



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

January 20, 1999

Camera type:	Wild RC30*	Camera serial no.:	5268
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13314
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

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

Reference: Letter dated January 20, 1999, from Ms. Phyllis Tuck.

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: 153.124 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	-1	-1	-1	0	0	1
Decentering (um)	0	0	1	1	2	3

Symmetric radial distortion parameters

$$\begin{aligned} K_0 &= 0.3604 \times 10^{-4} \\ K_1 &= -0.5260 \times 10^{-8} \\ K_2 &= 0.1523 \times 10^{-12} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

Decentering distortion parameters

$$\begin{aligned} P_1 &= -0.1179 \times 10^{-6} \\ P_2 &= 0.1235 \times 10^{-6} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

Calibrated principal point

$$\begin{aligned} x_p &= 0.008 \text{ mm} \\ y_p &= -0.001 \text{ mm} \end{aligned}$$

The values and parameters for Calibrated Focal Length (CFL), Symmetric Radial Distortion (K_0, K_1, K_2, K_3, K_4), Decentering Distortion (P_1, P_2, P_3, P_4), and Calibrated Principal Point [point of symmetry] (x_p, y_p) 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 (σ) of ± 3 microns.

* Equipped with Forward Motion Compensation

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 124

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	134	159	159	159	134	113	113
Tangential lines	134	159	159	113	134	95	80

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 Wild 420 No. 7569 and the 525 No. 7025 filters accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

<u>Indicated exposure time</u>	<u>Effective exposure time</u>	<u>Efficiency</u>
1/125	7.33 ms = 1/135 s	76%
1/250	4.00 ms = 1/250 s	76%
1/500	1.90 ms = 1/525 s	76%
1/1000	1.00 ms = 1/1000 s	76%

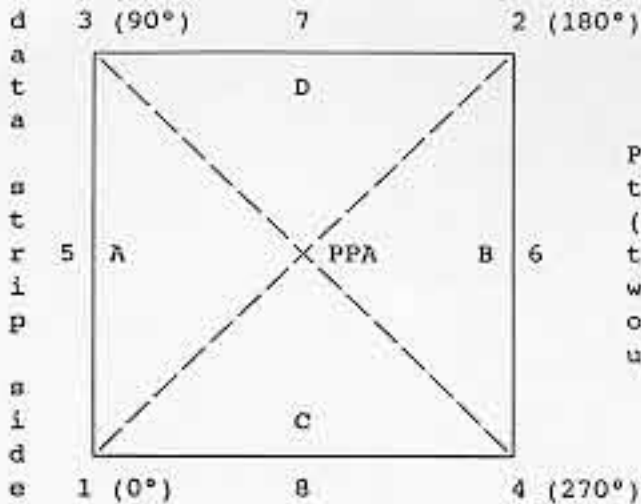
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5268-631 does not depart from a true plane by more than 13 μ m (0.0005 in).

This camera is equipped with a platen identification marker that will register "631" 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	0.003 mm	-0.001 mm
Indicated principal point, midside fiducials	0.004	0.003
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.008	-0.001

Fiducial Marks

1	-106.003 mm	-105.998 mm
2	106.008	105.997
3	-105.993	105.996
4	106.000	-105.998
5	-112.000	0.006
6	111.997	-0.001
7	0.011	112.001
8	-0.003	-112.004

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.818 mm 3-4: 299.804 mm

Lines joining these markers intersect at an angle of 90° 00' 07"

Midside fiducials

5-6: 223.997 mm 7-8: 224.006 mm

Lines joining these markers intersect at an angle of 89° 59' 54"

Corner fiducials (perimeter)

1-3: 211.994 mm 2-3: 212.001 mm
1-4: 212.003 mm 2-4: 211.995 mm

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

Note: For GPS applications, the nominal entrance pupil distance from the focal plane is 278 mm.

