



# United States Department of the Interior

GEOLOGICAL SURVEY  
RESTON, VA. 22092

## REPORT OF CALIBRATION of Aerial Mapping Camera

January 16, 1985

|                                  |                             |
|----------------------------------|-----------------------------|
| Camera type: Wild RC10           | Camera serial no.: 2035     |
| Lens type: Wild Super Aviogon II | Lens serial no. SAg II 2035 |
| Nominal focal length: 88 mm      | Maximum aperture: f/5.6     |
|                                  | Test aperture: f/11         |

Submitted by: Mark Hurd Aerial Surveys, Inc.  
Minneapolis, Minnesota 55426

Reference: Mark Hurd purchase order No. 4171, dated January 7, 1985.

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type V-F 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: 87.719 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 |
| mm           | um          | um                      | um      | um       | um       |
| 11.54 — 7.5  | 0           | 0                       | 0       | 0        | 0        |
| 23.50 — 15   | -2          | -1                      | -1      | -2       | -2       |
| 36.33 — 22.5 | -5          | -4                      | -4      | -6       | -5       |
| 50.64 — 30   | -7          | -6                      | -8      | -7       | -5       |
| 61.42 — 35   | -7          | -6                      | -7      | -9       | -6       |
|              | 40          | -5                      | -4      | -6       | -3       |
|              | 45          | 2                       | 5       | -1       | 4        |
| 104 — 50     | 10          | 12                      | 9       | 9        | 10       |
|              | 54.5        | 2                       | -5      | 7        | 4        |

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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.

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160  
 0 0 0 -2 -4 -6 -7 -7 -5 0 4 8 10 5 0 0 0  
 APPENDIX B (1 of 5)

### III. Resolving Power in cycles/mm

Area-weighted average resolution: 45.9

| Field angle:     | 0° | 7.5° | 15° | 22.5° | 30° | 35° | 40° | 45° | 50° | 54.5° |
|------------------|----|------|-----|-------|-----|-----|-----|-----|-----|-------|
| Radial lines     | 99 | 99   | 70  | 49    | 59  | 83  | 99  | 42  | 21  | 21    |
| Tangential lines | 99 | 70   | 59  | 49    | 42  | 42  | 49  | 59  | 49  | 42    |

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 9 to 470 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 505 Pan No. 4149 filter accompanying this camera are within 10 seconds of being parallel. This filter was used for the calibration.

### V. Shutter Calibration

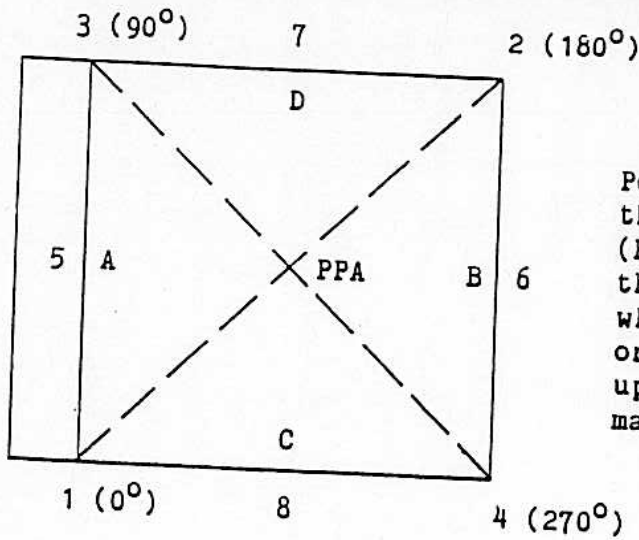
| <u>Indicated shutter speed</u> | <u>Effective shutter speed</u> | <u>Efficiency</u> |
|--------------------------------|--------------------------------|-------------------|
| 1/200                          | 5.25 ms = 1/190 s              | 86%               |
| 1/400                          | 2.50 ms = 1/400 s              | 86%               |
| 1/600                          | 1.67 ms = 1/600 s              | 86%               |
| 1/800                          | 1.19 ms = 1/840 s              | 86%               |

The effective shutter speeds were determined with the lens at aperture f/11. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

### VI. Magazine Platen

The platens mounted in Fairchild film magazines No. 52-468 and No. 52-577 do not depart from a true plane by more than 13 um (0.0005 in).

VII. Principal Point 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 direction-of-flight fiducial marker or data strip is to the left.

