



## United States Department of the Interior

GEOLOGICAL SURVEY  
RESTON, VA 22092REPORT OF CALIBRATION  
of Aerial Mapping Camera

September 24, 1993

Camera type: Jena LMK 1015*	Camera serial No.: 269159D
Lens type: Jena Lamegon FI/D	Lens serial No.: 7390029D
Nominal focal length: 153 mm	Maximum aperture: f/4.2
	Test aperture: f/4.2

Submitted by: Tuck Engineering, Inc.  
Big Stone Gap, Virginia

Reference: Tuck Engineering, Inc., purchase order  
No. 1331, dated September 20, 1993.

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type 157-01 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: 152.411 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	0	0	1	-2	-1
15	0	1	0	0	-1
22.7	-1	0	0	-1	-2
30	2	2	2	1	2
35	1	1	2	1	2
40	-2	-3	-1	-2	-1

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 away from the center of the field. These measurements are considered accurate within 5 um.

\* Equipped with Forward Motion Compensation

### III. Resolving Power in cycles/mm

Area-weighted average resolution: 93

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial lines	113	134	95	95	113	95	95
Tangential lines	113	113	113	95	95	67	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 405 No. 275579, the 500 No. 51740A, and the 550 No. 51413A filters accompanying this camera are within 10 seconds of being parallel. The 500 filter was used for the calibration.

### V. Shutter Calibration

<u>Indicated shutter speed</u>	<u>Effective shutter speed</u>	<u>Efficiency</u>
1/125	7.16 ms = 1/140 s	74%
1/175	5.00 ms = 1/200 s	74%
1/250	3.60 ms = 1/280 s	74%
1/350	2.43 ms = 1/410 s	74%
1/500	1.80 ms = 1/555 s	74%

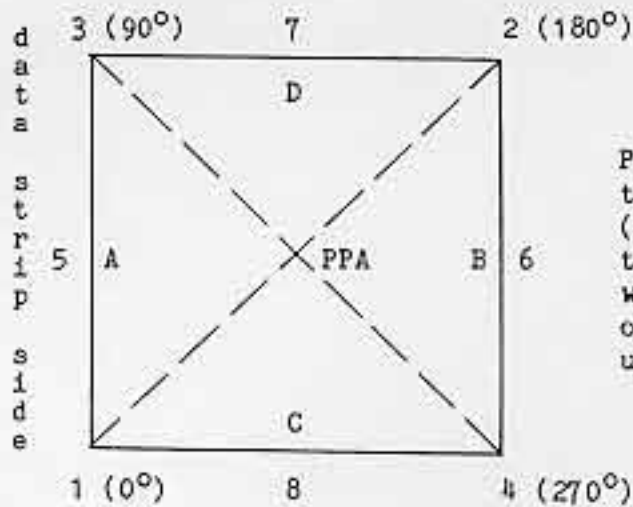
The effective shutter speeds were determined with the lens at aperture f/4.2. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

### VI. Magazine Platen

The platens mounted in LMK-K 24/120 film magazines No. 266472A and No. 269014B do not depart from a true plane by more than 13 um (0.0005 in).

The platens for these film magazines are equipped with identification markers that will register "266472" for magazine No. 266472A, and "269014" for magazine No. 269014B in the data strip area for each exposure.

VII. Principal Points 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 data strip is to the left.

	<u>X coordinate</u>	<u>Y coordinate</u>
Indicated principal point, corner fiducials	-0.006 mm	-0.004 mm
Indicated principal point, midside fiducials	-0.006	-0.001
Principal point of autocollimation	0.0	0.0
Calibrated principal point (point of symmetry)	-0.016	0.002

Fiducial Marks

1	-110.004 mm	-110.003 mm
2	109.994	109.997
3	-110.005	109.997
4	109.990	-110.003
5	-112.008	0.001
6	111.992	-0.002
7	-0.003	111.993
8	-0.009	-112.014

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 311.126 mm                      3-4: 311.124 mm

Lines joining these markers intersect at an angle of 89° 59' 57"

Midside fiducials

5-6: 224.000 mm                      7-8: 224.007 mm

Lines joining these markers intersect at an angle of 89° 59' 57"

Corner fiducials (perimeter)

