

# Laser Geodynamic Satellite Thermal/Optical/Vibrational Analyses and Testing

## Final Report

Volume II  
Technical Report

Book 2

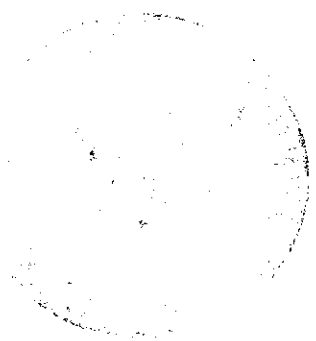
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**DR No. MA-04**  
**DPD No. 296**  
Contract NAS 8-30658

October 1974

Prepared for:

George C. Marshall Space Flight Center  
National Aeronautics and Space Administration  
Marshall Space Flight Center, Alabama 35812



**Aerospace  
Systems Division**

Ann Arbor, Michigan

Laser Geodynamic Satellite  
Thermal/Optical/Vibrational  
Analyses and Testing

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VOLUME II

BOOK 2

This Book 2 of Volume II contains only Appendix Q.

APPENDIX Q

11 SEPTEMBER 1974

LASER GEODYNAMIC SATELLITE (LAGEOS)

THERMO-OPTICAL ANALYSIS

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

Prepared for

Bendix Aerospace Division  
3300 Plymouth Road  
Ann Arbor, Michigan 48107

In response to contract No. T2997



**Optical Systems Division**

ITEK CORPORATION • 10 MAGUIRE ROAD • LEXINGTON, MASSACHUSETTS 02173



## FOREWARD

This final report, prepared by Itek Corporation, Lexington, Massachusetts under contract No. T2997 to Bendix Aerospace Systems Division, Ann Arbor, Michigan, covers work performed from May 3, 1974 to August 30, 1974 under the direction of Bendix Aerospace. The Bendix project manager was Mr. John M. Brueger and the thermal engineer was Mr. Eric Granholm.

The following Itek personnel were the primary contributors to the work summarized in the report:

Project Manager	M. Kahan
Lead Optical Engineer	R. Byrd
Lead Optical Analyst	M. Rimmer
Polarization Computations	J. Meiron

The report documents the performance as well as the sensitivity of an uncoated LAGEOS cube-corner retroreflector under a number of different thermal and manufacturing conditions for use in comparison with Bendix test data. Conclusions and recommendations for possible future work are also provided.

TABLE OF CONTENTS

	<u>Page</u>
Introduction	6
Procedure	6
Polarization Effects	9
Expected Diffraction Patterns (Perfect Cube)	13
Performance/Assumptions - Nominal Cube (1.5 arc-sec)	13
Notes On Absolute Intensity	47
Discussion - Manufacturing Error	48
Discussion - Thermal Effects	49
Off Nominal Cube	139
Summary	139
Appendix A - Effect of Beveled Edges	
Appendix B - 2.1 arc-sec Cube	
Appendix C - Briefing of 4 September 1974, George C. Marshall Space Flight Center	

ACKNOWLEDGEMENT

Our appreciation is provided to Bendix Aerospace for the opportunity to review our data with Mr. David Arnold of the Center for Astrophysics/Smithsonian Observatory. Mr. Arnold was quite helpful to us during both the review and analysis cycles of our activity and his support deserves special recognition.

ABSTRACT/SUMMARY

The purpose of this Itek Corporation LAGEOS Contract was to analytically demonstrate the quality of a retro-reflected laser signal's far field diffraction pattern. This information would be one of several inputs which would be used by Bendix Aerospace, NASA and SAO in configuring a Laser Geodynamic Satellite to accurately establish the physical motions and distortions of the solid earth. The overall effort was conducted as a part of the Earth and Ocean Physics Application Program (EOPAP).

The main tasks performed by Itek involved the modelling, over field angle, of an individual suprasil cube-corner having potential manufacturing variations (e.g. surface quality and angular anomalies) and environmental loadings. The far field characteristics included polarization effects and treated both far field patterns and encircled energy data. Thus, the energy in the 32-42  $\mu$ radian annular region was tabulated as an indicator of performance sensitivity as this was roughly the region where comparable Bendix Aerospace test data was taken.

The results are provided rather succinctly in appendix C in viewgraph form. Given no reflection or absorption losses a 1.5 arc-sec cube returned 21.6% of the incident energy on-axis and 10.8% at  $-15^\circ$  off-axis in the annulus of interest. The retroreflector's encircled energy data was relatively insensitive to irregular dihedral angle errors and surface quality effects. However, up to 6.8% changes in annular energy (e.g. 22% to 14%) were noted when all dihedral angles were simultaneously offset in the same direction by 0.5 arc-sec. The 3-D temperature profile analyzed changed the annular return only about 1%. Finally, the axial thermal gradients were found to compensate the radial gradients--the individual gradient types having fairly high sensitivity. In no case which was analyzed to simulate actual cube performance (as opposed to pure sensitivity determinations) did the annular return drop to 50% of that of the nominal cube--the criterion supplied us to assess degradation severity.

Future work suggested includes a more detailed comparison of the differences between various theoretical and experimental results for the specific cube geometries and test configurations of interest. This might help to further optimize the cubes.

Also, an additional treatment of field angle/polarization inputs may prove desirable. Eventually, an evaluation of performance at shorter wavelengths and of cube-corner arrays could be provided.

## INTRODUCTION

This report is submitted by Itek Corporation's Optical Systems Division in accordance with the requirement of contract T2997 to furnish a detailed analysis of a fused silica cube-corner retroreflector. This analysis has included the effects of manufacturing errors and temperature variations, which may affect the performance of the cube-corner retroreflector.

Figure 1 illustrates the process used in the cube-corner performance study. A perfect cube corner ( $90^\circ$  angles) was analyzed to confirm computer modeling. A specified  $+1.5 \text{ sec}$  wedge on each dihedral angle was then modelled and its effect noted. The effect of manufacturing error and the effects of manufacturing error combined with various temperature profiles were then examined. Also analyzed were the effects of a non uniform wedge angle with manufacturing error and with a manufacturing/temperature profile combination.

Each portion of this study is presented in detail in the body of this report to illustrate the performance of the cube corner retroreflector.

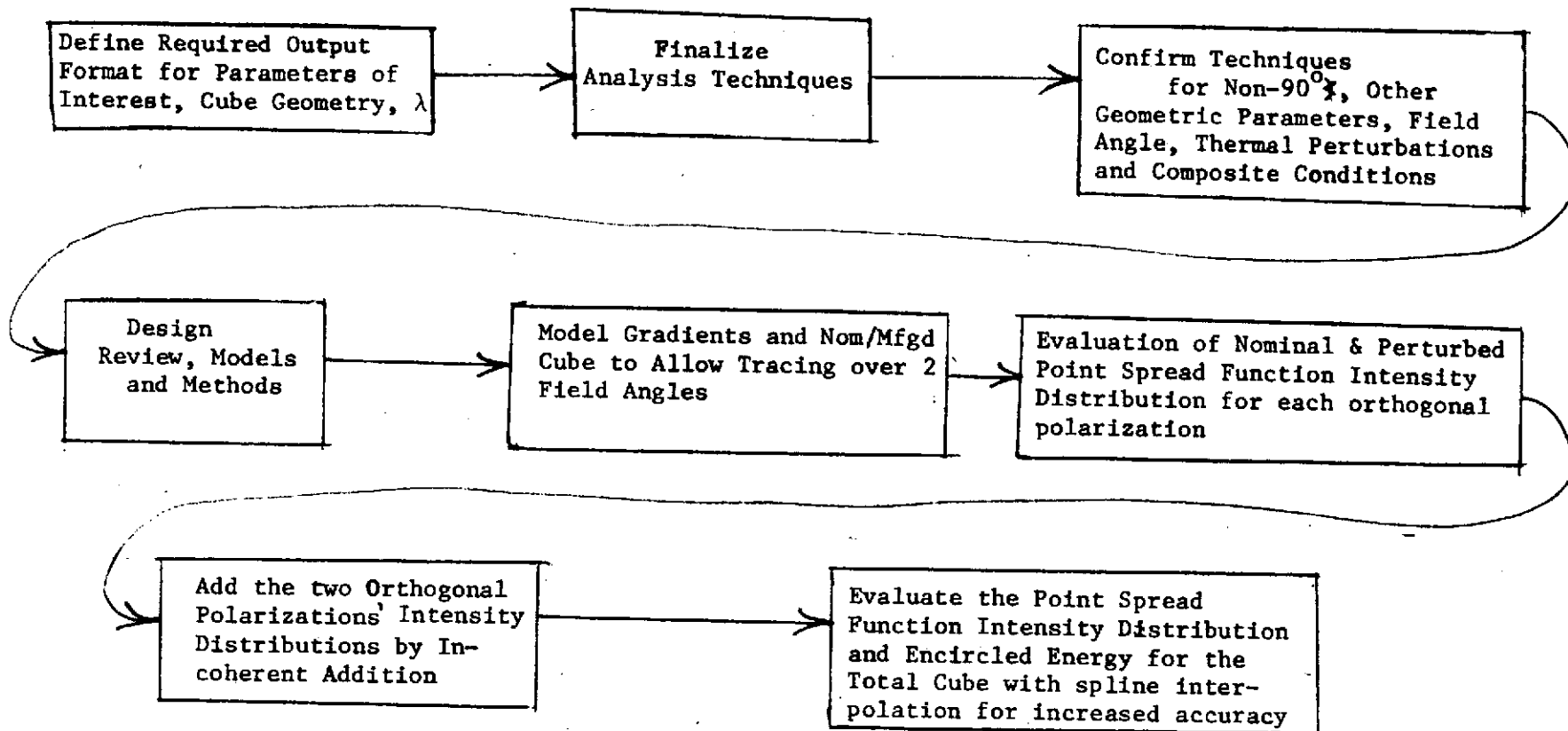
## PROCEDURE

The retrodirective nature of the cube-corner reflector is well known. Each ray incident on the front face of a perfect reflector, is consecutively reflected by the three reflecting surfaces and leaves the reflector in a direction parallel to the incoming ray at a point diametrically opposite to its point of entry. The order in which the rays are reflected from the surfaces affects their polarization properties. Hence, a plane wave of given polarization incident on a perfect cube-corner, emerges as a multi component collimated beam of different polarizations (and amplitudes). For normal incidence, each of these beams originates at one of the sections bounded by the cube edges, their images in the reflecting surfaces and the margin of the aperture (see Figure 2).

In order to trace rays through a cube corner and compute the polarization changes the cube was modelled by means of three tilted plane surfaces. The different sequences of reflection in the reflector are achieved by varying the tilts of the three tilted plane surfaces. Each permutation allows only the beam of one particular sextant to emerge from the exit pupil of the system since rays outside the particular segment intersect one or more of the surfaces beyond the corner edges and are rejected by Itek's proprietary ray trace program (see Figure 1).

The sectors with their respective amplitudes and phases are then combined into

FIGURE 1  
CUBE CORNER  
PROCESS FLOW CHART



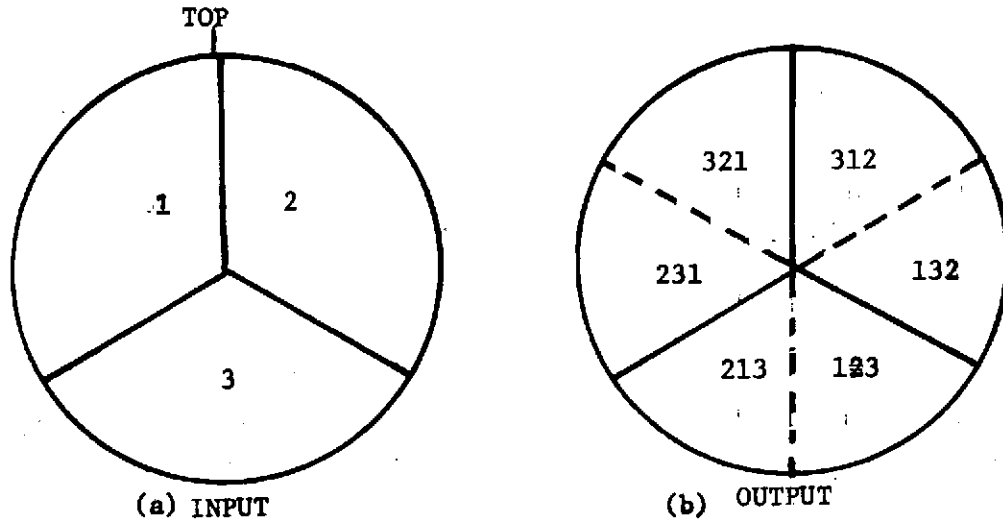


FIGURE 2

- a. Front view of cube corner retroreflector with circular front face. Reflecting surfaces are labelled 1-3.
- b. Sextants showing the sequence of reflections of the beam falling on the reflecting faces. Thus 132 indicates that light reflected by the surfaces in sequence 1, 3, and 2 will exit in the sextant noted.



one wavefront for each of the polarization components. The amplitudes and phases of the various sextants for a TIR cube-corner made of fused silica ( $\lambda = 6328\text{\AA}$ ,  $n = 1.457$ ) are shown in Table 1 for both on axis and  $-15^\circ$  off axis. The light was assumed to be plane polarized in the meridional plane (i.e. parallel to the real edge between surface 1 and surface 2 of Figure 2).

### POLARIZATION EFFECTS

The procedure used to compute the polarization effects was to follow rays through the reflector, and to determine the amplitude and phase changes between orthogonal polarizations caused by total internal reflection. It was found that the amplitude and phase, or equivalently the complex amplitudes, have different values for different sextants.

It was assumed that the incident light was monochromatic and linearly polarized. A set of axes for the resolution of the electromagnetic vector  $\underline{E}$  is shown in Figure 3.

The orthogonal sets of unit vectors  $\underline{p}, \underline{s}, \underline{r}$  and  $\underline{p}', \underline{s}', \underline{r}'$  are right handed, with  $\underline{r}$  and  $\underline{r}'$  the unit vectors in the ray direction,  $\underline{s}$  and  $\underline{s}'$  perpendicular to the plane of incidence and  $\underline{p}, \underline{p}'$  in that plane. The vector  $\underline{E}$  can then be represented by its two complex components  $E_s$  and  $E_p$  in the  $\underline{s}$  and  $\underline{p}$  directions\*, eg.

$$\underline{E} = E_s \underline{s} + E_p \underline{p} \quad (1)$$

If  $\underline{n}$  is the unit vector of the normal to the optical surface,  $\underline{s}$  and  $\underline{p}$  can be determined from:

$$\underline{s} = \underline{r} \times \underline{n} / \sin \alpha \quad (2)$$

$$\underline{p} = \underline{s} \times \underline{r}$$

where  $\sin \alpha = \sqrt{1 - (\underline{r} \cdot \underline{n})^2}$  and  $\alpha$  is the angle of incidence.

---

\* eg. the "P" and "Q", respectively, of Table 1.

TABLE 1  
 AMPLITUDE AND PHASE \* OF ORTHOGONAL (P AND Q)  
 VECTORS EXITING FROM CUBE-CORNER RETROREFLECTOR

<u>Reflection Order</u>	<u>Amplitude-P</u>	<u>Phase-P (radians)</u>	<u>Amplitude-Q</u>	<u>Phase-Q (radians)</u>
INPUT	0.	0.	1.0	0.0
123	.76	-1.63	.66	2.78
132	.27	0.31	.96	-1.83
312	.76	-2.48	.66	2.78
321	.76	+0.90	.66	2.78
231	.27	-2.83	.96	-1.83
213	.76	1.52	.66	2.78

POLARIZATION  $-15^{\circ}$  OFF AXIS

<u>Reflection Order</u>	<u>Amplitude-P</u>	<u>Phase-P (radians)</u>	<u>Amplitude-Q</u>	<u>Phase-Q (radians)</u>
INPUT	0.	0.	1.0	0.
123	0.88	1.70	.48	2.99
132	0.20	- .17	.92	1.91
312	0.88	-2.04	.48	2.99
321	0.88	1.10	.48	2.99
231	0.20	-3.31	.92	1.91
213	0.88	-1.45	.48	2.99

\* A negative sign in phase indicates a leading wavefront.

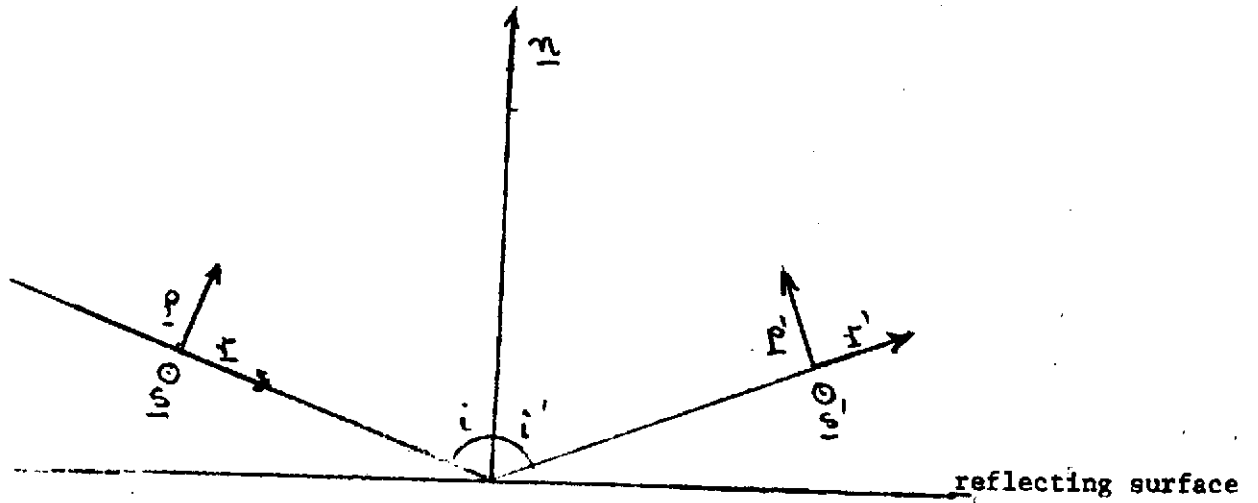


Figure 3. Coordinate axes at reflecting surface.

At each reflecting surface,  $k$ , the respective unit vectors  $\underline{s}_k$  and  $\underline{p}_k$  are determined and the new complex components  $E_{sk}$  and  $E_{pk}$  in these directions found from

$$(E_{sk}, E_{pk}) = C \begin{pmatrix} E_s \\ E_p \end{pmatrix} \quad (3)$$

where  $C$  is the transformation matrix

$$C = \begin{pmatrix} \underline{s} \cdot \underline{s}_k & \underline{p} \cdot \underline{s}_k \\ \underline{s} \cdot \underline{p}_k & \underline{p} \cdot \underline{p}_k \end{pmatrix} \quad (4)$$

Polarization phase shifts introduced by the total internal reflection can now be computed using well-known formulas of electromagnetic theory:

$$E'_{sk} = E_{sk} \frac{n \cos \alpha - i \sqrt{n^2 \sin^2 \alpha - 1}}{n \cos \alpha + i \sqrt{n^2 \sin^2 \alpha - 1}} \quad (5)$$

$$E'_{pk} = E_{pk} \frac{\cos \alpha - i n \sqrt{n^2 \sin^2 \alpha - 1}}{\cos \alpha + i n \sqrt{n^2 \sin^2 \alpha - 1}}$$

where  $n$  is the refractive index of the corner-cube material. Since the complex coefficients of reflectance are of the form  $e^{-2i\phi}$  we find that  $|E'_{sk}| = |E_{sk}|$  and  $|E'_{pk}| = |E_{pk}|$ , i.e., for each component only the phase is changed but not the amplitude.

Following reflection the unit vector  $\underline{s}_k$  remains unchanged, however, the new  $\underline{p}_k$  vector becomes

$$\underline{p}'_k = \underline{s}_k \times \underline{r}'_k$$

The emergent light is ultimately referred to the set of axes  $\underline{s}_1$  and  $\underline{p}_1$  of the ray incident on the front surface of the cube-corner reflector, and the combined polarization effect of the three total internal reflections is thus obtained.

### EXPECTED DIFFRACTION PATTERNS

To confirm the validity of the Itek program the diffraction patterns of a plane wave of  $\lambda = 5145\text{\AA}$  incident normally on a cube-corner of BK 7 glass ( $n = 1.52049$ ) were calculated. The cube was considered to be uncoated, hence only total internal reflection took place. The light was assumed to be plane polarized in the meridional direction. Figure 4 is a computer generated plot of the iso-irradiance contour of the Q polarization while Figure 5 is a plot of the iso-irradiance contour of the P polarization. The contour plot of the total pattern which is the sum of the P and Q polarization is shown in Figure 6. In addition the diffraction pattern was calculated assuming the light to be plane polarized in the saggital direction. The iso-irradiance contours are the same as those in Figures 4, 5, and 6, rotated  $180^\circ$  degrees. Figure 7 shows the effect of total internal reflection on the polarization of the ray bundle. The contours for the saggital polarization agreed well with published data.\*

### PERFORMANCE - NOMINAL CUBE

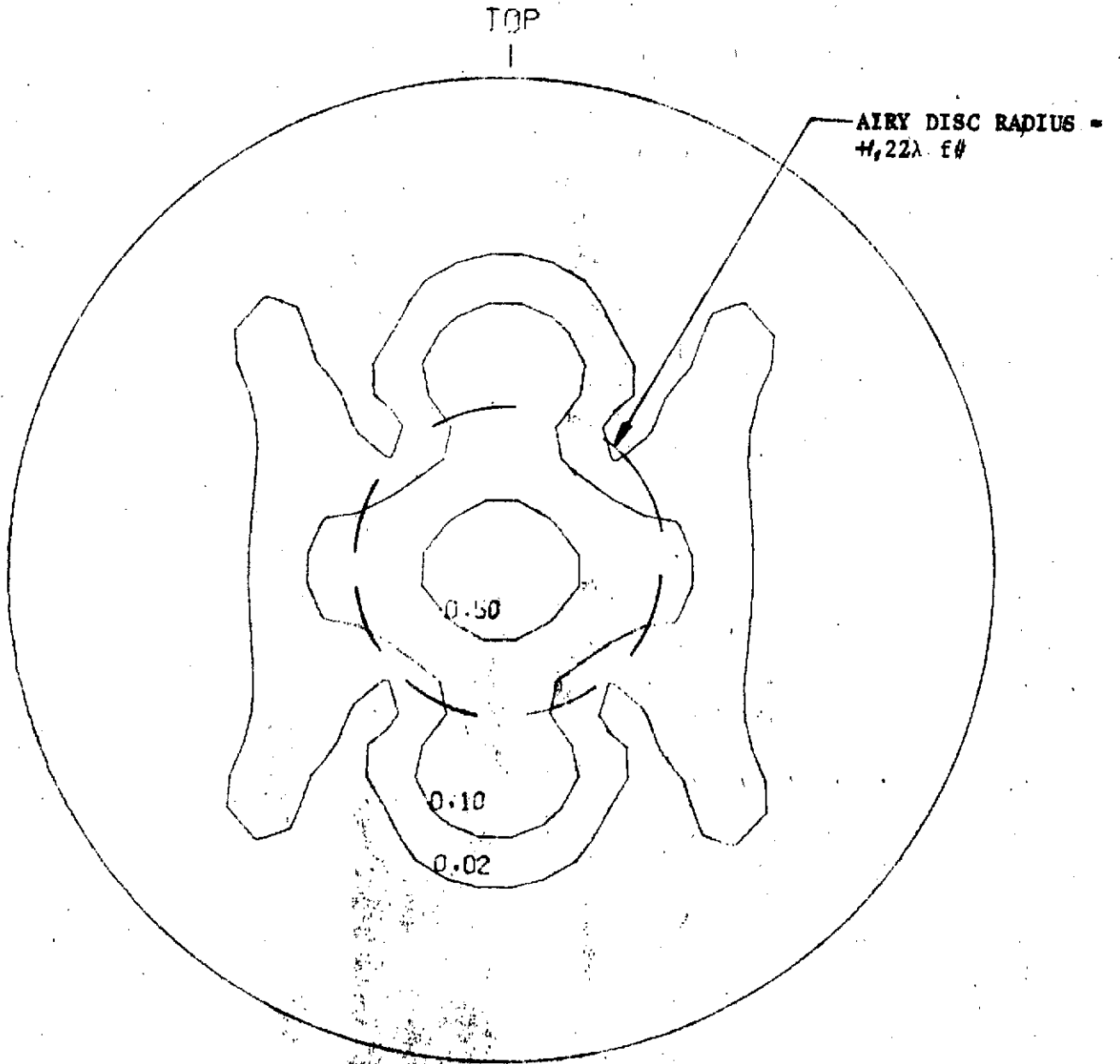
Once the computer modelling agreed with published data the nominal cube was evaluated. The dihedral angles used in the analysis are shown in Figure 8 for both a nominal cube and an off nominal cube. The assumptions used in the analysis are shown in Table 2. The cube-corner was ray traced to determine the combined effects of polarization, dihedral angle variations and intensity variations on each orthogonal polarization of the wavefront. The amplitude variations across the wavefront for the Q and P polarizations respectively are shown in Figures 9 and 10 for the on-axis case and in Figures 11 and 12 for the  $-15$  degrees off-axis case.

The amplitude variations of Figures 9 to 12 will be the same for all cases analyzed since they are dependent only upon the polarization and the input gaussian intensity variation. Some variation in polarization can occur with a different refractive index material but over the range of temperatures noted in this study the variation in index had a negligible effect on the polarization. The resultant phase variation across the aperture for the Q and P polarizations respectively are shown in printer maps (Figures 13 and 15) and wavefront plots (Figures 14 and 16) for the on-axis case. The intensity distribution for each polarization was then determined through the use of Itek's proprietary POINT program, which used the amplitude and phase of each polarization to get the normalized point spread function through a fourier transform. The intensity distributions were then added incoherently

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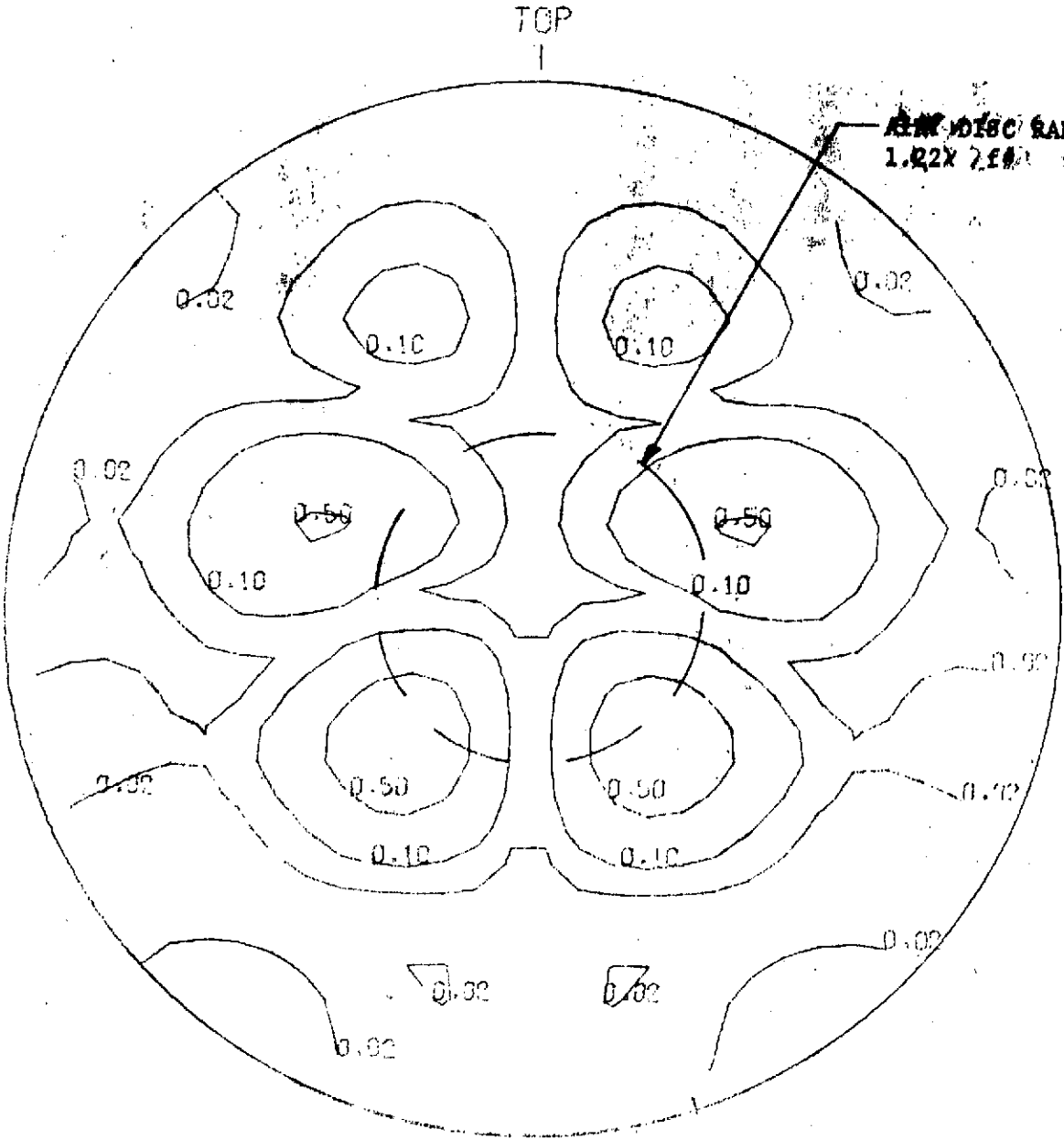
\* Chang, R.F., Currie, D.G., Alley, C.O. and Pittman, M.E. J. Optical Society of America, 61:431

