



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

July 11, 1997

Camera type:	Wild RC30*	Camera serial no.:	5097
Lens type:	Wild Universal Aviogon A4-F	Lens serial no.:	13130
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

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

Reference: Tuck Engineering, Inc., purchase
order No. 2251, dated July 9, 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: 152.842 mm

II. Lens Distortion

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

Symmetric radial distortion parameters

$$\begin{aligned} K_0 &= -0.1500 \times 10^{-4} \\ K_1 &= -0.0561 \times 10^{-10} \\ K_2 &= 0.8192 \times 10^{-13} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

Decentering distortion parameters

$$\begin{aligned} P_1 &= -0.4484 \times 10^{-8} \\ P_2 &= 0.8502 \times 10^{-7} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

Calibrated principal point

$$\begin{aligned} x_p &= 0.001 \text{ mm} \\ y_p &= -0.007 \text{ mm} \end{aligned}$$

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: 83

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	113	95	67	95	95	80
Tangential lines	113	113	95	80	80	67	67

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 Pan No. 6976 and the S25 Pan No. 7025 filters accompanying this camera are within 10 seconds of being parallel. The S25 filter was used for the calibration.

V. Shutter Calibration

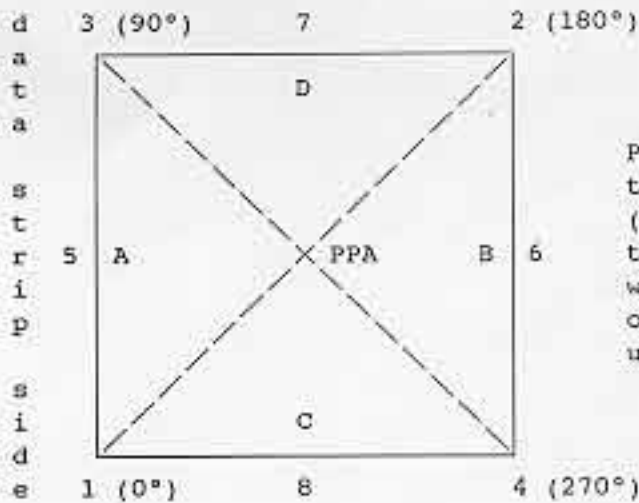
<u>Indicated exposure time</u>	<u>Effective exposure time</u>	<u>Efficiency</u>
1/125	8.00 ms = 1/125 s	81%
1/250	4.20 ms = 1/240 s	81%
1/500	2.10 ms = 1/475 s	81%
1/1000	1.05 ms = 1/950 s	81%

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. 5097-2 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 "2" 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	0.004 mm	0.000 mm
Indicated principal point, midside fiducials	0.004	-0.003
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.001	-0.007

Fiducial Marks

1	-105.997 mm	-106.003 mm
2	106.001	106.000
3	-105.992	105.996
4	106.006	-106.003
5	-110.000	-0.005
6	110.004	-0.001
7	0.004	110.000
8	0.004	-110.004

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.814 mm 3-4: 299.811 mm

Lines joining these markers intersect at an angle of 89° 59' 57"

Midside fiducials

5-6: 220.004 mm 7-8: 220.004 mm

Lines joining these markers intersect at an angle of 89° 59' 56"

Corner fiducials (perimeter)

1-3: 211.999 mm 2-3: 211.992 mm

1-4: 212.003 mm 2-4: 212.003 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 282 mm.

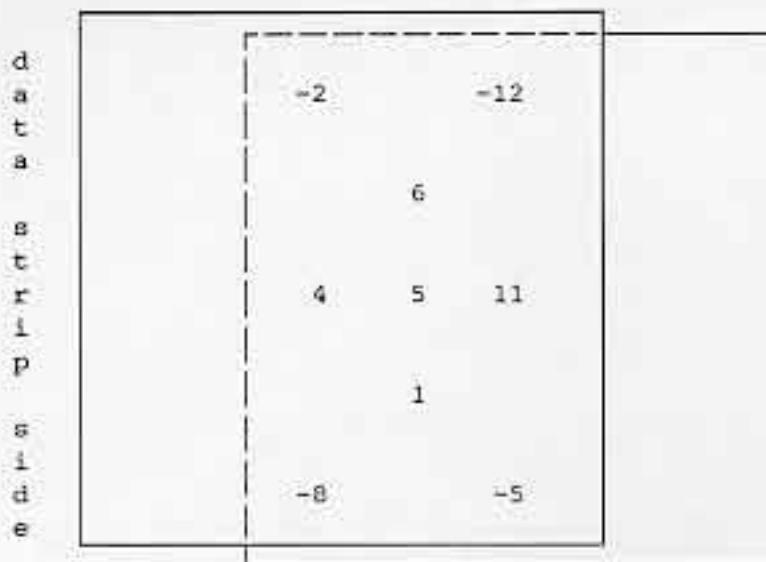
IX. Stereomodel Flatness

FMC Drive unit No.: 5097-2

Base/Height ratio: 0.6

Platen ID: 2

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 μ m.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 44

