# United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA  22092

## REPORT OF CALIBRATION     January 9, 1980

### of Aerial Mapping Camera

| | | | |
|---|---|---|---|
| Camera type  Wild Heerbrugg RC10 | | Camera serial no.  1758 | |
| Lens type  Wild Universal Aviogon II | | Lens serial no.  UAg II 3019 | |
| Nominal focal length  153 mm | | Maximum aperture  f/4 | |
| | | Test aperture  f/4 | |

Submitted by
NASA Ames Research Center
Moffett Field, California  94035

Reference: Letter dated October 27, 1978 from Mr. Thomas R. Pochari

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 3500K.

I.  **Calibrated Focal Length**:  153.197 mm

This measurement is considered accurate within  0.005 mm

II.  **Radial Distortion**:

| Field angle (degrees) | $\overline{D}_c$ µm | $D_c$ for azimuth angle | | | |
|---|---|---|---|---|---|
| | | 0° A-C µm | 90° A-D µm | 180° B-D µm | 270° B-C µm |
| 7.5 | -2 | -1 | -2 | -1 | -3 |
| 15 | -2 | -1 | -4 | -3 | -2 |
| 22.5 | -1 | 0 | -2 | -2 | 0 |
| 30 | 2 | 4 | 1 | 2 | 2 |
| 35 | 1 | 4 | -2 | 1 | 0 |
| 40 | 0 | 0 | -2 | 4 | -4 |

The radial distortion is measured for each of 4 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. $\overline{D}_c$ 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 micrometres 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__ µm.

III. <u>Resolving power in cycles/mm</u>   Area-weighted average resolution 53.4

| Field angle: | 0° | 7.5° | 15° | 22.5° | 30° | 35° | 40° | |
|---|---|---|---|---|---|---|---|---|
| Radial lines | 113 | 95 | 67 | 48 | 67 | 57 | 17 | |
| Tangential lines | 113 | 67 | 48 | 48 | 57 | 57 | 48 | |

The resolving power is obtained by photographing a series of test bars and examining the resulting 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. <u>Filter Parallelism</u>

The two surfaces of the Wild 520 Pan No. 5251 filter accompanying this camera are within ten seconds of being parallel. This filter was used for the calibration.

V. <u>Shutter Calibration</u>

| Indicated shutter speed | Effective shutter speed | Efficiency |
|---|---|---|
| 1/200 | 5.75 ms = 1/170 s | 80% |
| 1/400 | 2.62 ms = 1/380 s | 80% |
| 1/600 | 1.67 ms = 1/600 s | 80% |
| 1/800 | 1.25 ms = 1/800 s | 80% |
| 1/1000 | 1.00 ms = 1/1000 s | 80% |

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.

VI. <u>Magazine Platen</u>

The platen mounted in ____Wild RC10____ film magazine No. ___1758-139___ does not depart from a true plane by more than 13 µm (0.0005 in).

## VII.  Principal Point and Fiducial Coordinates
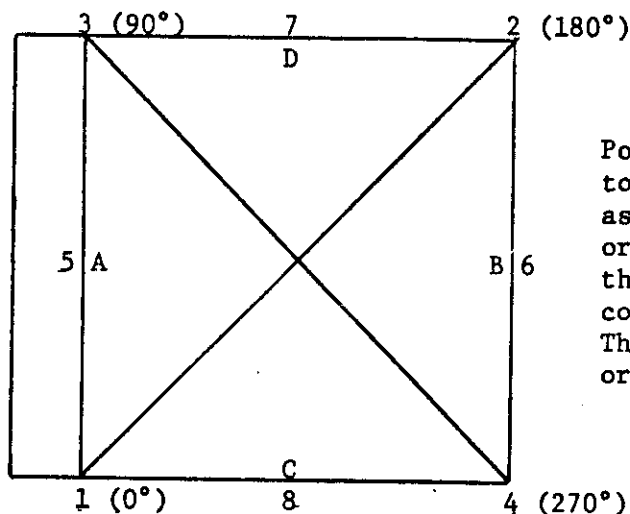


Positions of all points are referenced to the principal point of autocollimation as origin.  The diagram indicates the orientation of the reference points when the camera is viewed from the back, or a contact positive with the emulsion up.  The direction-of-flight fiducial marker or data strip is to the left.