Figure 4  
Intensity Distribution  
Q Polarization - On Axis  
Perfect 90° Cube



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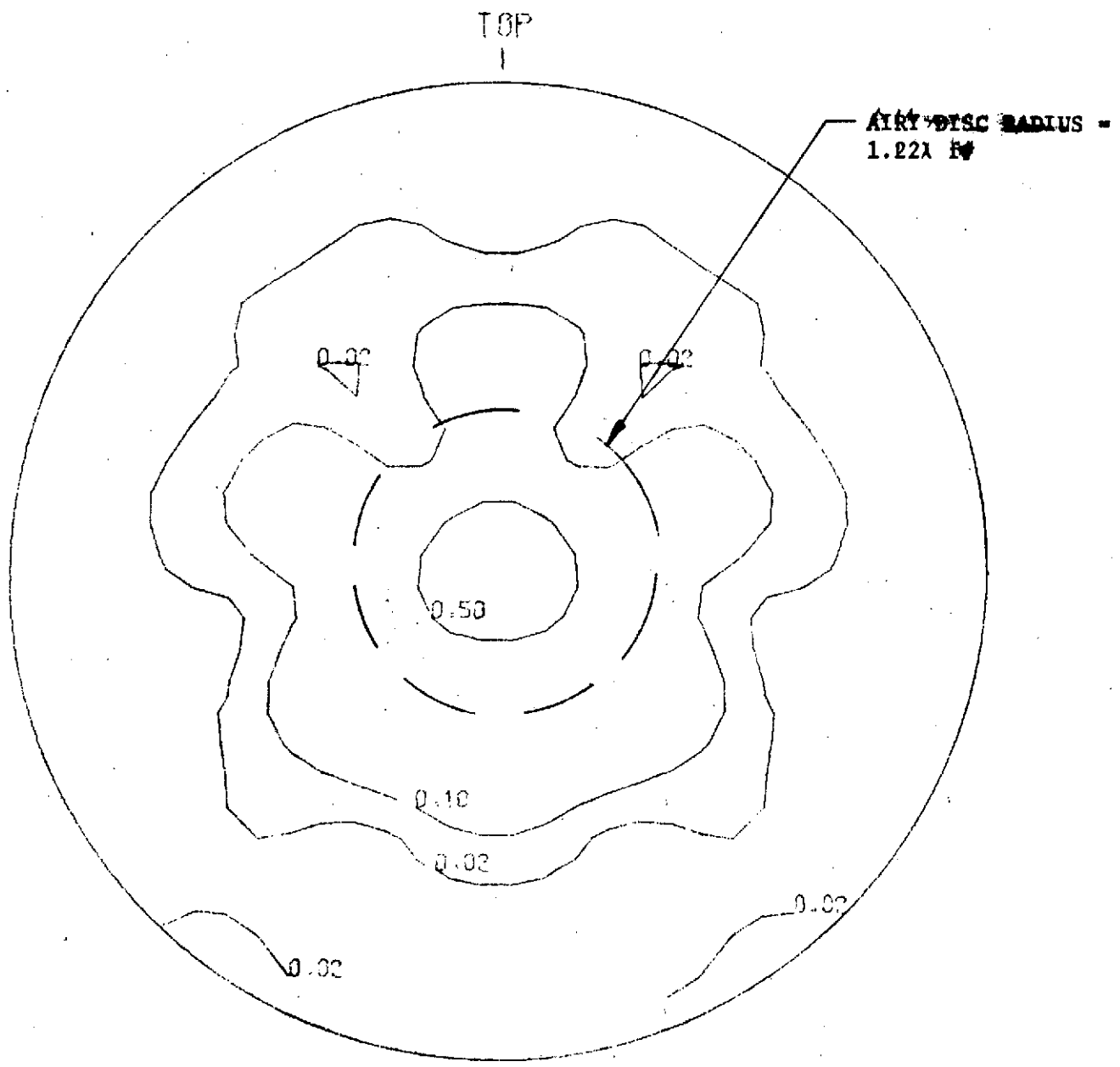
Figure 5  
Intensity Distribution  
P Polarization - On Axis  
Perfect 90° Cube



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Figure 6<sup>6</sup>

Intensity Distribution  
Total Pattern  
Perfect 90° Cube





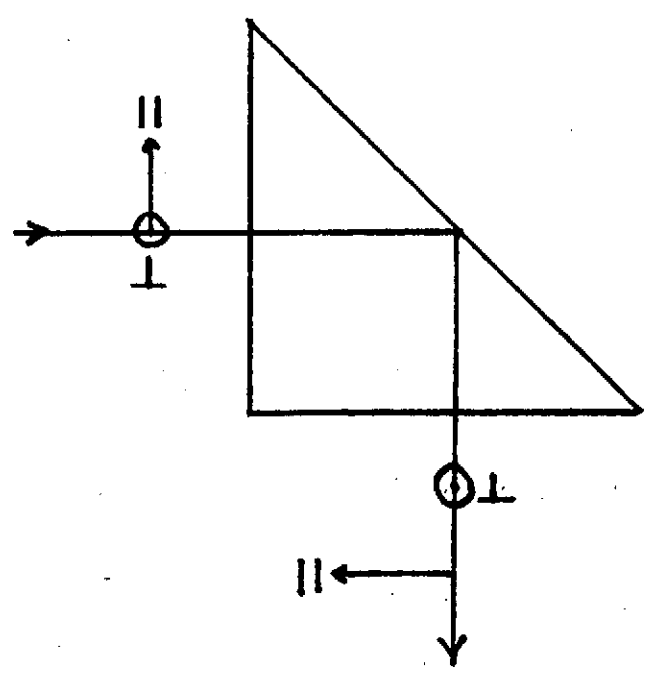
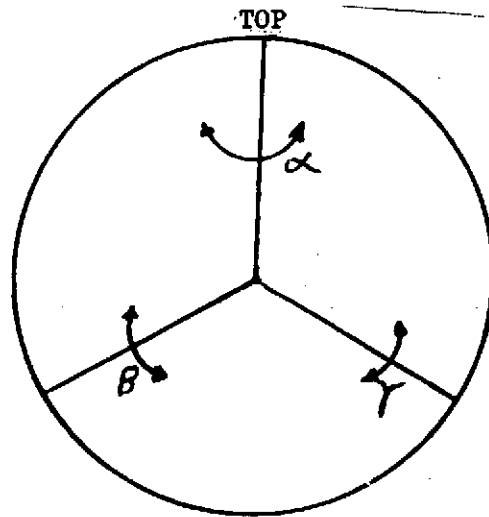


FIGURE 7

When linear polarized light is totally internally reflected the component perpendicular to the plane of incidence will exit lagging the component parallel to the plane of incidence. This will result in elliptically polarized light. In the cube corner there are three total internal reflections thus resulting in elliptically polarized light.

Figure 8  
 Dihedral Angles Used In Analysis of Cube Corner  
 Retroreflector



α  
 β  
 γ

Nominal Cube

90° + 1.5 sec

90° + 1.5 sec

90° + 1.5 sec

Off Nominal Cube

90° + 1.5 sec

90° + 1.0 sec

90° + 2.0 sec

TABLE 2

Assumptions/Specifications for LAGEOS Thermal-Optical Analysis

Number	Parameter	Data	Reference(s)
1.	Material	T-19 Suprasil 1 (special)	SOW 2.1 Table 1, No. 12, 4/30/74 letter; Amersil Catalogue EM-9227-1, 6/5/74 Amersil DN/DT Data; AIP Handbook.
2.	Geometry:		
	a) Face Diameter	38.10mm (1.500")	SOW 2.1.1, Fig. 2, Section A-a; Telecon, MK/EG,*6/11/74
	b) Face Shape	Circular, Concentric with axis	SOW 2.1.1, Fig. 2
	c) Dihedral Angles	See Figure 8, text	Fig. 2 and clarify TELECONS of 6/3 to 6/11/74.
	d) Bevels	0.20mm max.	Fig. 2
	e) Face to Apex (solid)	27.93mm (1.100")	Fig. 2; 4/30/74 Letter, Table 1, No. 12
	f) Mount I.D.	38.48mm (1.515")	Telecon, MK/EG, 5/23/74
	g) Mount Extension Beyond Face	1.00mm	Telecon, MK/EG, 5/23/74
3.	Manufacturing Variations (as appropos).		
	a) Peak	$\lambda/4$ total effect for each sextant of emitted wave- front over 90% of sextant's area	SOW 2.1.1, Fig. 2 and 4/30/74 Letter - Table No. 2
	b) Shape	Random but smooth 1.5 bumps/segment, rolled edge not consistently present and thus not appropriate	ZYGO info. of 6/3/74; Telecon MK/JB* 6/11/74
	c) Max Peak Error per segment	0.278 $\lambda$	Telecon, MK/JB, 6/10/74

\* MK = Mr. Mark Kahan (Itek), EG = Mr. Eric Granholm (Bendix), JB = MR. Jonathan Brueger (Bendix)

TABLE 2, CONTINUED

Number	Parameter	Data	Reference(s)
4.	Optical Orbital Characteristics	Stationary	SOW 2.2 and 4/30/74 Letter, Table 1 No. 4
5.	Temperature	25°C, Uniform	Telecon, MK/EG, 6/3/74
6.	Laser		
	a) Wavelength	6328Å	SOW 2.4.1
	b) Diameter	50mm	SOW 2.2.2
	c) Intensity Uniformity	Gaussian Variation of 20% over 50mm diameter	SOW 2.4.3
	d) Incident Quality	Flat	SOW 2.4.4 and 4/30/74 Letter, Table 1, No. 6
	e) Position	Centered on cube axis	Telecon, MK/JB, 6/11/74
	f) Polarization	Linear as per Table 1, text	SOW 2.4.5
	g) Type	CW	4/30/74 Letter, Table 1, No. 12
7.	Field Angles	0° - 15° SOW Fig. 1 of SOW	PRO1166
8.	Vacuum	Under 10 <sup>-6</sup> torr	SOW 2.5.1
9.	Coatings	None	4/30/74 Letter, Table 1, No. 12











FIGURE 13

Task 2.1 - Nominal Cube-On Axis  
Wavefront Map-Q Polarization

		Top, Typ.																																				
		55	52	48	45	41	41	45	48	52	55																											
		59	54	52	49	46	42	39	36	36	39	42	46	49	52	56	59																					
		57	53	50	47	43	40	37	33	30	30	33	37	40	43	47	50	53	57																			
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ADD  
1  
NONE

AVERAGE

AVERAGE

PLOT NUMBER 2

RMS

0.42

PK-PK

1.66

FREQ

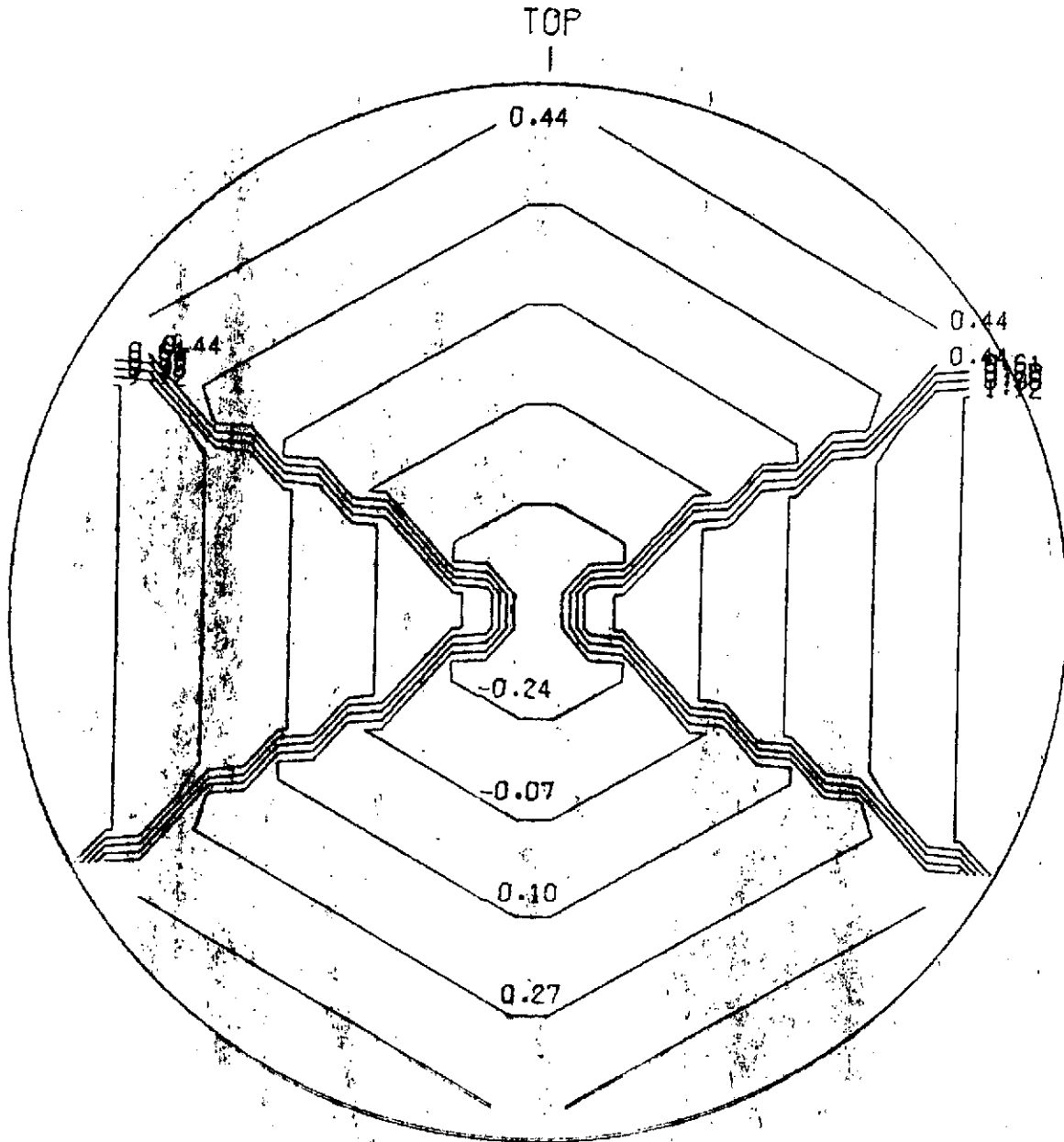
WAVEFRONT

FIGURE 14

26

Wavefront Plot-Q Polarization

Task 2.1 - Nominal Cube-On Axis



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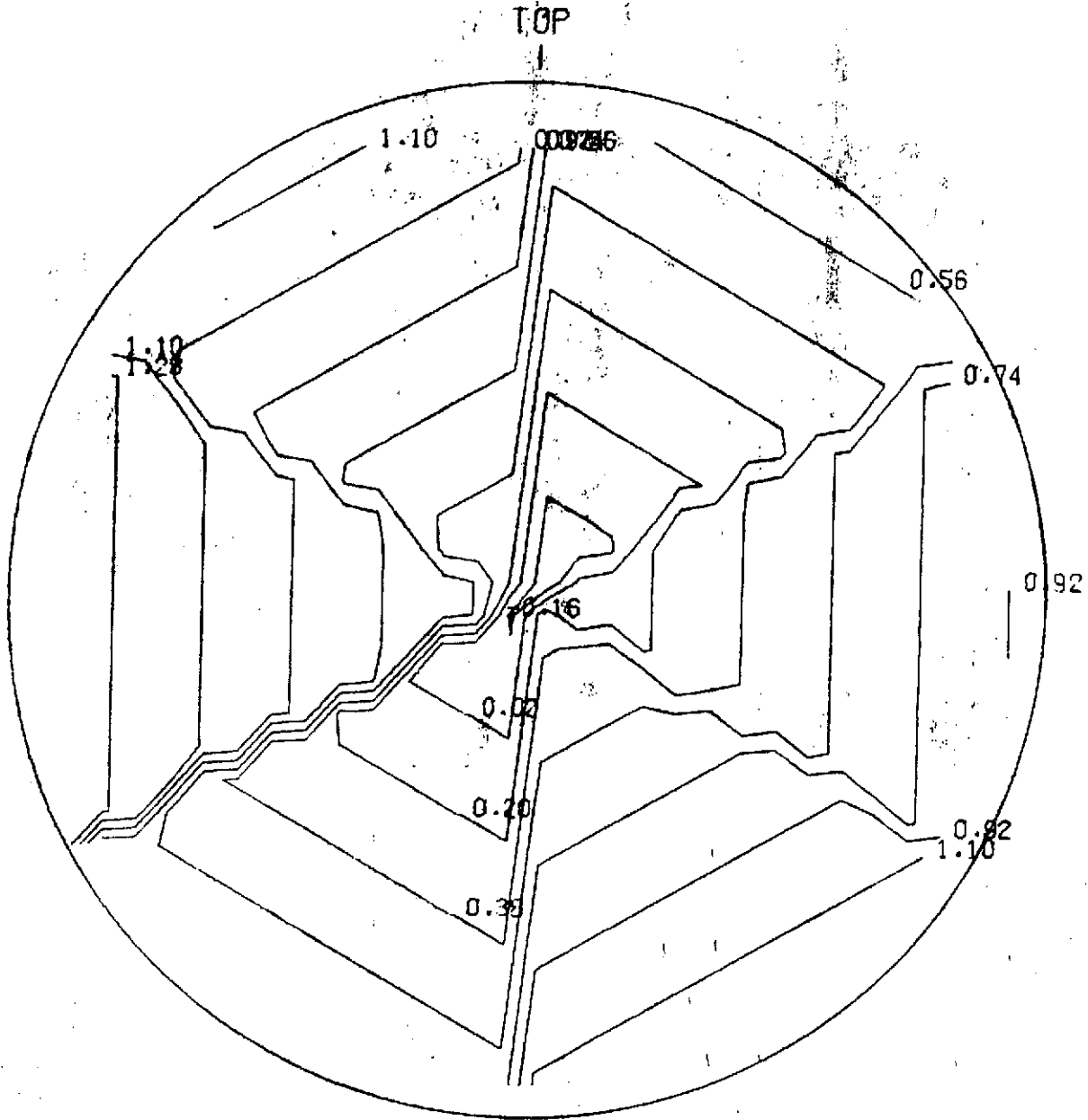
Q-26



FIGURE 16

Wavefront Plot-P Polarization

Task 2.1 - Nominal Cube-On Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

in the Itek developed FRED Program to obtain the resultant total intensity variation in the far field (Figures 17, 18, 19). In both the far field patterns and the wavefront patterns the tops of the patterns are observed looking from the cube corner toward the far field. The encircled energy was then obtained through the use of Itek's ENEN Program. The encircled energy is shown in Tables 3 and 4 in two microradian increments and five microradian increments respectively. The encircled energy is plotted out to 200 microradians in Figure 20. The effect of beveled edges are negligible as noted in Appendix A.

The full phase variation across the aperture for the Q and P polarizations respectively are shown in printer maps (Figures 21 and 23)\*\* and wavefront plots (Figures 22 and 24) for the  $-15^\circ$  off axis case. The resultant total intensity variation in the far field is shown in Figures 25, 26, and 27. The encircled energy distribution in the far field pattern is shown in Tables 5 and 6 and in Figure 28 for the  $-15^\circ$  off axis case. The values shown in all of the  $-15^\circ$  off axis cases' far field patterns must be multiplied by a 0.65 factor to obtain the intensity and encircled energy relative to the on axis case. This factor was obtained by computing the ratio of the areas exiting from the  $-15^\circ$  off axis case and the on axis case. The ratio of the areas was obtained by ratioing the sum of the squares of the amplitudes of the P and Q polarization at  $-15^\circ$  off axis to the sum of the squares of the amplitudes of the P and Q polarizations on axis.

\*\* Table 7 provides a handy referencesheet for locating figures (plots) and tables which are grouped at the end of the text from this point on.

Task 2.1 - Nominal Cube-On Axis

PRINTER MAP OF POINT SPREAD FUNCTION

(ONE SPACE REPRESENTS 8.04 μradians, Type NORMALIZED TO LARGEST VALUE = 0.0265 = 100

TOTAL ENERGY = 0.2461000D+J1

MAP REPRESENTS 0.2514043D+J1 OR 94.0286 PERCENT OF TOTAL ENERGY

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

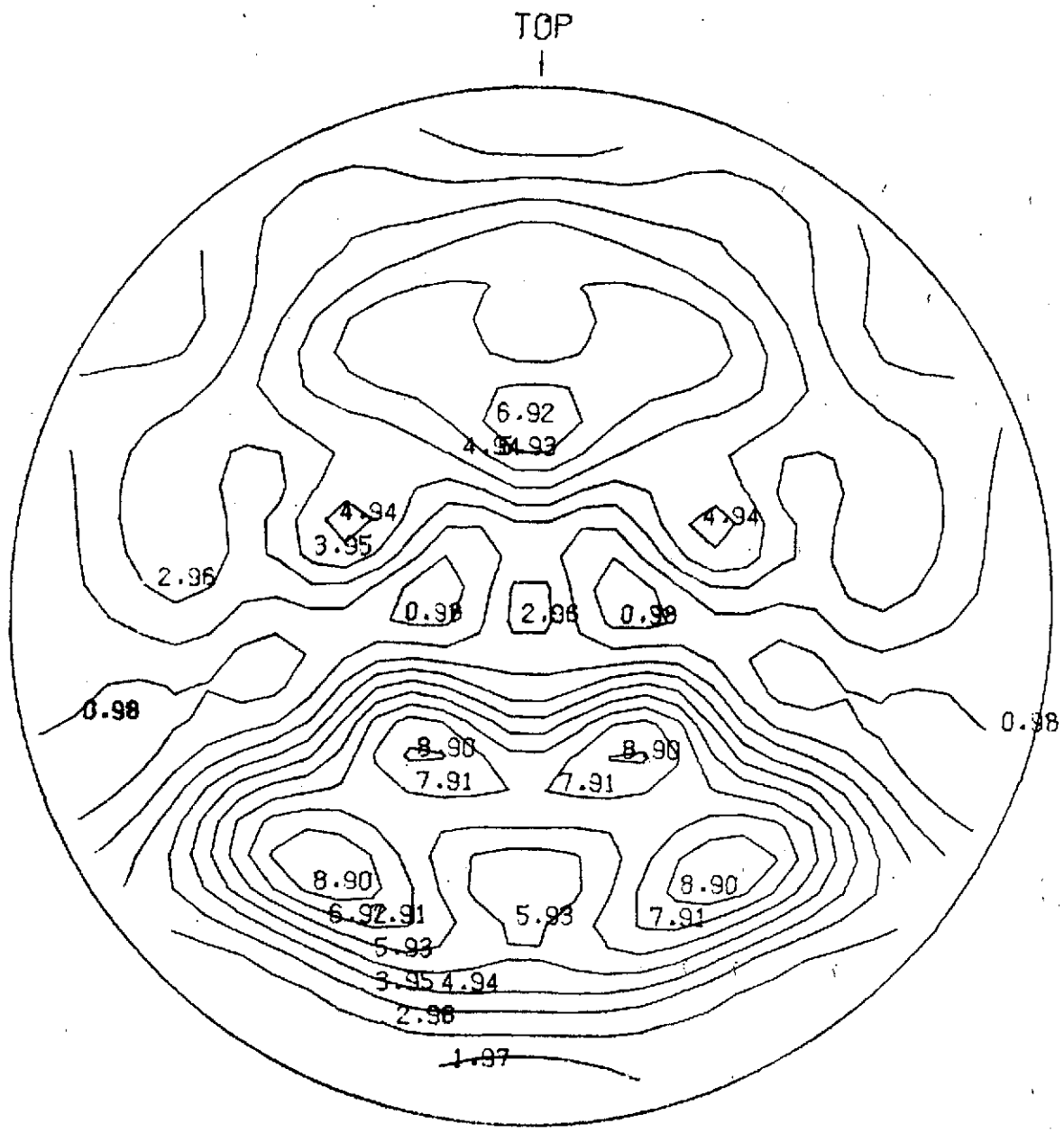
Top, Typ.

Grid of numerical data representing the point spread function, with values ranging from 0 to 100.

Q-30 10

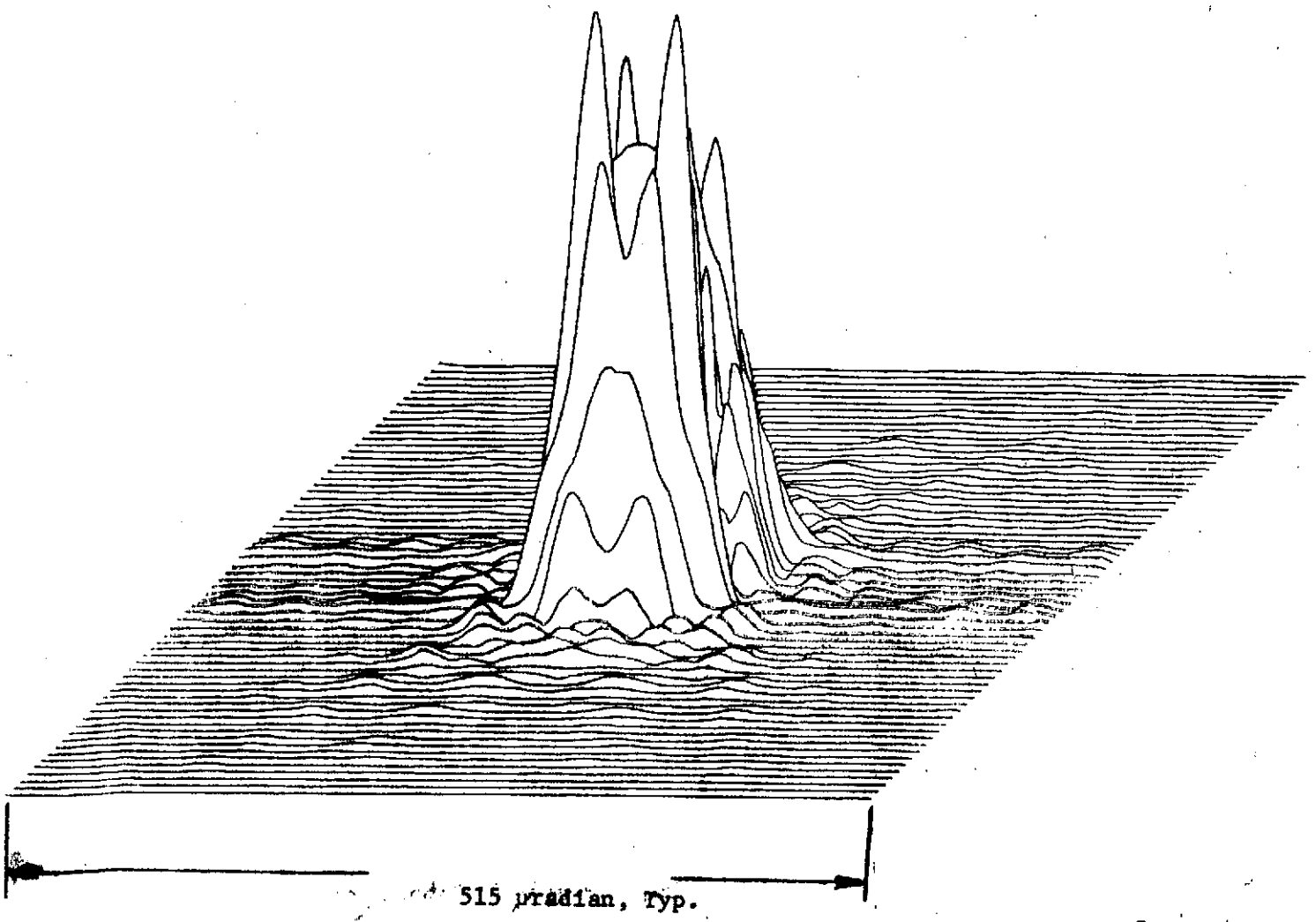
FIGURE 18

Task 2.1 - Nominal Cube-On Axis  
Intensity Distribution - Central 129 Microradians



~~Figure 10~~

Point Spread Function  
Task 2.1 - Nominal Cube-On Axis



515 radian, Typ.



