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United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

November 17, 2015

Camera type:	Zeiss RMK Top 15*	**Camera serial no.:**	149991
Lens type:	Zeiss Pleogon A3/4	**Lens serial no.:**	150000
Nominal focal Length:	153 mm	**Maximum aperture:**	f/4
		Test aperture:	f/4

Submitted by: Institut National de Cartographie et de Teledectio
Alger, Algerie

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: 153.062 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (µm)	1	2	2	2	1	-2
Decentering tangential (µm)	0	1	1	2	3	5

Symmetric radial distortion	Decentering distortion	Calibrated principal point
K_0 = -0.4851E-04	P_1 = 0.2834E-06	x_p = 0.003 mm
K_1 = 0.3406E-08	P_2 = -0.1093E-06	y_p = 0.004 mm
K_2 = 0.2805E-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: 98

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	134	134	113	95	95	80
Tangential Lines	113	113	113	113	95	80	67

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 USGS TOP 15 test filter KL-F (60%) No. 142399 are within 10 seconds of being parallel. This filter, in conjunction with the internal "B" filter, was used for the calibration.

V. Shutter Calibration

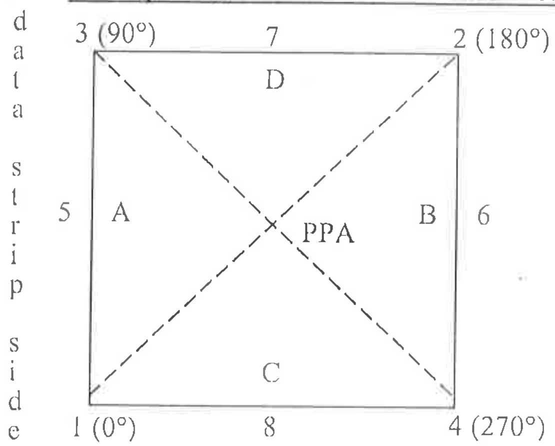
Indicated Time (sec)	Rise Time (μ sec)	Fall Time (μ	½ Width Time (ms)	Nom. Speed (sec)	Efficiency (%)
1/100	3543	3796	11.11	1/110	79
1/200	1750	1962	5.15	1/250	77
1/300	1225	1205	3.43	1/370	78
1/400	931	885	2.57	1/500	78
1/500	719	773	2.04	1/630	77

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. Magazine Platen

N/A

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	0.009	0.014
Indicated principal point, midside fiducials	0.017	0.012
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (point of symmetry)	0.003	0.004
Fiducial Marks		
1	-112.986	-112.988
2	113.004	113.017
3	-112.985	113.001
4	113.017	-112.988
5	-112.987	0.016
6	113.013	0.007
7	0.015	113.006
8	0.018	-112.991

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2:	319.608 mm	3-4:	319.606 mm

Lines joining these markers intersect at an angle o 89° 59' 59"

Midside fiducials	5-6:	226.000 mm	7-8:	225.997 mm

Lines joining these markers intersect at an angle o 90° 00' 11"

Corner fiducials (perimeter)	1-3:	225.989 mm	2-3:	225.989 mm
	1-4:	226.003 mm	2-4:	226.005 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 254 mm with a 10 mm filter thickness. Additional filter thickness will increase entrance pupil distance by 0.34 X added thickness.

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Climate and Land Use Change