Calibration Certificate

Lens cone

No.: 65 214 A

with lens

No.: 73 83 190 C

Date of calibration: 22.01.1987

Entries approved by:

VEB Carl Zeiss JENA

Department of Photogrammetry

1. General

The data given in this calibration certificate have been deter-
mined photographically with the yellow filter belonging to the
equipment of the LMK.

Distortion and resolution refer to the respective maximum aper-
ture ratio.

Calibration temperature is $22^{O}C \pm 1.5$ K.

The definition of the errors assigned to the measuring data corres-
ponds to the GDR standard, TGL 0-1319 (identical to DIN 1319,
issue in 1962).

The standard deviation e is related to a level of confidence of
P = 95% and corresponds to double the value of the mean error
usual in surveying, i.e. P = 68.3%.

All data given without any additional explanations are guaranteed
error limits within this standard.

Definition of the measured values (positive image):
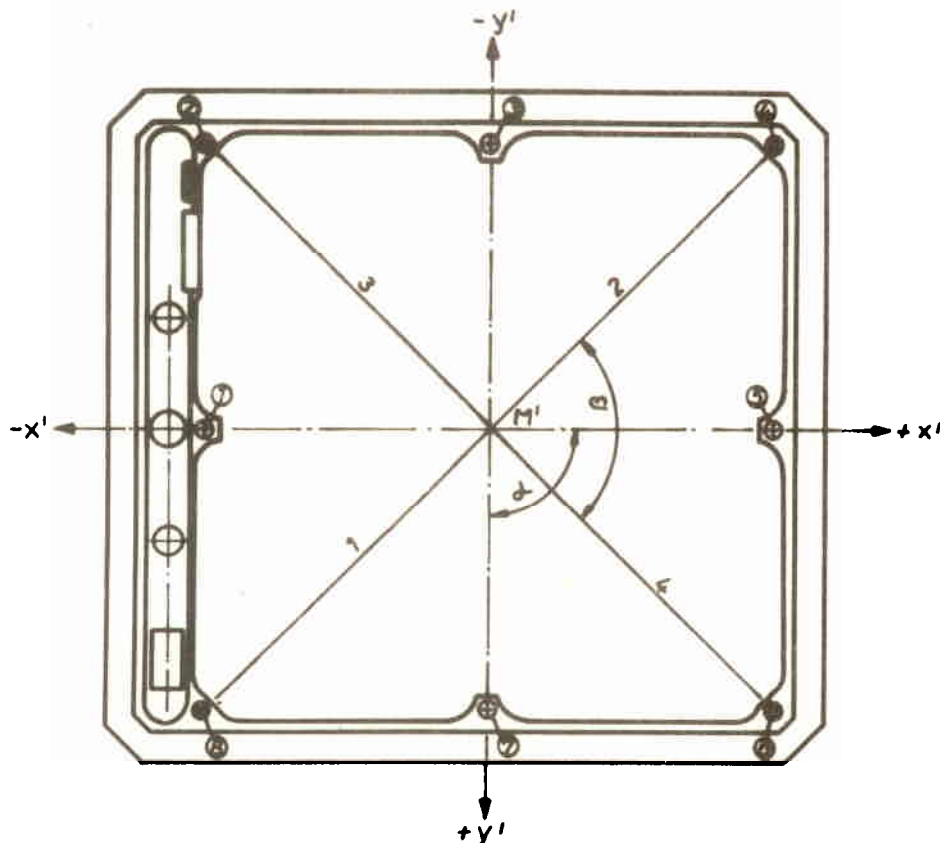
K $\hat{=}$ Temperature difference $t - t_{o}$, with t_{o} = 22 ^{O}C.

M'= Centre of fiducial mark (intersection point of the fiducial
   mark connecting lines in the centre of the format sides) =
   zero point of image coordinate system.

