USGS Report No. OSL/2903

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

January 22, 2003

Camera type: Wild RC30*
Lens type: Wild Universal Aviogon A4-F
Nominal focal length: 153 mm

Camera serial no.: 5353
Lens serial no.: 13050
Maximum aperture: f/4
Test aperture: f/4

Submitted by: Global Remote Sensing, Inc.
Edmonton, Alberta, Canada

Reference: Global Remote Sensing. Inc. letter of authorization from Mr. Roger Cucheran, dated January 16, 2003.

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: 152.749 mm

II. Lens Distortion

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

Symmetric radial distortion parameters

$K_0 = 0.4882 \times 10^{-4}$
$K_1 = -0.1173 \times 10^{-7}$
$K_2 = 0.5273 \times 10^{-12}$
$K_3 = 0.0000$
$K_4 = 0.0000$

Decentering distortion parameters

$P_1 = 0.5848 \times 10^{-7}$
$P_2 = 0.2885 \times 10^{-7}$
$P_3 = 0.0000$
$P_4 = 0.0000$

Calibrated principal point

$x_p = 0.003$ mm
$y_p = -0.001$ mm

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: 85

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	95	113	113	80	95	95	57
Tangential lines	95	95	80	80	95	80	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 filter No. 5590 and the 525 filter No. 6430 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	1652	1641	8.27	1/140	87
1/250	836	831	4.19	1/270	87
1/500	436	435	2.14	1/530	87
1/1000	228	228	1.09	1/1060	87

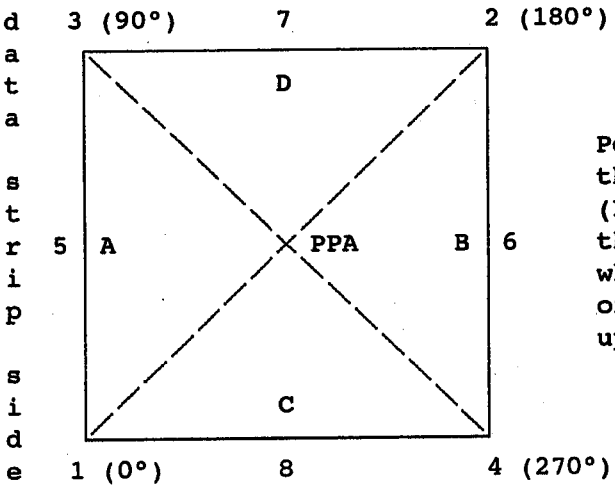
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5353-743 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 "743" 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.

	X coordinate	Y coordinate
Indicated principal point, corner fiducials	0.012 mm	-0.008 mm
Indicated principal point, midside fiducials	0.012	-0.005
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.003	-0.001

Fiducial Marks		
1	-105.988 mm	-106.008 mm
2	106.016	105.995
3	-105.992	105.992
4	106.017	-106.008
5	-109.989	-0.008
6	110.016	-0.002
7	0.007	109.996
8	0.016	-110.006

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)
1-2: 299.818 mm 3-4: 299.820 mm
Lines joining these markers intersect at an angle of 90° 00' 05"

Midside fiducials
5-6: 220.005 mm 7-8: 220.002 mm
Lines joining these markers intersect at an angle of 90° 00' 03"

Corner fiducials (perimeter)
1-3: 212.000 mm 2-3: 212.008 mm
1-4: 212.005 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.

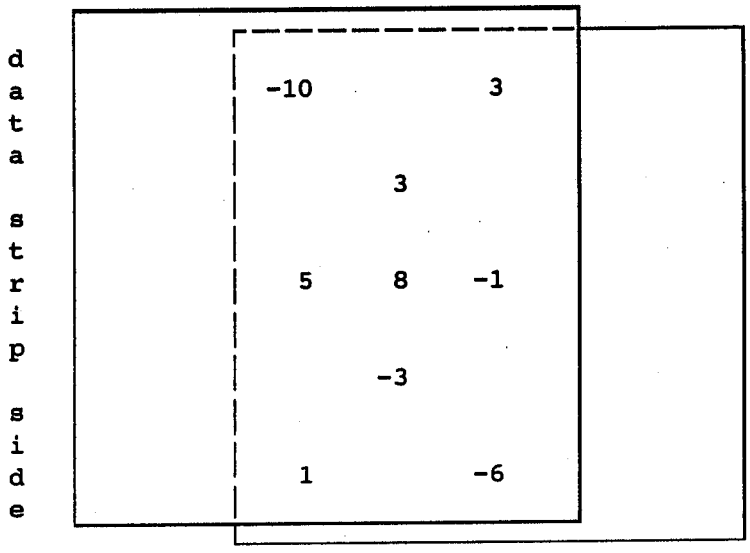
IX. Stereomodel Flatness

FMC Drive Unit No.: 5353-743

Platen ID: 743

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 Kodak 4425 copy film 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: 41

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	48	57	48	40	48	48	34
Tangential lines	48	48	40	40	40	34	28

LENS/FILM DISTORTION PARAMETERS

FMC Drive Unit No.: 5353-743 Base/Height ratio: 0.6

Platen ID: 743 Maximum angle of field tested: 40°

XI. Calibrated Focal Length: 152.778 mm

XII. Lens/Film Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	0	1	1	2	1	-1
Decentering (um)	0	1	1	3	4	6

Symmetric radial distortion parameters

$K_0 = -0.1560 \times 10^{-4}$
$K_1 = -0.2159 \times 10^{-8}$
$K_2 = 0.2286 \times 10^{-12}$
$K_3 = 0.0000$
$K_4 = 0.0000$

Decentering distortion parameters

$P_1 = -0.2938 \times 10^{-6}$
$P_2 = -0.1761 \times 10^{-6}$
$P_3 = 0.0000$
$P_4 = 0.0000$

Calibrated principal point

$x_p = 0.003$ mm
$y_p = -0.001$ mm

The above measurements were computed from Kodak 4425 copy film made from Kodak 2405 film exposed in the magazine.

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.

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2508, dated December 8, 1998.

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