United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION   June 27, 2001
of Aerial Mapping Camera

Camera type: Wild RC30*   Camera serial no.:   5242
Lens type: Wild Universal Aviogon /4-S   Lens serial no.:   13256
Nominal focal length: 153 mm   Maximum aperture: f/4
                                        Test aperture: f/4

Submitted by: EarthData Aviation
                  Hagerstown, Maryland

Reference: EarthData Aviation purchase order
                  No. PO 01-140, dated June 25, 2001.

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: 152.986 mm

II. Lens Distortion

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

Symmetric radial distortion parameters	Decentering distortion parameters	Calibrated principal point
$K_0 = 0.4772 \times 10^{-4}$	$P_1 = -0.0272 \times 10^{-9}$	$x_p = 0.001$ mm
$K_1 = -0.8201 \times 10^{-8}$	$P_2 = 0.4817 \times 10^{-7}$	$y_p = -0.009$ mm
$K_2 = 0.2814 \times 10^{-12}$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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 Cali-
brated Principal Point [point of symmetry] (x_p, y_p) were determined through a
least-squares Simultaneous Multiframe Analytical Calibration (SMAC) adjust-
ment. 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: 109

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	159	134	113	113	95	95
Tangential lines	134	134	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. 7533, and the 525 No. 7517 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

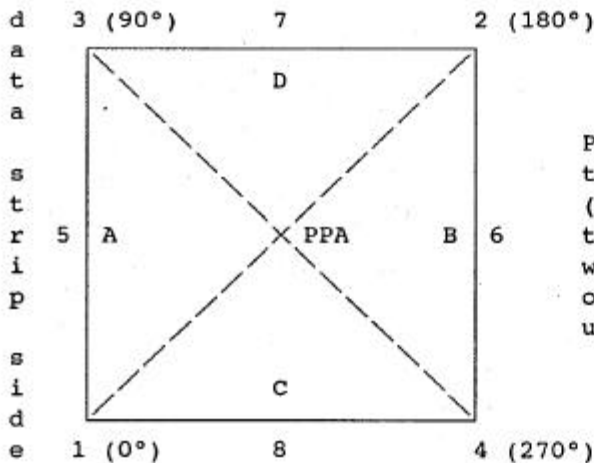| Indicated time (sec)	Rise time (μ sec)	Fall Time (μ sec)	½ width time (ms)	Nom. Speed (sec.)	Efficiency (%)
1/125	1737	1728	8.45	1/140	87
1/250	933	933	4.37	1/260	87
1/500	463	458	2.22	1/520	87
1/1000	225	219	1.13	1/1010	87

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. 5242-619 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 "619" in the data strip area for each exposure.