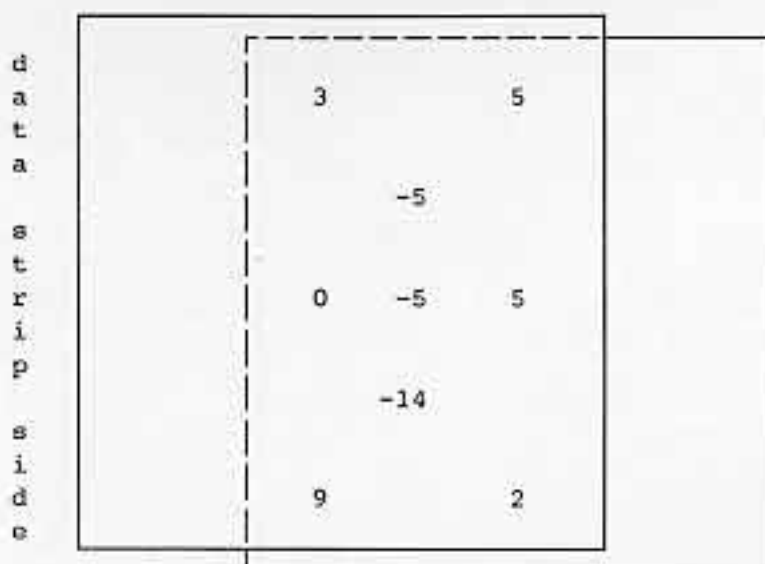
IX. Stereomodel Flatness

FMC Drive unit No.: 5269-631

Base/Height ratio: 0.6

Platen ID: 631

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. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 56

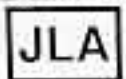
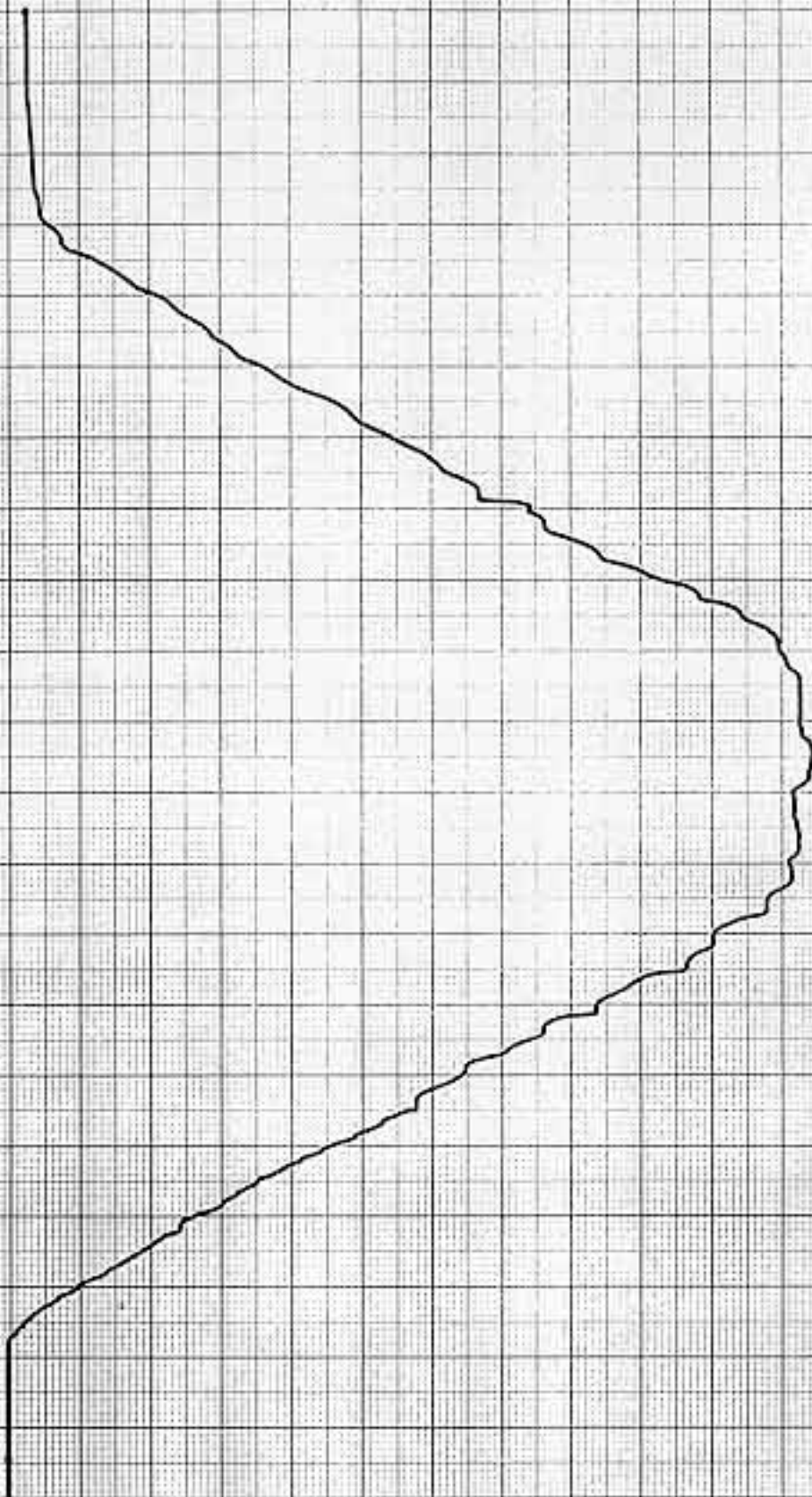
Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	67	67	67	67	67	48	48
Tangential lines	67	57	57	57	57	48	40

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2184, dated April 3, 1996.