Task 2.1 - Nominal Cube-On Axis

ENCIRCLED ENERGY

\*\*\*\*\*

CIRCLE \*  
 ----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*  
 Micro- \* CENTER (Microradians) Typ.  
 Radians \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 Typ. \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0
4.00	*	0.3	0.3	0.2	0.0	0.1	0.0	0.2	0.5	0.5
6.00	*	0.3	0.3	0.8	0.2	0.8	0.2	0.9	0.5	0.5
8.00	*	1.0	1.0	1.4	0.5	0.8	0.5	1.6	1.5	1.5
10.00	*	1.4	1.4	2.0	0.8	1.5	0.8	2.3	2.1	2.1
12.00	*	3.4	3.4	3.1	1.6	1.7	1.6	3.7	4.2	4.2
14.00	*	3.4	3.4	4.2	3.1	2.6	3.1	5.3	4.2	4.2
16.00	*	5.9	5.9	5.6	4.1	3.4	4.1	6.9	6.8	6.8
18.00	*	7.0	7.0	6.9	5.9	6.6	5.9	8.5	8.0	8.0
20.00	*	9.2	9.2	9.1	7.6	6.6	7.6	10.8	10.3	10.3
22.00	*	10.2	10.2	11.1	10.3	11.1	10.3	12.7	11.5	11.5
24.00	*	13.1	13.1	13.1	11.6	13.2	11.6	14.6	14.6	14.5
26.00	*	14.5	14.5	15.7	15.0	17.8	15.0	17.0	16.2	16.2
28.00	*	18.2	18.2	19.7	18.6	19.0	18.6	21.3	20.0	20.0
30.00	*	20.7	20.7	22.1	22.0	23.5	22.0	23.5	22.9	22.9
32.00	*	25.9	25.9	26.0	24.9	25.8	24.9	27.6	28.0	28.0
34.00	*	27.0	27.0	29.0	29.6	29.1	29.6	31.0	29.2	29.2
36.00	*	32.5	32.5	33.1	32.9	33.2	32.8	35.6	34.5	34.5
38.00	*	35.1	35.1	36.2	37.0	38.4	37.0	38.7	37.3	37.3
40.00	*	39.4	39.4	40.0	40.6	41.1	40.5	43.0	41.7	41.7
42.00	*	41.7	41.7	43.8	45.7	47.4	45.6	46.6	44.0	44.0
44.00	*	46.2	46.2	46.8	47.9	50.9	47.9	49.8	48.4	48.4
46.00	*	49.2	49.2	50.6	53.3	56.8	53.3	53.3	51.5	51.5
48.00	*	53.1	53.1	54.9	57.0	58.4	57.0	57.3	55.2	55.2
50.00	*	56.3	56.3	57.7	60.3	63.3	60.3	59.5	58.4	58.4
52.00	*	60.1	60.1	61.6	63.7	65.5	63.7	63.1	61.7	61.7
54.00	*	62.2	62.2	64.7	66.9	68.8	66.9	65.6	63.8	63.8
56.00	*	66.1	66.1	68.6	70.0	70.9	70.0	69.1	67.0	67.0
58.00	*	68.8	68.8	70.6	71.9	73.7	71.9	71.0	69.4	69.4
60.00	*	71.3	71.2	73.3	74.2	75.7	74.2	73.5	71.6	71.6
62.00	*	73.1	73.1	75.2	75.9	77.7	75.9	75.3	73.3	73.4
64.00	*	75.6	75.6	76.7	77.2	79.2	77.2	77.0	75.7	75.7
66.00	*	77.0	77.0	78.5	78.8	80.7	78.8	78.8	77.1	77.1
68.00	*	78.7	78.7	79.9	79.9	81.4	79.9	80.0	78.9	78.9
70.00	*	79.7	79.7	81.1	80.9	82.3	80.9	81.1	79.8	79.8
72.00	*	81.1	81.1	82.0	81.8	82.9	81.8	82.0	81.2	81.2
74.00	*	81.8	81.8	83.0	82.7	83.5	82.7	82.9	81.9	81.9
76.00	*	82.9	82.9	83.7	83.4	83.8	83.4	83.6	82.9	82.9
78.00	*	83.6	83.6	84.1	84.0	84.3	84.0	84.0	83.6	83.6
80.00	*	84.3	84.3	84.6	84.5	84.6	84.5	84.6	84.3	84.3

\*\*\*\*\*

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Task 2.1 - Nominal Cube-On Axis  
ENCIRCLED ENERGY

\*\*\*\*\*

CIRCLE \*  
----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
RADIUS \*  
----- \*

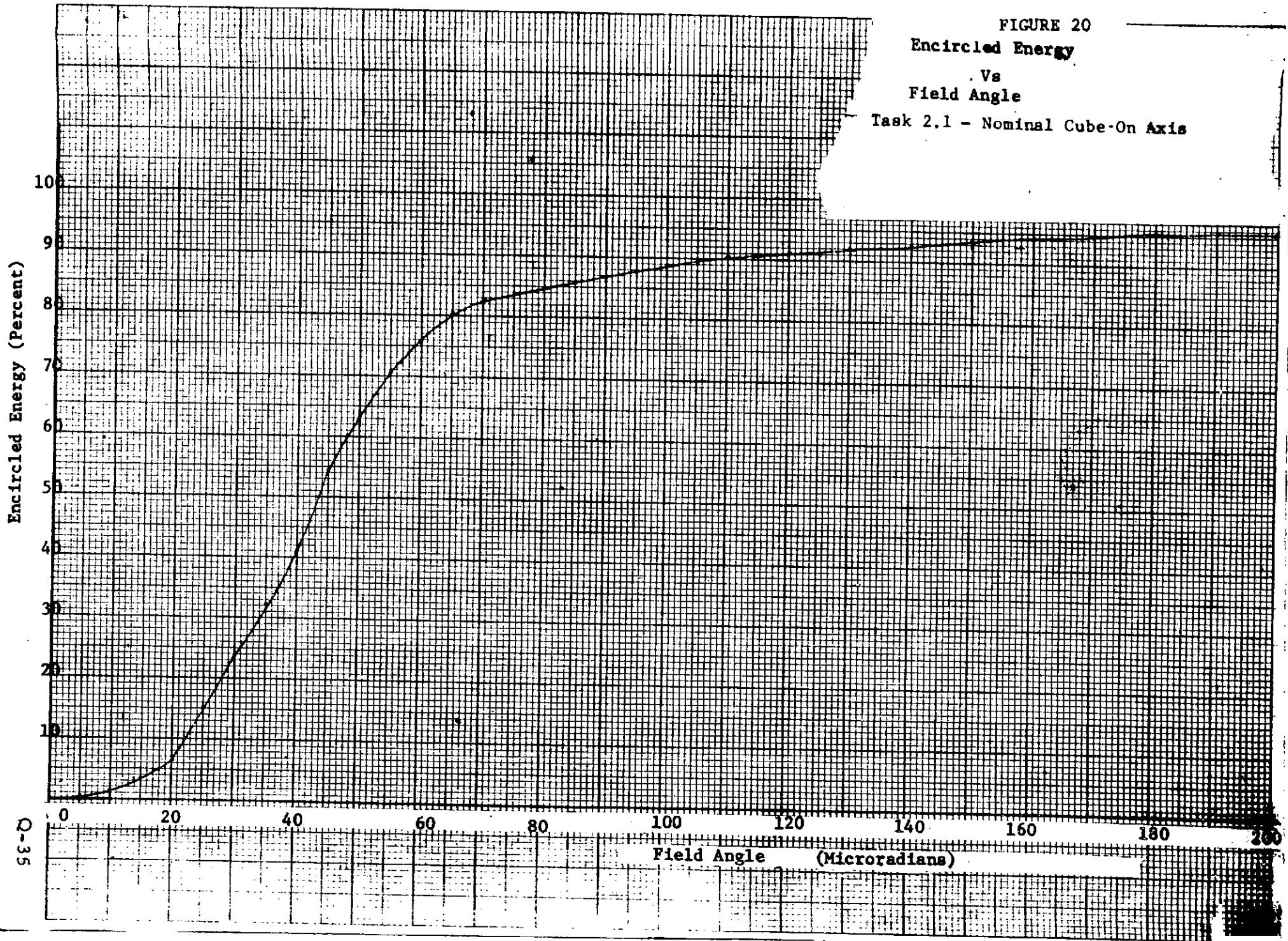
Micro- \* CENTER (Microradians) Typ.  
Radians \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
Typ. \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
\*  
\*

\*\*\*\*\*

5.00	*	0.3	0.3	0.6	0.2	0.5	0.2	0.7	0.5	0.5
10.00	*	1.4	1.4	2.0	0.8	1.5	0.8	2.3	2.1	2.1
15.00	*	4.9	4.9	5.2	3.5	3.4	3.5	6.4	5.7	5.7
20.00	*	9.2	9.2	9.1	7.6	6.6	7.6	10.8	10.3	10.3
25.00	*	14.0	14.0	14.9	14.7	15.1	14.7	16.4	15.7	15.6
30.00	*	20.7	20.7	22.1	22.0	23.5	22.0	23.5	22.9	22.9
35.00	*	30.3	30.3	31.1	30.5	32.1	30.5	33.1	32.3	32.3
40.00	*	39.4	39.4	40.0	40.6	41.1	40.5	43.0	41.7	41.7
45.00	*	47.9	47.9	48.9	51.5	54.3	51.5	51.7	50.1	50.1
50.00	*	56.3	56.3	57.7	60.3	63.3	60.3	59.5	58.4	58.4
55.00	*	64.8	64.8	66.9	68.5	70.4	68.5	67.7	65.8	65.8
60.00	*	71.3	71.2	73.3	74.2	75.7	74.2	73.5	71.6	71.6
65.00	*	76.3	76.2	77.9	78.2	80.2	78.2	78.1	76.4	76.4
70.00	*	79.7	79.7	81.1	80.9	82.3	80.9	81.1	79.8	79.8
75.00	*	82.5	82.5	83.3	83.1	83.6	83.1	83.3	82.5	82.5
80.00	*	84.3	84.3	84.6	84.5	84.6	84.5	84.6	84.3	84.3
85.00	*	85.5	85.5	85.6	85.8	85.8	85.8	85.7	85.6	85.6
90.00	*	86.5	86.5	86.6	86.8	86.8	86.8	86.8	86.7	86.7
95.00	*	87.5	87.5	87.6	87.7	87.9	87.7	87.8	87.7	87.7
100.00	*	88.4	88.4	88.5	88.6	88.9	88.6	88.6	88.5	88.5
105.00	*	89.2	89.2	89.4	89.4	89.6	89.4	89.4	89.2	89.2
110.00	*	89.9	89.9	90.1	90.0	90.2	90.0	90.0	89.9	89.9
115.00	*	90.5	90.5	90.6	90.5	90.6	90.5	90.6	90.6	90.6
120.00	*	91.0	91.0	91.0	91.1	91.1	91.1	91.1	91.1	91.1
125.00	*	91.4	91.4	91.5	91.5	91.5	91.5	91.6	91.5	91.5
130.00	*	91.9	91.9	91.9	92.0	92.1	92.0	92.0	92.0	92.0
135.00	*	92.4	92.4	92.4	92.4	92.5	92.4	92.4	92.3	92.3
140.00	*	92.8	92.8	92.8	92.8	92.8	92.8	92.9	92.8	92.8
145.00	*	93.1	93.1	93.1	93.2	93.2	93.2	93.2	93.1	93.1
150.00	*	93.4	93.4	93.4	93.5	93.5	93.5	93.5	93.4	93.4
155.00	*	93.8	93.8	93.8	93.8	93.8	93.8	93.7	93.8	93.8
160.00	*	94.2	94.2	94.1	94.1	94.1	94.1	94.0	94.1	94.1
165.00	*	94.4	94.4	94.5	94.4	94.4	94.4	94.4	94.4	94.4
170.00	*	94.7	94.7	94.8	94.7	94.8	94.7	94.8	94.7	94.7
175.00	*	95.0	95.0	95.0	95.0	95.1	95.0	95.1	95.0	95.0
180.00	*	95.2	95.2	95.3	95.3	95.4	95.3	95.3	95.3	95.3
184.99	*	95.5	95.5	95.5	95.6	95.5	95.6	95.5	95.6	95.6
189.99	*	95.7	95.7	95.7	95.8	95.8	95.8	95.7	95.8	95.8
194.99	*	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0
199.99	*	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2

\*\*\*\*\*

FIGURE 20  
Encircled Energy  
Vs  
Field Angle  
Task 2.1 - Nominal Cube-On Axis



Q-35

FIGURE 21

Task 2.1 - Nominal Cube -15° Off Axis

Wavefront Map-7 Polarization

118 114 114 118

127 123 120 116 112 108 108 112 116 120 123 127

129 125 121 118 114 110 106 103 103 106 110 114 118 121 125 129

127 123 119 116 112 108 104 101 97 97 101 104 108 112 116 119 123 127

128 125 121 117 114 110 106 102 99 95 91 91 95 99 102 106 110 114 117 121 125 128

126 123 119 115 112 108 104 100 97 93 89 86 86 89 93 97 100 104 108 112 115 119 123 126

121 117 113 110 106 102 98 95 91 87 83 80 80 83 87 91 95 98 102 106 110 113 117 121

108 101 95 108 104 100 96 93 89 85 81 78 74 74 78 81 85 89 93 96 100 104 108 95 101 108

114 108 101 95 89 83 84 91 87 83 79 76 72 68 68 72 76 79 83 87 91 94 83 89 95 101 108 114

114 108 101 95 89 83 77 70 64 77 74 70 66 63 63 66 70 74 77 64 70 77 83 89 95 101 108 114

120 114 108 101 95 89 83 77 70 64 58 52 64 61 57 57 61 64 52 58 64 70 77 83 89 95 101 108 114 120

120 114 109 101 95 89 83 77 70 64 58 52 45 39 51 51 39 45 52 58 64 70 77 83 89 95 101 108 114 120

120 114 109 101 95 89 83 77 70 64 58 52 45 57 54 54 57 45 52 58 64 70 77 83 89 95 101 108 114 120

114 108 101 95 89 83 77 70 64 58 71 67 63 59 59 63 67 71 58 64 70 77 83 89 95 101 108 114

114 108 101 95 89 83 77 70 84 80 76 73 69 65 65 69 73 76 80 84 70 77 83 89 95 101 108 114

108 101 95 89 101 87 93 89 86 82 78 75 71 71 75 78 82 86 89 93 97 101 89 95 101 108

108 101 114 110 106 103 99 95 92 88 84 80 77 77 80 84 88 92 95 99 103 106 110 114 101 108

123 120 116 112 109 105 101 97 94 90 86 82 82 86 90 94 97 101 105 108 112 116 120 123

125 122 118 114 110 107 103 99 96 92 88 88 92 96 99 103 107 110 114 118 122 125

127 124 120 116 112 109 105 101 98 94 94 98 101 105 109 112 116 120 124 127

129 126 122 118 114 111 107 103 100 100 103 107 111 114 118 122 126 129

128 124 120 116 113 109 105 105 109 113 116 120 124 128

126 122 118 115 111 111 115 118 122 126

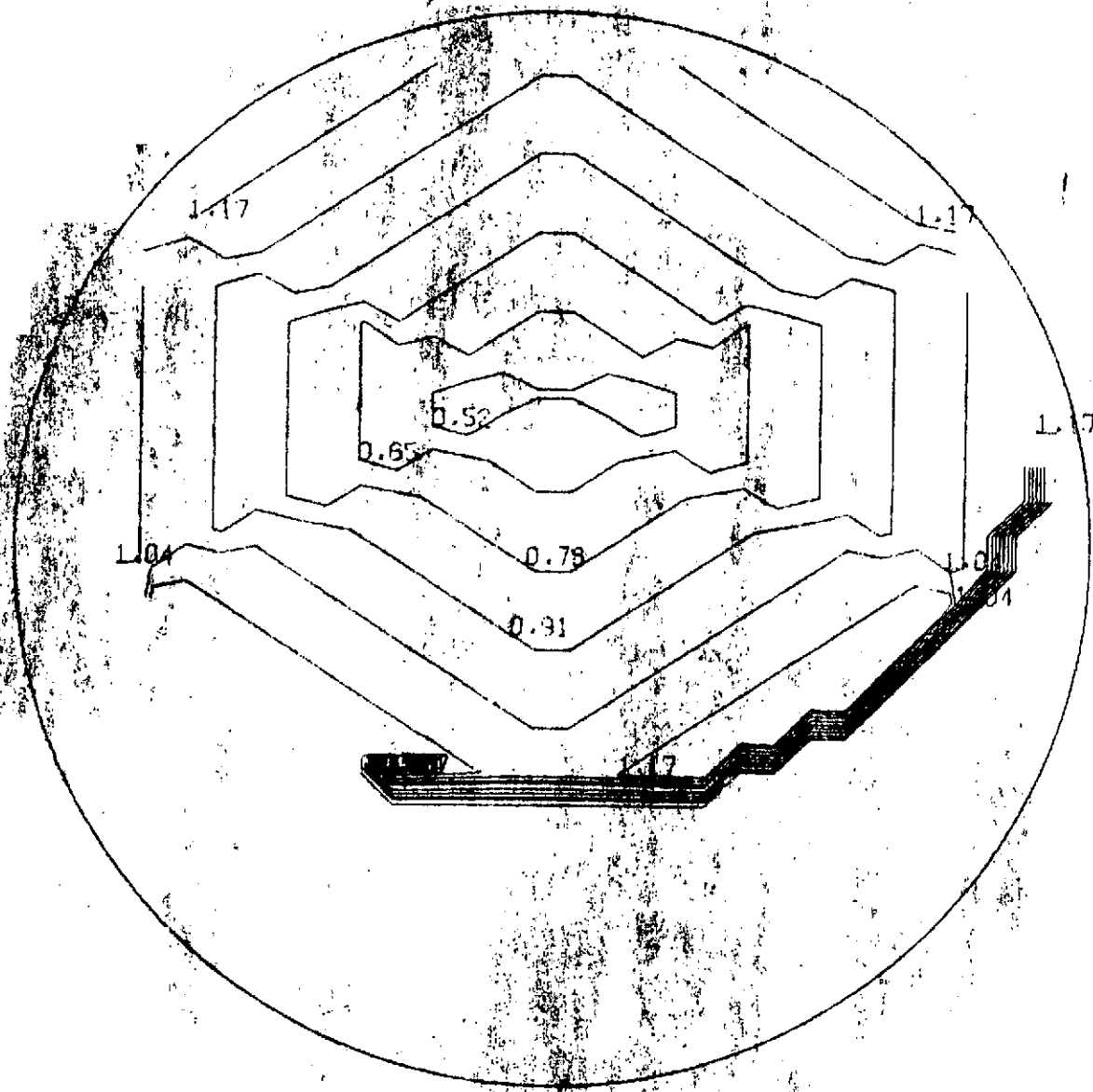
Q-36

FIGURE 22'

Task 2.1 - Nominal Cube -15° Off Axis

Wavefront Plot-Q Polarization

TOP

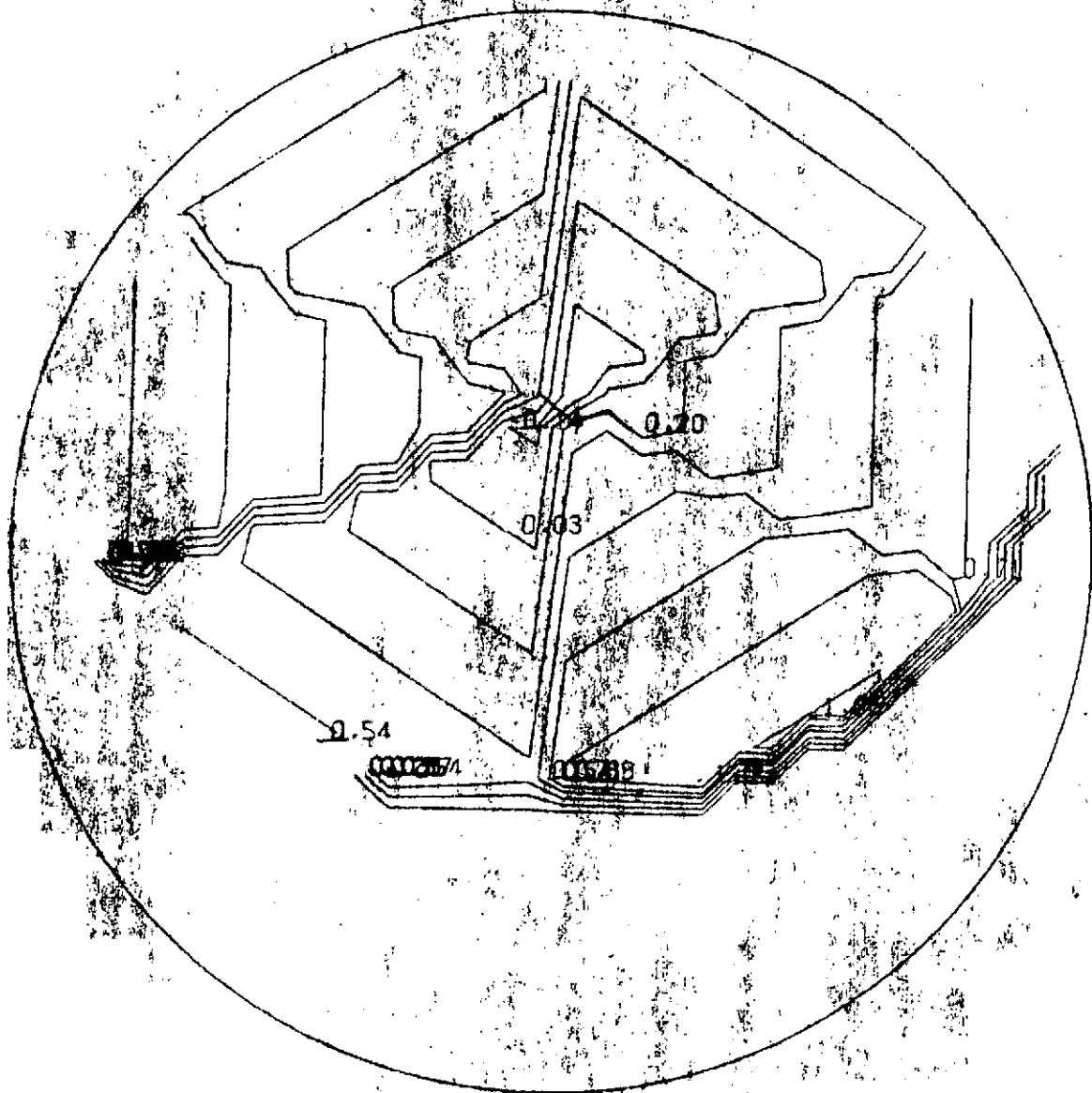


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FIGURE 24

Task 2.1 - Nominal Cube -15° Off Axis  
Wavefront Plot-P Polarization



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR





FIGURE 26

Task 2.1 - Nominal Cube -15° Off Axis  
Point Spread Function

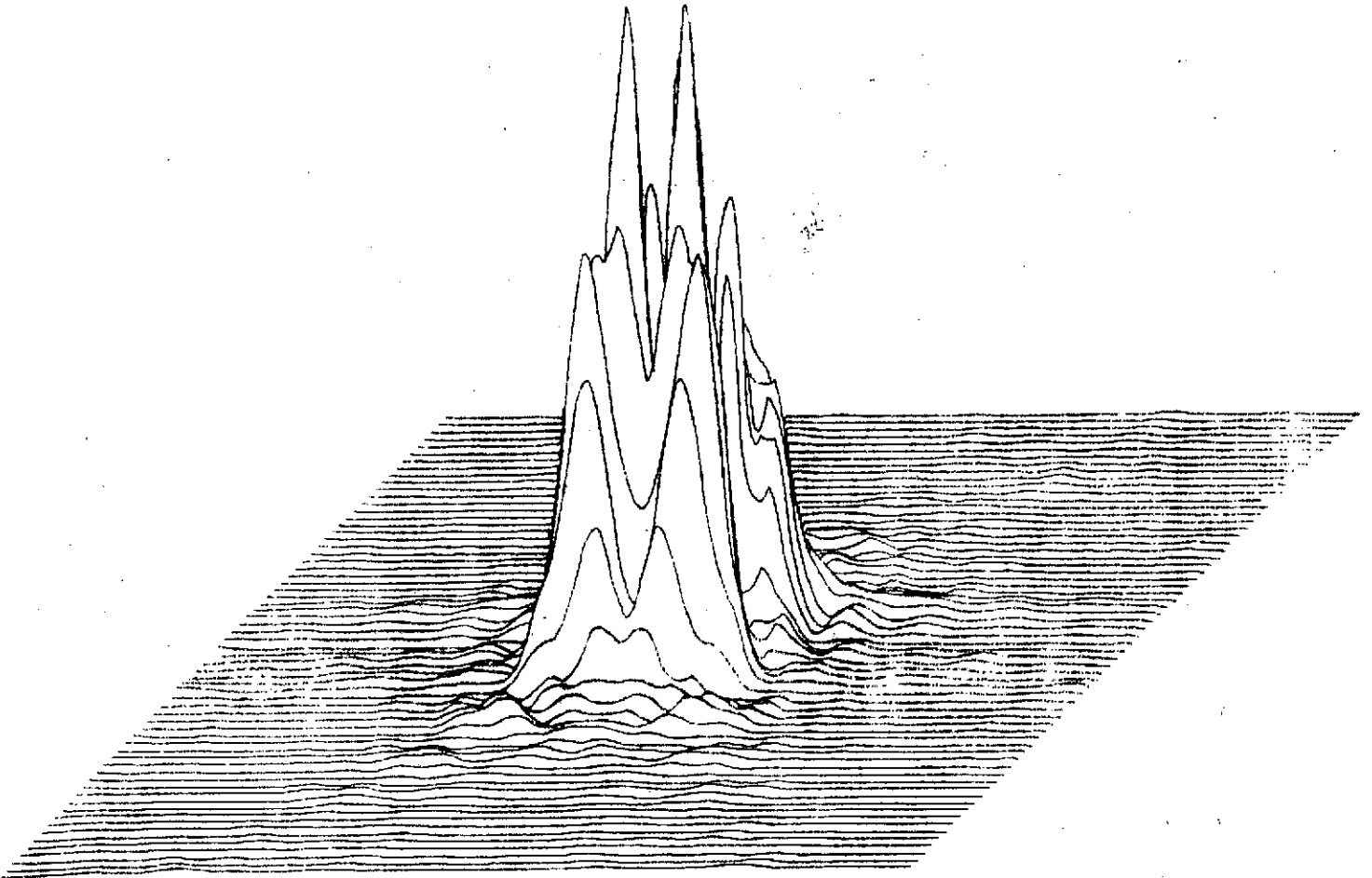
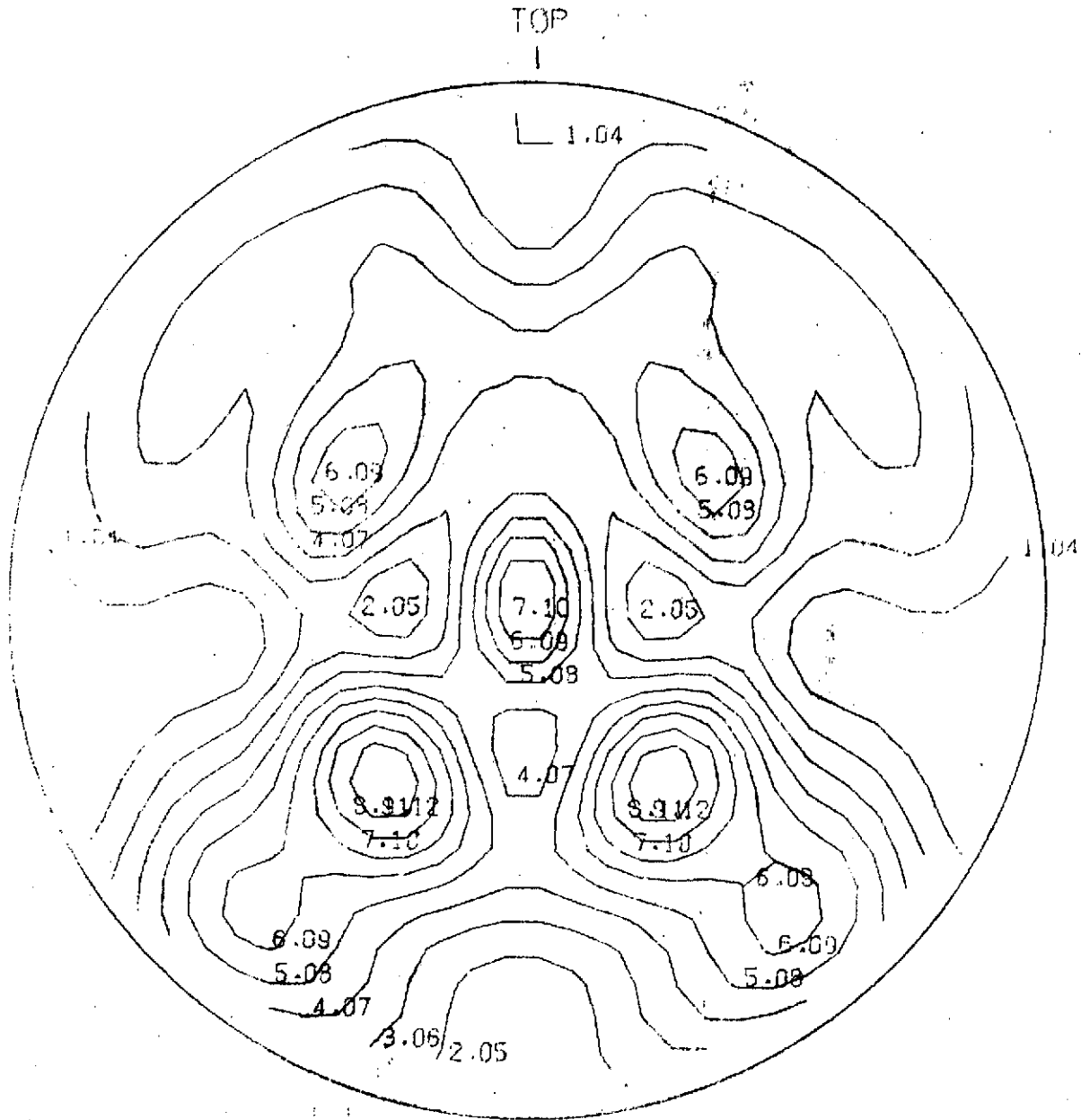


FIGURE 27

Task 2.1 - Nominal Cube -15° Off Axis

Intensity Distribution - Central 129 Microradians



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR.

