

CALIBRATION OF AERIAL SURVEY CAMERA
TO THE
SPECIFICATION FOR AERIAL SURVEY PHOTOGRAPHY

for

Selkirk Remote Sensing Ltd
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for Director

Manufacturer: Wild
Camera Type: RC-20
Lens Type: Universal Aviogon A-F
Nominal Focal Length: 153 mm
Optical Unit No.: UAGA-F 13122

Lens No.: UAGA-F 13122
Maximum Aperture: F/4
Calibration Aperture: F/4
Date of Calibration: January 5 1999
Calibrated Focal Length: 152.730 mm
Photographic Emulsion: Panchromatic

FILTER (Section 62):

Number: 7004 Type: 525nm AV 2X
Maximum deviation: 2 Seconds
Maximum Change of Deviation: 1 Second
Maximum Departure from Parallelism: 2 Seconds

"A"

IMAGE ILLUMINATION (Section 51 & 52):

Minimum 57 % to 140 mm off axis.

CAMERA SHUTTER (Section 43):

Operation: Satisfactory
Speeds

Mark	125	250	500	1000
Total Time Seconds	$\frac{1}{95}$	$\frac{1}{187}$	$\frac{1}{370}$	$\frac{1}{740}$
Effective Time Seconds	$\frac{1}{120}$	$\frac{1}{230}$	$\frac{1}{470}$	$\frac{1}{930}$

FILM LOCATION SURFACE (Section 54):

Defined by: Fiducial Frame

Deviation from Flatness: .002 mm.

FOCUS (Section 48):

Focus Setting: Satisfactory

FOCAL LENGTH (Section 36):

Calibrated focal length: 152.730 mm.

Equivalent focal length: 152.75 mm.

RADIAL MEASURED DISTORTION (Section 46):

Unit-0.001 mm

Angle Degrees	Distortion at Semi-Diagonals				Average Distortion	Reference Distortion
	1	2	3	4		
5.63	1	3	2	0	2	-1
11.25	2	3	3	5	3	-1
16.88	0	2	4	4	3	0
22.50	3	-1	4	5	3	1
28.13	-2	-4	1	4	0	2
33.75	-4	-9	-1	3	-3	0
39.38	-6	-17	-4	3	-6	-3
42.19	-6	-18	-8	10	-5	-1

Maximum departure of average from reference .004 mm to 42.2 Deg.

ASYMMETRY ABOUT PRINCIPAL POINT OF AUTOCOLLIMATION (Section 46):

Maximum asymmetry .015 mm to 42.2 Deg.

ASYMMETRY ABOUT PRINCIPAL POINT OF BEST SYMMETRY (Section 46)

Maximum asymmetry .002 mm to 42.2 Deg.

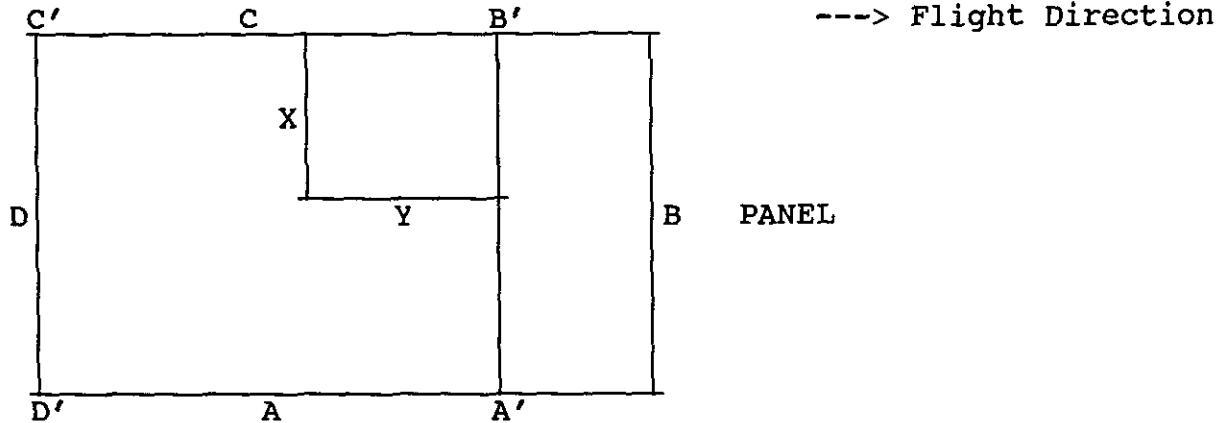
TANGENTIAL MEASURED DISTORTION (Section 46):