|  | X coordinate | Y coordinate |
|---|---|---|
| Indicated principal point, corner fiducials | 0.008 mm | 0.005 mm |
| Indicated principal point, midside fiducials | 0.011 mm | -0.006 |
| Principal point of autocollimation | 0.0 | 0.0 |
| Calibrated principal point (point of symmetry) | 0.002 | 0.000 |

| Fiducial Marks |  |  |
|---|---|---|
| 1 | -105.999 mm | -105.995 mm |
| 2 | 106.019 | 106.007 |
| 3 | -105.973 | 106.003 |
| 4 | 105.990 | -105.995 |
| 5 | -109.981 | -0.010 |
| 6 | 110.009 | -0.002 |
| 7 | 0.025 | 109.998 |
| 8 | -0.004 | -110.004 |

## VIII.  Distances Between Fiducial Marks

Corner fiducials (diagonals)
        1-2   299.827  mm          3-4   299.785  mm
Lines joining these markers intersect at an angle of 89° 59' 51"

Midside fiducials
        5-6   219.990  mm          7-8   220.001  mm
Lines joining these markers intersect at an angle of 89° 59' 26"

Corner fiducials (perimeter)
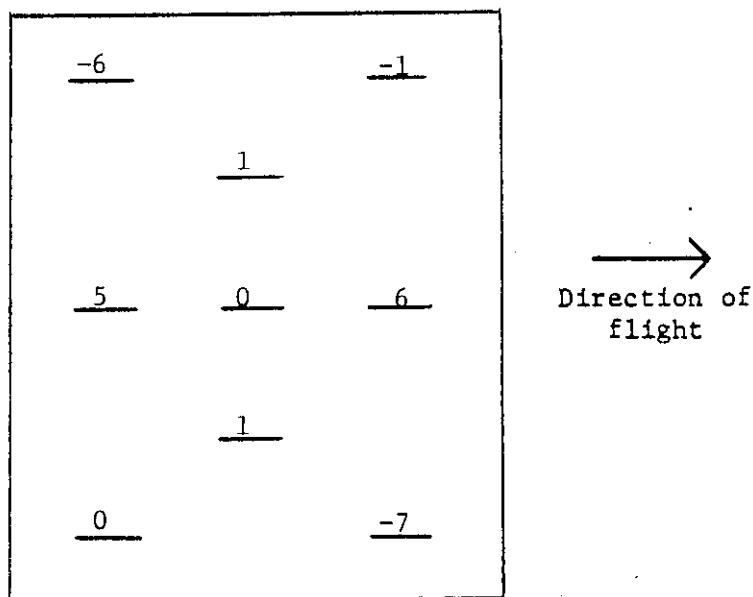        1-3   211.997  mm          2-3   211.991  mm
        1-4   211.989  mm          2-4   212.002  mm
The method of measuring these distances is considered accurate within 0.005 mm.

# STEREOMODEL FLATNESS TEST AND FILM RESOLUTION

Camera No. __1758__    Lens No. __UAg II 3019__    Magazine No. __1758-139__

Focal length __153.197 mm__    Maximum angle of field tested __40$^{\circ}$__

Base-height ratio __0.6__    Accuracy of determination __5 µm__



Stereomodel
Test point array
(values in micrometres)

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.

Resolving Power, in cycles/mm    Area-weighted average resolution 34.1
Film:   Type 2405

| Field angle: | 0° | 7.5° | 15° | 22.5° | 30° | 35° | 40° |
|---|---|---|---|---|---|---|---|
| Radial lines | 57 | 57 | 40 | 34 | 40 | 34 | 17 |
| Tangential lines | 57 | 48 | 34 | 34 | 34 | 34 | 28 |

This report supersedes the previous calibration of this camera contained in
USGS Report of Calibration No. RT-R/383, dated January 24, 1978.

William P. Tayman
Branch of Research and Design
Topographic Division