VII. Principal Points and Fiducial Coordinates

```
d   3 (90°)        7            2 (180°)
a
t              ┌─────────────────┐
a              │ ╲     D       ╱ │
               │   ╲       ╱     │
s              │     ╲   ╱       │
t              │       ╳         │
r   5  A       │  ×  PPA         │  B   6
i              │       ╱ ╲       │
p              │     ╱     ╲     │
               │   ╱         ╲   │
s              │ ╱     C       ╲ │
i              └─────────────────┘
d
e   1 (0°)         8            4 (270°)
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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.

	X coordinate	Y coordinate
Indicated principal point, corner fiducials	0.001 mm	-0.002 mm
Indicated principal point, midside fiducials	0.000	-0.002
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.001	-0.009

Fiducial Marks

	X coordinate	Y coordinate
1	-106.003 mm	-106.002 mm
2	106.000	105.994
3	-105.996	106.000
4	105.997	-106.002
5	-111.996	0.002
6	111.997	-0.006
7	0.004	111.997
8	-0.004	-112.009

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)
      1-2: 299.813 mm   3-4: 299.810 mm
Lines joining these markers intersect at an angle of 89° 59' 58"

Midside fiducials
      5-6: 223.993 mm   7-8: 224.006 mm
Lines joining these markers intersect at an angle of 90° 00' 00"

Corner fiducials (perimeter)
      1-3: 212.003 mm   2-3: 211.996 mm
      1-4: 211.999 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 283 mm.
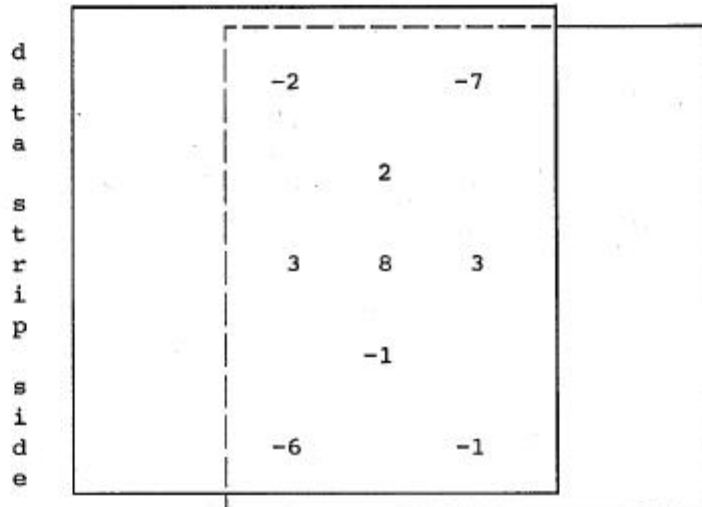
IX. Stereomodel Flatness

FMC Drive Unit No.: 5242-619   Base/Height ratio: 0.6

Platen ID: 619   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) diaposi- tives made from Kodak 2405 film exposures. These measurements can vary by as much as ± 5 µm from model to model.

X.   System Resolving Power on film in cycles/mm
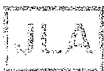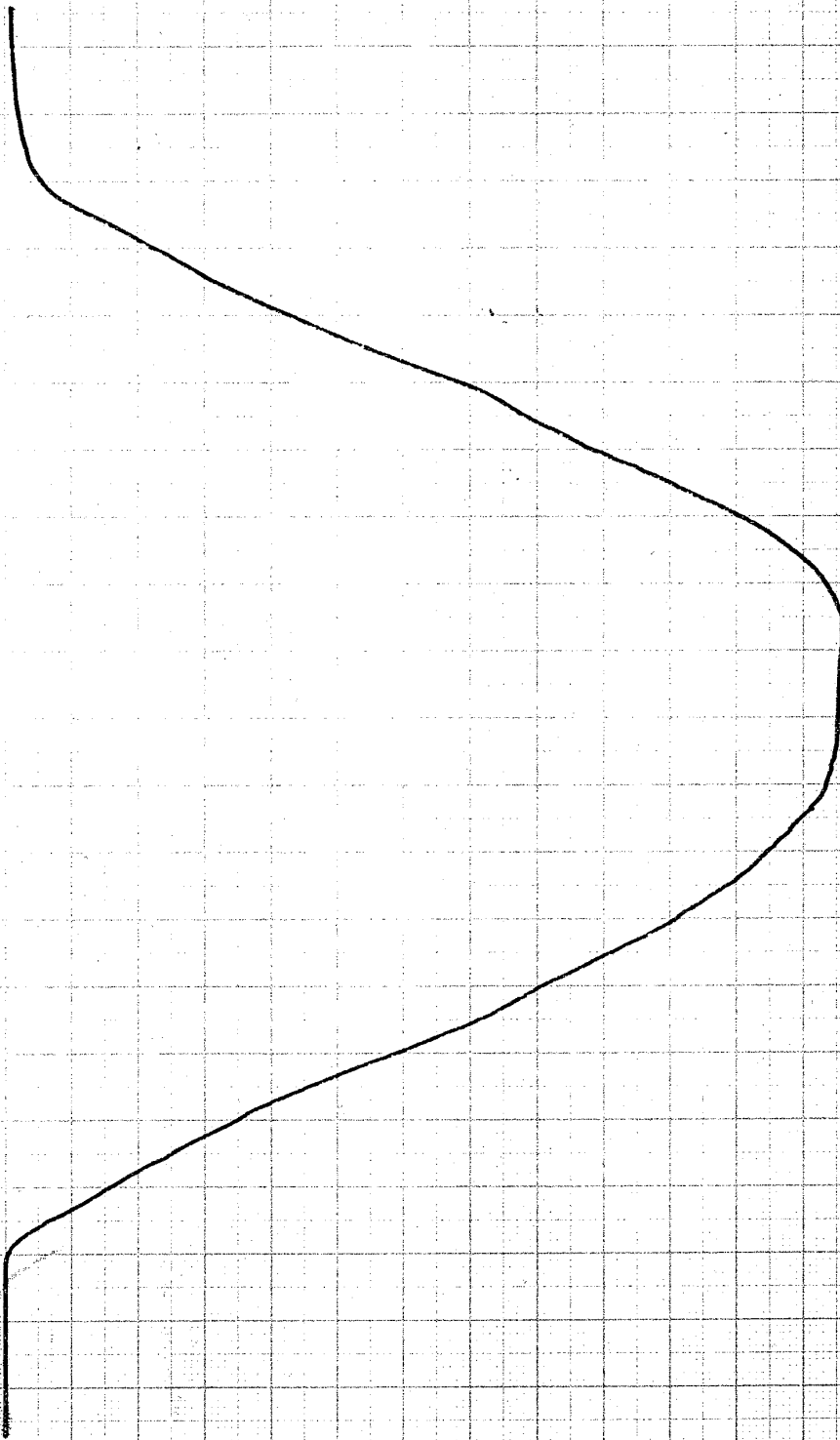
Area-weighted average resolution: 52   Film: Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2444, dated June 3, 1998.

John J. Lenart
Chief, Technology Operations Section
National Mapping Division

| 5x OBJ | 5-6 | .36D | λ 50 = 525 nm AV 2x | 6/25/01 | 2760 |
| 2MM x .12 MM | 5-6 | 1:1 | #517 U. AVIOGON 14-5 | | |

U. AVIOGON 14-5
13256
EARTHDATA AVIATION

						DATE	
5x OBJ	5-6	.36D	250 = 420nm AV2x			6/25/04	2760
2MM x .12MM	5-6	1:1	#1533 U. AVIOGON 14-5 13256 EARTHDATA AVIATION				
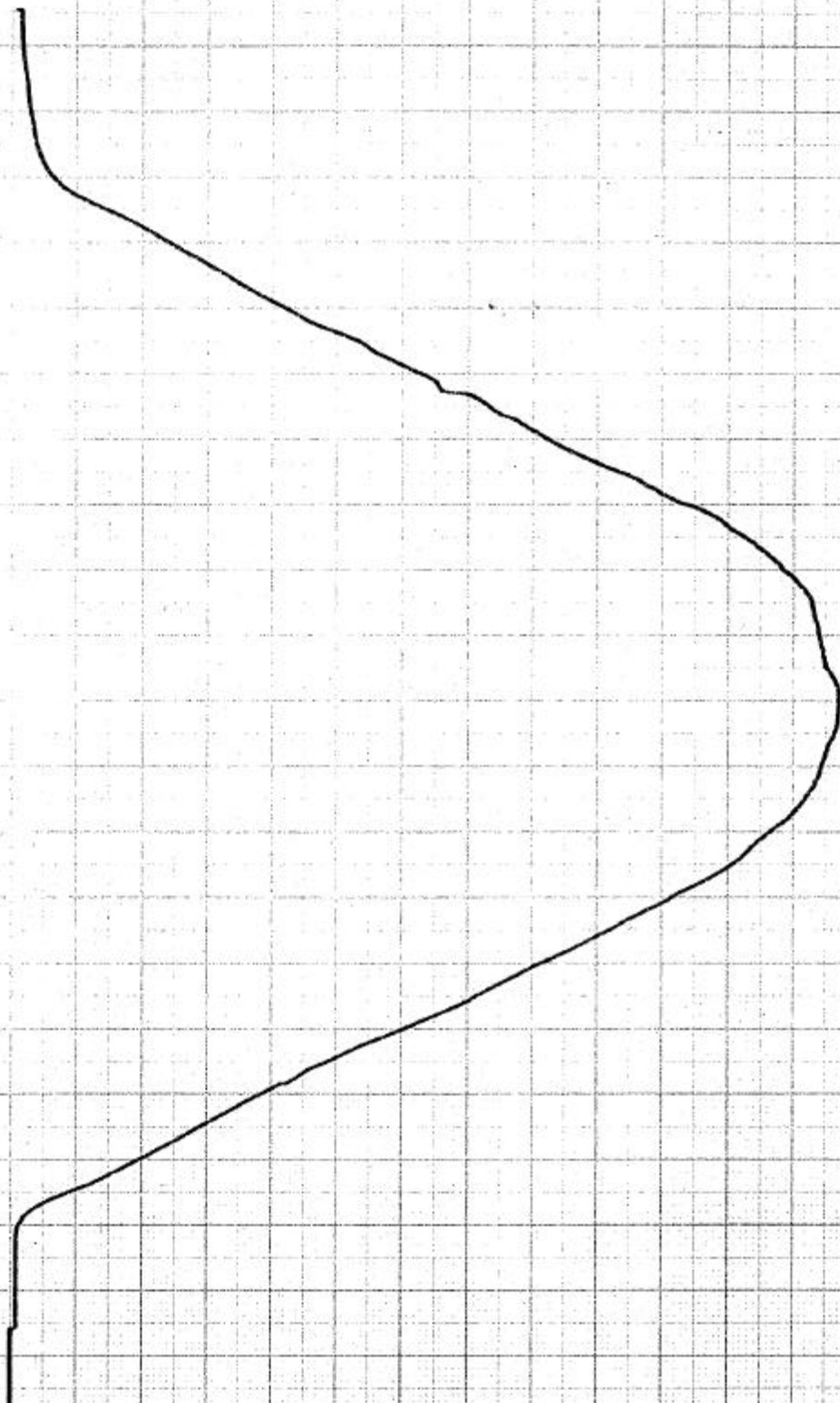
Lens Resolving Power at Maximum Aperture
(153 mm lens)