Maximum tangential distortion .003 mm to 42.2 Deg.

FIDUCIAL MARKS (Sections 40,41 & 42):

Semi-diagonal 4

Semi-diagonal 3



Semi-diagonal 1

Semi-diagonal 2

Angle between A'C'- B'D' is 90 deg + 3 seconds. The fiducial centre is within .001 mm of the point of autocollimation. Distance between the fiducial marks, and also between the marks and the principal point of autocollimation, P, are as follows:

A' - B'	212.003 mm	A' - P	149.907 mm
B' - C'	211.998 mm	B' - P	149.907 mm
C' - D'	211.997 mm	C' - P	149.906 mm
D' - A'	211.995 mm	D' - P	149.901 mm

The position of the principal point of autocollimation and of the principal point of best symmetry are given in a rectangular coordinate system as shown, with the fiducial centre as origin.

Principal point of autocollimation (X = 0.000, Y = 0.000) mm.
Principal point of best symmetry (X = -0.011, Y = 0.012) mm.

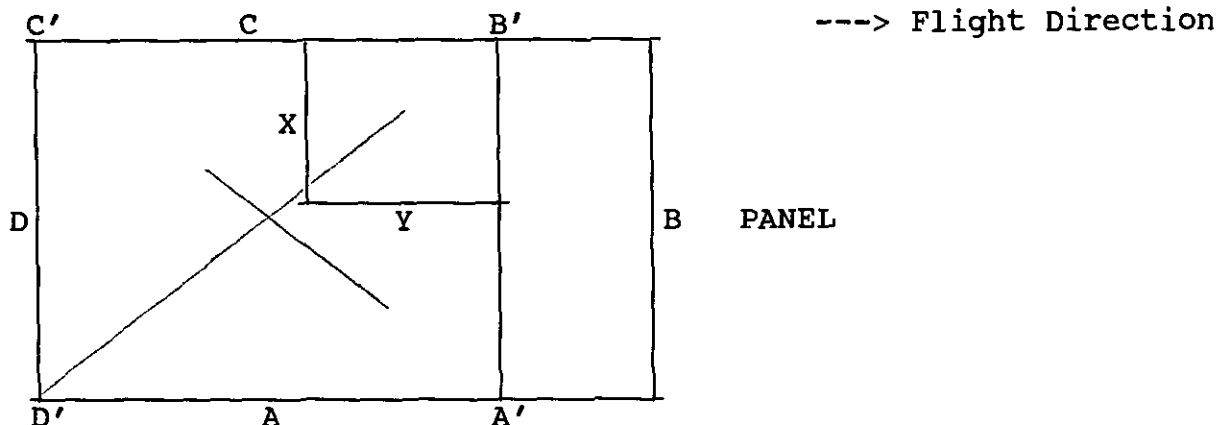
RESOLUTION MEASURED AT F/5.6:

Area Weighted Average Spatial Frequency = 45 linepairs/mm

FIDUCIAL MARKS (Sections 40,41 & 42):

Semi-diagonal 4

Semi-diagonal 3



Semi-diagonal 1

Semi-diagonal 2

Angle between A C - B D is $90 \text{ deg} + 5 \text{ seconds}$. The fiducial centre is within .004 mm of the point of autocollimation. Distance between the fiducial marks, and also between the marks and the principal point of autocollimation, are as follows:

A - C	220.003 mm	A - P	110.000 mm
B - D	219.995 mm	B - P	110.002 mm
		C - P	110.003 mm
		D - P	109.993 mm

The position of the principal point of autocollimation and of the principal point of best symmetry are given in a rectangular coordinate system as shown, with the fiducial centre as origin.

