

United States Department of the Interior



U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

May 7, 1997

Camera type:	Wild RC30*	Camera serial no.:	5217
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13243
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: AeroGraphics Corp.
Bohemia, New York

Reference: AeroGraphics Corp., purchase order
No. 3638, dated May 6, 1997.

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: 152.392 mm

II. Lens Distortion

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

<u>Symmetric radial distortion parameters</u>	<u>Decentering distortion parameters</u>	<u>Calibrated principal point</u>
$K_0 = 0.3283 \times 10^{-4}$	$P_1 = -0.1331 \times 10^{-6}$	$x_p = 0.002 \text{ mm}$
$K_1 = -0.3074 \times 10^{-8}$	$P_2 = 0.2227 \times 10^{-7}$	$y_p = 0.000 \text{ mm}$
$K_2 = 0.2761 \times 10^{-13}$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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: 108

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	134	113	113	113	95	113
Tangential lines	113	113	113	113	113	95	95

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. 7418 and the 525 No. 7428 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

<u>Indicated exposure time</u>	<u>Effective exposure time</u>	<u>Efficiency</u>
1/125	8.00 ms = 1/125 s	80%
1/250	4.00 ms = 1/250 s	80%
1/500	2.10 ms = 1/475 s	80%
1/1000	1.05 ms = 1/950 s	80%

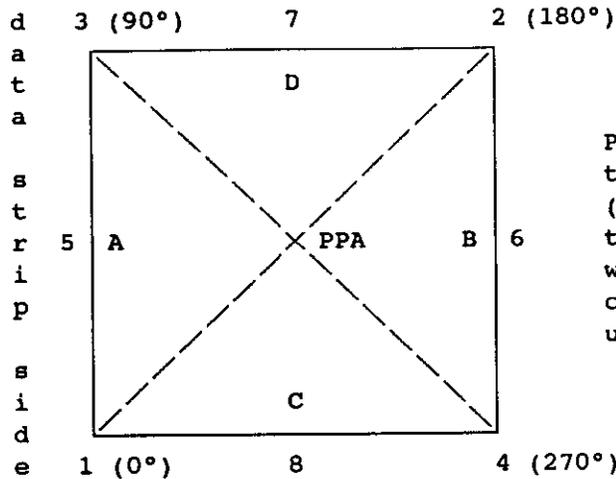
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5217-583 does not depart from a true plane by more than 13 um (0.0005 in).

This camera is equipped with a platen identification marker that will register "583" 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	-0.002 mm	-0.003 mm
Indicated principal point, midside fiducials	-0.005	-0.001
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.002	0.000

Fiducial Marks

1	-105.998 mm	-105.998 mm
2	105.990	105.988
3	-106.006	105.994
4	106.000	-105.998
5	-112.006	0.002
6	111.994	-0.004
7	-0.009	111.985
8	-0.001	-111.991

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.795 mm 3-4: 299.812 mm

Lines joining these markers intersect at an angle of 90° 00' 08"

Midside fiducials

5-6: 224.001 mm 7-8: 223.977 mm

Lines joining these markers intersect at an angle of 90° 00' 13"

Corner fiducials (perimeter)

1-3: 211.992 mm 2-3: 211.996 mm

1-4: 211.998 mm 2-4: 211.986 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 283 mm.

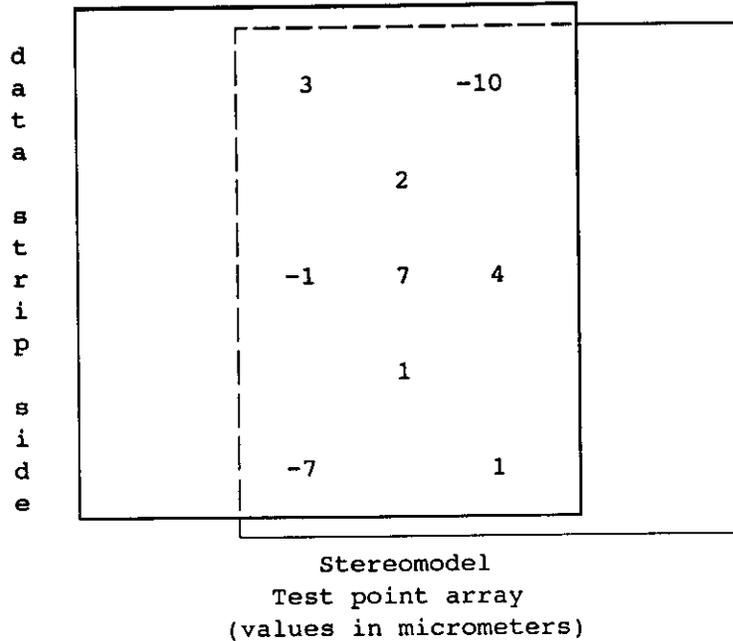
IX. Stereomodel Flatness

FMC Drive unit No.: 5217-583

Base/Height ratio: 0.6

Platen ID: 583

Maximum angle of field tested: 40°



The values shown on the diagram are the average departures from flatness (at negative scale) for two computer-simulated stereomodels based on comparator measurements on contact glass (Kodak Micro-flat) diapositives made from Kodak 2405 film exposures. These measurements are considered accurate within 5 um.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 49

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	48	48	48	40	48	48

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/1990, dated May 14, 1994.

Bradish F. Johnson

Bradish F. Johnson
Chief, Optical Science Laboratory
National Mapping Division