ENCIRCLED ENERGY  
-----

\*\*\*\*\*

CIRCLE \*  
----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
RADIUS \*  
----- \*  
(MI- \* CENTER (MICRONS):  
CPONS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
\*

\*\*\*\*\*

2.00	*	0.0	0.0	0.1	0.0	0.2	0.0	0.1	0.0	0.0
4.00	*	0.4	0.4	0.3	0.2	0.2	0.2	0.3	0.5	0.5
6.00	*	0.4	0.4	0.9	0.5	1.8	0.5	1.0	0.5	0.5
8.00	*	1.2	1.2	1.7	1.2	1.8	1.2	1.8	1.6	1.6
10.00	*	1.7	1.7	2.1	1.6	3.4	1.6	2.4	2.2	2.2
12.00	*	3.9	3.9	3.4	3.0	3.9	3.0	3.8	4.6	4.6
14.00	*	3.9	3.9	4.5	4.6	4.9	4.6	5.4	4.6	4.6
16.00	*	6.6	6.5	5.8	6.1	5.7	6.0	7.0	7.7	7.7
18.00	*	7.6	7.6	7.2	7.8	8.0	7.8	8.8	9.0	9.0
20.00	*	9.9	9.9	9.4	9.9	8.0	9.9	11.5	11.5	11.6
22.00	*	11.0	11.0	11.5	12.3	11.4	12.3	14.0	12.9	12.9
24.00	*	13.7	13.7	13.2	13.6	13.7	13.5	15.9	16.0	16.0
26.00	*	15.0	15.0	16.0	16.5	17.9	16.5	18.9	17.6	17.6
28.00	*	18.1	18.0	19.2	19.3	19.3	19.3	22.6	20.8	20.8
30.00	*	20.2	20.2	21.9	22.3	24.1	22.3	25.0	23.6	23.6
32.00	*	24.6	24.6	24.5	24.7	27.0	24.7	27.7	27.7	27.7
34.00	*	25.4	25.4	27.7	28.7	30.2	28.7	30.9	28.7	28.7
36.00	*	30.4	30.4	30.9	31.8	34.2	31.8	34.1	33.2	33.1
38.00	*	32.8	32.8	34.2	35.4	37.8	35.4	36.7	35.7	35.7
40.00	*	36.9	36.9	37.6	38.9	39.9	38.9	40.3	39.4	39.4
42.00	*	39.1	39.1	41.5	43.1	43.6	43.0	43.8	41.5	41.5
44.00	*	43.5	43.5	44.1	45.0	46.4	45.0	46.3	45.6	45.6
46.00	*	46.3	46.3	47.8	49.3	50.3	49.3	50.0	48.6	48.6
48.00	*	49.7	49.7	51.4	52.4	52.0	52.4	53.9	51.9	51.8
50.00	*	52.7	52.7	53.8	55.0	56.2	55.0	56.2	55.1	55.1
52.00	*	55.7	55.7	56.8	57.8	59.3	57.8	59.4	58.3	58.3
54.00	*	57.6	57.6	59.6	60.9	62.7	60.8	62.1	60.1	60.1
56.00	*	60.8	60.8	62.8	64.0	65.7	63.9	65.4	63.2	63.2
58.00	*	63.3	63.3	64.9	66.0	68.9	66.0	67.2	65.7	65.7
60.00	*	65.6	65.6	67.6	68.9	71.3	68.9	69.9	67.9	67.9
62.00	*	67.6	67.6	69.9	71.3	73.4	71.3	71.9	69.7	69.7
64.00	*	70.7	70.7	71.7	73.0	75.2	73.0	73.5	72.1	72.1
66.00	*	72.6	72.6	74.1	75.3	77.0	75.3	75.5	73.8	73.8
68.00	*	74.6	74.7	76.0	76.7	77.7	76.7	76.8	75.5	75.5
70.00	*	76.2	76.2	77.6	78.1	79.1	78.1	78.1	76.8	76.8
72.00	*	78.0	78.0	78.9	79.1	80.2	79.1	79.1	78.2	78.2
74.00	*	78.9	78.9	80.2	80.3	81.1	80.3	80.1	79.0	79.0
76.00	*	80.4	80.4	81.3	81.2	81.8	81.2	81.0	80.2	80.2
78.00	*	81.3	81.3	81.8	81.9	82.6	81.9	81.5	81.0	81.0
80.00	*	82.2	82.2	82.7	82.7	83.2	82.7	82.3	81.8	81.8

\*\*\*\*\*

Task 2.1 - Nominal Cube, -15° Off Axis

ENCIRCLED ENERGY

```

*****
CIRCLE *
----- *
RADIUS *
----- *
(MI- *
CRONS) *
CENTER (MICRONS):
* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13
* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13
*****

```

RADIUS	X=-10.13	X=10.13	X=0.0	X=-10.13	X=0.0	X=10.13	X=0.0	X=-10.13	X=10.13
5.00	0.4	0.4	0.8	0.5	1.1	0.5	0.9	0.5	0.5
10.00	1.7	1.7	2.1	1.6	3.4	1.6	2.4	2.2	2.2
15.00	5.5	5.5	5.5	5.4	5.7	5.4	6.4	6.4	6.4
20.00	9.9	9.9	9.4	9.9	8.0	9.9	11.5	11.5	11.6
25.00	14.6	14.6	15.5	16.1	14.9	16.1	18.3	17.0	17.1
30.00	20.2	20.2	21.9	22.3	24.1	22.3	25.0	23.6	23.6
35.00	28.6	28.6	29.1	29.7	33.1	29.7	32.0	31.3	31.3
40.00	36.9	36.9	37.6	38.9	39.9	38.9	40.3	39.4	39.4
45.00	44.9	44.9	46.2	47.8	48.2	47.8	48.4	47.1	47.1
50.00	52.7	52.7	53.8	55.0	56.2	55.0	56.2	55.1	55.1
55.00	59.7	59.7	61.1	62.2	65.0	62.2	63.7	62.1	62.1
60.00	65.6	65.6	67.6	68.9	71.3	68.9	69.9	67.9	67.9
65.00	71.5	71.5	73.3	74.5	76.1	74.5	74.8	72.9	72.9
70.00	76.2	76.2	77.6	78.1	79.1	78.1	78.1	76.8	76.8
75.00	79.9	79.9	80.7	80.7	81.5	80.7	80.5	79.7	79.7
80.00	82.2	82.2	82.7	82.7	83.2	82.7	82.3	81.8	81.8
85.00	83.7	83.7	84.0	84.2	84.4	84.2	83.7	83.5	83.5
90.00	84.9	84.9	85.1	85.2	85.3	85.2	85.0	84.9	84.9
95.00	85.9	85.9	86.0	86.0	86.0	86.0	86.1	86.1	86.1
100.00	86.8	86.7	86.8	86.8	86.9	86.8	87.1	87.0	87.0
105.00	87.5	87.5	87.5	87.7	87.9	87.7	88.0	87.8	87.8
110.00	88.3	88.3	88.4	88.5	88.7	88.5	88.7	88.5	88.5
115.00	89.2	89.2	89.2	89.3	89.4	89.3	89.3	89.2	89.2
120.00	89.9	89.9	90.0	89.9	90.0	89.9	89.8	89.8	89.8
125.00	90.5	90.5	90.6	90.5	90.6	90.5	90.3	90.3	90.3
130.00	91.0	91.0	91.1	91.0	91.1	91.0	90.8	90.8	90.8
135.00	91.3	91.3	91.3	91.4	91.5	91.4	91.5	91.4	91.4
140.00	91.8	91.8	91.9	91.9	91.8	91.9	91.9	91.8	91.8
145.00	92.3	92.3	92.3	92.2	92.2	92.2	92.2	92.2	92.2
150.00	92.7	92.7	92.8	92.6	92.7	92.6	92.6	92.6	92.6
155.00	93.0	93.0	93.1	93.0	93.1	93.0	93.0	92.9	92.9
160.00	93.4	93.4	93.4	93.4	93.4	93.4	93.3	93.4	93.4
165.00	93.7	93.7	93.7	93.8	93.8	93.8	93.8	93.8	93.8
170.00	94.0	94.0	94.0	94.1	94.1	94.1	94.1	94.1	94.1
175.00	94.3	94.3	94.3	94.4	94.4	94.4	94.4	94.4	94.4
180.00	94.6	94.6	94.7	94.7	94.8	94.7	94.7	94.7	94.7
184.99	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
189.99	95.3	95.3	95.3	95.3	95.3	95.3	95.2	95.2	95.2
194.99	95.5	95.5	95.6	95.5	95.6	95.5	95.4	95.4	95.4
199.99	95.8	95.8	95.8	95.8	95.8	95.8	95.7	95.7	95.7

```

*****

```

FIGURE 28

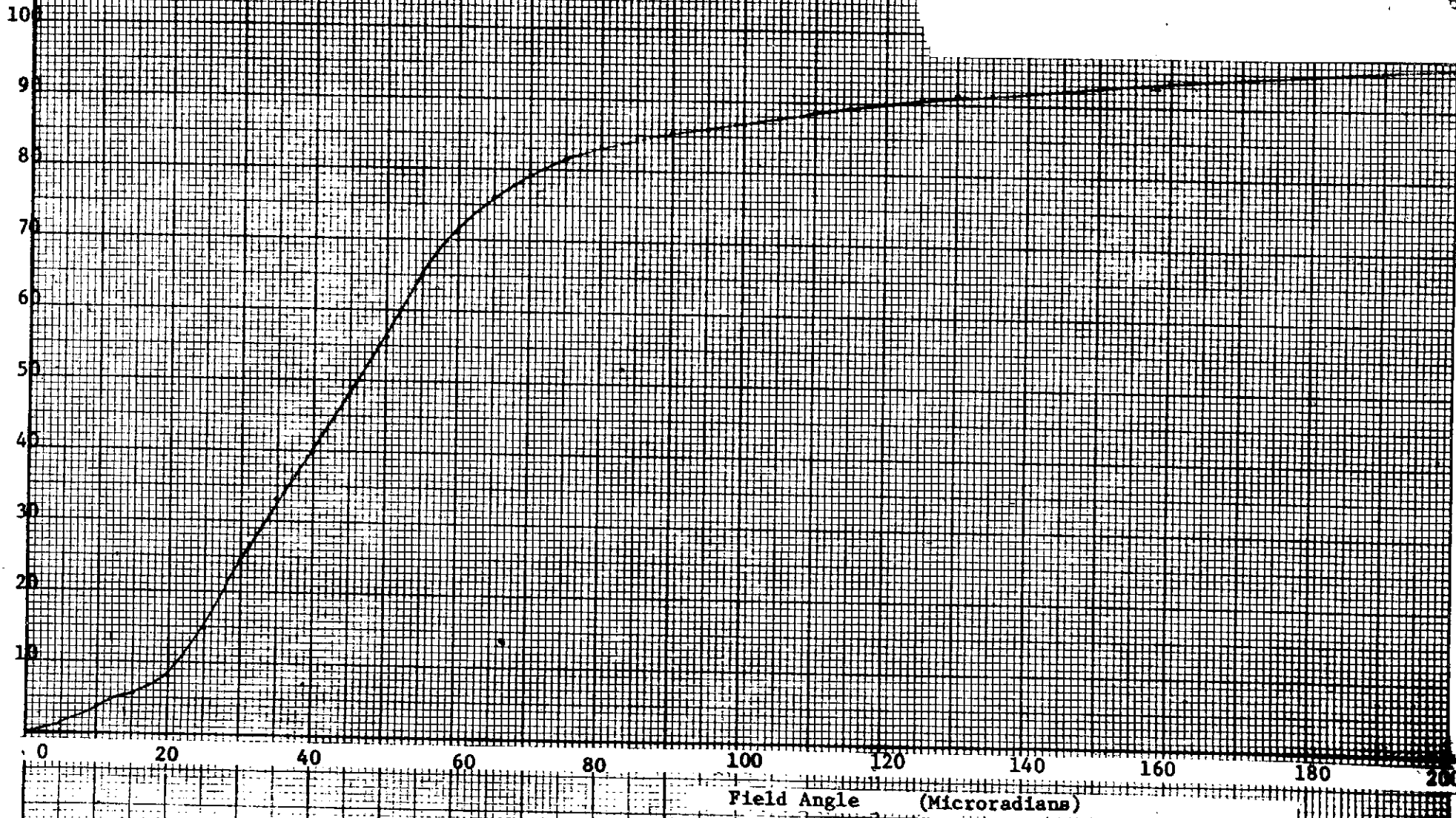
Encircled Energy

$V_e$

Field Angle

Task 2.1 - Nominal Cube -15° Off Axis

Encircled Energy (Percent)



Q-45

TABLE 7

Figure Numbers and Tables That Give the Performance of the Specified Cases

Task	Case	Wavefront Maps	Wavefront Plots	Intensity Map	Intensity Plot	Encircled Energy Plot	Encircled Energy Tables
2.1	Nominal Cube-On Axis	13,15	14,16	17	18,19	20	3,4
2.1	Nominal Cube- $15^\circ$ Off Axis	21,23	22,24	25	26,27	28	5,6
2.2	Nominal Cube - On Axis + 0.278 $\lambda$ mfg error	29,31	30,32	33	34,35	36	8,9
2.2	Nominal Cube $15^\circ$ Off Axis + 0.278 $\lambda$ mfg error	37,39	38,40	41	42,43	44	10,11
2.3B	Nominal Cube On Axis + 0.278 $\lambda$ mfg error + first temperature case	55,57	56,58	59	60,61	62	12,13
2.3B	Nominal Cube $15^\circ$ Off Axis + 0.278 $\lambda$ mfg error + first temperature case	63,65	64,66	67	68,69	70	14,15
2.3A1	Nominal Cube On Axis * + 0.278 $\lambda$ mfg error + second temperature case	71,73	72,74	75	76,77	78	16,17
2.3A2	Nominal Cube On Axis + 0.278 $\lambda$ mfg error + third temperature case	79,81	80,82	83	84,85	86	18,19
2.5A	Nominal Cube On Axis + 0.278 $\lambda$ mfg error + axial gradient	87,89	88,90	91	92,93	94	20,21
2.5B	Nominal Cube On Axis + 0.278 $\lambda$ mfg error + radial gradient	95,97	96,98	99	100,101	102	22,23
2.4A	Off Nominal Cube On Axis + 0.278 $\lambda$ mfg error	103,105	104,106	107	108,109	110	24,25
2.4A	Off Nominal Cube $15^\circ$ Off Axis + 0.278 $\lambda$ mfg error	111,113	112,114	115	116,117	118	26,27
2.4B2	Off Nominal Cube On Axis + 0.278 $\lambda$ mfg error + 1st AT case	119,121	120,122	123	124,125	126	28,29
2.4B2	Off Nominal Cube $15^\circ$ Off Axis + 0.278 $\lambda$ mfg error + first temperature case	127,129	128,130	131	132,133	134	30,31

\*Note: If figures are unlabelled an on axis condition is assumed.

### ABSOLUTE INTENSITY

The results of the diffraction calculations performed in POINT are a square grid of points, each of which gives the energy diffracted into a square of a given size. A convenient measure is the ratio of the energy per steradian to the total energy emerging from the cube. This gives a number in units of steradians<sup>-1</sup> which, when multiplied by the total power (or energy), gives the absolute intensity at that point. This number can be obtained from the computer printed maps of the point spread function as follows:

Figure 17 shows a map of a point spread function of the on axis nominal cube.

Define the following items.

- E = total energy in PSF
- D = grid spacing (radians)
- I<sub>m</sub> = largest value in PSF
- I<sub>p</sub> = printed value in map of PSF
- I/E = ratio of intensity to total energy (steradians<sup>-1</sup>)

The value of I/E is

$$I/E = \frac{I_m}{100 E D^2} I_p \text{ Steradians}^{-1}$$

The values in Figure 17 are

- E = 2.461
- D = 8.04 x 10<sup>-6</sup> radians
- I<sub>m</sub> = 0.0265

So that

$$I/E = 1.67 \times 10^6 I_p \text{ Steradians}^{-1}$$

For example, the center point in Figure 17 has a value of 47. If the total power emerging from the cube were 1 watt, the intensity at the center would be

$$I = 7.83 \times 10^7 \text{ watts/steradian}$$

### MANUFACTURING ERROR

A random wavefront with a correlation of 0.66 over the face was subsequently placed on each surface to simulate manufacturing errors on the small optical surfaces. The OPD on the surfaces were scaled so that the resultant wavefront OPD in each of the six output sectors would have  $0.278\lambda$  OPD peak-peak\* as measured at 0.6328 microns. The OPD's were determined by the equation (on axis);

$$\text{Surface Deformation} = \frac{0.278 \lambda}{2\sqrt{3} \cos 55^\circ}$$

Since there is a variation in the angle at which the rays strike each surface, each of the six sectors output OPD was then scaled to  $0.278\lambda$  peak to peak.

The resultant wavefront from the  $0.278\lambda$  OPD condition was then added to the effects of polarization and the dihedral angle variation to obtain the manufacturing degraded wavefront. The performance of the manufacturing degraded cases are given in Figures 29-36 for the on axis case and Figures 37-44 for the  $-15^\circ$  off axis case.

### TEMPERATURE VARIATION EFFECT

Temperature distributions obtained from Bendix Aerospace were used to determine the effect of temperature variation on the performance of the cube corner. The first temperature case is shown in Figures 45 and 46. The temperature coefficient of the refractive index (DN/DT) of Homosil was found to be  $8.98 \times 10^{-6}/^\circ\text{C}$  in going from a nominal temperature of  $25^\circ\text{C}$  to a final temperature at  $2.8^\circ\text{C}$ . This value was obtained by taking the average of DN/DT over that range as obtained from Amersil. The DN/DT of suprasil ranged from  $7-8.5 \times 10^{-6}/^\circ\text{C}$  while the DN/DT of Homosil ranged from  $8.32-9.0 \times 10^{-6}/^\circ\text{C}$ . The value of DN/DT of Homosil was used as a worst case analysis. The DN/DT at  $2.8^\circ\text{C}$  was found to be  $8.72 \times 10^{-6}/^\circ\text{C}$ . The DN/DT at  $-46.95^\circ\text{C}$  was  $8.32 \times 10^{-6}/^\circ\text{C}$ . The DN/DT used for the third temperature case (Figures 49 and 50), the radial gradient (Figure 51) and the axial gradient (Figure 52) was  $9.0 \times 10^{-6}/^\circ\text{C}$ . The effect of the specified axial gradient alone on the wavefront is shown in Figure 53. The effect of the radial gradient on the wavefront is shown in Figure 54. As may be seen from Figure 53 and 54 the radial and axial gradients work in opposite directions.

The specified axial gradient will compensate for the spread due to the non  $90^\circ$  dihedral angles while the radial gradient will add to the dihedral angle effect.

The temperature distributions given in Figures 45 to 50 were such that the axial gradient and the radial gradient compensated for each other. As a result the temperature distributions supplied had little effect on the performance of the corner cube as shown by the Figures listed in Table 7.

\*  $0.25\lambda$  pk-pk OPD over 90% of sector's area



TABLE 8

ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error - On Axis

\*\*\*\*\*  
 CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \*  
 CRONS) \*  
 CENTER (MICRONS):  
 \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
4.00	0.2	0.3	0.1	0.1	0.0	0.0	0.1	0.3	0.2
6.00	0.2	0.3	0.6	0.2	0.1	0.1	0.6	0.3	0.2
8.00	0.8	1.0	1.0	0.4	0.1	0.2	1.0	1.1	0.8
10.00	1.1	1.3	1.4	0.7	0.4	0.4	1.6	1.5	1.0
12.00	2.4	2.8	2.2	1.0	0.6	0.7	2.5	3.1	2.2
14.00	2.4	2.8	3.2	1.9	1.4	1.6	3.5	3.1	2.2
16.00	4.1	4.7	4.4	2.4	1.9	2.1	4.8	5.1	3.9
18.00	4.9	5.4	5.5	3.7	4.5	3.4	5.8	5.9	4.8
20.00	6.6	7.3	7.5	4.8	4.5	4.7	8.0	8.0	6.7
22.00	7.4	8.0	8.8	7.0	8.1	6.8	9.4	8.9	7.6
24.00	9.8	10.6	10.7	8.1	9.4	8.2	11.3	11.6	10.4
26.00	11.0	11.7	12.5	11.0	13.0	11.0	13.1	13.0	11.9
28.00	14.3	15.4	15.8	14.1	14.0	14.1	17.0	16.7	15.5
30.00	16.4	17.5	17.5	17.3	18.0	17.3	18.8	19.3	18.1
32.00	20.8	22.2	20.9	19.7	19.8	19.7	22.7	24.0	22.7
34.00	21.7	23.2	23.3	24.1	23.6	24.1	25.6	25.1	23.6
36.00	26.3	23.0	27.0	26.8	26.9	26.8	29.9	30.0	28.4
38.00	28.4	30.2	29.9	30.8	32.2	30.8	32.7	32.5	30.8
40.00	32.6	34.2	33.6	33.9	34.6	33.9	36.8	36.5	35.0
42.00	34.4	36.1	37.3	38.8	41.0	38.9	40.1	38.5	36.9
44.00	39.0	40.3	40.7	41.3	43.8	41.1	43.4	42.6	41.4
46.00	41.9	42.9	44.2	46.6	49.6	46.4	46.6	45.2	44.3
48.00	46.3	45.8	48.7	50.4	51.0	50.0	50.6	49.0	48.4
50.00	49.6	49.8	51.2	53.6	55.9	53.4	52.7	51.9	51.5
52.00	53.9	53.5	55.3	57.0	58.2	56.7	56.4	55.2	55.3
54.00	56.2	55.7	57.9	60.1	61.8	60.0	58.8	57.3	57.3
56.00	60.2	59.4	62.0	63.2	64.0	63.1	62.4	60.4	60.8
58.00	62.8	62.1	64.0	65.2	67.2	65.1	64.4	62.8	63.2
60.00	65.5	64.6	66.9	67.6	69.3	67.6	67.2	65.1	65.8
62.00	67.4	66.5	68.9	69.8	71.6	69.8	69.2	66.8	67.5
64.00	70.2	69.2	70.8	71.3	73.2	71.3	71.0	69.3	70.3
66.00	71.7	70.9	72.7	73.4	75.0	73.3	72.9	70.9	71.8
68.00	73.9	72.9	74.3	74.7	75.8	74.7	74.3	72.9	73.9
70.00	75.0	74.1	75.7	76.1	77.1	76.1	75.7	74.1	75.1
72.00	76.8	75.9	76.9	77.2	78.0	77.2	76.9	75.8	76.8
74.00	77.7	76.7	78.2	78.3	78.9	78.3	78.1	76.7	77.7
76.00	79.1	78.2	79.2	79.3	79.6	79.3	79.2	78.2	79.1
78.00	80.0	79.1	79.9	80.0	80.4	80.0	79.9	79.2	79.9
80.00	81.0	80.1	80.8	80.8	81.0	80.8	80.8	80.2	80.9

\*\*\*\*\*

TABLE 9

ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error On Axis

\*\*\*\*\*  
 CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CIRCLES) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*  
 \*\*\*\*\*

5.00	0.2	0.3	0.4	0.2	0.1	0.1	0.4	0.3	0.2
10.00	1.1	1.3	1.4	0.7	0.4	0.4	1.6	1.5	1.0
15.00	3.4	3.9	4.0	2.1	1.9	1.8	4.3	4.3	3.2
20.00	6.6	7.3	7.5	4.8	4.5	4.7	8.0	8.0	6.7
25.00	10.6	11.4	11.9	10.8	11.2	10.7	12.5	12.6	11.4
30.00	16.4	17.5	17.5	17.3	18.0	17.3	18.8	19.3	18.1
35.00	24.5	26.1	25.3	24.7	26.0	24.7	27.7	27.9	26.5
40.00	32.6	34.2	33.6	33.9	34.6	33.9	36.8	36.5	35.0
45.00	40.7	41.9	42.5	44.8	47.4	44.7	45.2	44.2	43.0
50.00	49.6	49.8	51.2	53.6	55.9	53.4	52.7	51.9	51.5
55.00	58.8	58.0	60.4	61.7	63.5	61.5	61.0	59.1	59.6
60.00	65.5	64.6	66.9	67.6	69.3	67.6	67.2	65.1	65.8
65.00	70.9	69.9	72.0	72.6	74.3	72.6	72.2	70.1	71.0
70.00	75.0	74.1	75.7	76.1	77.1	76.1	75.7	74.1	75.1
75.00	78.5	77.6	78.7	78.8	79.2	78.9	78.7	77.6	78.5
80.00	81.0	80.1	80.8	80.8	81.0	80.8	80.8	80.2	80.9
85.00	82.6	82.0	82.6	82.8	82.9	82.8	82.8	82.2	82.7
90.00	84.1	83.9	84.3	84.5	84.6	84.5	84.5	84.1	84.4
95.00	85.6	85.8	85.8	86.0	86.3	86.0	86.0	85.8	85.8
100.00	86.8	87.2	87.2	87.3	87.8	87.4	87.3	87.1	86.9
105.00	87.9	88.3	88.5	88.4	88.8	88.5	88.5	88.2	88.0
110.00	89.0	89.3	89.4	89.3	89.6	89.4	89.3	89.2	89.0
115.00	89.9	90.1	90.1	90.1	90.2	90.0	90.1	90.1	89.9
120.00	90.6	90.7	90.7	90.7	90.7	90.7	90.8	90.8	90.7
125.00	91.2	91.2	91.2	91.3	91.3	91.3	91.4	91.3	91.3
130.00	91.7	91.7	91.8	91.8	91.9	91.9	91.9	91.8	91.8
135.00	92.2	92.3	92.3	92.3	92.5	92.3	92.3	92.3	92.2
140.00	92.7	92.7	92.8	92.8	92.9	92.8	92.8	92.7	92.7
145.00	93.0	93.1	93.1	93.2	93.2	93.2	93.2	93.1	93.1
150.00	93.4	93.4	93.5	93.5	93.5	93.5	93.5	93.5	93.4
155.00	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8
160.00	94.2	94.2	94.1	94.1	94.1	94.1	94.0	94.1	94.1
165.00	94.5	94.4	94.5	94.4	94.4	94.4	94.4	94.4	94.4
170.00	94.7	94.7	94.8	94.7	94.8	94.7	94.8	94.7	94.7
175.00	95.0	95.0	95.0	95.0	95.1	95.0	95.1	95.0	95.0
180.00	95.2	95.2	95.3	95.3	95.4	95.3	95.3	95.3	95.3
184.99	95.5	95.5	95.5	95.6	95.5	95.6	95.5	95.6	95.6
189.99	95.7	95.8	95.7	95.8	95.8	95.8	95.8	95.8	95.8
194.99	96.0	96.0	96.0	96.0	96.1	96.0	96.0	96.0	96.0
199.99	96.2	96.3	96.2	96.2	96.2	96.2	96.2	96.2	96.3

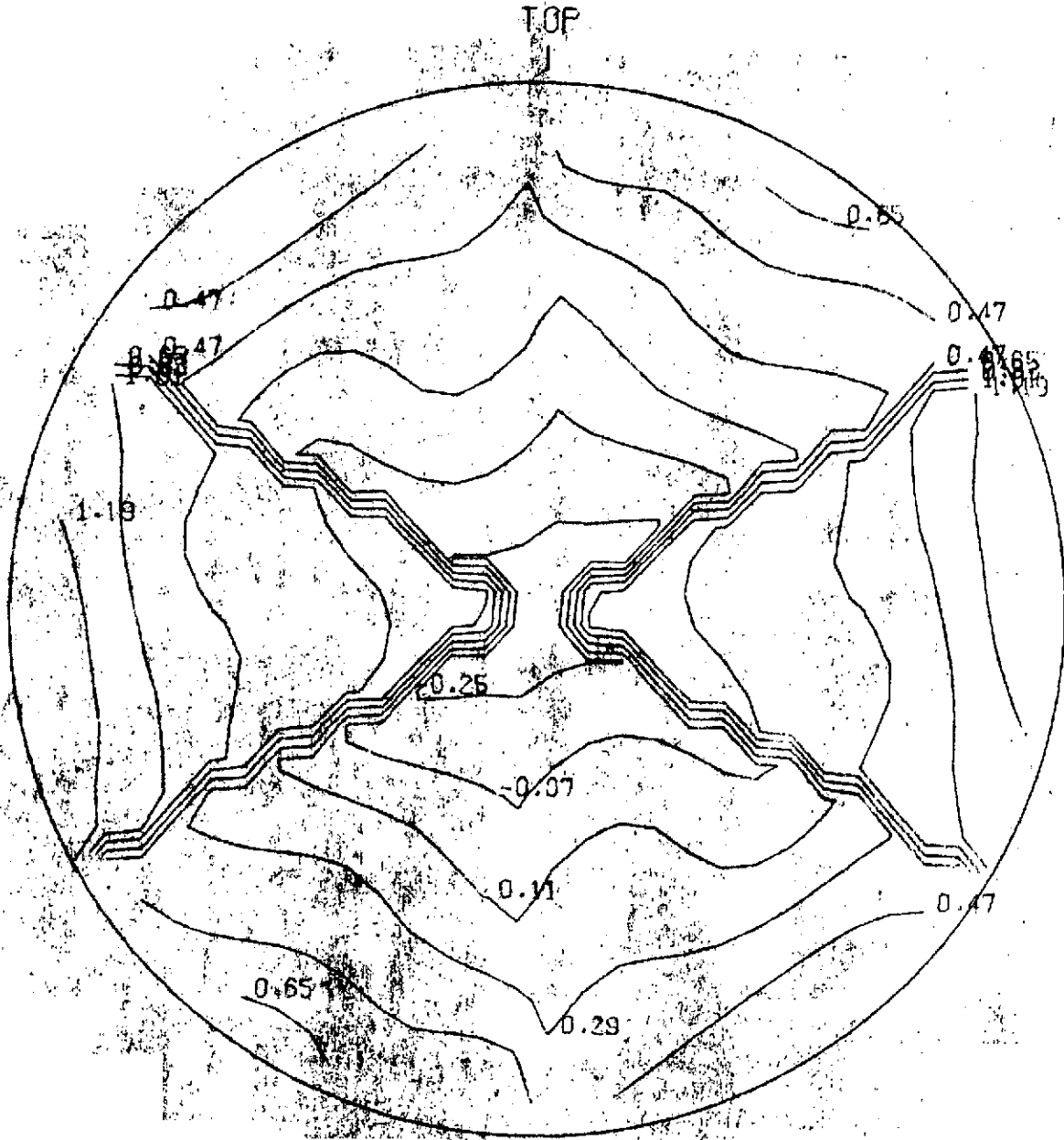
\*\*\*\*\*



FIGURE 30

Wavefront Plot-Q Polarization

Task 2.2 - Nominal + Mfg. Error - On Axis



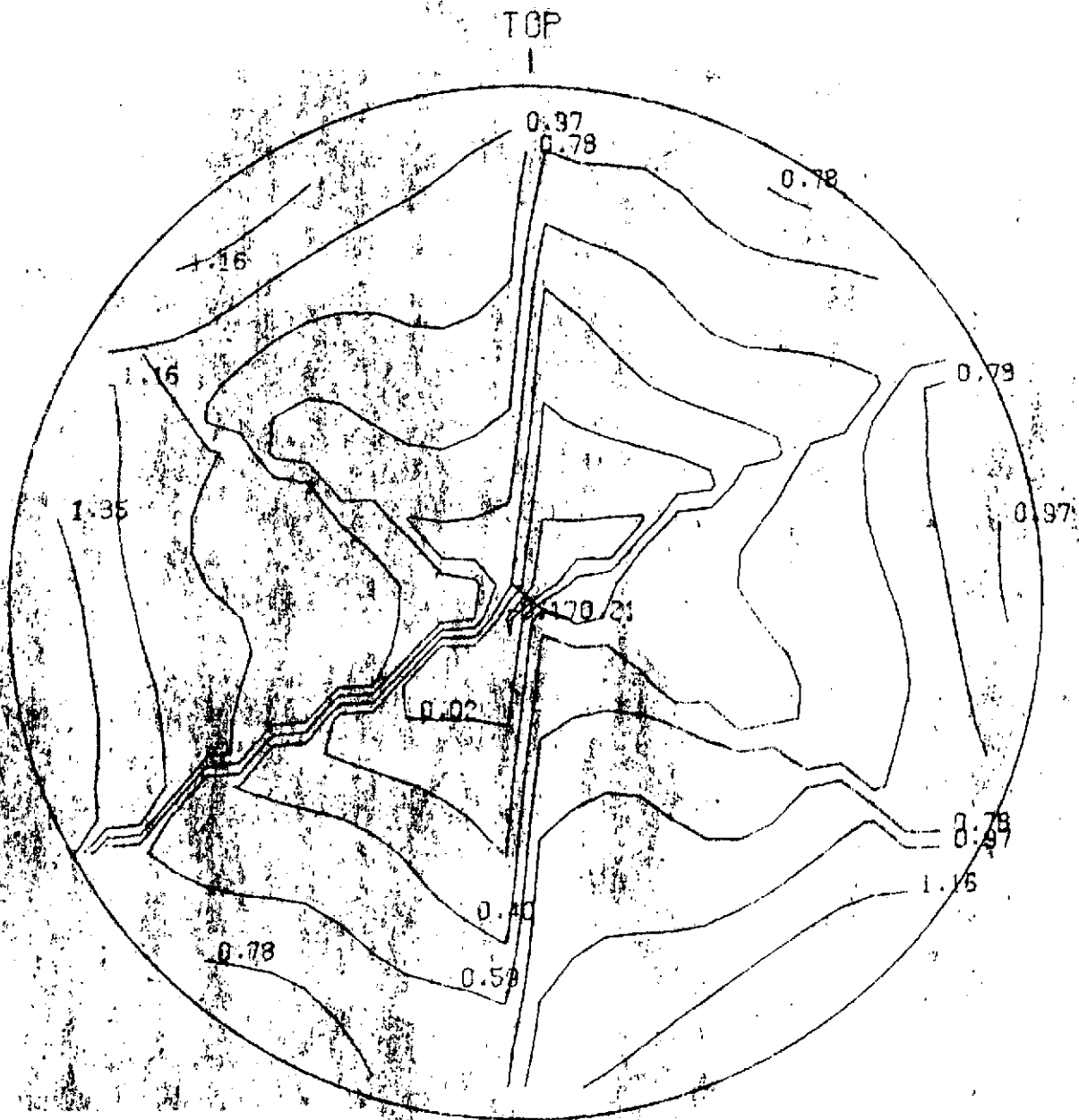
REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FIGURE 32