Frank C. Maccue

Frank C. Maccue
Chief, Optical Science Laboratory
National Mapping Division



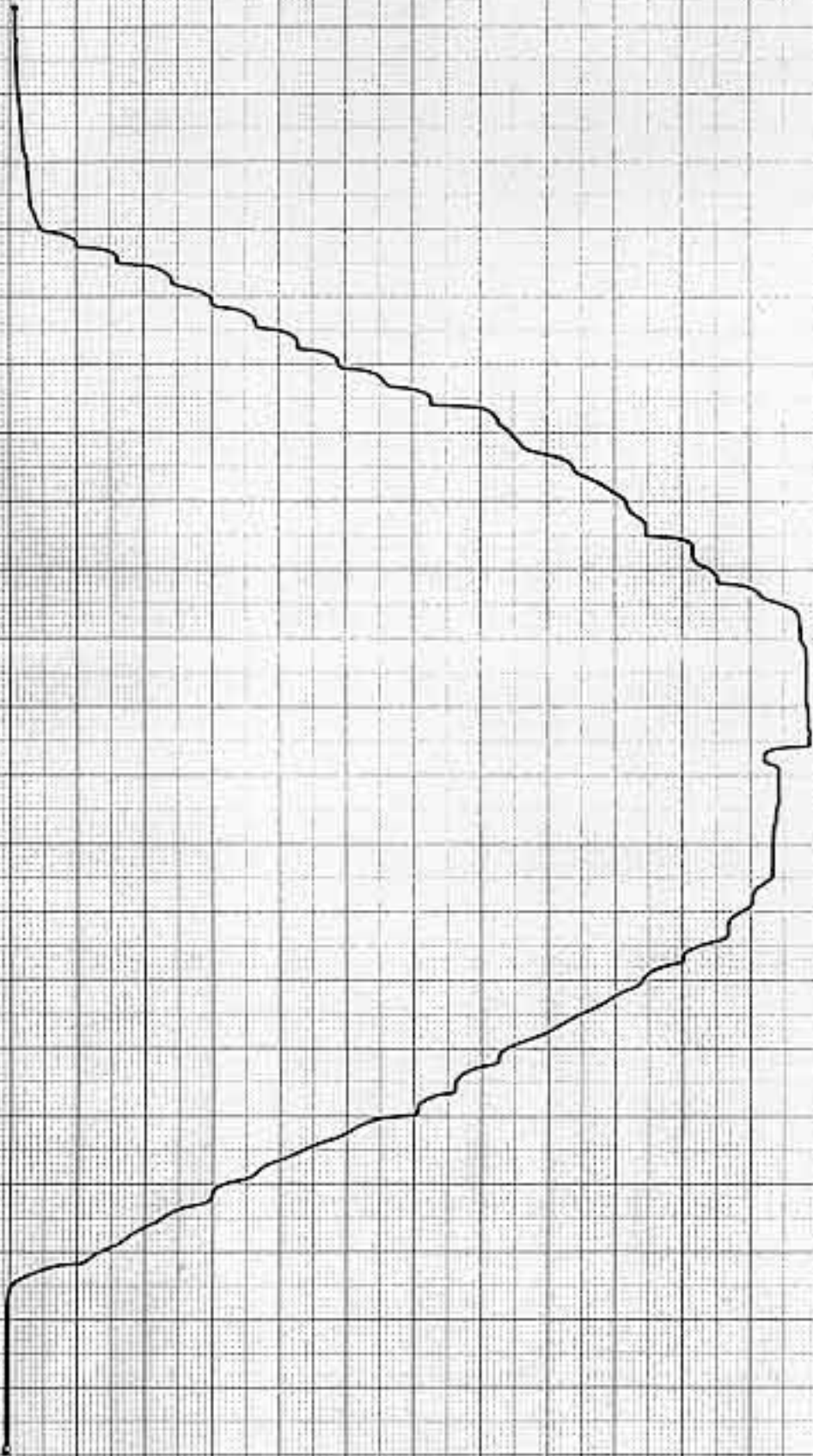
OPTICAL MAGNIFYING
 OBJECTIVE POWER (X)
 5x005
 SLIT (ACTUAL)
 2mm x .12mm

PROFILER CLASS
 S-6
 FEEDBACK SETTING
 S-6

WEDGE ANGLE
 .360
 RATIO
 1:1

WAVE
 $\lambda_{50} = 525 \text{ nm Au } 2x$
 SERIALS
 # 2025
 U. AVIATION / 4-5
 13314
 TILK ENGINEERING, INC.