2. Data of interior orientation

Test emulsion: GIMO - LP 3

2.1. Calibrated focal length c_k =   152.44   mm ±0.01 mm

2.2. Position of other reference points in the image coordinate system

2.2.1. Intersection point of the connecting lines of the fiducial marks in the picture corners

x' = ∓ 0.00   mm ±0.01 mm

y' = ∓ 0.00   mm ±0.01 mm

2.2.2. Principal point

x' = − 0.01   mm ±0.01 mm

y' = ∓ 0.00   mm ±0.01 mm

2.2.3. Symmetry point of distortion

x' = − 0.01   mm, s = ±0.01 mm

y' = ∓ 0.00   mm, s = ±0.01 mm

2.3. Intersection angle of the fiducial mark connecting lines

2.3.1. Fiducial marks in the centres of the format sides

α =   99.998   gon, s = ±0.003 gon +)

2.3.2. Fiducial marks in the picture corners

β = 100.000   gon, s = ±0.003 gon

2.4. Radial distortion (μm)
A positive sign corresponds to an enlargement of the image radius.

| Reference point | Measuring direction | LMK 9/15 | Field angle in gon |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 9/15 | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 |
| | | 21 | 8 | 16 | 24 | 28 | 32 | 36 | | |
| | | 30 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | |
| Zero point of the image coordinate system | 1 | | + 2 | − 1 | − 1 | − 3 | − 1 | − 3 | | |
| | 2 | | + 2 | + 2 | − 1 | − 3 | + 1 | + 1 | | |
| | 3 | | + 2 | + 1 | − 1 | − 5 | − 4 | − 9 | | |
| | 4 | | + 2 | + 1 | 0 | − 1 | + 6 | + 7 | | |
| Symmetry point of distortion | 1 | | + 2 | 0 | − 1 | − 3 | 0 | − 1 | | |
| | 2 | | + 2 | + 1 | − 1 | − 3. | 0 | − 1 | | |
| | 3 | | + 2 | + 1 | 0 | − 2 | + 1 | − 1 | | |
| | 4 | | + 2 | + 1 | − 1 | − 4 | + 1 | − 1 | | |
| Average values | | | + 2 | + 1 | − 1 | − 3 | 0 | − 1 | | |

Standard deviation of the distortion values related to the symmetry point of distortion: s = ± (3.0 + 1.5 • tan τ) (μm)

+) 1 gon = $\dfrac{\pi}{200}$ rad = 15.708 • 10^{-3} rad

Mean distortion
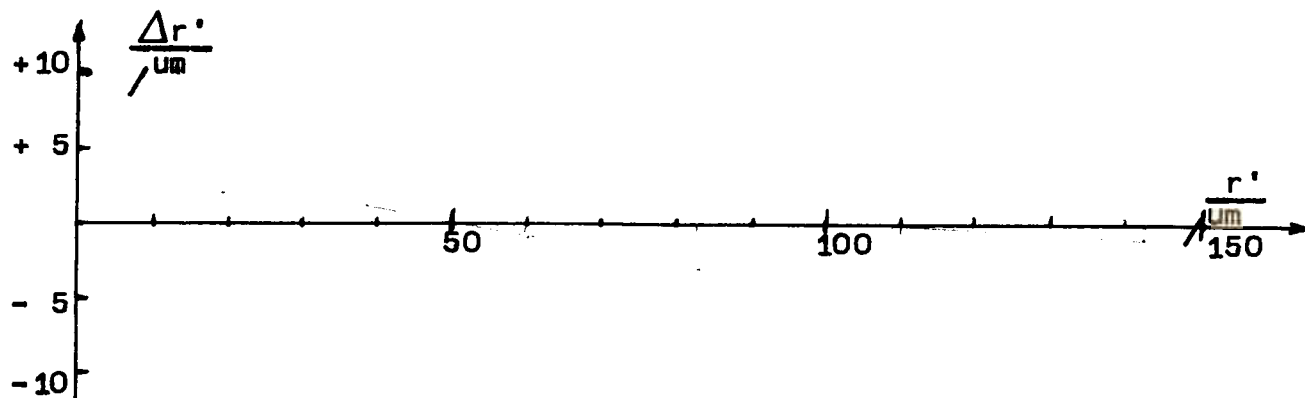
Distortion on the semidiagonals related to the symmetry point of distortion