Wavefront Plot-P Polarization

Task 2.2 - Nominal + Mfg. Error - On Axis



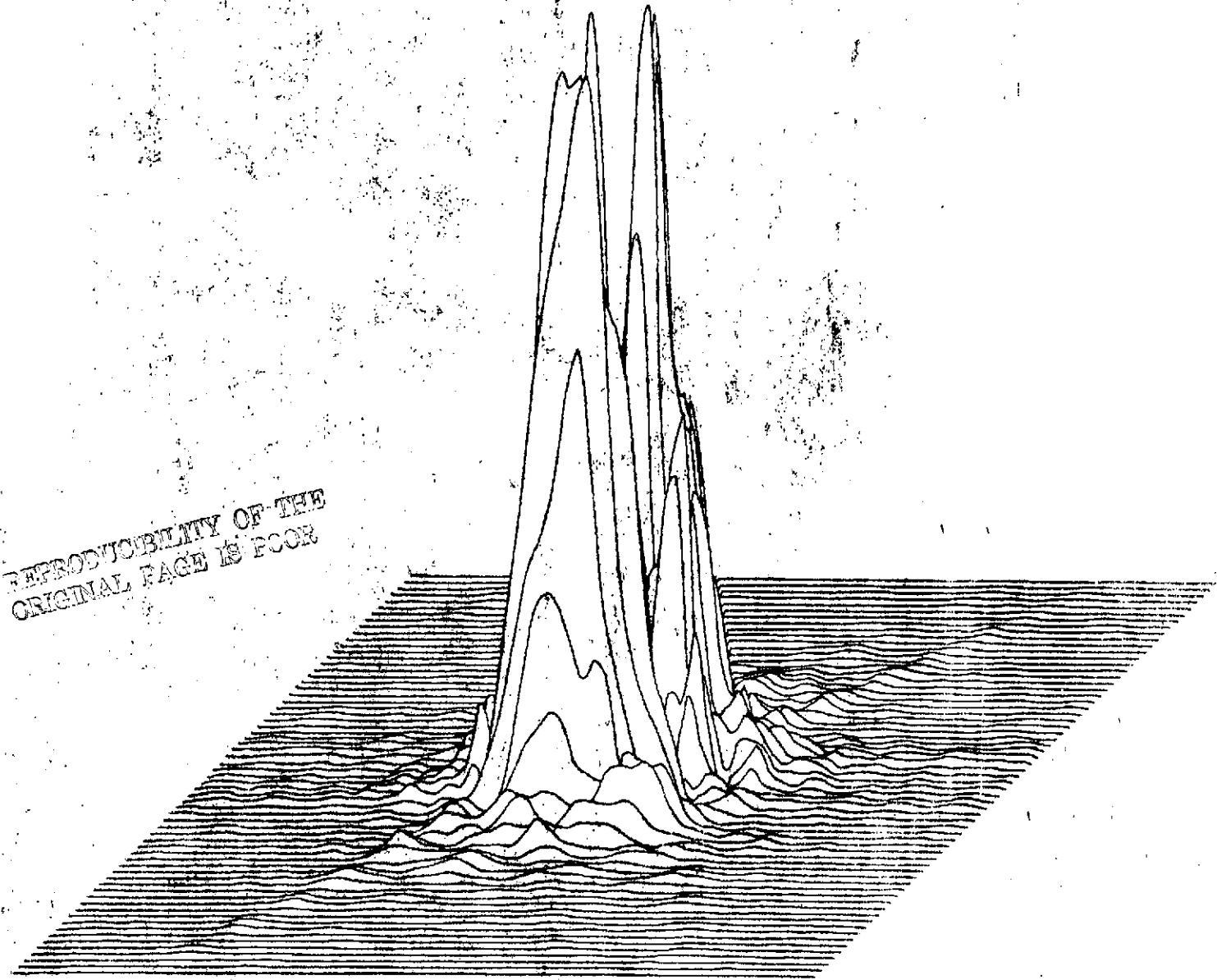
REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FIGURE 34

Point Spread Function

Task 2.2 - Nominal + Mfg. Error - On Axis



REPRODUCIBILITY OF THE ORIGINAL FACE IS POOR



FIGURE 35

Intensity Distribution - Central 129 Microradians

Task 2.2 - Nominal + Mfg. Error - On Axis

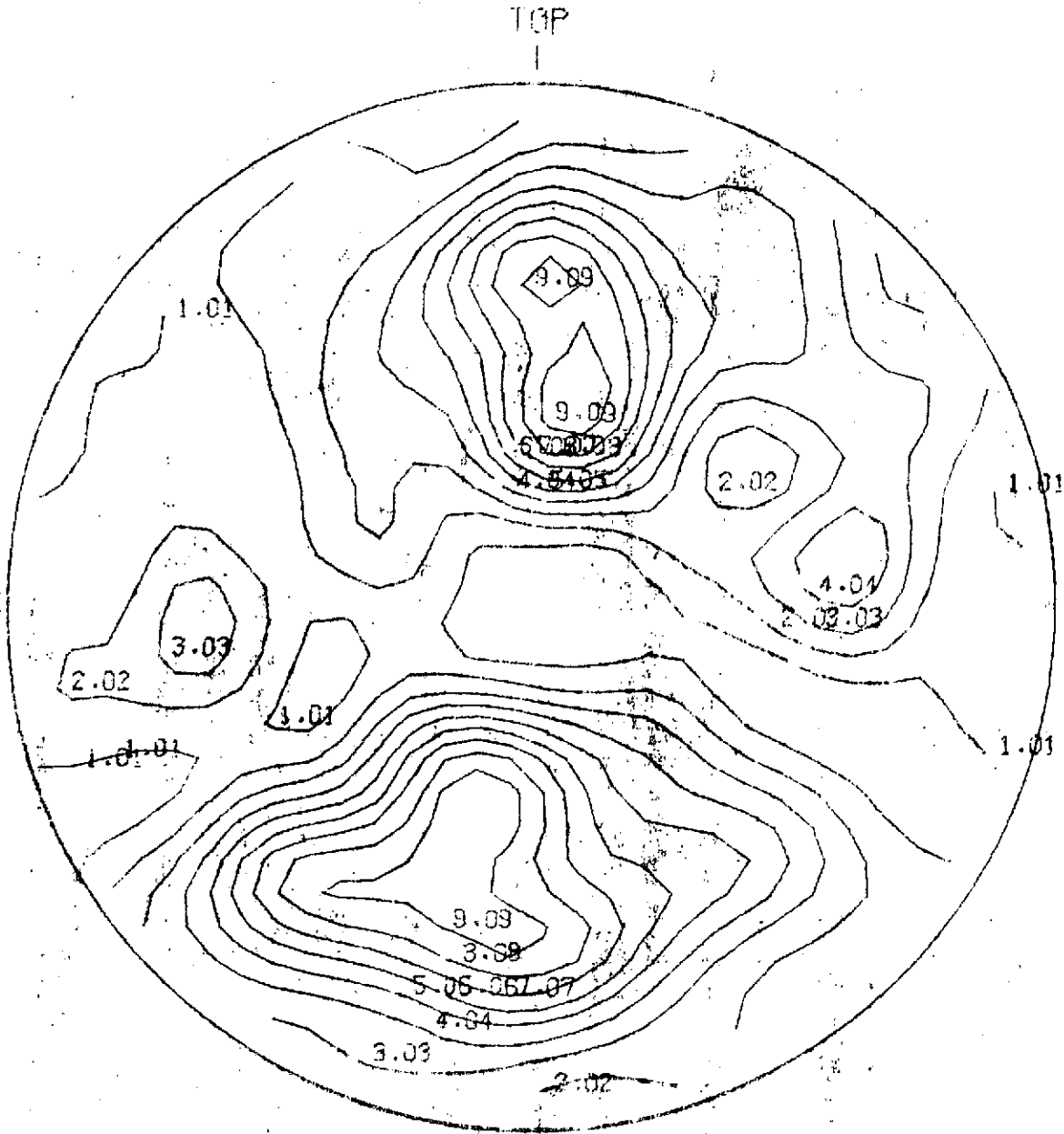
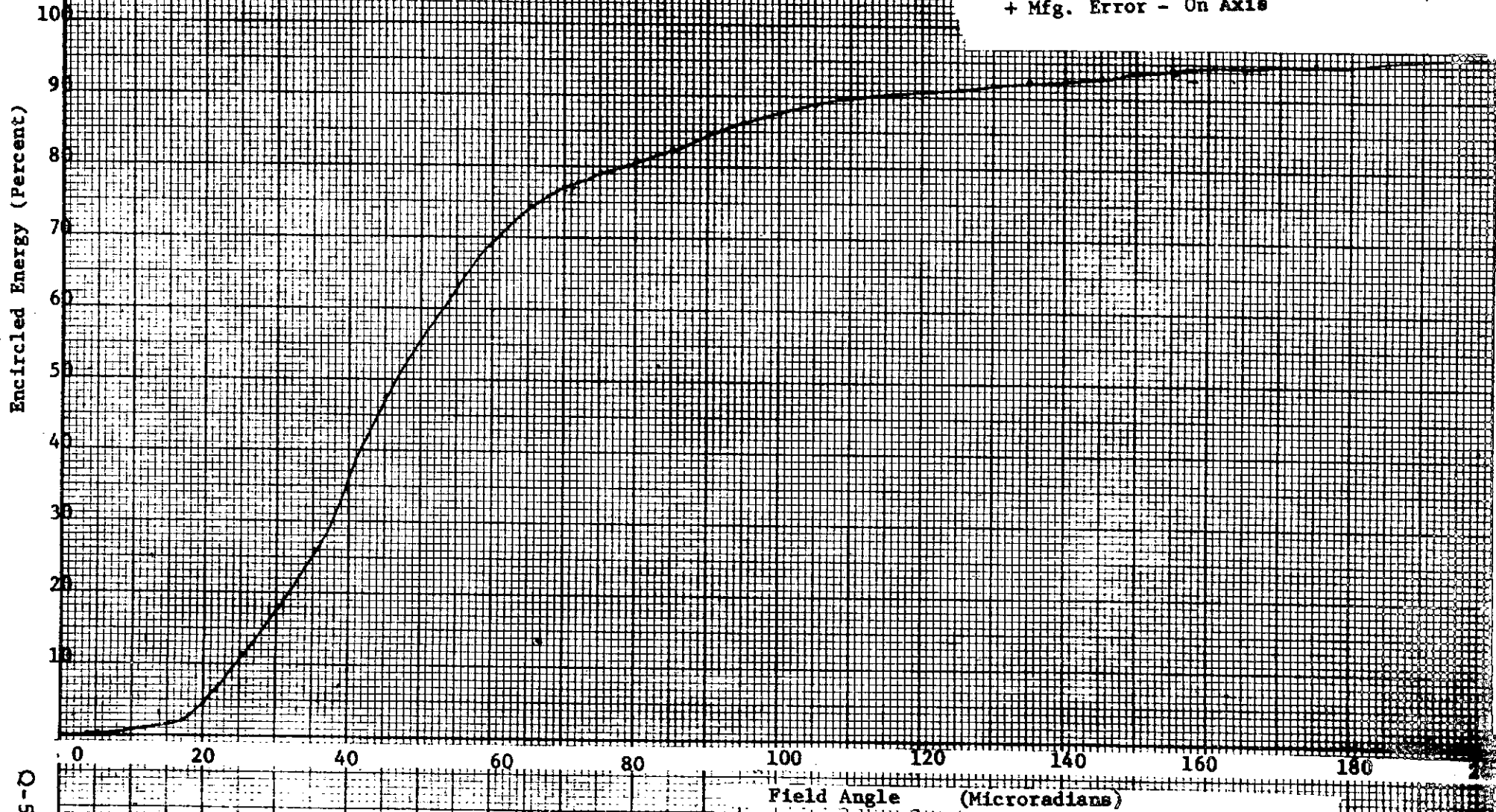


FIGURE 36  
Encircled Energy  
Vs  
Field Angle

Task 2.2 - Nominal

+ Mfg. Error - On Axis



ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error -15° Off Axis

\*\*\*\*\*

CIRCLE \*  
----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
RADIUS \*  
----- \*

(MI- \* CENTER (MICRONS):  
CRONS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
\*

\*\*\*\*\*

2.00	*	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0
4.00	*	0.3	0.4	0.2	0.2	0.2	0.2	0.2	0.5	0.5
6.00	*	0.3	0.4	0.7	0.7	1.6	0.7	0.8	0.5	0.5
8.00	*	1.1	1.2	1.3	1.4	1.6	1.4	1.4	1.5	1.5
10.00	*	1.6	1.7	1.7	2.0	3.1	1.9	1.9	2.1	2.0
12.00	*	3.5	3.7	2.7	3.3	3.5	3.3	3.0	4.4	4.2
14.00	*	3.5	3.7	3.7	4.9	4.5	4.9	4.5	4.4	4.2
16.00	*	6.0	6.3	4.8	6.4	5.3	6.4	5.7	7.4	7.0
18.00	*	7.0	7.3	6.2	7.9	7.6	7.9	7.4	8.6	8.2
20.00	*	9.1	9.3	8.0	10.1	7.6	10.1	9.6	11.0	10.5
22.00	*	10.1	10.4	10.2	12.1	10.9	12.0	12.2	12.3	11.7
24.00	*	12.6	12.7	11.6	13.4	12.9	13.3	13.7	15.1	14.5
26.00	*	13.8	13.9	14.6	15.8	16.7	15.6	16.9	16.6	16.0
28.00	*	16.6	16.5	17.5	18.5	18.1	18.2	20.3	19.5	19.0
30.00	*	18.8	18.6	20.2	20.9	22.3	20.5	23.0	22.0	21.6
32.00	*	22.9	22.5	22.4	23.3	24.9	22.9	25.4	25.8	25.6
34.00	*	23.7	23.3	25.7	26.6	27.5	26.2	28.8	26.7	26.5
36.00	*	28.3	27.9	28.3	29.8	31.3	29.5	31.5	30.8	30.8
38.00	*	30.6	30.3	31.3	33.0	34.5	32.6	34.1	33.2	33.2
40.00	*	34.5	34.2	34.3	36.5	36.7	36.3	37.1	36.6	36.7
42.00	*	36.6	36.3	38.1	40.3	40.0	40.2	40.6	38.7	38.8
44.00	*	40.7	40.5	40.1	42.3	43.1	42.4	42.6	42.4	42.6
46.00	*	43.5	43.4	44.3	46.1	46.9	46.3	46.5	45.4	45.7
48.00	*	46.6	46.6	47.5	49.3	48.6	49.6	50.1	48.4	48.7
50.00	*	49.6	49.6	50.5	51.6	52.9	51.9	52.5	51.7	52.0
52.00	*	52.6	52.7	53.3	54.3	56.0	54.6	55.7	54.8	55.0
54.00	*	54.3	54.5	56.8	57.2	59.3	57.5	58.7	56.7	57.0
56.00	*	57.6	57.8	59.8	60.5	62.4	60.7	62.1	59.8	60.0
58.00	*	60.1	60.3	62.1	62.6	65.5	62.8	64.0	62.5	62.6
60.00	*	62.6	62.8	64.8	65.6	68.0	65.6	66.8	64.6	64.9
62.00	*	64.6	64.8	67.4	68.0	70.1	68.0	69.1	66.6	66.8
64.00	*	67.9	67.9	69.0	69.8	72.1	69.8	71.0	69.2	69.5
66.00	*	69.8	69.9	71.6	72.1	74.1	72.2	73.2	71.1	71.4
68.00	*	72.1	72.0	73.4	73.8	74.9	73.9	74.6	72.9	73.3
70.00	*	73.8	73.7	75.2	75.3	76.6	75.5	76.1	74.3	74.8
72.00	*	75.8	75.6	76.5	76.5	77.9	76.7	77.2	75.9	76.3
74.00	*	76.7	76.6	78.2	77.9	79.1	78.2	78.4	76.9	77.3
76.00	*	78.5	78.3	79.5	79.1	80.1	79.3	79.4	78.3	78.6
78.00	*	79.6	79.5	80.2	80.0	81.1	80.2	80.1	79.3	79.5
80.00	*	80.6	80.6	81.4	81.0	81.8	81.1	81.0	80.3	80.4

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error - -15° Off Axis

\*\*\*\*\*

CIRCLE \*

----- \*

RADIUS \*

----- \*

(MI-

CRONS) \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

\* CENTER (MICRONS):

\* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13

\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*

\*\*\*\*\*

5.00	*	0.3	0.4	0.7	0.6	0.9	0.6	0.7	0.5	0.5
10.00	*	1.6	1.7	1.7	2.0	3.1	1.9	1.9	2.1	2.0
15.00	*	5.0	5.3	4.4	5.8	5.3	5.8	5.2	6.2	5.9
20.00	*	9.1	9.3	8.0	10.1	7.6	10.1	9.6	11.0	10.5
25.00	*	13.4	13.5	14.1	15.3	14.1	15.2	16.5	16.1	15.5
30.00	*	18.8	18.6	20.2	20.9	22.3	20.5	23.0	22.0	21.6
35.00	*	26.6	26.2	26.6	27.8	30.3	27.4	29.5	29.0	28.9
40.00	*	34.5	34.2	34.3	36.5	36.7	36.3	37.1	36.6	36.7
45.00	*	42.0	41.9	42.7	44.6	44.6	44.8	45.0	43.9	44.2
50.00	*	49.6	49.6	50.5	51.6	52.9	51.9	52.5	51.7	52.0
55.00	*	56.5	56.7	58.0	58.7	61.7	58.9	60.2	58.7	58.8
60.00	*	62.6	62.8	64.8	65.6	68.0	65.6	66.8	64.6	64.9
65.00	*	68.7	68.7	70.7	71.3	73.1	71.4	72.4	70.0	70.3
70.00	*	73.8	73.7	75.2	75.3	76.6	75.5	76.1	74.3	74.8
75.00	*	77.9	77.7	78.7	78.5	79.7	78.7	78.9	77.7	78.1
80.00	*	80.6	80.6	81.4	81.0	81.8	81.1	81.0	80.3	80.4
85.00	*	82.5	82.6	83.3	83.1	83.5	83.1	82.9	82.4	82.3
90.00	*	84.1	84.2	84.6	84.6	84.8	84.5	84.4	84.2	84.0
95.00	*	85.4	85.6	85.7	85.8	85.9	85.7	85.7	85.7	85.5
100.00	*	86.5	86.6	86.6	86.7	86.9	86.7	86.9	86.8	86.7
105.00	*	87.4	87.4	87.6	87.7	87.8	87.7	87.8	87.6	87.6
110.00	*	88.3	88.3	88.5	88.5	88.7	88.6	88.6	88.4	88.5
115.00	*	89.2	89.2	89.3	89.2	89.4	89.3	89.3	89.2	89.3
120.00	*	89.9	89.9	90.0	89.9	90.1	90.0	89.9	89.8	89.9
125.00	*	90.5	90.5	90.6	90.5	90.7	90.6	90.4	90.3	90.3
130.00	*	91.0	91.0	91.1	91.1	91.1	91.1	90.9	90.9	90.8
135.00	*	91.4	91.4	91.4	91.5	91.5	91.5	91.5	91.5	91.5
140.00	*	91.9	91.8	91.9	91.9	91.9	91.9	91.9	91.9	91.9
145.00	*	92.3	92.3	92.3	92.3	92.2	92.3	92.2	92.2	92.2
150.00	*	92.7	92.7	92.7	92.7	92.7	92.6	92.6	92.6	92.6
155.00	*	93.0	93.1	93.1	93.1	93.1	93.0	93.0	93.0	92.9
160.00	*	93.4	93.4	93.4	93.4	93.4	93.4	93.3	93.4	93.4
165.00	*	93.8	93.7	93.8	93.8	93.8	93.8	93.8	93.8	93.8
170.00	*	94.1	94.0	94.0	94.1	94.2	94.1	94.1	94.1	94.1
175.00	*	94.4	94.3	94.4	94.4	94.4	94.4	94.4	94.4	94.4
180.00	*	94.7	94.7	94.7	94.7	94.8	94.7	94.8	94.7	94.7
184.99	*	95.0	95.0	95.0	94.9	94.9	95.0	95.0	95.0	95.0
189.99	*	95.2	95.3	95.3	95.2	95.3	95.3	95.2	95.2	95.2
194.99	*	95.5	95.5	95.6	95.5	95.6	95.5	95.5	95.5	95.4
199.99	*	95.8	95.8	95.8	95.8	95.8	95.8	95.7	95.8	95.7

\*

\*\*\*\*\*



FIGURE 38

Wavefront Plot-Q Polarization

Task 2.2 - Nominal + Mfg. Error -15° Off Axis

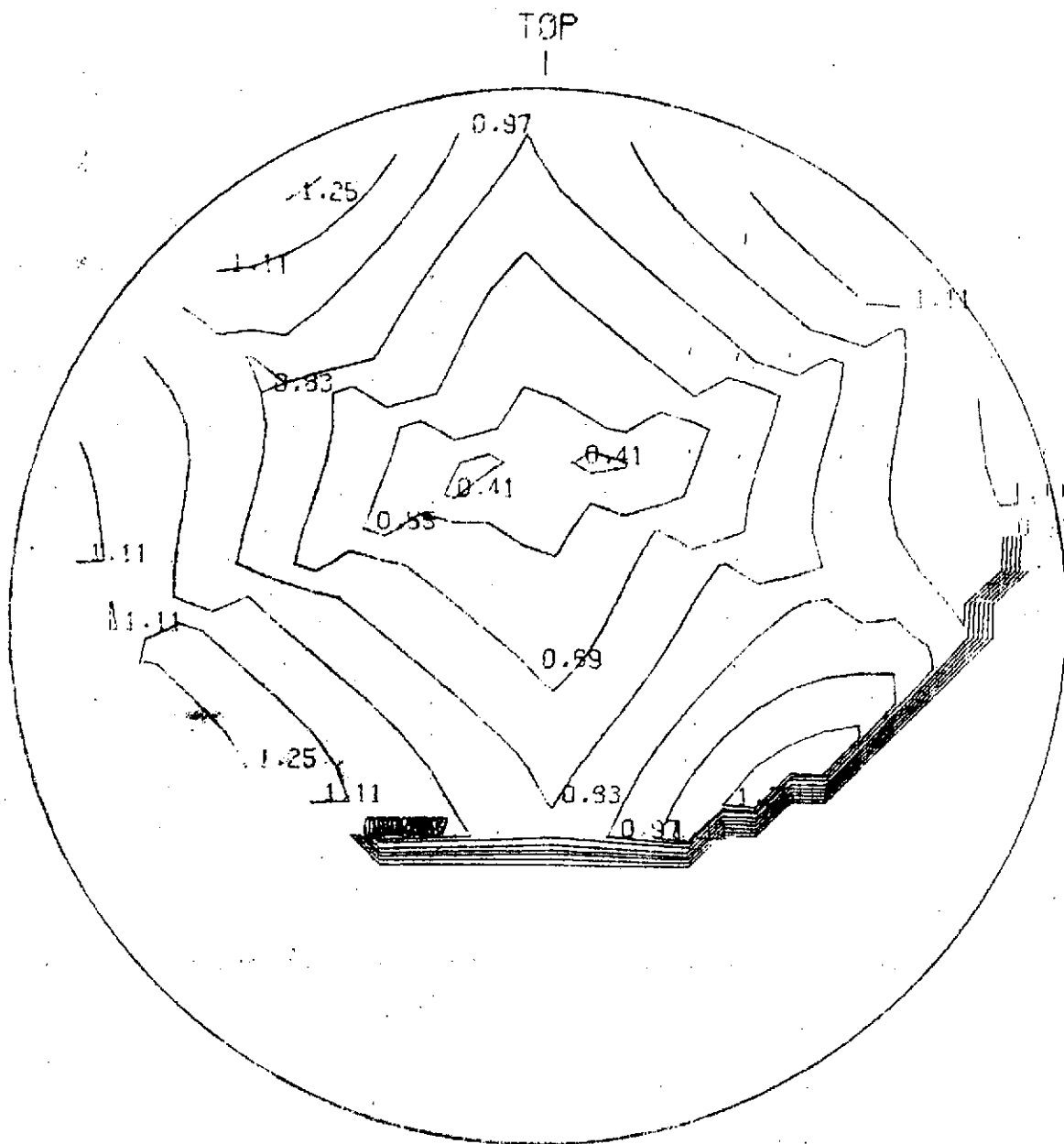
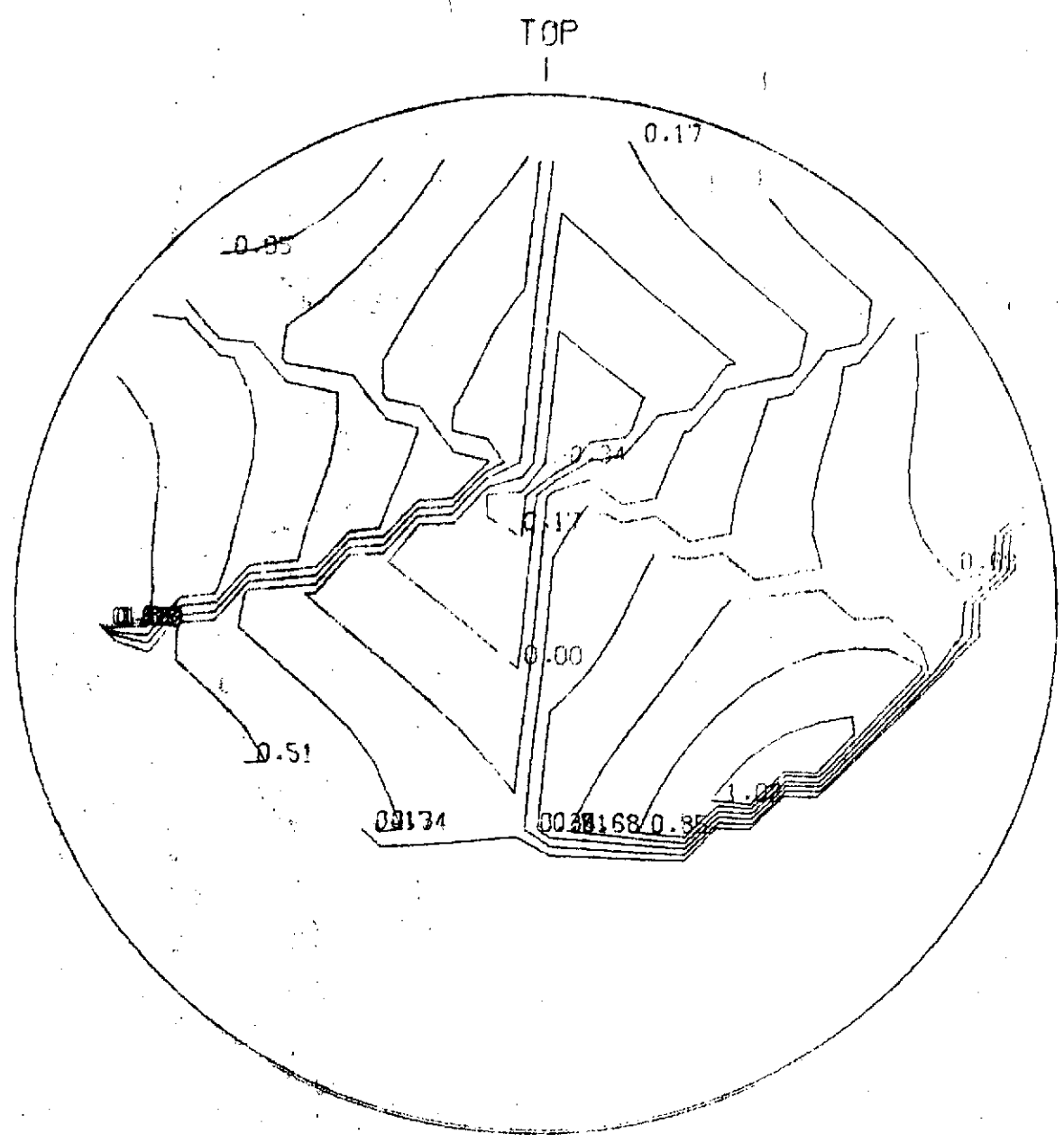




