United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

REPORT OF CALIBRATION
of Aerial Mapping Camera

August 3, 1983

Camera type: Zeiss RMK A 15/23
Lens type: Zeiss Pleogon A4
Nominal focal length: 153 mm

Camera serial no.: 119029
Lens serial no.: 118980
Maximum aperture: f/4
Test aperture: f/4

Submitted by: NASA, Ames Research Center
Moffett Field, California 94035

Reference: NASA, Ames Research Center purchase order No. A 06617C(VAB), dated June 9, 1983.

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: 153.412 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	1	0	1	2	2
15	1	0	0	0	3
22.5	0	-2	3	-2	1
30	1	-2	1	1	3
35	2	2	2	0	2
40	-2	-3	-1	-3	-2

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: 85.8

Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	159	159	134	113	95	67	57
Tangential lines	159	134	113	95	80	57	48

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 A No. 125219, the F No. 125223 and the KL-F No. 126071 filters accompanying this camera are within ten seconds of being parallel. The A filter was used for the calibration.

V. Shutter Calibration

Indicated shutter speed	Effective shutter speed	Efficiency
1/200	3.00 ms = 1/330 s	73%
1/400	1.62 ms = 1/620 s	73%
1/600	1.16 ms = 1/860 s	73%
1/800	0.88 ms = 1/1140 s	73%
1/1000	0.70 ms = 1/1430 s	73%

The effective shutter speeds were determined with the lens at aperture f/4. The method is considered accurate within 3%. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

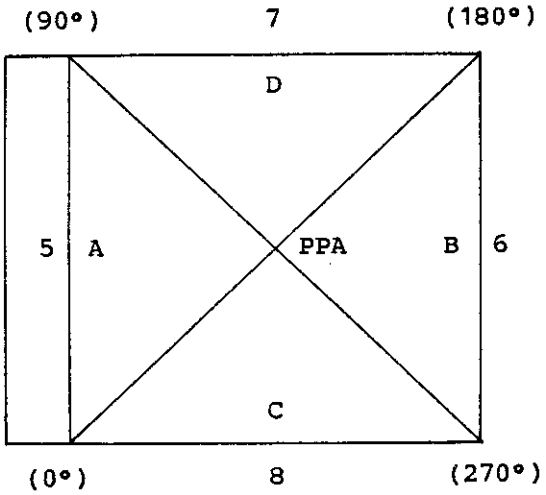
VI. Magazine Platen

The platen mounted in FK 24/120 film magazine No. 118777 does not depart from a true plane by more than 17 um (0.0007 in.).

The platen mounted in FK 24/120 film magazine No. 118846 does not depart from a true plane by more than 16 um (0.0006 in.).

This camera is equipped with an EMI-2 automatic exposure control, with the detector located beside the camera lens.

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.

	X coordinate	Y coordinate
Indicated principal point, midside fiducials	-0.008 mm	-0.004 mm
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	0.069	0.001

Fiducial Marks		
5	-113.014 mm	-0.004 mm
6	112.994	-0.004
7	-0.006	112.994
8	-0.011	-112.960

VIII. Distances Between Fiducial Marks

Midside fiducials

5-6: 226.008 mm 7-8: 225.954 mm

Lines joining these markers intersect at an angle of 89° 59' 56"

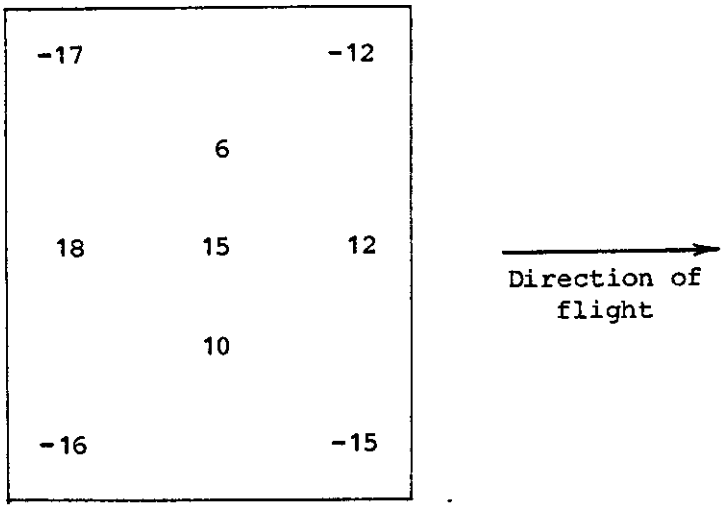
The method of measuring these distances is considered accurate within 0.005 mm.

IX. Stereomodel Flatness

Magazine No.: 118777

Base/Height ratio: 0.6

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 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. Resolving Power in cycles/mm

Area-weighted average resolution: 46.0

Film: Type 2405

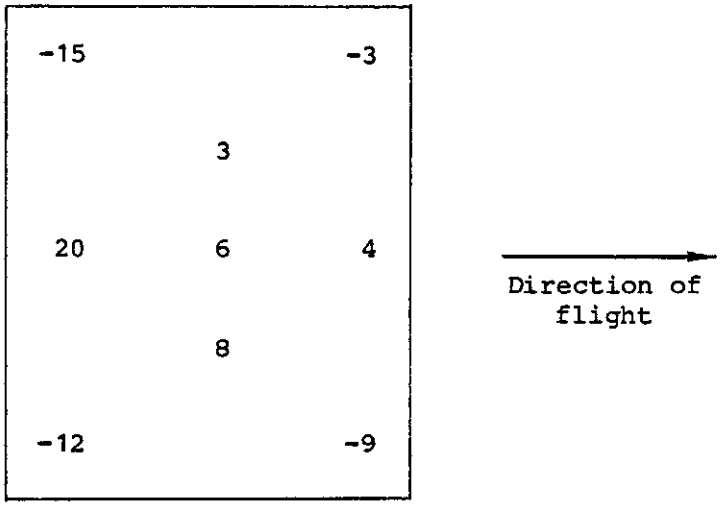
Field angle:	0°	7.5°	15°	22.5°	30°	35°	40°
Radial lines	80	67	67	57	48	40	34
Tangential lines	80	67	57	48	48	34	28

IX. Stereomodel Flatness

Magazine No.: 118846

Base/Height ratio: 0.6

Maximum angle of field tested: 40°



Stereomodel
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This report supersedes the previous calibration of this camera contained in USGS Report of Calibration No. RT-R/428, dated June 7, 1978.

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