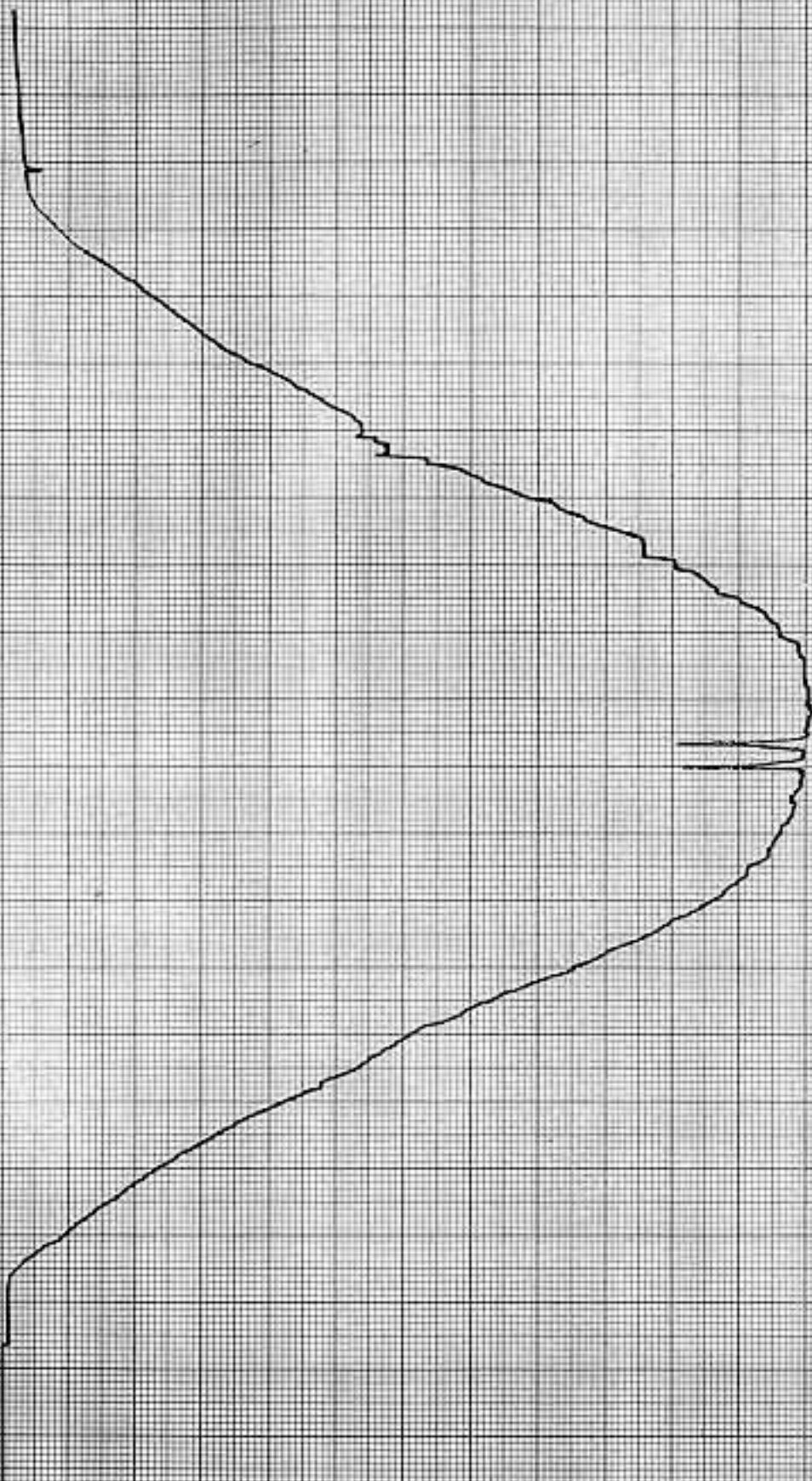
Film: Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/1399, dated November 10, 1988.