FIGURE 40

Wavefront Plot-P Polarization

Task 2.2 - Nominal + Mfg. Error -15° Off Axis



REPRODUCIBILITY OF THIS  
ORIGINAL PAGE IS POOR

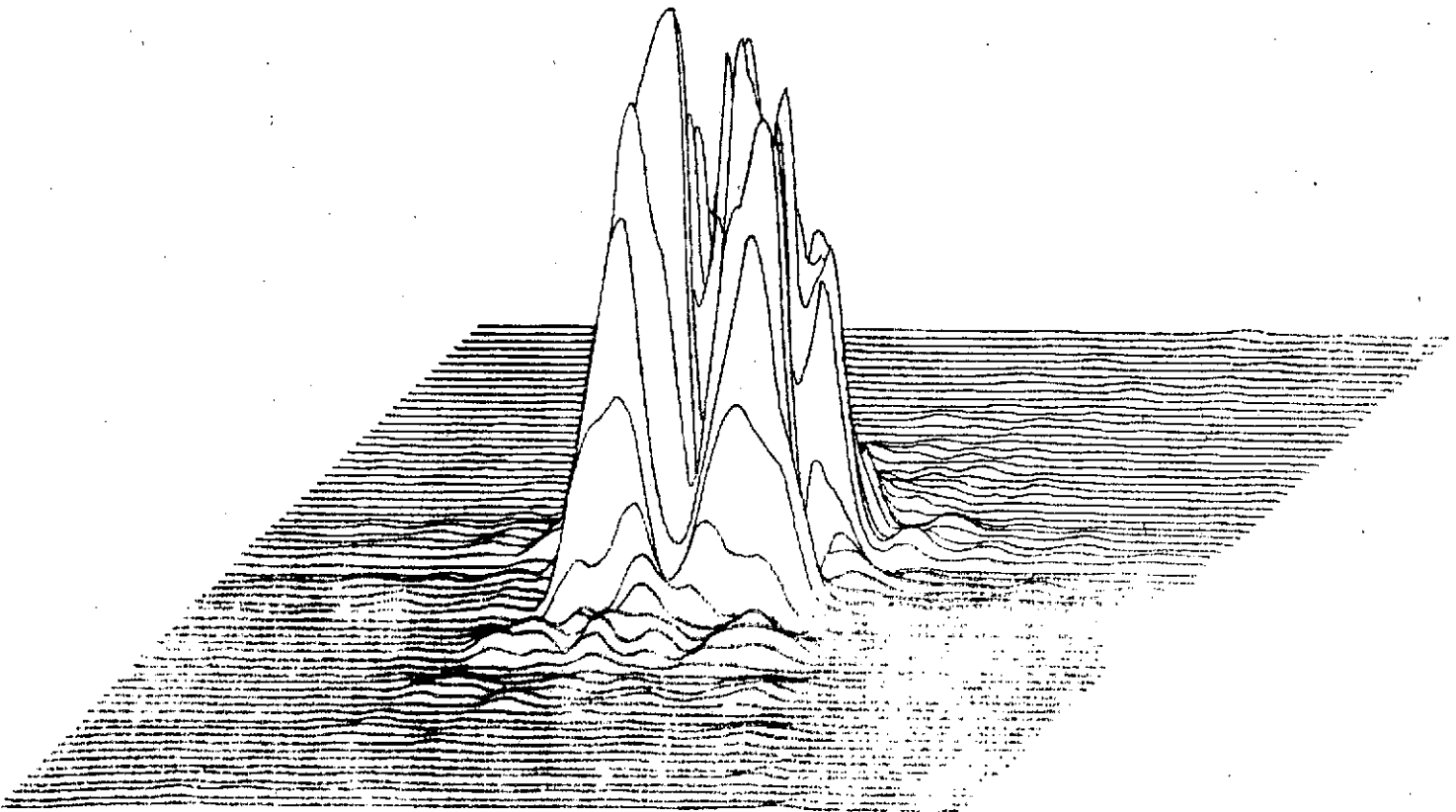




FIGURE 42

Point Spread Function

Task 2.2 - Nominal + Mfg. Error -15° Off Axis



Intensity Distribution - Central 129 Microradians

Task 2.2 - Nominal + Mfg. Error -15° Off Axis

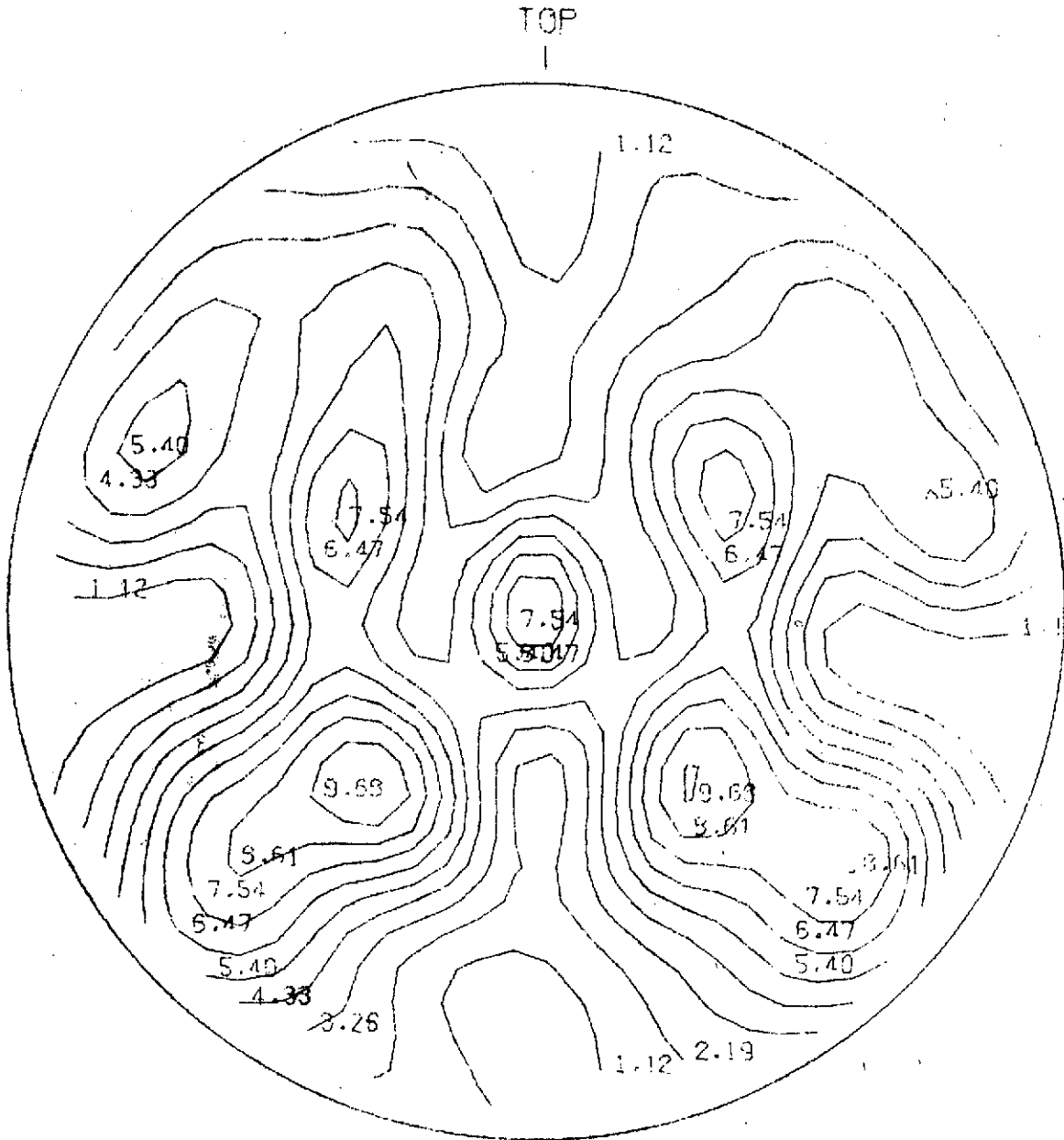


FIGURE 44

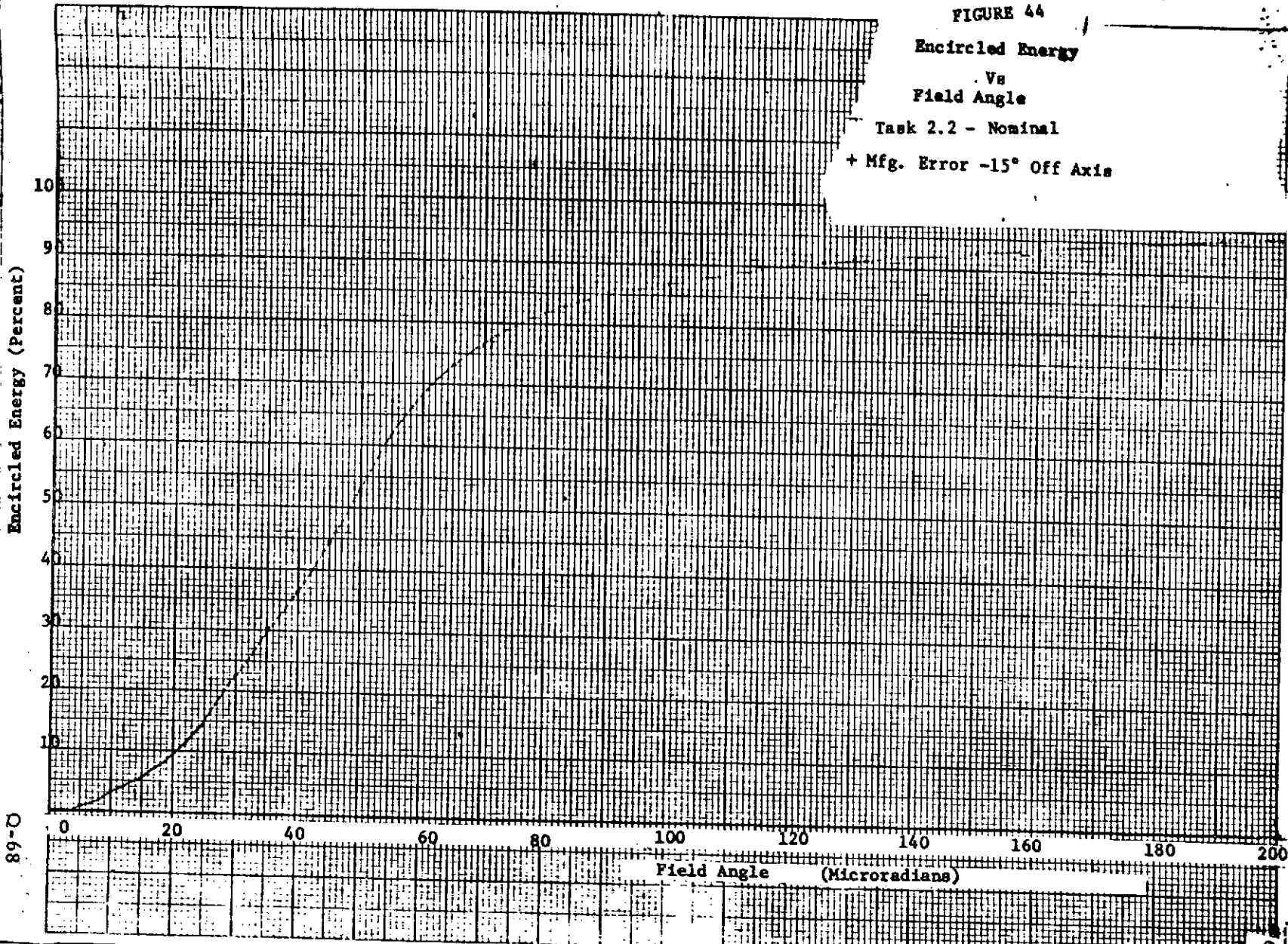
Encircled Energy

V<sub>8</sub>

Field Angle

Task 2.2 - Nominal

+ Mfg. Error -15° Off Axis



Encircled Energy (Percent)

89-0

Field Angle (Microradians)

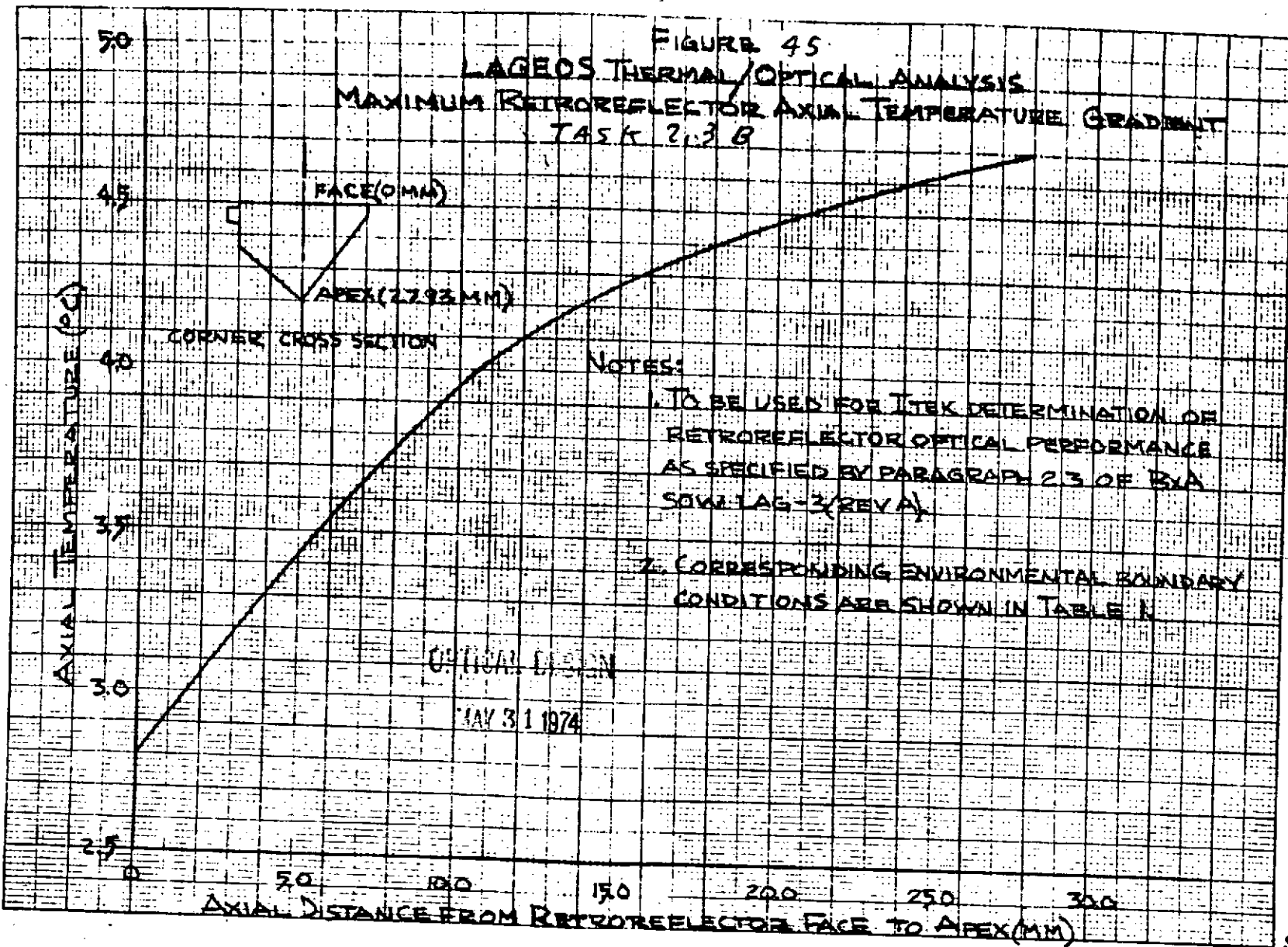
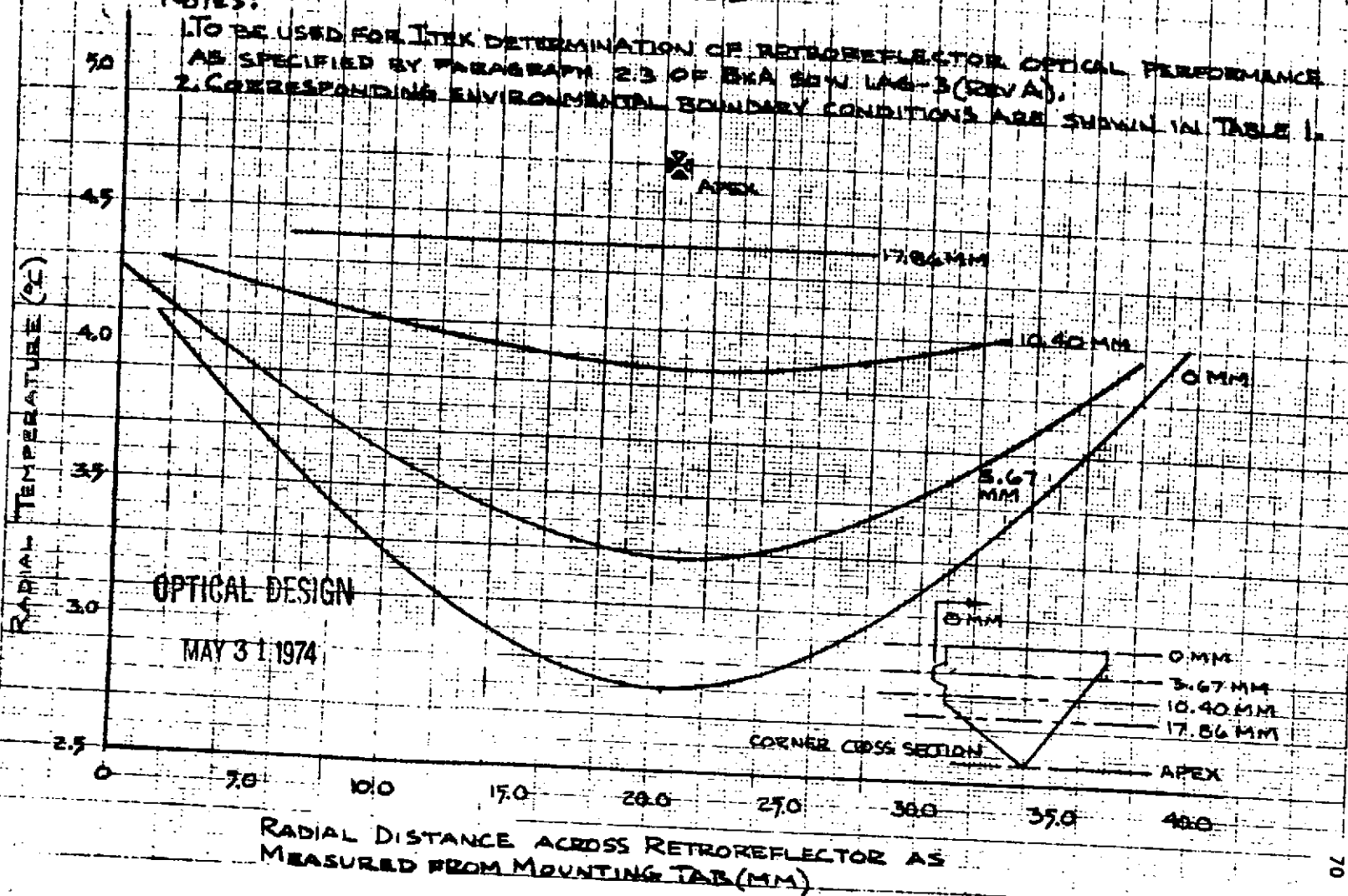


FIGURE 46  
 LAGEOS THERMAL/OPTICAL ANALYSIS  
 MAXIMUM RETROREFLECTOR RADIAL TEMPERATURE GRADIENTS  
 TASK 2.3B

NOTES:

1. TO BE USED FOR ITRK DETERMINATION OF RETROREFLECTOR OPTICAL PERFORMANCE AS SPECIFIED BY PARAGRAPH 2.3 OF SXA SEN LAG-3 (REV A).
2. CORRESPONDING ENVIRONMENTAL BOUNDARY CONDITIONS ARE SHOWN IN TABLE 1.



0-70

Attachment to Memo 74-520-215

EAG 5-18-74

FIGURE 47

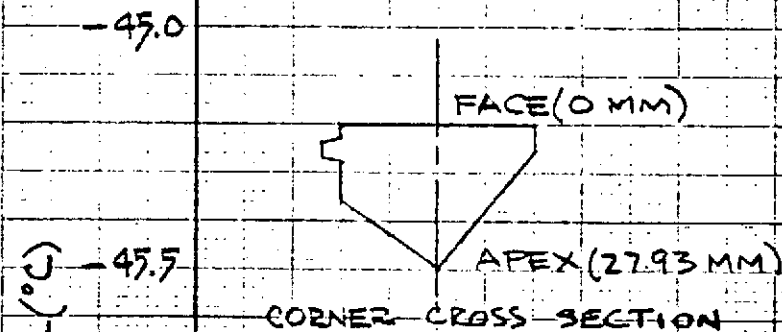
LAGEOS THERMAL/OPTICAL ANALYSIS  
MAXIMUM RETROREFLECTOR AXIAL TEMPERATURE GRADIENT OPTICAL DESIGN  
TASK 2.3A1

JUL 6 1974

ADVANCE COPY  
FOR INFORMATION PURPOSES ONLY

OPTICAL DESIGN

6 1974



AXIAL TEMPERATURE (°C)

NOTES:

1. TO BE USED FOR ITEX DETERMINATION OF RETRO-REFLECTOR OPTICAL PERFORMANCE AS SPECIFIED BY PARAGRAPH
2. RETROREFLECTOR TEMPERATURES ARE BASED ON A -30°C CAVITY TEMPERATURE, FULL SUN, § 2-03 COATED RETAINER RING.

-45.0  
-45.5  
-46.0  
-46.5  
-47.0

0 5.0 10.0 15.0 20.0 25.0 30.0

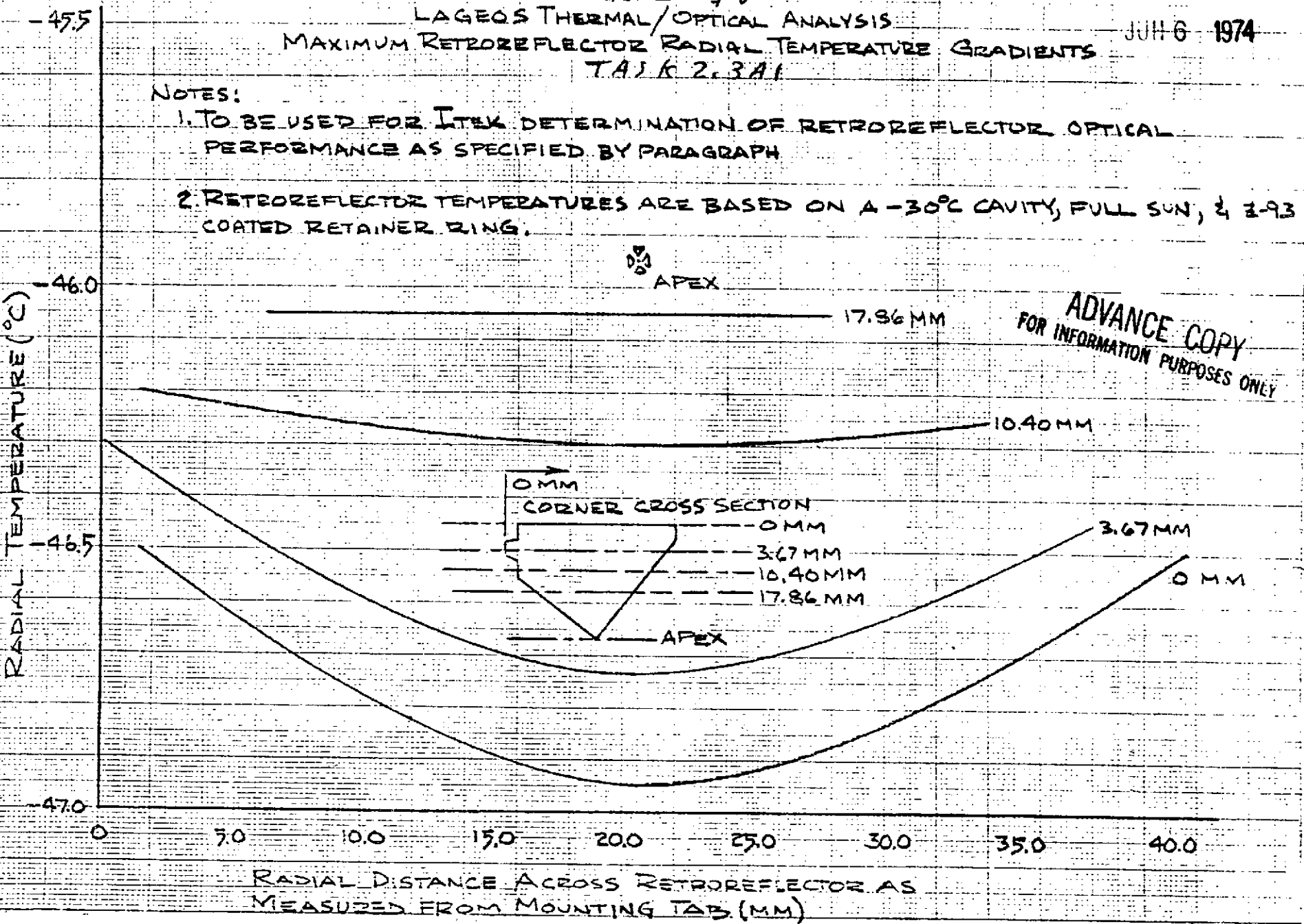
AXIAL DISTANCE FROM RETROREFLECTOR FACE TO APEX (MM)

JUL 6 1974

FIGURE 48  
LAGEOS THERMAL/OPTICAL ANALYSIS  
MAXIMUM RETROREFLECTOR RADIAL TEMPERATURE GRADIENTS  
TASK 2.3A1

NOTES:

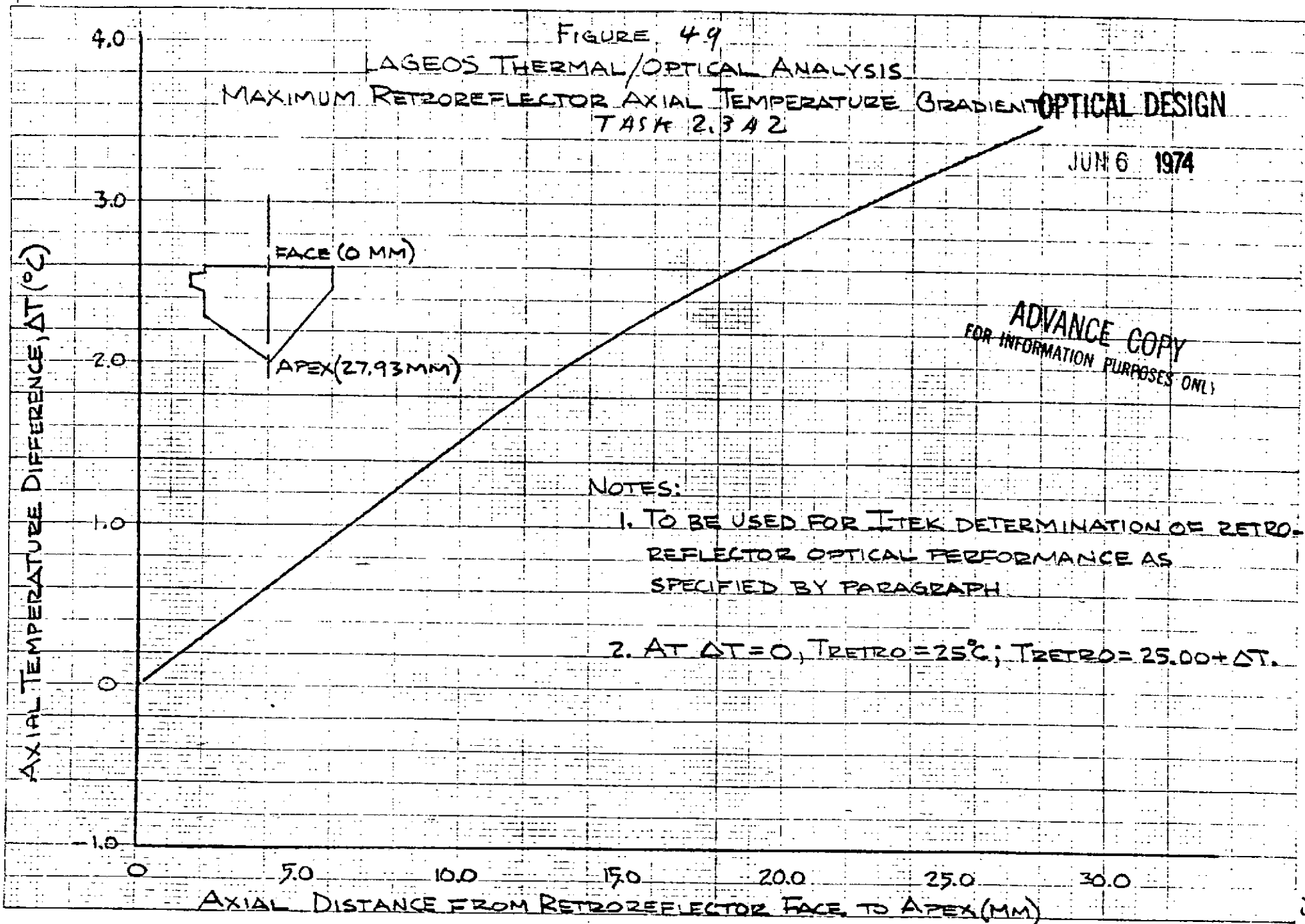
- 1. TO BE USED FOR Itek DETERMINATION OF RETROREFLECTOR OPTICAL PERFORMANCE AS SPECIFIED BY PARAGRAPH
- 2. RETROREFLECTOR TEMPERATURES ARE BASED ON A -30°C CAVITY, FULL SUN, & Z-93 COATED RETAINER RING.



