

CARL ZEISS
OBERKÖCHEN/WÜRTT.

CALIBRATION CERTIFICATE
FOR PHOTOGRAMMETRIC CAMERAS

CAMERA TYPE: RMK A 30/23 SERIAL NO. 137624
LENS TYPE: TOPAR A1 SERIAL NO. 137634
MAX. APERTURE: F/5.6 NOM. FOCAL LENGTH: 305 MM

1) CALIBRATED FOCAL LENGTH = 304.807 MM

2) DISTORTION /0.001 MM, REFERRING TO P.P. OF SYMMETRY PPS

S/MM=	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
A	0	1	4	2	2	1	1	0	-1	-1	-3	0	0	0	-2	-2
B	0	-1	0	-1	0	1	0	0	0	0	-1	-3	0	-1	-1	-2
C	0	1	0	0	0	3	3	1	-1	0	1	-1	2	1	2	-1
D	0	2	1	2	0	2	1	1	0	-1	0	-1	2	3	2	-2
AV.	0	1	1	1	1	2	1	0	0	-1	-1	-1	1	1	0	-2

3) P.P. OF AUTOCOLLIMATION AND FIDUCIAL CENTRE, REFERRING TO PPS

P.P. OF AUTOCOLLIMATION PPA X= .003 Y= .009 MM
FIDUCIAL CENTRE FC X= .030 Y= .021 MM

4) FIDUCIAL MARKS, REFERRING TO PPS

X1= 113.042 X2=-112.969 X3= .031 X4= .028 MM
Y1= .023 Y2= .019 Y3= 113.003 Y4=-112.991 MM
DISTANCES 1-2= 226.011 3-4= 225.994 MM

