# United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

REPORT OF CALIBRATION
of Aerial Mapping Camera

March 22, 1983

Camera type: Wild RC 10
Lens type: Wild Universal Aviogon II
Nominal focal length: 153 mm

Camera serial no.: 1470
Lens serial no.: UAg II 3011
Maximum aperture: f/4
Test aperture: f/4

Submitted by: NASA, Ames Research Center
Moffett Field, California 94035

Reference: NASA, Ames purchase order No. R/A-03352C (VJT)
dated February 4, 1983.

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 three 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: 153.207 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 | -1 | -2 | -3 | 0 | 1 |
| 15 | -2 | -2 | -3 | -3 | 1 |
| 22.5 | 0 | -2 | 1 | -2 | 2 |
| 30 | 2 | 0 | 2 | 3 | 3 |
| 35 | 2 | 3 | 1 | -1 | 3 |
| 40 | -1 | -1 | 0 | 0 | -2 |

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 of the image from its ideal position for the calibrated focal length. A positive value indicates a 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: 59.0

| Field angle: | 0° | 7.5° | 15° | 22.5° | 30° | 35° | 40° |
|---|---|---|---|---|---|---|---|
| Radial lines | 80 | 80 | 95 | 67 | 80 | 57 | 20 |
| Tangential lines | 80 | 57 | 48 | 57 | 67 | 57 | 40 |

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 520 Pan No. 5220 filter accompanying this camera are within ten seconds of being parallel. This filter was used for the calibration.

## V. Shutter Calibration

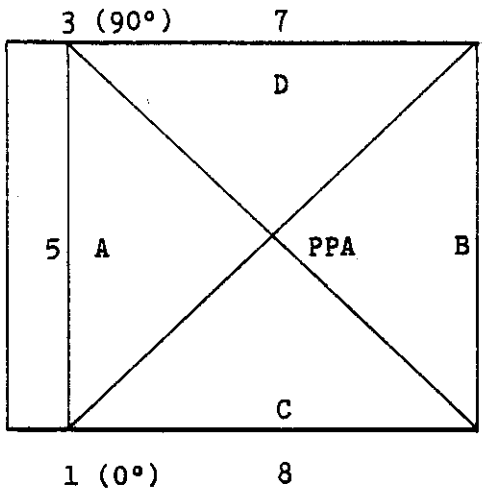
| Indicated shutter speed | Effective shutter speed | Efficiency |
|---|---|---|
| 1/200 | 4.50 ms = 1/220 s | 82% |
| 1/400 | 2.25 ms = 1/440 s | 82% |
| 1/600 | 1.50 ms = 1/670 s | 82% |
| 1/800 | 1.12 ms = 1/890 s | 82% |
| 1/1000 | 0.90 ms = 1/1110 s | 82% |

The effective shutter speeds were determined with the lens at aperture f/4. The method is considered accurate within 3%. 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. 1470-120 does 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.

| | X coordinate | Y coordinate |
|---|---|---|
| Indicated principal point, corner fiducials | 0.008 mm | 0.002 mm |
| Indicated principal point, midside fiducials | 0.008 | 0.004 |
| Principal point of autocollimation | 0.0 | 0.0 |
| Calibrated principal point (point of symmetry) | -0.012 | 0.000 |

| Fiducial Marks | | |
|---|---|---|
| 1 | -105.991 mm | -105.991 |
| 2 | 106.006 | 105.996 |
| 3 | -105.976 | 105.997 |
| 4 | 105.991 | -105.991 |
| 5 | -109.990 | 0.006 |
| 6 | 109.997 | 0.002 |
| 7 | 0.023 | 110.000 |
| 8 | -0.008 | -109.990 |

## VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)
1-2: 299.802 mm 3-4: 299.781 mm
Lines joining these markers intersect at an angle of 89° 59' 56"

Midside fiducials
5-6: 219.986 mm 7-8: 219.989 mm
Lines joining these markers intersect at an angle of 89° 59' 35"
Corner fiducials (perimeter)
1-3: 211.987 mm 2-3: 211.983 mm
1-4: 211.982 mm 2-4: 211.987 mm

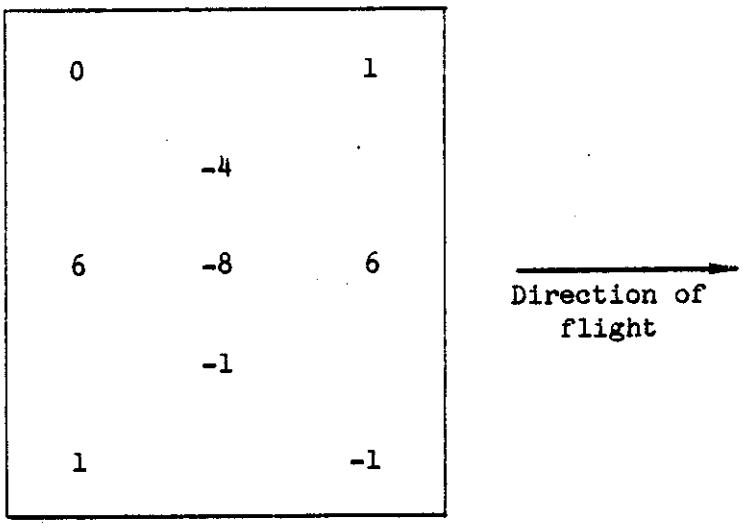
The method of measuring these distances is considered accurate within 0.005 mm.

IX. Stereomodel Flatness

Magazine No.: 1470-120

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 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: 37.9

Film: Type 2405

| Field angle: | 0° | 7.5° | 15° | 22.5° | 30° | 35° | 40° |
|---|---|---|---|---|---|---|---|
| Radial lines | 57 | 57 | 57 | 40 | 48 | 40 | 17 |
| Tangential lines | 57 | 34 | 34 | 34 | 40 | 40 | 24 |

This report supersedes the previous calibration of this camera contained in USGS Report of Calibration No. RT-R/548, dated August 17, 1979.

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