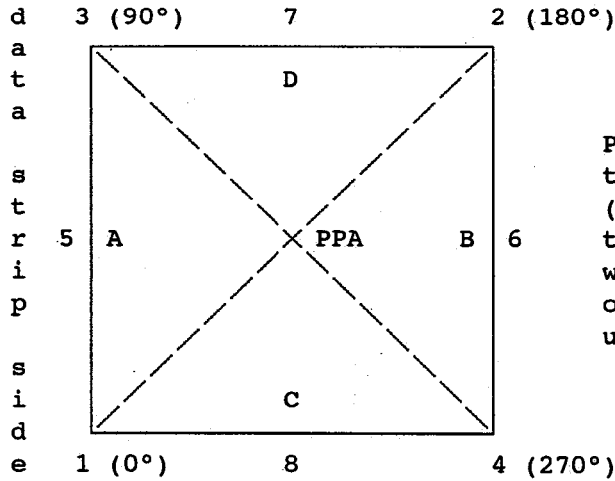
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC20 drive unit No. 5075-9 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 "9" 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	0.013 mm	0.003 mm
Indicated principal point, midside fiducials	0.010	0.005
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.001	0.002

Fiducial Marks

1	-105.994 mm	-105.995 mm
2	106.018	106.001
3	-105.982	106.003
4	106.006	-105.995
5	-111.992	0.006
6	112.015	0.003
7	0.016	112.003
8	0.003	-111.995

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.819 mm 3-4: 299.804 mm

Lines joining these markers intersect at an angle of 90° 00' 02"

Midside fiducials

5-6: 224.007 mm 7-8: 223.997 mm

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

Corner fiducials (perimeter)

1-3: 211.999 mm 2-3: 212.000 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.

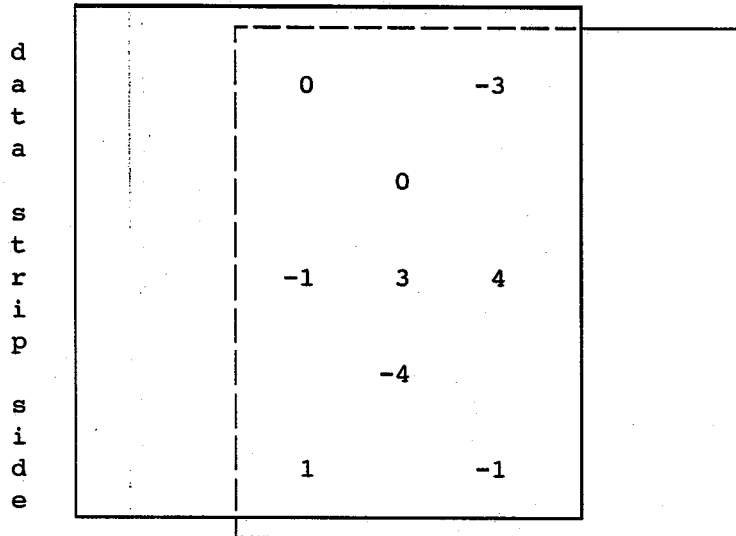
IX. Stereomodel Flatness

FMC Drive unit No.: 5075-9

Base/Height ratio: 0.6

Platen ID: 9

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 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: 51

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	57	48	48	48	40

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