# United States Department of the Interior

**U.S. GEOLOGICAL SURVEY**
**Reston, Virginia 20192**

**REPORT OF CALIBRATION**
**of Aerial Mapping Camera**

February 18, 2016

| | | | |
|---|---|---|---|
| **Camera type:** | Wild RC30* | **Camera serial no.:** | 5325 |
| **Lens type:** | Wild Universal Aviogon /4-S | **Lens serial no.:** | 13366 |
| **Nominal focal Length:** | 153 mm | **Maximum aperture:** | f/4 |
| | | **Test aperture:** | f/4 |

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

**Reference:**

These measurements were made on Agfa glass plates, 0.19 inch thick, with spectroscopic emulsion type APX 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: 153.295 mm

## II. Lens Distortion

| Field angle: | 7.5º | 15º | 22.7º | 30º | 35º | 40º |
|---|---|---|---|---|---|---|
| Symmetric radial (μm) | -1 | -2 | -2 | -1 | 0 | 2 |
| Decentering tangential (μm) | 0 | 0 | 1 | 2 | 3 | 4 |

| Symmetric radial distortion | Decentering distortion | Calibrated principal point |
|---|---|---|
| $K_0$ = 0.5451E-04 | $P_1$ = -0.1030E-06 | $x_p$ = 0.011 mm |
| $K_1$ = -0.6208E-08 | $P_2$ = 0.2217E-06 | $y_p$ = -0.003 mm |
| $K_2$ = 0.1200E-12 | $P_3$ = 0.0000 | |
| $K_3$ = 0.0000 | $P_4$ = 0.0000 | |
| $K_4$ = 0.0000 | | |

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: 112

| Field angle: | 0º | 7.5º | 15º | 22.7º | 30º | 35º | 40º |
|---|---|---|---|---|---|---|---|
| Radial Lines | 159 | 134 | 134 | 113 | 113 | 113 | 113 |
| Tangential Lines | 159 | 134 | 113 | 113 | 113 | 95 | 95 |

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 filter No. 7448 and 525 filter No. 7766 accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

## V. Shutter Calibration

| Indicated Time (sec) | Rise Time (μ sec) | Fall Time (μ | ½ Width Time (ms) | Nom. Speed (sec) | Efficiency (%) |
|---|---|---|---|---|---|
| 1/125 | 1080 | 1105 | 8.94 | 1/120 | 92 |
| 1/250 | 558 | 517 | 4.57 | 1/240 | 93 |
| 1/500 | 286 | 286 | 2.30 | 1/470 | 92 |
| 1/1000 | 138 | 133 | 1.17 | 1/930 | 93 |

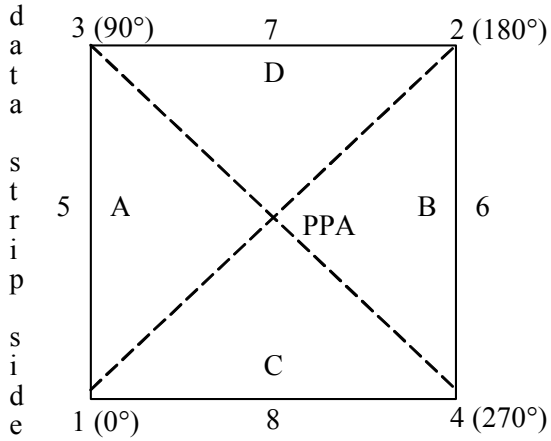
The effective exposure times were determined with the lens at aperature f/4. The method is considered accurate within 3 percent. The technique used is described in International Standard ISO 516:1999(E).

## VI. Film Platen

The platen mounted in Wild drive unit No. 5325 does not depart from a true plane by more than 13 μm (0.0005 in).

This camera is equipped with a platen identification marker that will register "707" in the data strip area for each exposure.

## VII. Principal Point and Fiducial Mark 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 data strip is to the left.

| | X coordinate (mm) | Y coordinate (mm) |
|---|---|---|
| Indicated principal point, corner fiducials | 0.011 | 0.004 |
| Indicated principal point, midside fiducials | 0.009 | 0.004 |
| Principal point of autocollimation (PPA) | 0.000 | 0.000 |
| Calibrated principal point (point of symmetry) | 0.011 | -0.003 |
| Fiducial Marks | | |
| 1 | -105.991 | -105.992 |
| 2 | 106.014 | 106.001 |
| 3 | -105.984 | 106.001 |
| 4 | 106.005 | -105.992 |
| 5 | -111.985 | 0.010 |
| 6 | 112.008 | -0.003 |
| 7 | 0.012 | 111.994 |
| 8 | 0.005 | -111.985 |

## VIII. Distances Between Fiducial marks

| | | | | |
|---|---|---|---|---|
| Corner fiducials (diagonals) | 1-2: | 299.812 mm | 3-4: | 299.801 mm |

Lines joining these markers intersect at an angle o 90° 00' 04"

| | | | | |
|---|---|---|---|---|
| Midside fiducials | 5-6: | 223.993 mm | 7-8: | 223.979 mm |

Lines joining these markers intersect at an angle o 90° 00' 06"

| | | | | |
|---|---|---|---|---|
| Corner fiducials (perimeter) | 1-3: | 211.993 mm | 2-3: | 211.998 mm |
| | 1-4: | 211.996 mm | 2-4: | 211.993 mm |

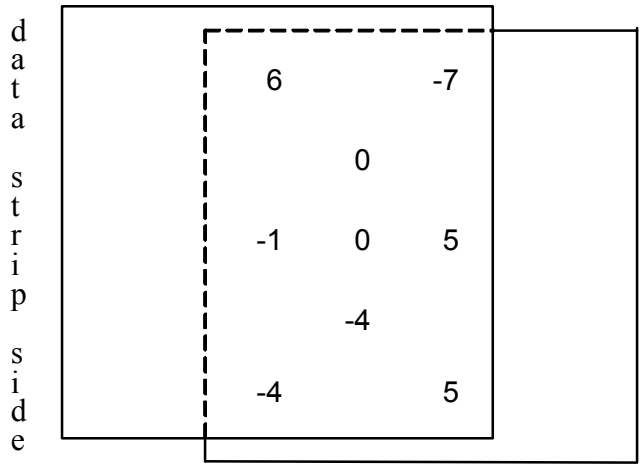
The Method of measuring these distances is considered accurate within 0.003 mm

**Note:** For GPS applications, the nominal entrance pupil distance from the focal plane is 277mm.

## IX. Stereomodel Flatness

**FMC Drive Unit No:** 5325 **Base/Height ratio:** 0.6

**Platen ID:** 707 **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 stereo models. The values are based on comparator measurements on Agfa Avitone P3p copy film made from Agfa Aviphot Pan 200 film exposures. These measurements are considered accurate to within 5 µm.

## X. System Resolving Power on film in cycles/mm

**Area-weighted average resolution:** 52 **Film:** Pan 200

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3487, dated October 23, 2009.

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Climate and Land Use Change