United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA 22092

REPORT OF CALIBRATION   December 2, 1992
of Aerial Mapping Camera

Camera type: Wild RC10   Camera serial No.:   2960
Lens type: Wild Universal Aviogon /4   Lens serial No.:   13049
Nominal focal length: 153 mm   Maximum aperture: f/4
                                      Test aperture: f/4

Submitted by: North West Geomatics Ltd.
                Edmonton, Alberta, Canada

Reference: Leica, Inc., purchase order No.
                108245, dated November 30, 1992.

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:**   152.804 mm

This measurement is considered accurate within 0.005 mm

II. **Radial Distortion**

Field angle	$\bar{D}_c$	D_c for azimuth angle			
		0° A-C	90° A-D	180° B-D	270° B-C
degrees	um	um	um	um	um
7.5	0	-1	0	0	-1
15	-2	-2	-2	-1	-3
22.7	-3	-2	-4	-4	-3
30	0	-1	0	-1	0
35	2	2	1	3	1
40	1	2	1	1	1

The radial distortion is measured for each of four radii of the focal plane separated by 90° in azimuth. To minimize plotting error due to distortion, a full least-squares solution is used to determine the calibrated focal length. $\bar{D}_c$ is the average distortion for a given field angle. Values of distortion D_c based on the calibrated focal length referred to the calibrated principal point (point of symmetry) are listed for azimuths 0°, 90°, 180° and 270°. The radial distortion is given in micrometers and indicates the radial displacement away from the center of the field. These measurements are considered accurate within 5 um.

III. Resolving Power in cycles/mm

Area-weighted average resolution: 83

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial lines	113	134	80	57	95	95	80
Tangential lines	113	113	80	80	80	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 No. 6862 and the 525 No. 6695 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

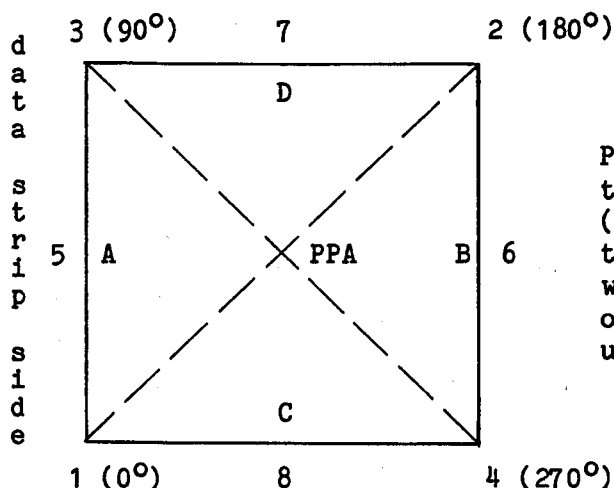| Indicated shutter speed	Effective shutter speed	Efficiency
1/200	5.00 ms = 1/200 s	80%
1/400	2.50 ms = 1/400 s	80%
1/600	1.67 ms = 1/600 s	80%
1/800	1.25 ms = 1/800 s	80%
1/1000	1.02 ms = 1/980 s	80%

The effective shutter speeds 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 RC10 drive unit No. 2960-328 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 "328" 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°)
```

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	-0.002 mm	0.001 mm
Indicated principal point, midside fiducials	-0.003	0.002
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	-0.004	0.000

Fiducial Marks

	X	Y
1	-106.008 mm	-105.999 mm
2	105.999	105.994
3	-106.000	106.000
4	105.998	-105.999
5	-110.005	0.002
6	109.999	0.002
7	-0.003	109.999
8	-0.003	-110.004

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)
       1-2: 299.813 mm   3-4: 299.811 mm
Lines joining these markers intersect at an angle of 90° 00' 07"

Midside fiducials
       5-6: 220.004 mm   7-8: 220.003 mm
Lines joining these markers intersect at an angle of 90° 00' 00"

Corner fiducials (perimeter)
       1-3: 211.998 mm   2-3: 211.999 mm
       1-4: 212.006 mm   2-4: 211.993 mm

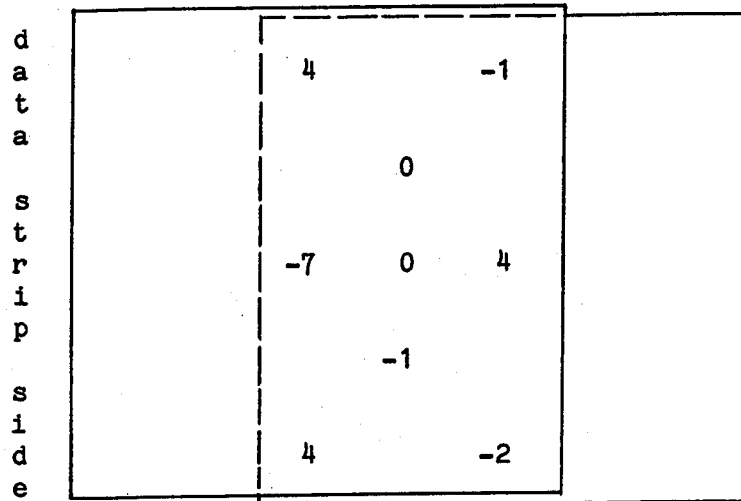The method of measuring these distances is considered accurate within 0.005 mm.

IX. Stereomodel Flatness

Drive unit No.:   2960-328

Platen ID: 328

Base/Height ratio: 0.6

Maximum angle of field tested: 40°

```
d
a                 4            -1
t
a
s                      0
t
r     -7      0      4
i
p
      -1
s
i
d     4            -2
e
```

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 um.

X.   Resolving Power in cycles/mm

Area-weighted average resolution: 42

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial lines	67	57	48	34	40	48	40
Tangential lines	67	48	48	40	40	40	34

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/1560, dated August 30, 1990.

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National Mapping Division

FILM RADIAL DISTORTION, STEREOMODEL FLATNESS AND RESOLVING POWER

Drive unit No.: 2960-328
Platen ID: 328

Base/Height ratio: 0.6
Maximum angle of field tested: 40°

Calibrated Focal Length

flash plate: 152.804 mm
film: 152.818 mm

IX. Radial Distortion

Field angle	$\bar{D}_c$	D_c for azimuth angle			
		0° A-C	90° A-D	180° B-D	270° B-C
degrees	um	um	um	um	um
7.5	2	2	3	1	3
15	3	5	3	4	2
22.7	0	-1	-1	2	1
30	3	3	3	2	3
35	1	0	0	3	0
40	-4	-2	-4	-4	-5

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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.

Stereomodel test point array
(values in micrometers)

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