United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

May 21, 2009

Camera type:	Wild RC30*	**Camera serial no.:**	5224
Lens type:	Wild Universal Aviogon /4-S	**Lens serial no.:**	13241
Nominal focal Length:	153 mm	**Maximum aperture:**	f/4
		Test aperture:	f/4

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

Reference: Keystone Aerial Survey, Inc. purchase order No. 3499, dated May 15, 2009.

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: 152.610 mm

II. Lens Distortion

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

Symmetric radial distortion	Decentering distortion	Calibrated principal point
K_0 = 0.5014E-04	P_1 = -0.6759E-08	x_p = -0.004 mm
K_1 = -0.4681E-08	P_2 = 0.2595E-07	y_p = -0.008 mm
K_2 = 0.4526E-13	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: 105

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	134	134	113	113	80	113
Tangential Lines	113	113	113	95	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. 7314 and 525 filter No. 5818 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 sec)	½ Width Time (ms)	Nom. Speed (sec)	Efficiency (%)
1/125	655	651	10.81	1/100	96
1/250	287	288	4.80	1/220	96
1/500	147	143	2.44	1/420	96
1/1000	77	71	1.23	1/850	96

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. 5224 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 "596" 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	0.010	-0.002
Indicated principal point, midside fiducials	0.007	-0.005
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (point of symmetry)	-0.004	-0.008
Fiducial Marks		
1	-105.990	-106.001
2	106.006	105.993
3	-105.990	105.995
4	106.013	-106.001
5	-111.986	-0.006
6	112.006	-0.004
7	0.007	111.990
8	0.007	-112.014

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2:	299.807 mm	3-4:	299.813 mm
Lines joining these markers intersect at an angle of	90° 00' 05"			
Midside fiducials	5-6:	223.992 mm	7-8:	224.004 mm
Lines joining these markers intersect at an angle of	89° 59' 59"			
Corner fiducials (perimeter)	1-3:	211.996 mm	2-3:	211.996 mm
	1-4:	212.004 mm	2-4:	211.995 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 283mm.

IX. Stereomodel Flatness

FMC Drive Unit No: 5224 **Base/Height ratio:** 0.6

Platen ID: 596 **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 Kodak 2405 film exposures. These measurements are considered accurate to within 5 µm.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 47 **Film:** Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3239, dated May 26, 2006.

Michael G. Benson
Remote Sensing Technologies Project Manager
Geography Discipline