



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 22092

REPORT OF CALIBRATION of Aerial Mapping Camera

November 4, 1996

| | |
|--|-------------------------|
| Camera type: Wild RC30* | Camera serial no.: 5046 |
| Lens type: Wild Universal Aviogon A4-F | Lens serial no.: 13086 |
| Nominal focal length: 153 mm | Maximum aperture: f/4 |
| | Test aperture: f/4 |

Submitted by: Keystone Aerial Surveys, Inc.
Philadelphia, Pennsylvania

Reference: Keystone Aerial Surveys, Inc., purchase
order No. 4802, dated October 29, 1996.

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: 152.929 mm

II. Lens Distortion

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

Symmetric radial distortion parameters

$$\begin{aligned} K_0 &= 0.3663 \times 10^{-4} \\ K_1 &= -0.8868 \times 10^{-8} \\ K_2 &= 0.4019 \times 10^{-12} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

Decentering distortion parameters

$$\begin{aligned} P_1 &= -0.6615 \times 10^{-7} \\ P_2 &= 0.1223 \times 10^{-6} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

Calibrated principal point

$$\begin{aligned} x_p &= 0.004 \text{ mm} \\ y_p &= 0.003 \text{ mm} \end{aligned}$$

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: 80

| Field angle: | 0° | 7.5° | 15° | 22.7° | 30° | 35° | 40° |
|------------------|----|------|-----|-------|-----|-----|-----|
| Radial Lines | 95 | 113 | 113 | 80 | 95 | 80 | 67 |
| Tangential lines | 95 | 80 | 80 | 80 | 80 | 67 | 67 |

80

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. 4986 and the 525 No. 5818 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

| <u>Indicated exposure time</u> | <u>Effective exposure time</u> | <u>Efficiency</u> |
|--------------------------------|--------------------------------|-------------------|
| 1/125 | 8.00 ms = 1/125 s | 80% |
| 1/250 | 4.25 ms = 1/235 s | 80% |
| 1/500 | 2.11 ms = 1/475 s | 80% |
| 1/1000 | 1.06 ms = 1/945 s | 80% |

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(R1976).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5046-460 does not depart from a true plane by more than 13 μ m (0.0005 in).

This camera is equipped with a platen identification marker that will register "460" in the data strip area for each exposure.

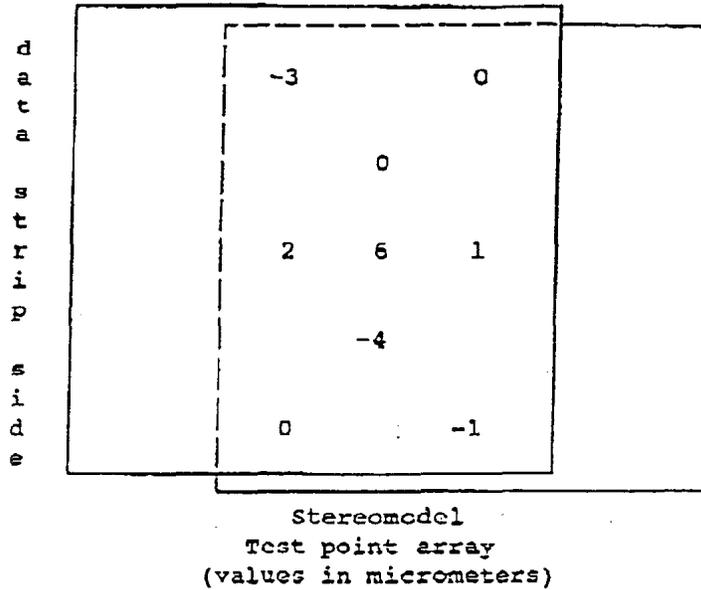
IX. Stereomodel Flatness

Drive unit No.: 5046-460

Base/Height ratio: 0.6

Platen ID: 460

Maximum angle of field tested: 40°



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. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 39

Film: Type 2405

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

LENS/FILM DISTORTION PARAMETERS

Magazine No.: 5046-460

Base/Height ratio: 0.6

Platen ID: 460

Maximum angle of field tested: 40°

XI. Calibrated Focal Length: 152.931 mm

XII. Lens/Film Distortion

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

Symmetric radial distortion parameters

$K_0 = -0.1764 \times 10^{-4}$
 $K_1 = -0.3713 \times 10^{-8}$
 $K_2 = 0.3463 \times 10^{-12}$
 $K_3 = 0.0000$
 $K_4 = 0.0000$

Decentering distortion parameters

$P_1 = -0.7712 \times 10^{-7}$
 $P_2 = 0.2802 \times 10^{-7}$
 $P_3 = 0.0000$
 $P_4 = 0.0000$

Calibrated principal point

$x_p = 0.004$ mm
 $y_p = 0.003$ mm

The above measurements were computed from contact glass positives 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/1929, dated November 9, 1993.

Bradish F. Johnson

Bradish F. Johnson
 Chief, Optical Science Laboratory
 National Mapping Division