- Indicated principal point, corner fiducials
- Indicated principal point, midside fiducials
- Principal point of autocollimation
- Calibrated principal point (point of symmetry)

|  | <u>X coordinate</u> | <u>Y coordinate</u> |
|--|---------------------|---------------------|
| Indicated principal point, corner fiducials    | -0.018 mm           | -0.006 mm           |
| Indicated principal point, midside fiducials   | -0.015              | -0.002              |
| Principal point of autocollimation             | 0.0                 | 0.0                 |
| Calibrated principal point (point of symmetry) | 0.004               | 0.000               |

Fiducial Marks

|   |             |             |
|---|-------------|-------------|
| 1 | -106.008 mm | -106.007 mm |
| 2 | 105.974     | 105.996     |
| 3 | -106.012    | 105.994     |
| 4 | 105.976     | -106.007    |
| 5 | -110.009    | -0.001      |
| 6 | 109.977     | -0.002      |
| 7 | -0.014      | 109.996     |
| 8 | -0.017      | -110.010    |

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.803 mm                      3-4: 299.805 mm

Lines joining these markers intersect at an angle of 89° 59' 44"

Midside fiducials

5-6: 219.986 mm                      7-8: 220.006 mm

Lines joining these markers intersect at an angle of 89° 59' 58"

Corner fiducials (perimeter)

1-3: 212.001 mm                      2-3: 211.987 mm

1-4: 211.984 mm                      2-4: 212.003 mm

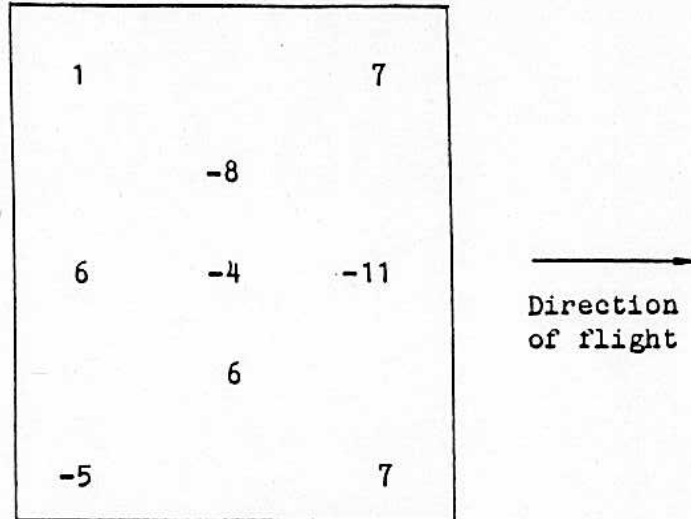
The method of measuring these distances is considered accurate within 0.005 mm

IX. Stereomodel Flatness

Magazine No.: 52-468

Base/Height ratio: 1.0

Maximum angle of field tested: 54.5°



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. Resolving Power in cycles/mm

Area-weighted average resolution: 30.5

Film: Type 2405

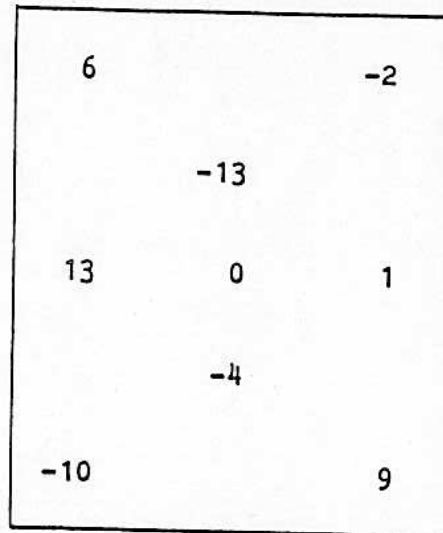
| Field angle:     | 0° | 7.5° | 15° | 22.5° | 30° | 35° | 40° | 45° | 50° | 54.5° |
|------------------|----|------|-----|-------|-----|-----|-----|-----|-----|-------|
| Radial lines     | 59 | 49   | 42  | 42    | 42  | 49  | 49  | 30  | 17  | 14    |
| Tangential lines | 59 | 42   | 42  | 35    | 30  | 24  | 30  | 35  | 35  | 35    |

IX. Stereomodel Flatness

Magazine No.: 52-577

Base/Height ratio: 1.0

Maximum angle of field tested: 54.5°



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. Resolving Power in cycles/mm

Area-weighted average resolution: 30.9

Film: Type 2405

| Field angle:     | 0° | 7.5° | 15° | 22.5° | 30° | 35° | 40° | 45° | 50° | 54.5° |
|------------------|----|------|-----|-------|-----|-----|-----|-----|-----|-------|
| Radial lines     | 59 | 49   | 49  | 42    | 35  | 49  | 49  | 30  | 17  | 14    |
| Tangential lines | 59 | 49   | 42  | 35    | 30  | 30  | 35  | 35  | 35  | 30    |

This report supersedes the previous calibration of this camera contained in USGS Report of Calibration No. RSAS/722, dated July 10, 1981.

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