Bradish F. Johnson

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

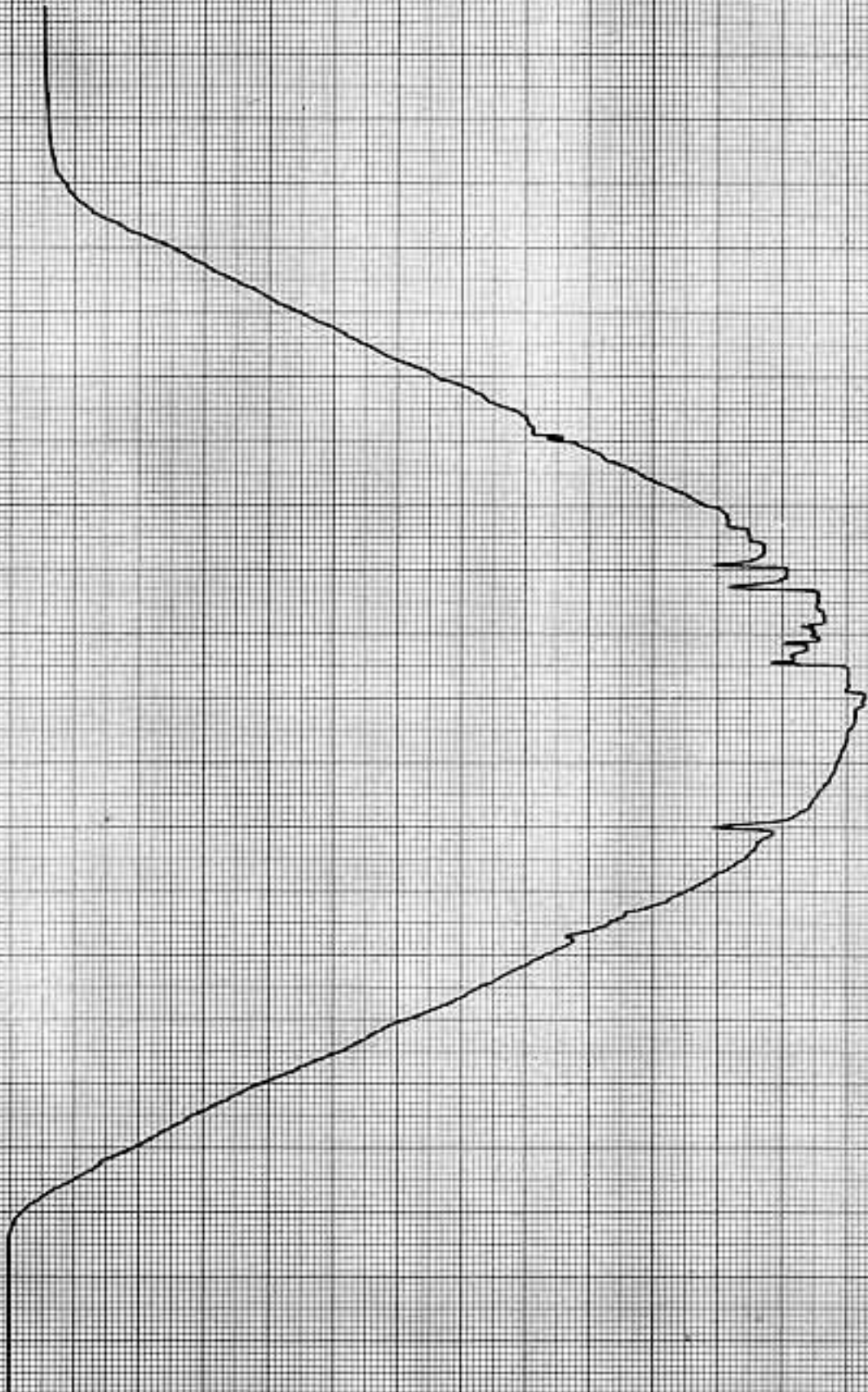


JOYCE
LOEBL

RECORDING
MICRODENSITOMETER
FORM MD1
Harlow V5732

OPTICAL MAGNIF. = OBJECTIVE POWER x 22 5X085	PROPORT. CONTR. 5-6	WEDGE RANGE .36D	SAMPLE λ50 = 420 nm AU 2X	DATE 7/10/97	RECORD No. 2336
SLIT (ACTUAL) 2mm x 12mm	FEEDBACK SETTING 5-6	RATIO 1:1	REMARKS: U. AVIATION A4-F 13130 #6976		

TUCK ENGINEERING, INC.



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OPTICAL MAGNIF. =
OBJECTIVE POWER x 22
5x0BJ

PROPORT. CONTR.
5-6

WEDGE RANGE
.360

SAMPLE
λ50=525 nm AV 2X

DATE

RECORD No.

SLIT (ACTUAL)
2mm x .12mm

FEEDBACK SETTING
5-6

RATIO
1:1

REMARKS:
#5
7025
U. AVIOLON A4-F
13130

7/10/97 2336

TUCK ENGINEERING, INC.

LENS RESOLVING POWER

REPORT No. OSL/2336

LENS No. 13130

Max. Aperture: f/4

Test Aperture: f/4

AWAR: 83