DATE
 1/20/99
 RECORDING
 2519



JLA

OPTICAL MIRROR
 5x083
 2mm x 12mm

FOCUS/HT LOW/1
 5-6
 FEEDBACK SETTING
 5-6

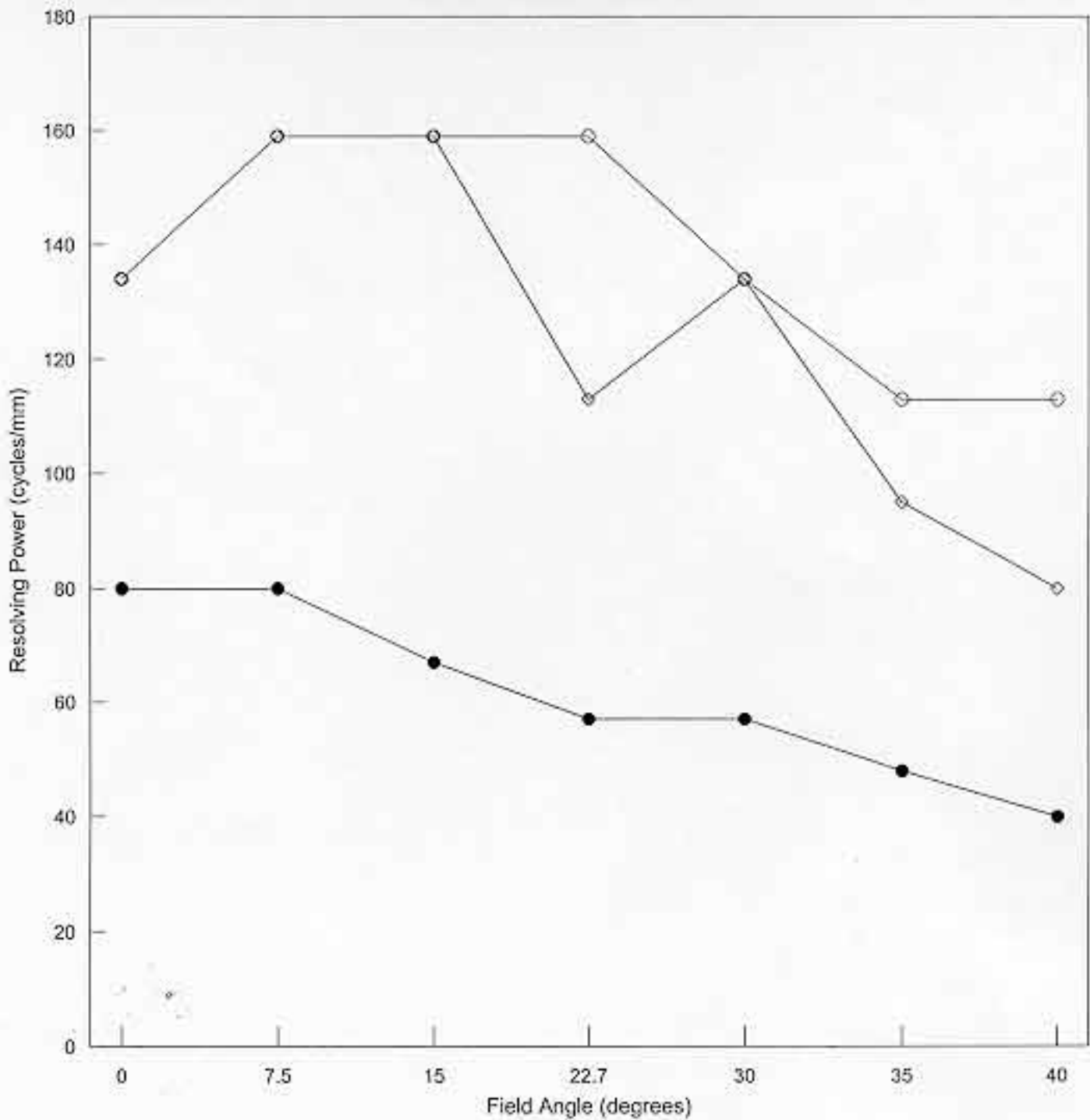
WAVELENGTH
 .300
 RATIO
 1:1

WAVE
 150 - 420mm AU 2x
 REMARKS
 W. AUGERON M-5
 13314
 TUCK ENGINEERING INC.

DATE
 1/20/99
 REFERENCE
 2519

LENS RESOLVING POWER AT MAXIMUM APERTURE

OSL2519 Lens No. 13314



○ RADIAL ◇ TANGENTIAL ● NAPP/USGS Specs.

AWAR
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