5) PHOTOGRAPHIC RESOLVING POWER, IN CYCLES PER MM

AREA WEIGHTED AVERAGE RESOLUTION 39

FIELD ANGLE /DEG = 0 7 14 24

RADIAL LINES 47 45 36 38
TANGENTIAL LINES 47 46 39 35

FILM: AVIPHOT PAN 150 SPEED 20 DIN
DEVELOPED IN ULTRAFIN 1+15

6) FILTERS

KL (CLEAR) NO. ---, C-F1 No. 139 089
B (YELLOW) NO. 137 644
D (ORANGE) NO. 137 654

7) MAGAZINE PLATEN

FK 24/120 NO. ---, CC 24 No. 136 391

ABTEILUNG FUER GEODAESIE UND PHOTOGRAMMETRIE

I.A. *W. Lorch*

DATE 22.07.87

Dr.-Ing. W. Lorch

RMK A 30/23

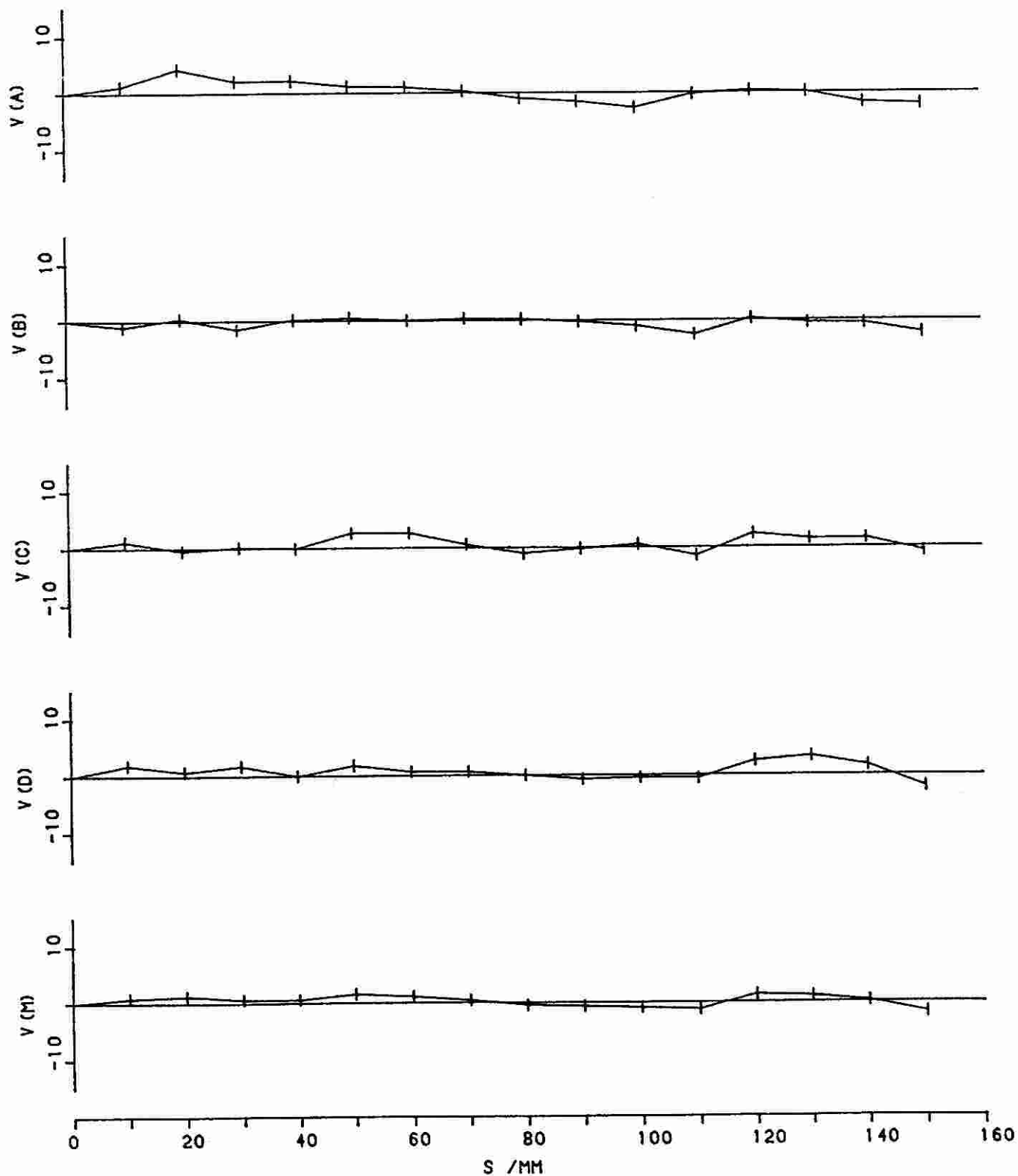
NO. 137624

TOPAR A1 5.6/305

NO. 137634

CFL=304.807 MM

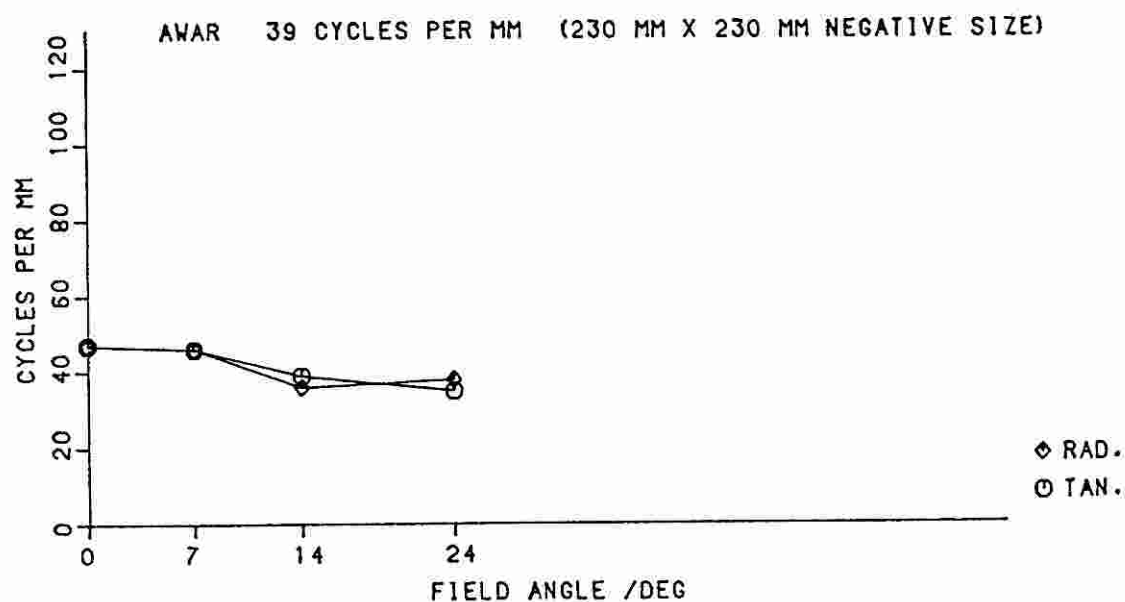
DISTORTION /0.001 MM, REFERRING TO PPS



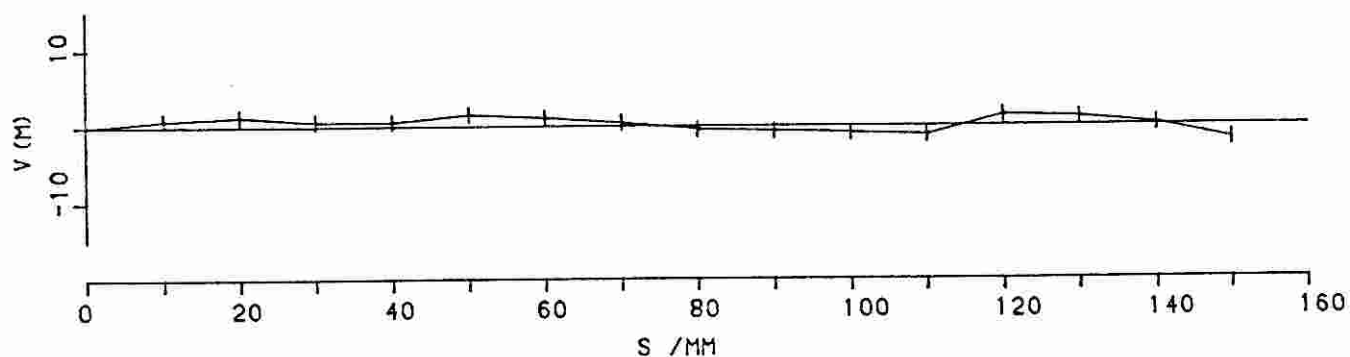
RMK A 30/23

NO. 137624

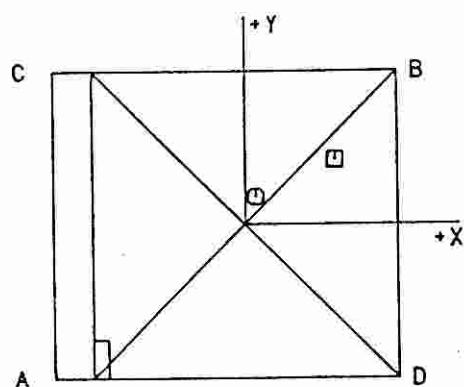
PHOTOGRAPHIC RESOLVING POWER



DEPARTURE OF AVERAGE DISTORTION FROM ZERO REFERENCE



PRINCIPAL POINT (PPA., PPS) AND FIDUCIAL CENTRE (FC)



COORDINATES, REFERRING TO PPS

	X /MM	Y /MM
⊙ PPA	0.003	0.009
⊠ FC	0.030	0.021

\perp 0.01 X-AXIS AS DEFINED BY FIDUCIAL MARK COORDINATES
 $\alpha(A) = 0.0^\circ$ $\alpha(D) = \alpha(A) + 90^\circ$

A p p e n d i x

This camera has been tested in accordance with the existing regulations. The methods used are based on the Recommended Procedures for Calibrating Photogrammetric Cameras and for Related Optical Tests (International Society of Photogrammetry, 1960, reaffirmed 1964). The optical performance and the external construction are in accordance with our terms of delivery.

1. Calibrated Focal Length

The calibrated focal length is chosen so as to minimize the square sum of the radial measured distortion.

2. Distortion

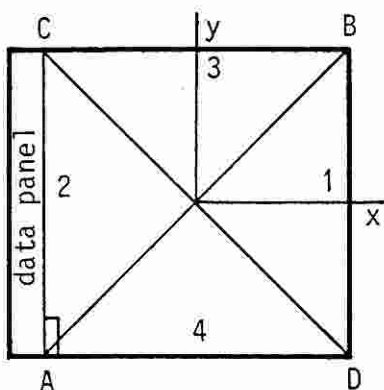
The values of radial distortion refer to the calibrated focal length and to the principal point of symmetry (Section 3). A positive value indicates that the image is further from the centre than its distortionfree position.

The radial distortion is measured for points of the focal plane separated by 10 mm from the axis for each of the four radii A, B, C, and D. AV ist the average radial measured distortion at a given radial distance. Measurements are made at maximum aperture on the goniometer by attaching the filter D (cut-off wavelength 535 nm at transmittance 50 %). The standard deviation of the distortion values given can be assumed to be less than 0.002 mm.

The maximum tangential distortion, i.e. the displacement of the central image from a straight line connecting corresponding image points at equal but opposite angular separations from the axis, does not exceed 0.005 mm.