●——● 1
○——○ 2
+══+ 3
△══△ 4
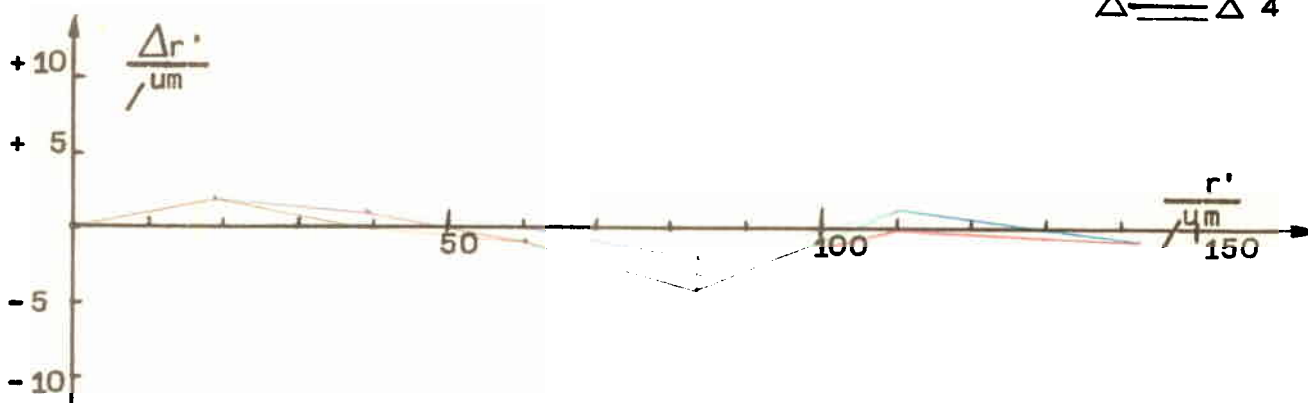
2.5. <u>Tangential residual errors</u>

Mean value for the largest field angle

Diagonal 1 - 2: ∓ 2 /um

Diagonal 3 - 4: ∓ 2 /um

3. <u>Image coordinates of the fiducial marks (mm)</u>

Point No.	x'	y'
1	− 110.000	− 0.004
2	− 109.998	− 110.001
3	∓ 0.000	− 110.000
4	+ 110.002	− 109.996
5	+ 110.003	+ 0.004
6	+ 109.998	+ 110.004
7	∓ 0.000	+ 110.000
8	− 110.000	+ 109.995

Standard deviation of the image coordinates: s = ±0.006 mm

4. **Fiducial mark spacings**

1	-	5	220.005 mm
3	-	7	220.000 mm
2	-	6	311.128 mm
4	-	8	311.122 mm

The distances have been derived from the image coordinates
of the fiducial marks.

5. **Photographic resolution**

The photographic resolution has been determined on the basis
of the recommendations of the International Society of Photo-
grammetry.

Test pattern: Three-line target with high contrast (log k = 2.0)
Test emulsion: ORWO - NP 15
Developer: ORWO - A 71
Developing time: 2 min
Developing temperature: 20 °C
Gradation γ = 1.0

Mean values of the photographic resolution in lines/mm from
the two image diagonals:

Test position	LMK 9/15	Field angles in gon								
		0	8	16	24	32	40	48	56	64
	21	0	8	16	24	32	38			
	30	0	4	8	12	16	20	24	28	
radial		118	109	90	90	85	80	65		
tangential		118	100	90	77	72	59	33		

6. **Filter parallelism**

The LMK 15   No. 265 014 A   comprises the following
filters:

350/45 /15	No. 50 976 A	(clear)
500/45 /15	No. 51 005 A	(yellow)
550/45 /15	No. 51 030 A	(orange)

The parallelism of the filter surfaces is ≦ 5"

7. <u>Flatnes of the film pressure plate</u>

The deviation of the film pressure plate surface from an ideal plane is $\leq \pm$ 0.008 mm.

8. <u>Notes:</u>