



# United States Department of the Interior

GEOLOGICAL SURVEY  
RESTON, VIRGINIA 22092

REPORT OF CALIBRATION  
of Aerial Mapping Camera

November 16, 1981

Camera type:	Zeiss RMK A 15/23	Camera serial no.:	111683
Lens type:	Zeiss Pleogon A2	Lens serial no.:	112649
Nominal focal length:	153 mm	Maximum aperture:	f/5.6
		Test aperture:	f/5.6

Submitted by: Keystone Aerial Surveys, Inc.  
Philadelphia, Pennsylvania 19114

Reference: Keystone purchase order No. 1658, dated November 4, 1981.

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 three 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: 153.202 mm

This measurement is considered accurate within 0.005 mm

II. Radial Distortion

Field angle	$\bar{D}_c$	$D_c$ for azimuth angle			
		0° A-C	90° A-D	180° B-D	270° B-C
degrees	um	um	um	um	um
7.5	-5	-5	-4	-6	-4
15	-8	-8	-10	-10	-6
22.5	-8	-9	-7	-9	-8
30	-2	-3	-1	-2	-1
35	4	4	4	2	5
40	6	5	6	6	5

The radial distortion is measured for each of four 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.  $\bar{D}_c$  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 micrometers 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 um.

III. Resolving Power in cycles/mm

Area-weighted average resolution: 69.5

Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	113	113	113	95	67	57	57
Tangential lines	113	113	95	80	57	48	40

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 B No. 114071, the D No. 111490 and the KL No. 120555 filters accompanying this camera are within ten seconds of being parallel. The B filter was used for the calibration.

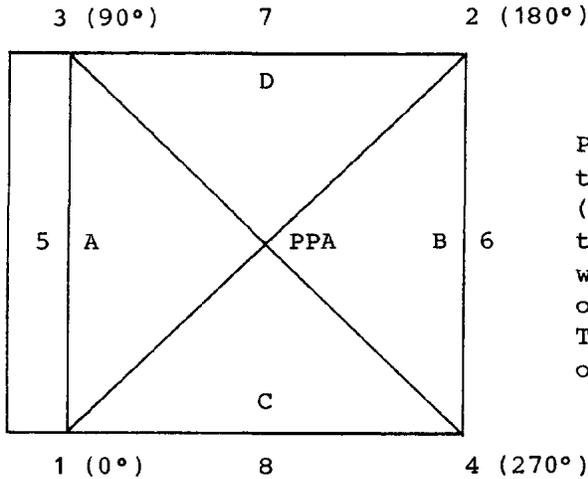
V. Shutter Calibration

(Not applicable)

VI. Magazine Platen

(Not applicable)

VII. Principal Point and Fiducial 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 direction-of-flight fiducial marker or data strip is to the left.

	<u>X coordinate</u>	<u>Y coordinate</u>
Indicated Principal point, corner fiducials	0.089 mm	-0.084 mm
Indicated principal point, midside fiducials	0.006	0.024
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	0.017	0.000

Fiducial Marks

1	-103.946 mm	-103.947 mm
2	103.935	103.589
3	-103.901	103.919
4	103.939	-103.947
5	-112.990	0.004
6	112.900	0.043
7	0.006	112.996
8	0.005	-112.994

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 293.744 mm                      3-4: 293.948 mm

Lines joining these markers intersect at an angle of 90° 02' 38"

Midside fiducials

5-6: 225.890 mm                      7-8: 225.989 mm

Lines joining these markers intersect at an angle of 89° 59' 24"

Corner fiducials (perimeter)

1-3: 207.865 mm                      2-3: 207.836 mm

1-4: 207.885 mm                      2-4: 207.536 mm

The method of measuring these distances is considered accurate within 0.005 mm.

This report supersedes the previous calibration of this camera contained in USGS Report of Calibration No. RT-R/639, dated August 5, 1980.

*William P. Tayman*  
 William P. Tayman  
 Chief, Optical Science Section  
 National Mapping Division