Q-72

72





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**FIGURE 50**  
**LAGEOS THERMAL/OPTICAL ANALYSIS**  
**MAXIMUM RETROREFLECTOR RADIAL TEMPERATURE GRADIENTS**  
**TASK 2.3.4.2**

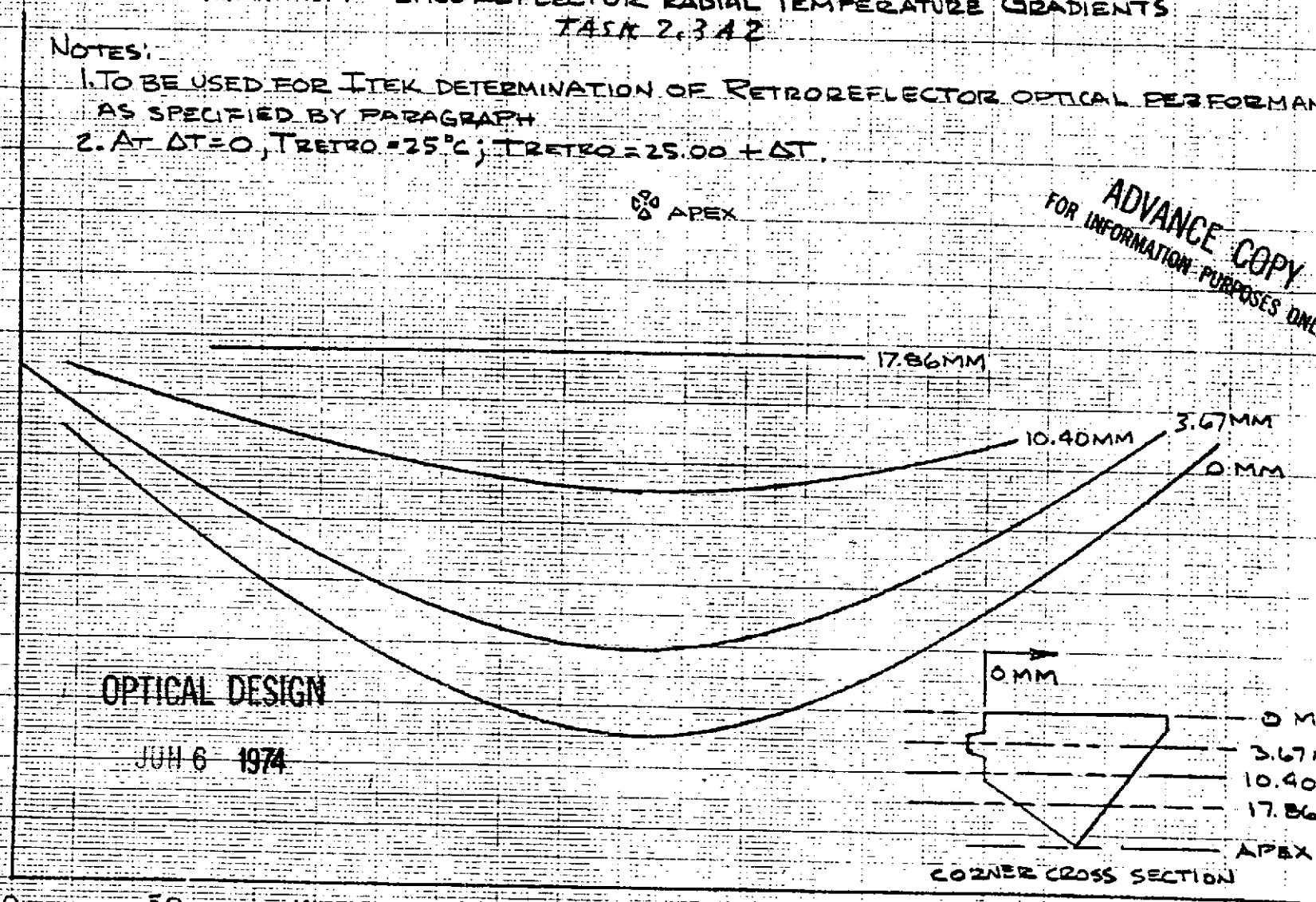
**NOTES:**

1. TO BE USED FOR ITEK DETERMINATION OF RETROREFLECTOR OPTICAL PERFORMANCE AS SPECIFIED BY PARAGRAPH
2. AT  $\Delta T = 0$ ,  $T_{RETRO} = 25^{\circ}C$ ;  $T_{RETRO} = 25.00 + \Delta T$ .

**ADVANCE COPY**  
 FOR INFORMATION PURPOSES ONLY

RADIAL TEMPERATURE DIFFERENCE,  $\Delta T$  ( $^{\circ}C$ )

4.0  
3.0  
2.0  
1.0  
0  
-1.0



**OPTICAL DESIGN**

JUN 6 1974

CORNER CROSS SECTION

RADIAL DISTANCE ACROSS RETROREFLECTOR AS MEASURED FROM MOUNTING TAB (MM)

0-74

74

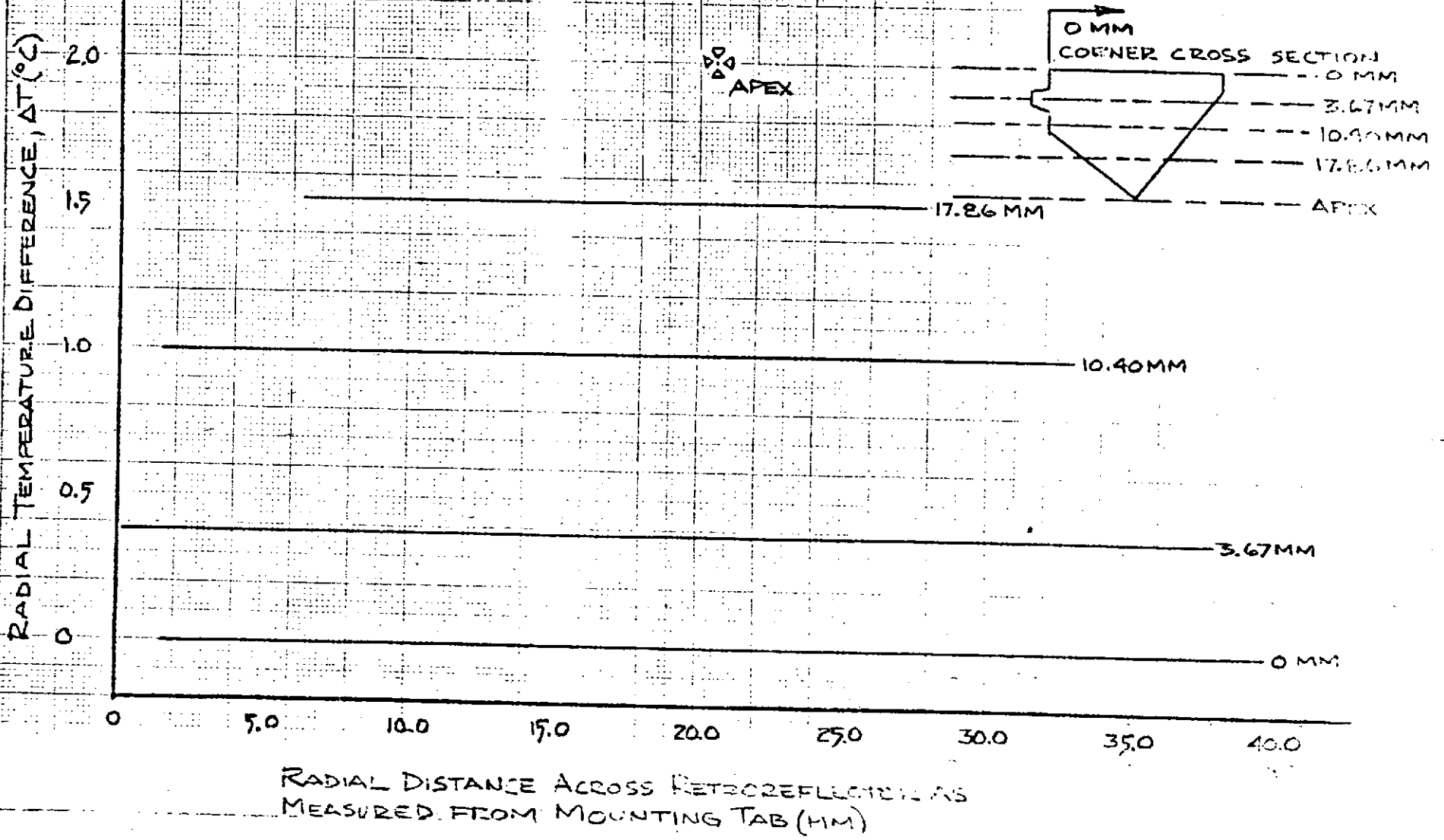
FIGURE 51

LAGEOS THERMAL/OPTICAL ANALYSIS

RETROREFLECTOR UNIT AXIAL TEMPERATURE GRADIENT  
TASK 2.5A

NOTES:

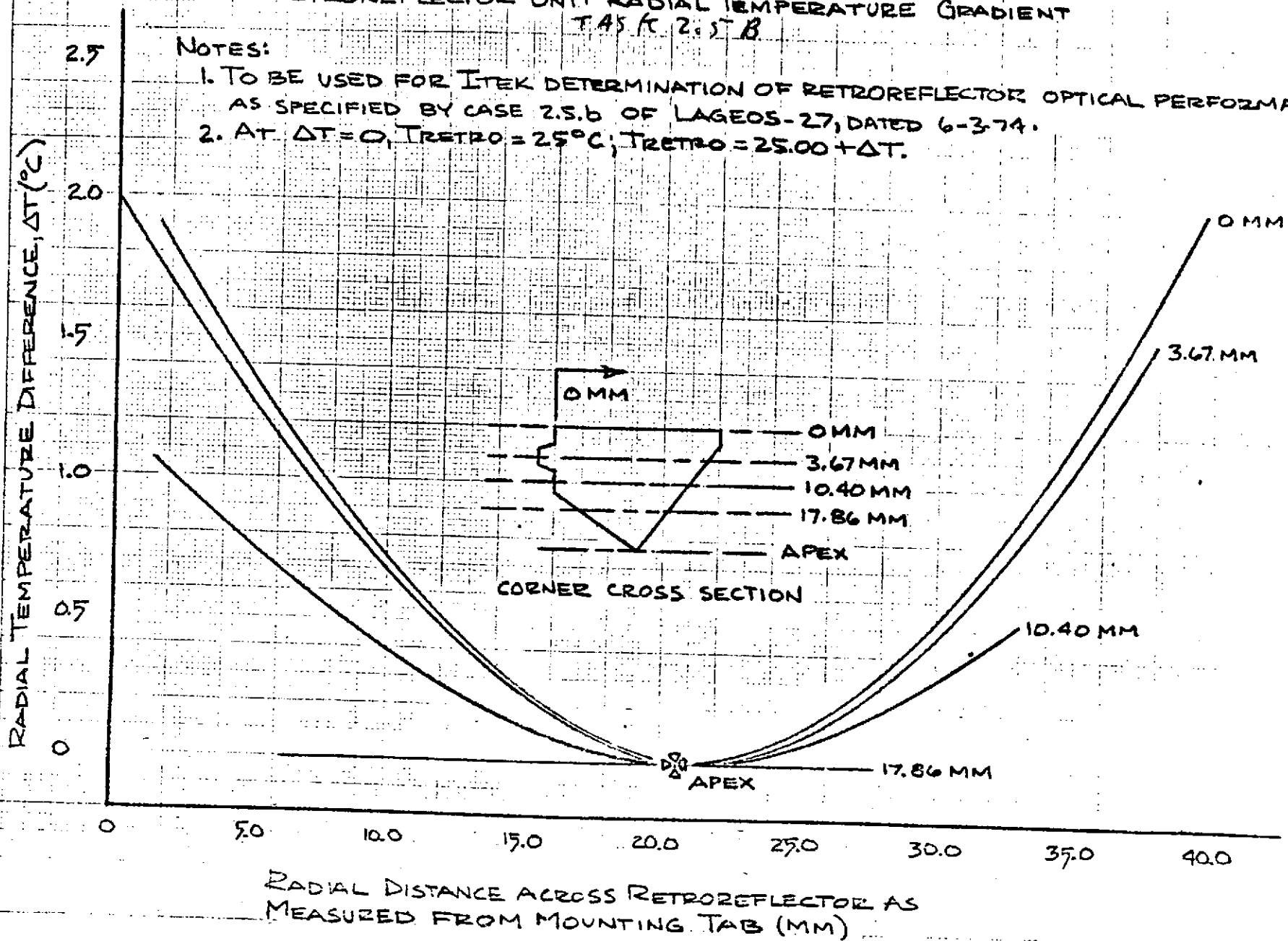
1. TO BE USED FOR ITEK DETERMINATION OF RETROREFLECTOR OPTICAL PERFORMANCE AS SPECIFIED BY CASE 2.5.Q OF LAGEOS-27, DATED 6-3-74.
2. AT  $\Delta T = 0$ ,  $T_{RETRO} = 25^{\circ}\text{C}$ ;  $T_{RETRO} = 25.00 + \Delta T$ .



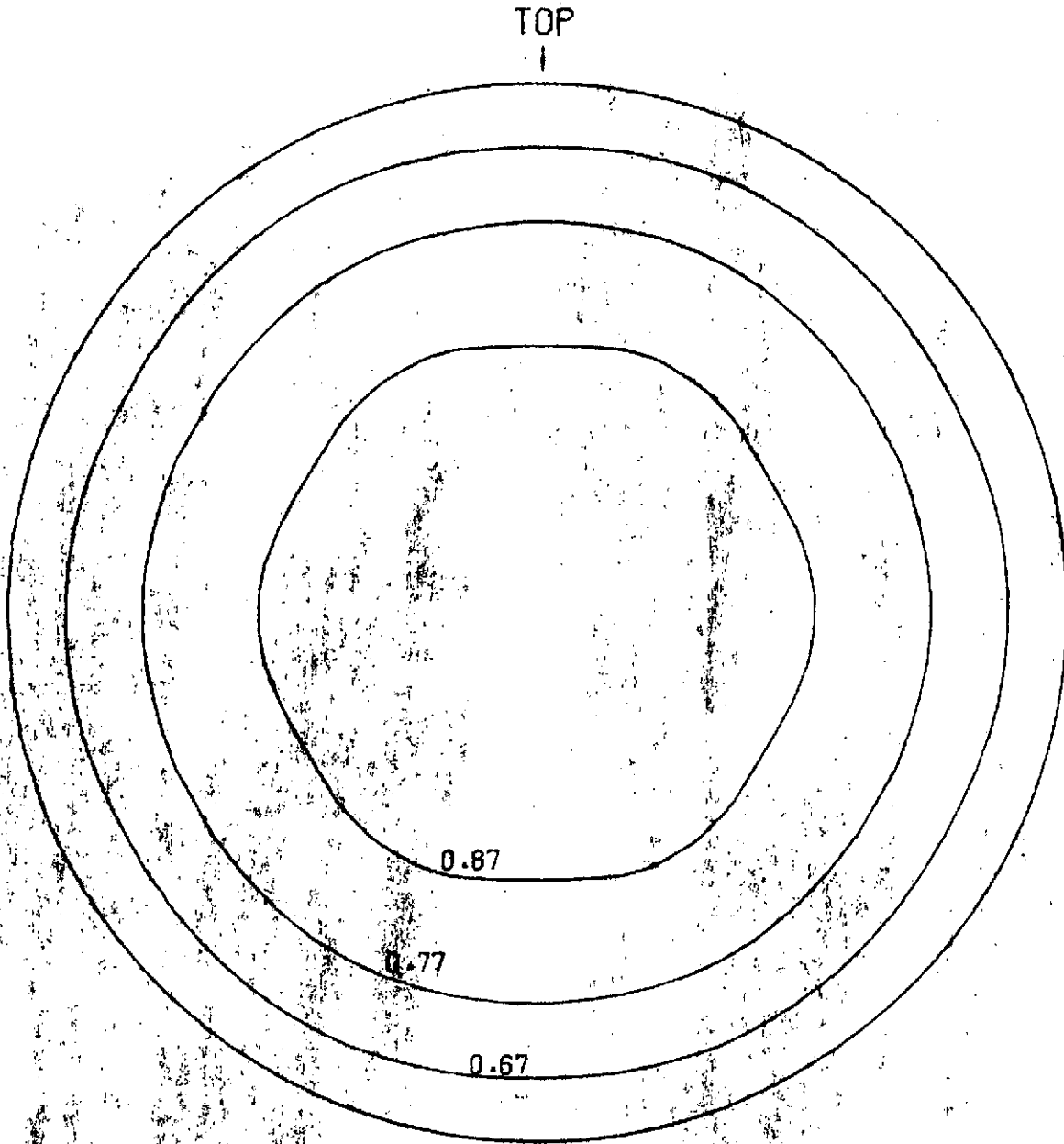
**FIGURE 92**  
**LAGEOS THERMAL/OPTICAL ANALYSIS**  
**RETROREFLECTOR UNIT RADIAL TEMPERATURE GRADIENT**  
**TAS FC 2.57 B**

**NOTES:**

1. TO BE USED FOR ITEK DETERMINATION OF RETROREFLECTOR OPTICAL PERFORMANCE AS SPECIFIED BY CASE 2.5.6 OF LAGEOS-27, DATED 6-3-74.
2. AT  $\Delta T = 0$ ,  $T_{RETRO} = 25^{\circ}\text{C}$ ;  $T_{RETRO} = 25.00 + \Delta T$ .

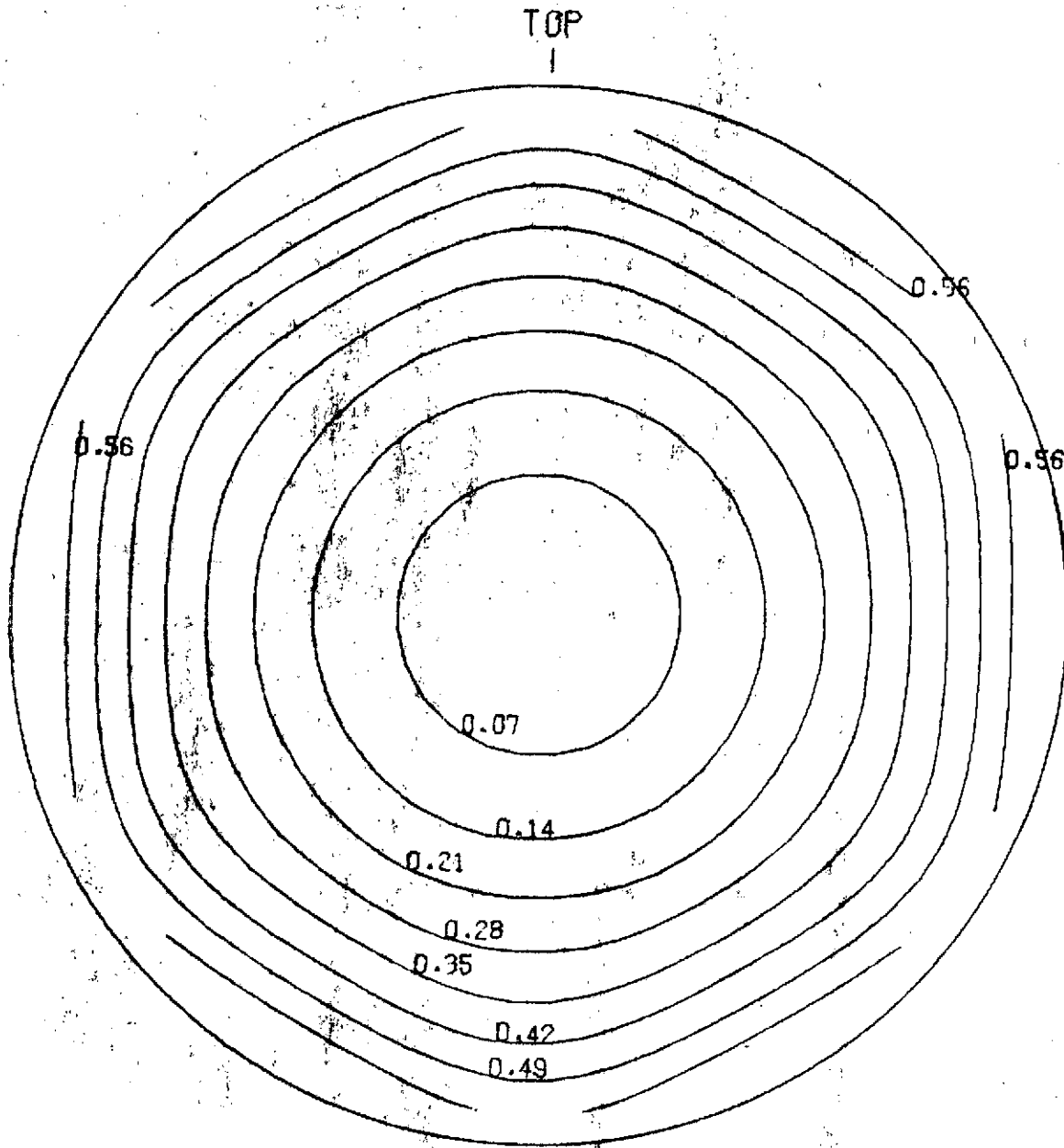


Effect of an Axial Gradient on the  
Wavefront of a Cube Corner



REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

FIGURE 54  
EFFECT OF A RADIAL GRADIENT ON A  
WAVEFRONT OF A CUBE CORNER



E N C I R C L E D    E N E R G Y

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis

\*\*\*\*\*

\*\*\*\*\*

CIRCLE \*  
----- \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*  
----- \*

(MI- \*  
CRONS) \*

CENTER (MICRONS):

\* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

RADIUS	X = -10.13	X = 10.13	X = 0.0	X = -10.13	X = 0.0	X = 10.13	X = 0.0	X = -10.13	X = 10.13
5.00	0.2	0.3	0.3	0.2	0.1	0.1	0.4	0.3	0.3
10.00	1.1	1.2	1.2	0.7	0.4	0.4	1.4	1.4	1.1
15.00	3.4	3.7	3.7	2.1	1.8	1.9	4.0	4.0	3.2
20.00	6.4	6.9	7.0	4.7	4.3	4.7	7.5	7.5	6.4
25.00	10.2	10.9	11.4	10.3	10.7	10.3	11.9	11.9	10.8
30.00	15.8	16.8	16.9	16.4	17.3	16.5	17.9	18.3	17.3
35.00	23.8	25.2	24.6	23.6	24.7	23.6	26.5	26.9	25.5
40.00	31.7	33.3	32.7	32.6	33.1	32.5	35.6	35.4	33.9
45.00	39.6	40.8	41.4	43.4	45.8	43.2	44.1	43.1	41.8
50.00	48.5	48.8	50.0	52.3	54.7	52.1	51.7	50.9	50.4
55.00	57.8	57.2	59.4	60.8	62.6	60.6	60.3	58.5	58.8
60.00	64.9	64.2	66.4	67.2	68.8	67.2	66.9	64.9	65.3
65.00	70.6	69.8	71.9	72.6	74.5	72.6	72.2	70.1	70.8
70.00	75.0	74.3	76.0	76.5	77.7	76.5	76.0	74.3	75.2
75.00	78.8	78.0	79.2	79.4	80.0	79.4	79.1	78.0	78.8
80.00	81.5	80.6	81.4	81.4	81.7	81.5	81.4	80.6	81.4
85.00	83.2	82.5	83.2	83.3	83.4	83.3	83.4	82.6	83.2
90.00	84.6	84.3	84.7	84.9	85.0	84.9	84.9	84.5	84.8
95.00	86.0	86.0	86.1	86.3	86.5	86.3	86.3	86.1	86.2
100.00	87.1	87.4	87.4	87.5	87.9	87.6	87.5	87.3	87.2
105.00	88.1	88.5	88.6	88.6	88.9	88.7	88.6	88.4	88.1
110.00	89.1	89.4	89.5	89.4	89.7	89.5	89.5	89.4	89.2
115.00	90.0	90.2	90.2	90.2	90.3	90.1	90.2	90.2	90.0
120.00	90.7	90.8	90.8	90.8	90.8	90.8	90.9	90.9	90.7
125.00	91.2	91.3	91.3	91.4	91.4	91.3	91.5	91.4	91.3
130.00	91.8	91.8	91.9	91.9	92.0	91.9	92.0	91.9	91.9
135.00	92.3	92.3	92.4	92.4	92.5	92.4	92.3	92.3	92.3
140.00	92.7	92.7	92.8	92.9	92.9	92.9	92.9	92.8	92.8
145.00	93.1	93.1	93.2	93.2	93.2	93.2	93.2	93.2	93.1
150.00	93.5	93.5	93.5	93.6	93.6	93.6	93.5	93.5	93.5
155.00	93.8	93.8	93.9	93.8	93.8	93.8	93.8	93.8	93.8
160.00	94.2	94.2	94.2	94.1	94.1	94.1	94.1	94.1	94.1
165.00	94.5	94.5	94.5	94.4	94.4	94.5	94.4	94.4	94.4
170.00	94.7	94.7	94.8	94.7	94.8	94.7	94.8	94.7	94.7
175.00	95.0	95.0	95.0	95.0	95.1	95.0	95.1	95.0	95.0
180.00	95.3	95.3	95.3	95.3	95.4	95.3	95.4	95.3	95.3
184.99	95.5	95.5	95.5	95.6	95.6	95.6	95.5	95.6	95.6
189.99	95.8	95.8	95.8	95.9	95.8	95.9	95.8	95.8	95.8
194.99	96.0	96.0	96.0	96.0	96.1	96.0	96.0	96.0	96.0
199.99	96.3	96.3	96.2	96.2	96.3	96.3	96.2	96.3	96.3

\*\*\*\*\*

TABLE 13

ENCIRCLED ENERGY

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis \*\*\*\*\*

CIRCLE \*  
----- \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*  
----- \*

(MI- \* CENTER (MICRONS):

----- \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
\*  
\*\*\*\*\*

2.00	*	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
4.00	*	0.2	0.3	0.1	0.1	0.0	0.0	0.1	0.3	0.3
6.00	*	0.2	0.3	0.5	0.3	0.1	0.1	0.5	0.3	0.3
8.00	*	0.8	0.9	0.8	0.5	0.1	0.2	0.9	1.0	0.8
10.00	*	1.1	1.2	1.2	0.7	0.4	0.4	1.4	1.4	1.1
12.00	*	2.4	2.6	2.0	1.1	0.5	0.8	2.2	2.9	2.3
14.00	*	2.4	2.6	3.0	2.0	1.2	1.6	3.3	2.9	2.3
16.00	*	4.0	4.5	4.0	2.4	1.8	2.2	4.4	4.8	3.8
18.00	*	4.8	5.1	5.1	3.7	4.3	3.4	5.5	5.6	4.7
20.00	*	6.4	6.9	7.0	4.7	4.3	4.7	7.5	7.5	6.4
22.00	*	7.2	7.6	8.4	6.8	7.8	6.7	8.9	8.4	7.4
24.00	*	9.4	10.1	10.2	7.9	9.1	8.0	10.6	10.9	9.9
26.00	*	10.6	11.2	12.0	10.6	12.6	10.6	12.4	12.3	11.4
28.00	*	13.7	14.7	15.2	13.5	13.5	13.6	16.2	15.8	14.8
30.00	*	15.8	16.8	16.9	16.4	17.3	16.5	17.9	18.3	17.3
32.00	*	20.1	21.4	20.2	18.8	19.0	18.9	21.6	23.0	21.7
34.00	*	20.9	22.4	22.6	23.0	22.5	23.0	24.5	24.1	22.7
36.00	*	25.6	27.2	26.2	25.6	25.6	25.6	28.7	28.9	27.4
38.00	*	27.6	29.4	29.1	29.5	30.7	29.5	31.5	31.4	29.8
40.00	*	31.7	33.3	32.7	32.6	33.1	32.5	35.6	35.4	33.9
42.00	*	33.5	35.2	36.3	37.4	39.4	37.3	39.0	37.4	35.8
44.00	*	38.0	39.3	39.6	39.8	42.1	39.5	42.3	41.5	40.3
46.00	*	40.9	41.9	43.0	45.1	48.1	44.9	45.5	44.2	43.2
48.00	*	45.2	45.7	47.5	49.0	49.5	48.6	49.6	48.0	47.3
50.00	*	48.5	48.8	50.0	52.3	54.7	52.1	51.7	50.9	50.4
52.00	*	52.8	52.5	54.1	55.8	57.0	55.6	55.5	54.4	54.4
54.00	*	55.1	54.8	56.8	59.2	60.8	59.0	58.0	56.5	56.4
56.00	*	59.2	53.6	61.1	62.4	63.1	62.3	61.8	59.9	60.1
58.00	*	62.0	51.4	63.2	64.6	66.6	64.5	63.9	62.4	62.6
60.00	*	64.5	64.2	66.4	67.2	68.8	67.2	66.9	64.9	65.3
62.00	*	66.9	50.1	68.4	69.6	71.4	69.6	69.0	66.7	67.2
64.00	*	69.8	59.1	70.5	71.2	73.2	71.2	71.0	69.3	70.1
66.00	*	71.5	70.8	72.6	73.5	75.3	73.5	73.0	71.0	71.7
68.00	*	73.7	72.9	74.4	74.9	76.1	74.9	74.6	73.1	74.0
70.00	*	75.0	74.3	76.0	76.5	77.7	76.5	76.0	74.3	75.2
72.00	*	77.0	76.2	77.3	77.6	78.7	77.6	77.3	76.1	77.1
74.00	*	77.9	77.1	78.6	78.9	79.6	78.9	78.5	77.1	78.0
76.00	*	79.5	78.6	79.8	79.9	80.3	79.9	79.6	78.6	79.4
78.00	*	80.4	79.6	80.5	80.6	81.1	80.6	80.4	79.6	80.3
80.00	*	81.5	80.6	81.4	81.4	81.7	81.5	81.4	80.6	81.4

