



United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
Reston, Virginia 20192

REPORT OF CALIBRATION  
of Aerial Mapping Camera

October 30, 2000

Camera type: Wild RC30\* Camera serial no.: 5324  
 Lens type: Wild Universal Aviogon /4-S Lens serial no.: 13365  
 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 26, 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: 153.282 mm

II. Lens Distortion

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

<u>Symmetric radial distortion parameters</u>	<u>Decentering distortion parameters</u>	<u>Calibrated principal point</u>
K <sub>0</sub> = 0.1183 x 10 <sup>-3</sup>	P <sub>1</sub> = 0.8838 x 10 <sup>-7</sup>	x <sub>p</sub> = 0.011 mm
K <sub>1</sub> = -0.2195 x 10 <sup>-7</sup>	P <sub>2</sub> = 0.3862 x 10 <sup>-7</sup>	y <sub>p</sub> = -0.005 mm
K <sub>2</sub> = 0.8144 x 10 <sup>-12</sup>	P <sub>3</sub> = 0.0000	
K <sub>3</sub> = 0.0000	P <sub>4</sub> = 0.0000	
K <sub>4</sub> = 0.0000		

The values and parameters for Calibrated Focal Length (CFL), Symmetric Radial Distortion (K<sub>0</sub>, K<sub>1</sub>, K<sub>2</sub>, K<sub>3</sub>, K<sub>4</sub>), Decentering Distortion (P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, P<sub>4</sub>), and Calibrated Principal Point [point of symmetry] (x<sub>p</sub>, y<sub>p</sub>) 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: 106

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	113	134	113	113	95	95
Tangential Lines	134	113	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 4<sup>th</sup> 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. 7759, and the 525 No. 7765 filters accompanying this camera are within 10 seconds of being parallel. This 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	1697	1701	8.13	1/140	87
1/250	892	897	4.23	1/270	87
1/500	437	443	2.15	1/530	87
1/1000	230	223	1.09	1/1060	87

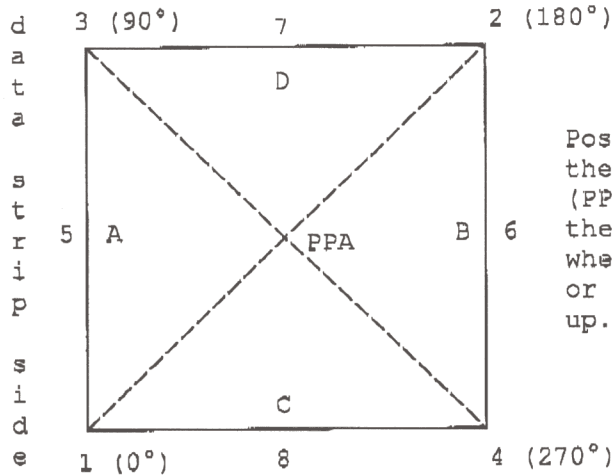
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5324-706 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 "706" 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	0.000 mm	-0.002 mm
Indicated principal point, midside fiducials	-0.002	-0.001
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) $x_p, y_p$	0.011	-0.005

Fiducial Marks

1	-105.997 mm	-106.000 mm
2	105.994	105.993
3	-106.004	105.995
4	106.005	-106.000
5	-112.002	-0.001
6	112.000	0.000
7	-0.006	111.990
8	0.002	-111.998

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.802 mm      3-4: 299.816 mm

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

Midside fiducials

5-6: 224.001 mm      7-8: 223.988 mm

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

Corner fiducials (perimeter)

1-3: 211.995 mm      2-3: 211.998 mm  
 1-4: 212.002 mm      2-4: 211.993 mm

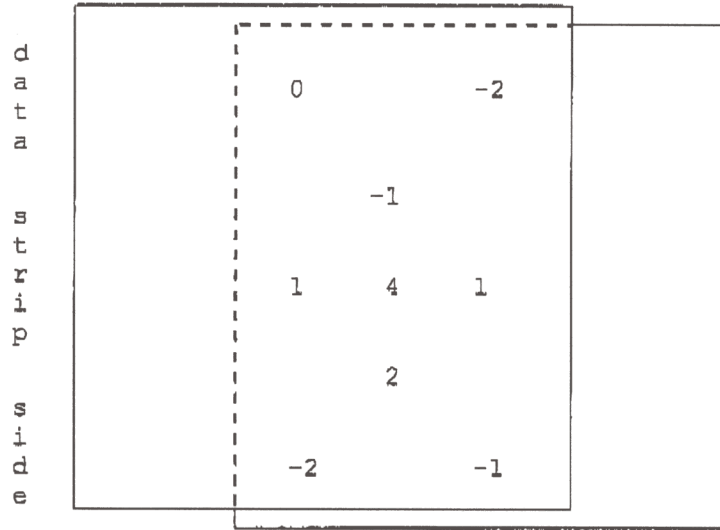
The method of measuring these distances is considered accurate within 0.003 mm

Note: For GPS applications, the nominal entrance pupil distance from the focal plane is 278 mm.

IX. Stereomodel Flatness

FMC Drive Unit No.: 5324-706  
 Platen ID: 706

Base/Height ratio: 0.6  
 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: 53

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	67	57	57	57	57	57	48
Tangential Lines	67	57	57	57	48	48	48

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