3. Principal Point and Fiducial Centre

The positions of the principal point of autocollimation and of the fiducial centre (Section 4) are given in a rectangular coordinate system as shown, with the principal point of symmetry as origin.



Regarding the origin for distortion values it must be realized that in the photogrammetric process, the asymmetry due to a displacement of that point is eliminated together with the asymmetry introduced by camera tilt. The principal point of symmetry is chosen as origin for distortion, because only this residual asymmetry cannot be eliminated by simple compensation.

4. Fiducial Marks

Coordinates of the fiducial marks are given in a rectangular system as shown above, with the principal point of symmetry as origin. Fiducial marks 1 and 2 lie in the line of flight. The lines joining opposite pairs of fiducial marks intersect at an angle within 30 seconds of 90° . The point of intersection (fiducial centre) is within 0.02 mm of the principal point of autocollimation. The location of the fiducial marks can be assumed to be accurate within 0.005 mm.

For coordinate measurements the fiducial marks are recorded on photographic glass plates. Corner fiducials of the central perspective type like reseau crosses can be used to control film flatness and are therefore also subject to the deviation of the glass plate from a true plane. That is why the coordinates of this type of fiducial marks are determined only to an accuracy of 0.03 mm.

5. Photographic Resolving Power

The resolving power is obtained by photographing a series of three line test figures. The difference of log luminance between the lines and the background is 1.6. The photographs are taken under the recommended standard illumination by using the filter B (cut-off wavelength 480 nm at transmittance 50 %) in parallel light. The camera is used at full aperture. The resulting image is examined with a low power stereoscopic microscope to find the spatial frequency of the finest pattern resolved. The values of resolving power are reduced to the image plane and refer to the focus setting as used for determining the calibrated focal length.

6. Filters

The two surfaces of the filters listed in the certificate are within 5 seconds of being parallel.

7. Magazine Platen

The platen mounted in the film magazine, serial no. as indicated in the certificate, does not depart from a true plane by more than 0.010 mm.