Principal point of autocollimation (X = 0.003, Y = -0.002) mm.
Principal point of best symmetry (X = -0.008, Y = 0.010) mm.

Note:

The following is a supplementary section which uses the the SMAC technique employed by USGS in the United States. Also included is the USGS's format for representing the fiducial marks.

Calibrated focal length: 152.723 mm

Lens Distortion

Field angle (degs):	5.6	11.3	16.9	22.5	28.1	33.7	39.4	42.2
Symmetrical radial (um)	1	2	3	4	3	2	0	0
Decentering (um)	0	0	0	0	1	2	3	4

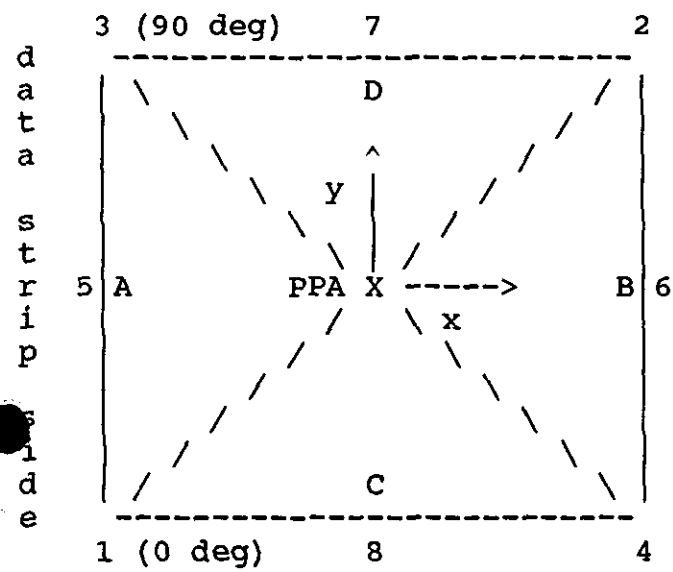
Symmetric radial distortion parameters	Decentering distortion parameters	Calibrated principal point
k0 = 0.8500E-04	p1 = 0.1695E-06	xp = -0.002mm
k1 = -0.5185E-08	p2 = -0.1580E-06	yp = 0.001mm
k2 = -0.7229E-13	p3 = 0.1979E-05	
k3 = 0.5384E-17		

Angular errors (secs) associated with coordinate systems

1st exposure	x = -0.35	y = 0.01	z = -2.64
2nd exposure	x = -0.78	y = -1.18	z = -8.95

The values and parameters for the calibrated focal length (CFL) symmetrical radial distortion (k1,k2,k3) decentering distortion (p1,p2,p3) and calibrated principal point (point of symmetry, xp,yp) were determined through a least squares simultaneous multiframe analytical calibration (SMAC) adjustment. The x and y coordinate measurements utilized in the adjustment of the above parameters have a standard deviation of +/- 2um.

Principal Points of 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.

	x coord (mm)	y coord (mm)
Indicated principal point, corner fiducials	0.000	0.000
Indicated principal point, midside fiducials	0.003	0.002
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (pt. of sym. xp,yp)	-0.002	0.001

Fiducial Marks

1	-105.995	-106.006
2	105.994	106.005
3	-106.004	105.997
4	106.000	-105.992
5	-110.003	0.003
6	110.000	0.000
7	0.002	110.002
8	0.005	-109.993

Distances between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.813mm 3-4: 299.809mm

Lines joining these markers intersect at an angle of 89deg 59min 57sec

Corner fiducials (perimeter)

1-3: 212.003mm 2-3: 211.998mm

1-4: 211.995mm 2-4: 211.997mm

Midside fiducials

5-6: 220.003mm 7-8: 219.995mm

Lines joining these markers intersect at an angle of 90deg 0min 5sec

The method of measuring these distances is considered accurate within 0.003mm