1-3: 220.000 mm                      2-3: 220.000 mm

1-4: 219.995 mm                      2-4: 220.000 mm

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

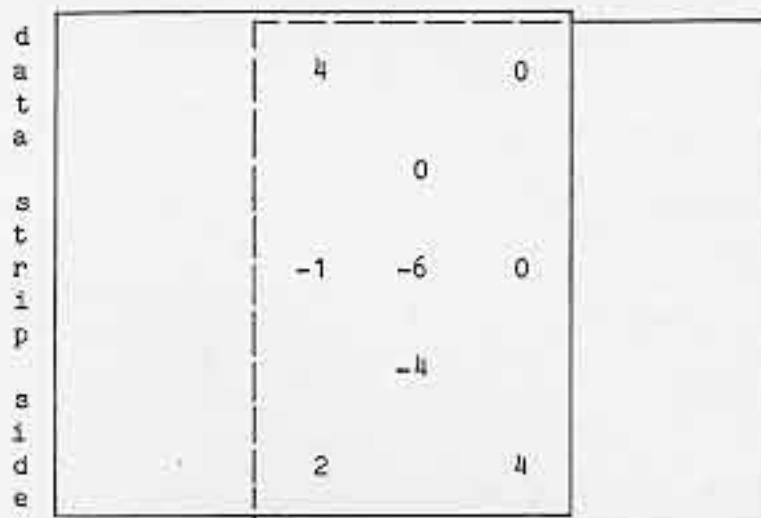
IX. Stereomodel Flatness

Magazine No.: 266472A

Base/Height ratio: 0.6

Magazine ID: 266472

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  $\mu$ m.

X. Resolving Power in cycles/mm

Area-weighted average resolution: 42

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial lines	57	48	48	48	48	40	40
Tangential lines	57	48	48	40	40	34	34

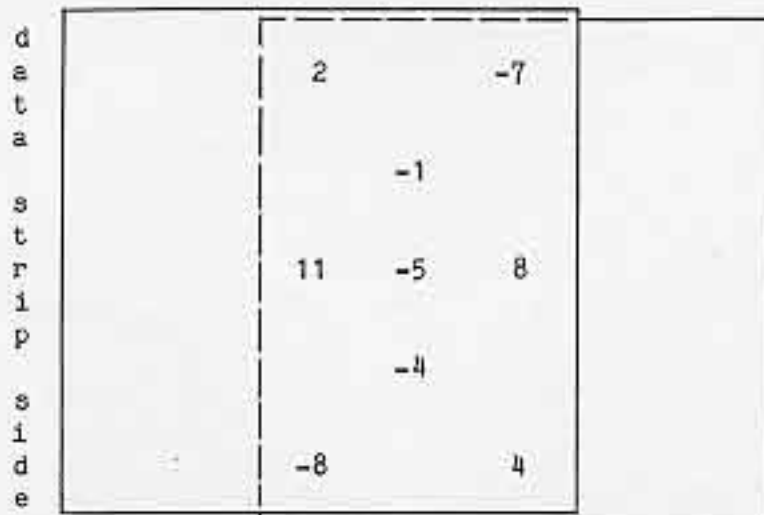
IX. Stereomodel Flatness

Magazine No.: 269014B

Base/Height ratio: 0.6

Magazine ID: 269014

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  $\mu$ m.

