



# United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Reston, Virginia 22092

## REPORT OF CALIBRATION of Aerial Mapping Camera

April 3, 1996

Camera type:	Wild RC30*	Camera serial no.:	5268
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13314
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Tuck Engineering, Inc.  
Big Stone Gap, Virginia

Reference: Leica, Inc., purchase order No.  
20002, dated April 1, 1996.

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: 153.124 mm

II. Lens Distortion

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

Symmetric radial  
distortion parameters

Decentering  
distortion parameters

Calibrated  
principal point

$$\begin{aligned} K_0 &= 0.7776 \times 10^{-5} \\ K_1 &= -0.1267 \times 10^{-8} \\ K_2 &= 0.2880 \times 10^{-13} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} P_1 &= -0.1418 \times 10^{-6} \\ P_2 &= 0.4358 \times 10^{-7} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} x_p &= 0.008 \text{ mm} \\ y_p &= 0.003 \text{ mm} \end{aligned}$$

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 ( $\sigma$ ) of  $\pm 3$  microns.

\* Equipped with Forward Motion Compensation.

### III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 122

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial lines	134	159	159	134	134	113	113
Tangential lines	134	159	134	113	113	113	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. 7569 and the 525 No. 7545 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

### V. Shutter Calibration

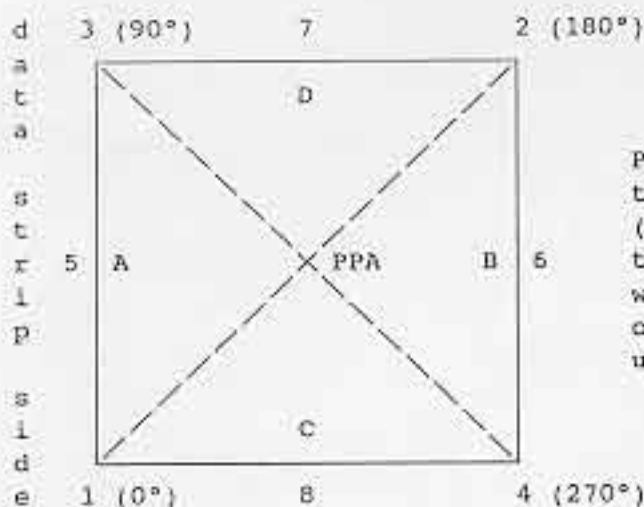
<u>Indicated exposure time</u>	<u>Effective exposure time</u>	<u>Efficiency</u>
1/125	7.66 ms = 1/130 s	80%
1/250	4.00 ms = 1/250 s	80%
1/500	2.00 ms = 1/500 s	80%
1/1000	1.00 ms = 1/1000 s	80%

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. 5268-631 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 "631" 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	-0.004 mm
Indicated principal point, midside fiducials	-0.001	-0.002
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) $x_p, y_p$	0.008	0.003

Fiducial Marks

1	-105.996 mm	-106.004 mm
2	105.997	105.992
3	-106.002	105.996
4	106.006	-106.004
5	-111.999	0.001
6	112.000	-0.005
7	-0.004	111.994
8	0.003	-112.005

VIII. Distances Between Fiducial Marks

## Corner fiducials (diagonals)

1-2: 299.805 mm      3-4: 299.820 mm

Lines joining these markers intersect at an angle of  $90^{\circ} 00' 04''$

## Midside fiducials

5-6: 223.999 mm      7-8: 223.999 mm

Lines joining these markers intersect at an angle of  $90^{\circ} 00' 12''$

## Corner fiducials (perimeter)

1-3: 212.000 mm      2-3: 212.000 mm

1-4: 212.003 mm      2-4: 211.995 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 286 mm.

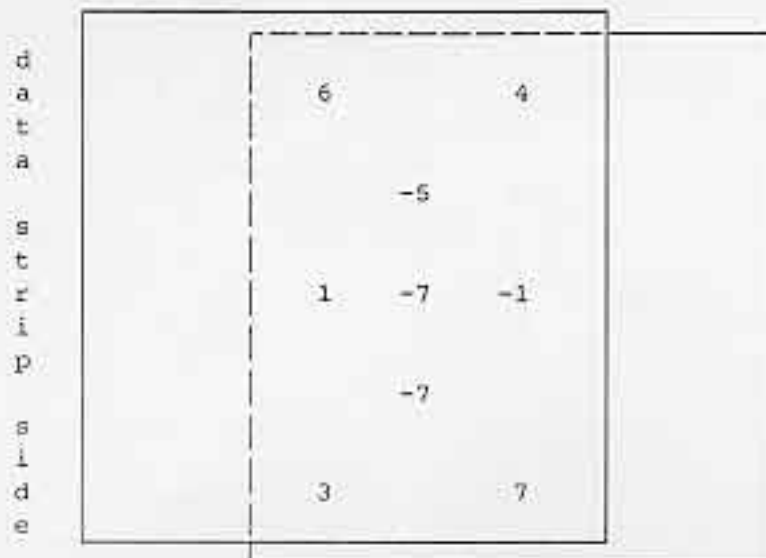
IX. Stereomodel Flatness

Drive unit No.: 5268-631

Base/Height ratio: 0.6

Platen ID: 631

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 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  $\mu$ m.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 55

Film: Type 2405

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

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