X. Resolving Power in cycles/mm

Area-weighted average resolution: 45

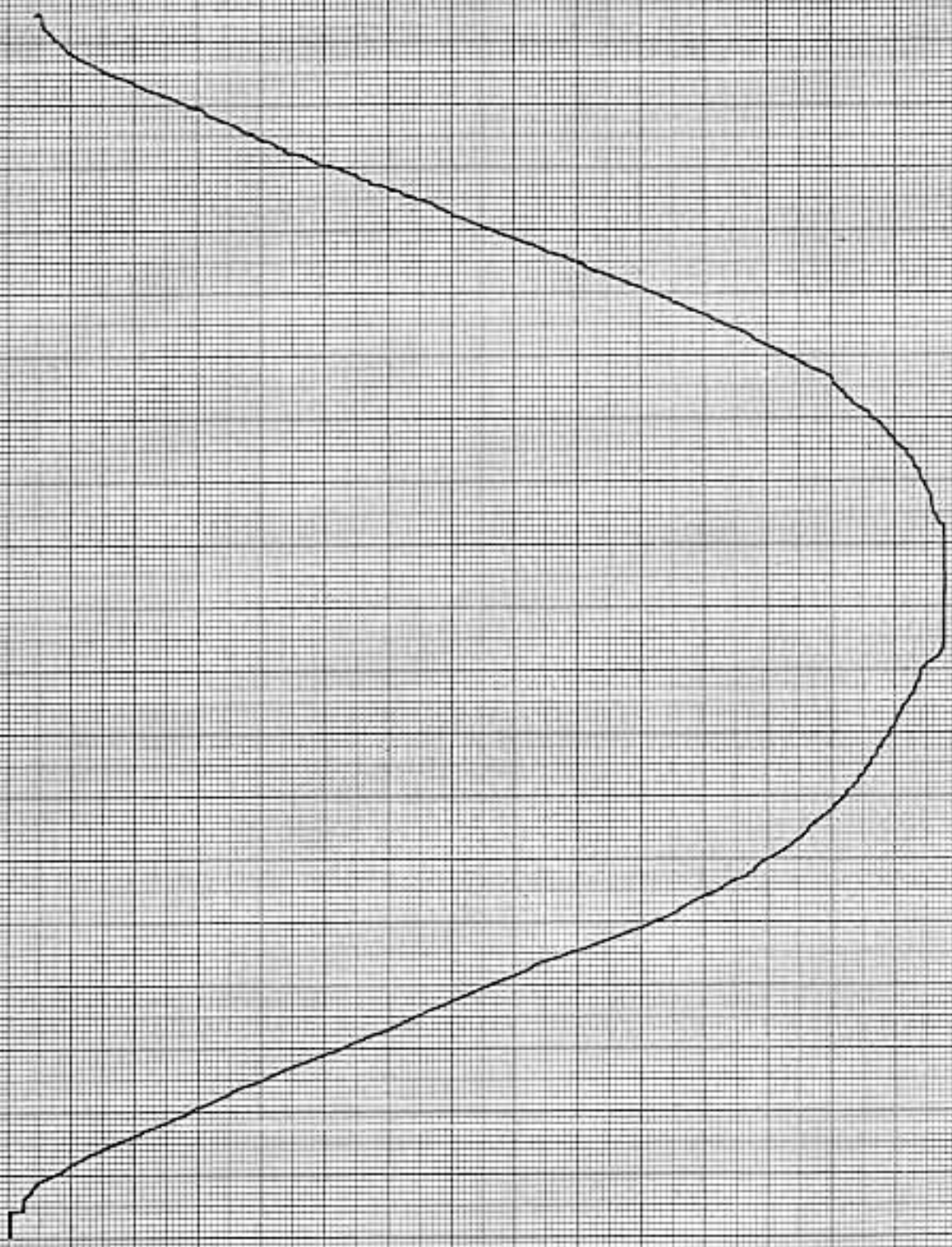
Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial lines	57	48	48	48	48	48	40
Tangential lines	57	48	48	48	48	40	34

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/1546, dated June 28, 1990.

*Bradish F. Johnson*

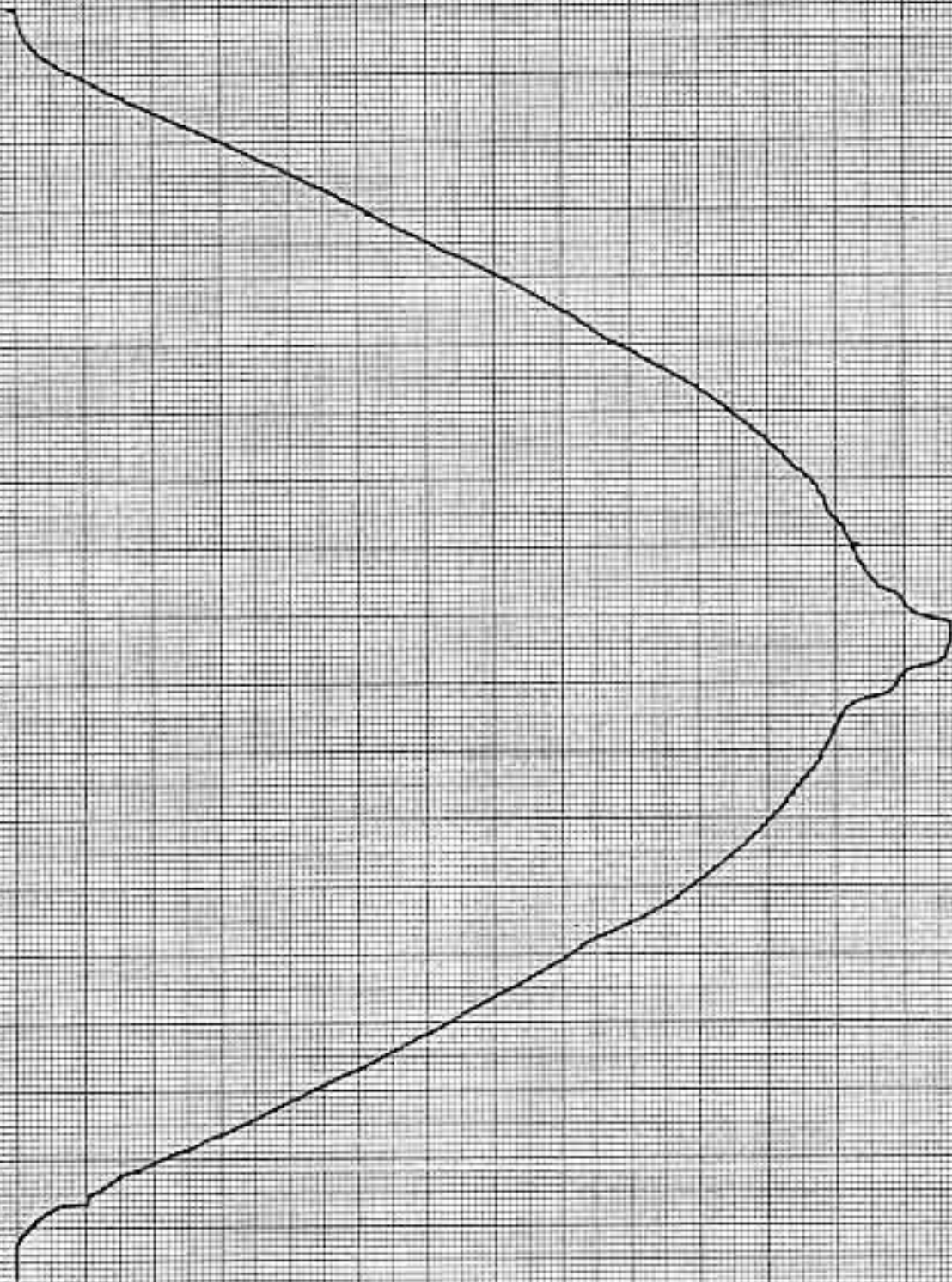
Bradish F. Johnson  
Chief, Optical Science Laboratory  
National Mapping Division



**JOYCE**  
**LOEBL**

RECORDING  
MICRODENSITOMETER  
ORH MD1  
Version V5732

OPTICAL MAGNIF. = OBJECTIVE POWER 23 5X OBJ	PROPORT. CONTR. 5-6	WEDGE RANGE .360	SAMPLE: 500/0.45/15	DATE 9/21/93	RECORD No. 1915
SLIT (ACTUAL) 2mm X .12mm	FEEDBACK SETTING 5-6	RATIO 1:1	REMARKS: # 51740A LAMEGON PI/D 7390029D TUCK ENG., INC.		



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LOEBL

OPTICAL MAGNIF. #  
OBJECTIVE POWER #22  
5XOBJ

PROPORT. LENTL  
5-6

WEDGE RANGE  
.360

SAMPLE  
405/0.45/15

DATE

RECORD No.

SLIT (ACTUAL)  
2mm X .12mm

FEEDBACK SETTING RATIO  
5-6

1:1

REMARKS:  
VR  
275579

LHMEGON PZ10  
73900290

9/21/93

1915

TUCK ENG, INC

# LENS RESOLVING POWER

REPORT No. OSL/1915

LENS No. 7390029D

Max. Aperture: f/4.2

Test Aperture: f/4.2

AWAR: 93