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

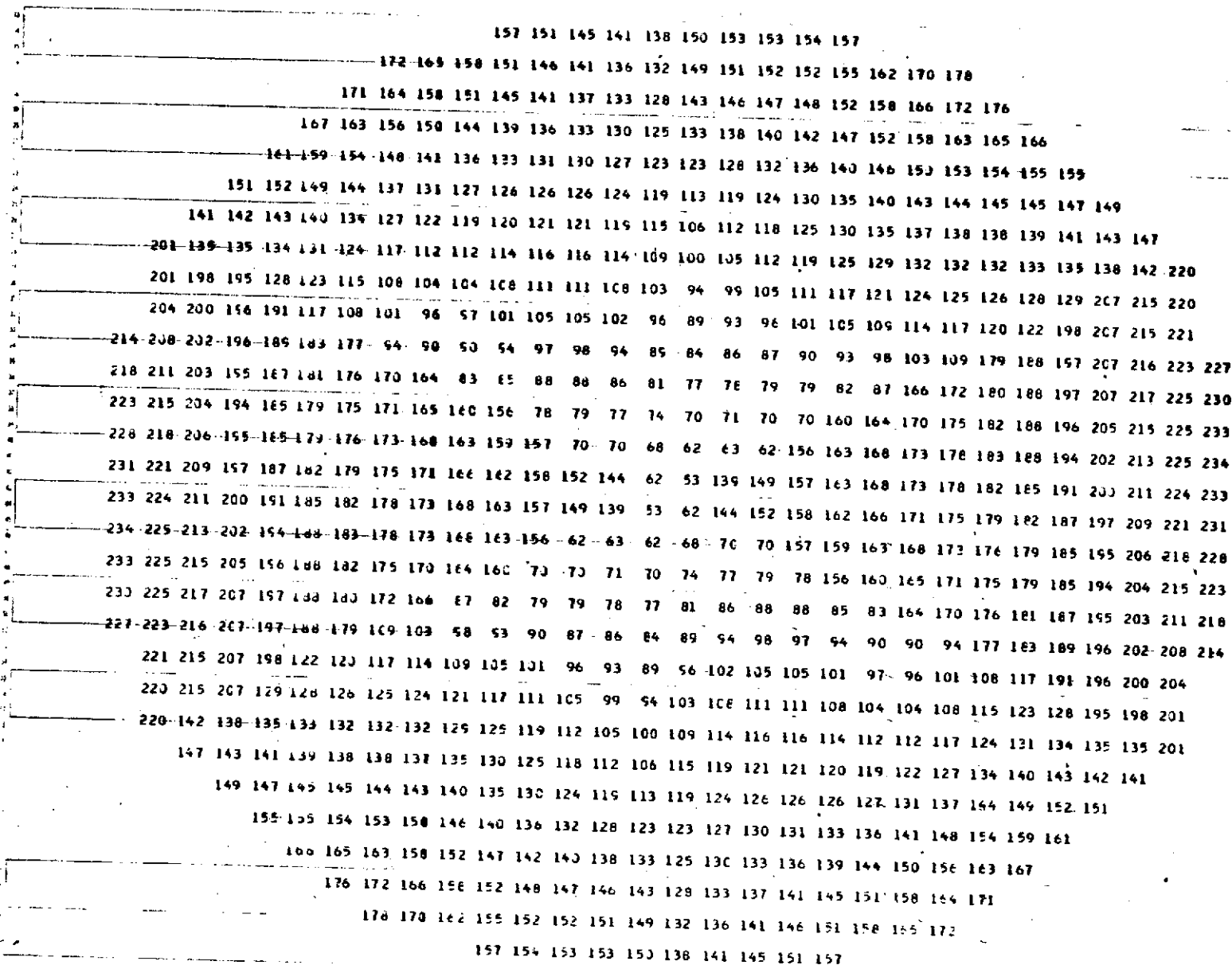


FIGURE 33

Wavefront Map - Polarization

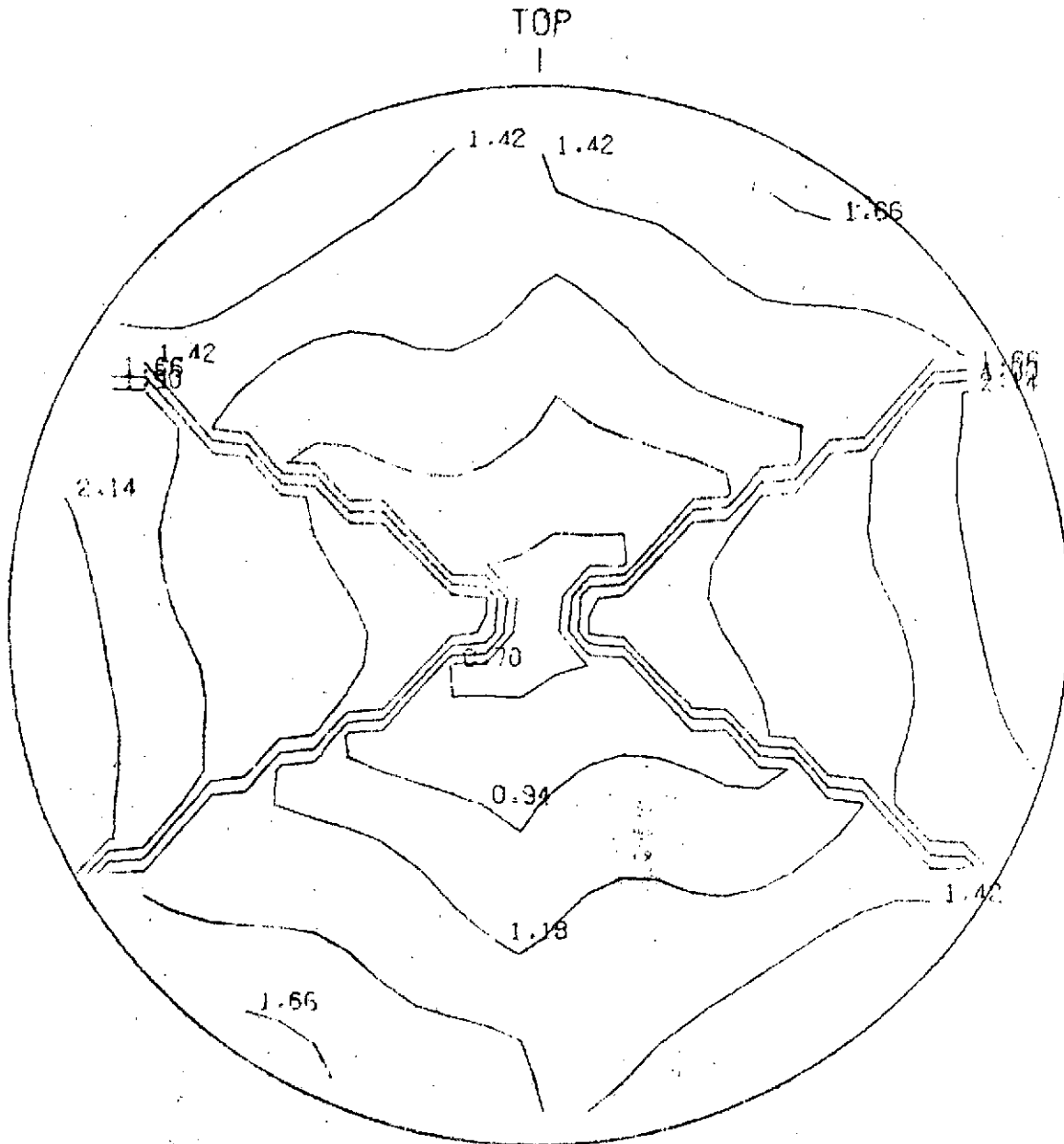
Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis

MAP IN UNITS OF 0.01 WAVES



Wavefront Plot-Q Polarization

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis





Wavefront Plot-P Polarization

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis

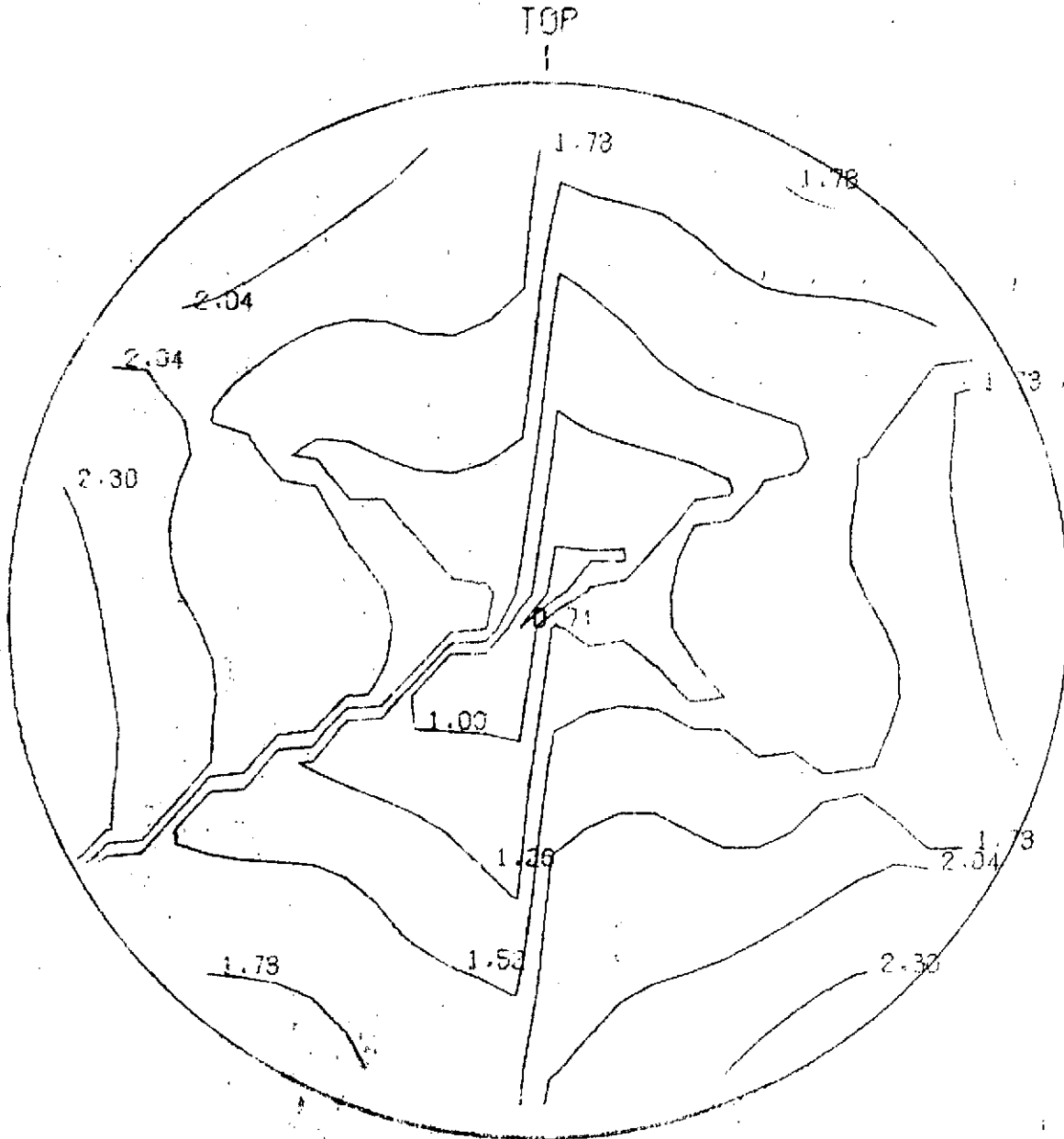




FIGURE 60

## Point Spread Function

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis

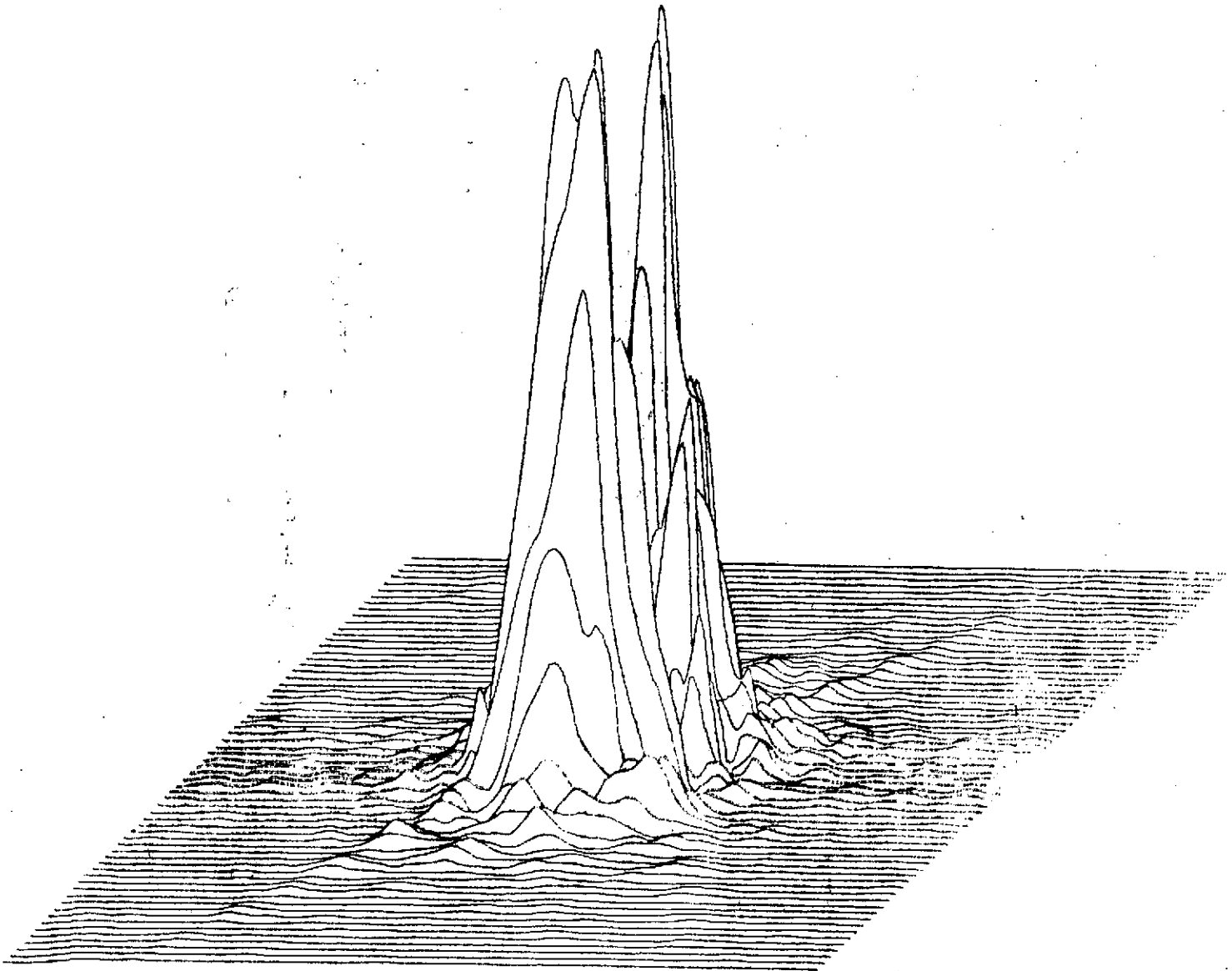


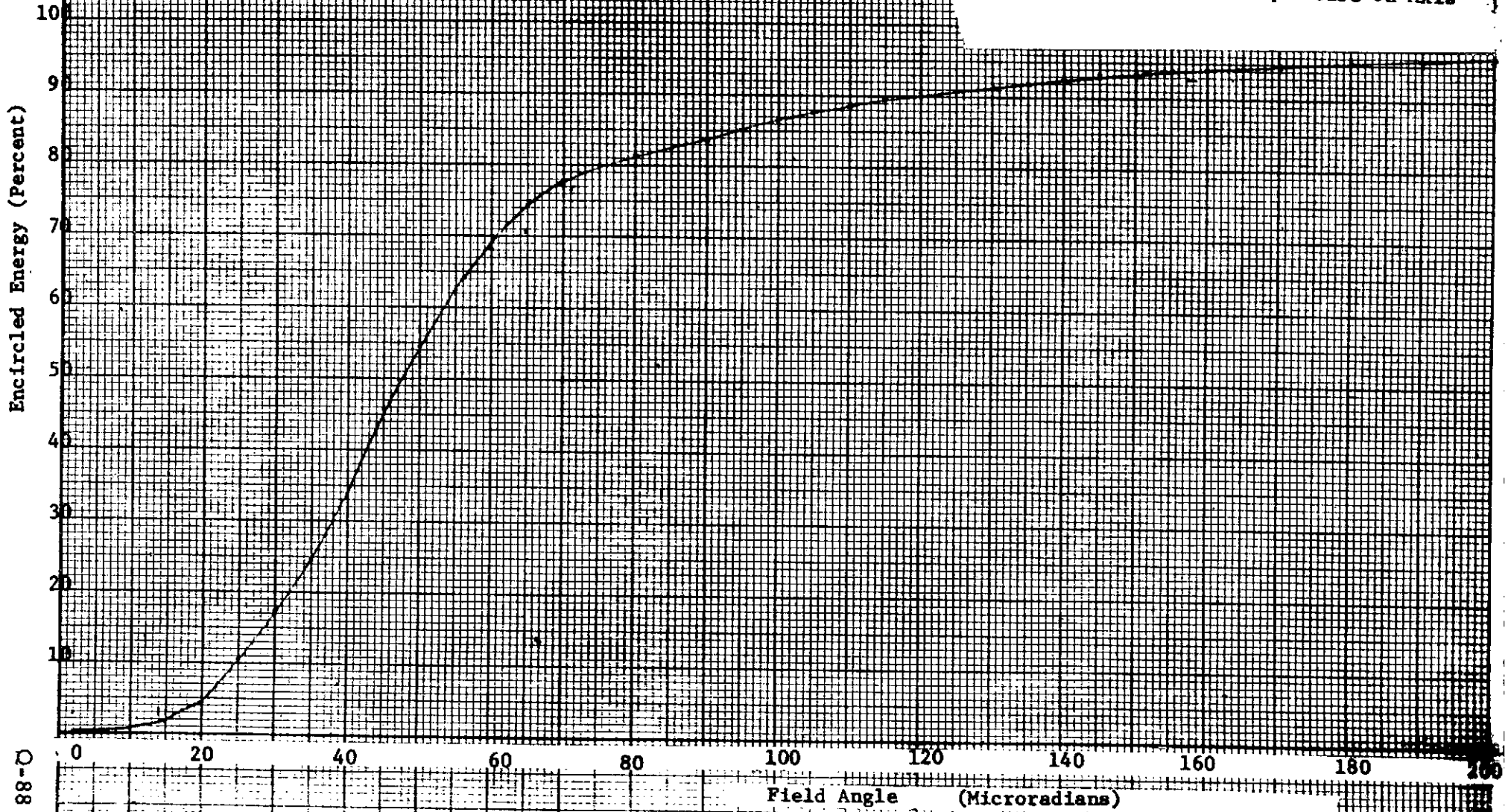


FIGURE 62

Encircled Energy  
Vs  
Field Angle

Task 2.3B - Nominal

+ Mfg. Error + First Temperature On Axis



88-0



ENCIRCLED ENERGY

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

CIRCLE RADIUS	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
(MIL-ORNS)	CENTER (MICRONS):									
	X= -10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13	
	Y= -10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13	
2.00	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	
4.00	0.3	0.3	0.2	0.2	0.1	0.2	0.2	0.4	0.4	
6.00	0.3	0.3	0.4	0.6	1.1	0.6	0.5	0.4	0.4	
8.00	0.9	1.0	0.8	1.2	1.1	1.2	0.9	1.2	1.2	
10.00	1.3	1.4	1.1	1.7	2.1	1.6	1.2	1.7	1.6	
12.00	3.0	3.1	1.8	2.9	2.4	2.8	2.0	3.7	3.5	
14.00	3.0	3.1	2.7	4.1	3.2	4.1	3.3	3.7	3.5	
16.00	5.1	5.3	3.5	5.5	3.9	5.4	4.2	6.2	5.9	
18.00	6.0	6.2	4.8	6.7	5.9	6.7	5.7	7.2	6.9	
20.00	7.8	8.0	6.3	8.7	5.9	8.7	7.5	9.4	9.0	
22.00	8.7	8.9	8.5	10.3	9.0	10.3	10.0	10.5	10.1	
24.00	10.9	11.0	9.7	11.6	10.9	11.5	11.3	13.0	12.6	
26.00	12.0	12.1	12.6	13.6	14.6	13.5	14.4	14.4	13.9	
28.00	14.5	14.5	15.3	16.2	15.8	16.0	17.6	17.2	16.7	
30.00	16.6	16.5	17.9	18.3	19.7	18.0	20.3	19.5	19.1	
32.00	20.4	20.3	19.9	20.7	22.2	20.4	22.5	23.1	22.8	
34.00	21.7	21.0	23.0	23.8	24.5	23.5	25.9	24.0	23.8	
36.00	25.7	25.4	25.5	27.0	28.1	26.7	28.4	28.0	27.9	
38.00	28.0	27.8	28.3	30.1	31.2	29.7	31.0	30.4	30.3	
40.00	31.8	31.5	31.2	33.6	33.2	33.4	33.9	33.7	33.8	
42.00	33.9	33.6	35.0	37.3	36.6	37.2	37.4	35.7	35.9	
44.00	37.9	37.7	36.9	39.4	39.7	39.4	39.3	39.5	39.7	
46.00	40.7	40.5	41.2	43.1	43.6	43.2	43.4	42.5	42.8	
48.00	43.8	43.7	44.5	46.4	45.4	46.5	47.0	45.6	45.8	
50.00	46.9	46.8	47.7	48.7	49.9	48.9	49.6	48.9	49.1	
52.00	49.9	50.0	50.5	51.5	53.2	51.7	52.9	52.1	52.2	
54.00	51.7	51.8	54.3	54.5	56.6	54.6	56.1	54.1	54.3	
56.00	55.1	55.3	57.4	58.0	59.9	58.1	59.7	57.4	57.5	
58.00	57.8	58.0	59.7	60.3	63.2	60.4	61.7	60.2	60.3	
60.00	60.4	60.6	62.6	63.4	65.9	63.4	64.8	62.6	62.7	
62.00	62.5	62.7	65.3	66.0	68.1	66.0	67.3	64.7	64.9	
64.00	66.0	66.0	67.0	68.0	70.3	68.0	69.3	67.5	67.8	
66.00	68.1	68.1	69.9	70.5	72.5	70.6	71.8	69.6	70.0	
68.00	70.5	70.4	71.9	72.4	73.4	72.6	73.4	71.5	72.0	
70.00	72.4	72.3	73.9	74.1	75.4	74.3	75.1	73.1	73.7	
72.00	74.6	74.4	75.4	75.4	77.0	75.7	76.3	74.9	75.4	
74.00	75.6	75.4	77.2	77.1	78.4	77.3	77.7	76.0	76.5	
76.00	77.6	77.4	78.7	78.4	79.5	78.6	78.8	77.5	77.9	
78.00	78.8	78.7	79.6	79.4	80.7	79.6	79.6	78.7	79.0	
80.00	80.0	79.9	81.0	80.6	81.6	80.7	80.7	79.8	80.0	

\*\*\*\*\*

TABLE 15

ENCIRCLED ENERGY

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

\*\*\*\*\*

CIRCLE \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*

(MI-  
CRONS) \*

CENTER (MICRONS):

X=	-10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13
Y=	-10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13

\*\*\*\*\*

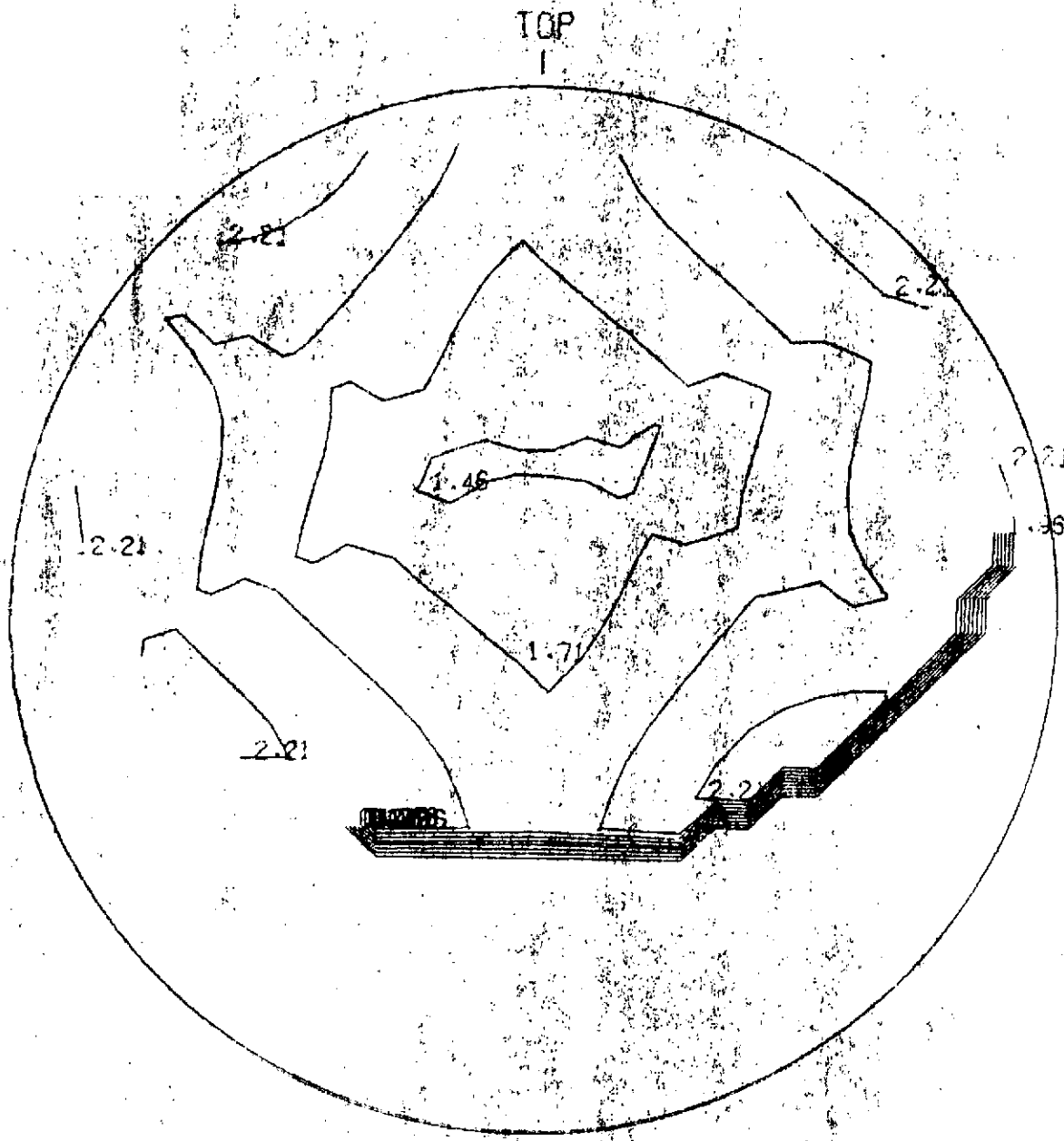
5.00	*	0.3	0.3	0.4	0.5	0.7	0.5	0.4	0.4	0.4
10.00	*	1.3	1.4	1.1	1.7	2.1	1.6	1.2	1.7	1.6
15.00	*	4.3	4.4	3.1	5.0	3.9	4.9	3.7	5.2	4.9
20.00	*	7.8	8.0	6.3	8.7	5.9	8.7	7.5	9.4	9.0
25.00	*	11.6	11.7	12.2	13.2	12.1	13.1	14.1	13.9	13.4
30.00	*	16.6	16.5	17.9	18.3	19.7	18.0	20.3	19.5	19.1
35.00	*	24.0	23.8	23.8	25.1	27.2	24.7	26.4	26.3	26.1
40.00	*	31.8	31.5	31.2	33.6	33.2	33.4	33.9	33.7	33.8
45.00	*	39.3	39.0	39.7	41.6	41.2	41.7	41.8	41.0	41.2
50.00	*	46.9	46.8	47.7	48.7	49.9	48.9	49.6	48.9	49.1
55.00	*	54.0	54.1	55.4	56.1	59.2	56.2	57.6	56.2	56.2
60.00	*	60.4	60.6	62.6	63.4	65.9	63.4	64.8	62.6	62.7
65.00	*	66.8	66.8	69.0	69.7	71.4	69.7	70.9	68.4	68.7
70.00	*	72.4	72.3	73.9	74.1	75.4	74.3	75.1	73.1	73.7
75.00	*	76.9	76.7	77.8	77.7	79.1	77.9	78.3	76.9	77.3
80.00	*	80.0	79.9	81.0	80.6	81.6	80.7	80.7	79.8	80.0
85.00	*	82.2	82.3	83.2	82.9	83.6	82.9	82.8	82.2	82.1
90.00	*	84.0	84.1	84.6	84.6	84.9	84.5	84.4	84.1	83.9
95.00	*	85.5	85.6	85.7	85.8	86.0	85.7	85.8	85.7	85.5
100.00	*	86.6	86.6	86.7	86.8	86.9	86.8	86.9	86.8	86.7
105.00	*	87.5	87.5	87.7	87.7	87.8	87.7	87.8	87.6	87.6
110.00	*	88.3	88.4	88.5	88.5	88.7	88.6	88.6	88.4	88.5
115.00	*	89.2	89.2	89.3	89.2	89.4	89.3	89.3	89.1	89.3
120.00	*	89.9	89.9	90.0	89.9	90.1	90.0	89.9	89.8	89.9
125.00	*	90.5	90.5	90.6	90.6	90.7	90.6	90.5	90.4	90.4
130.00	*	91.0	91.0	91.1	91.1	91.2	91.1	91.0	90.9	90.9
135.00	*	91.5	91.4	91.5	91.5	91.5	91.5	91.6	91.5	91.5
140.00	*	91.9	91.9	91.9	91.9	91.9	91.9	91.9	91.9	91.9
145.00	*	92.3	92.3	92.3	92.3	92.2	92.3	92.3	92.3	92.2
150.00	*	92.7	92.7	92.7	92.7	92.7	92.7	92.6	92.7	92.6
155.00	*	93.0	93.1	93.1	93.1	93.1	93.0	93.1	93.0	93.0
160.00	*	93.4	93.4	93.4	93.4	93.4	93.4	93.4	93.5	93.4
165.00	*	93.8	93.7	93.8	93.8	93.8	93.8	93.8	93.8	93.8
170.00	*	94.1	94.0	94.1	94.2	94.2	94.2	94.1	94.1	94.1
175.00	*	94.4	94.4	94.4	94.4	94.5	94.4	94.4	94.4	94.5
180.00	*	94.7	94.7	94.7	94.7	94.8	94.7	94.8	94.7	94.7
184.99	*	95.0	95.0	95.0	95.0	94.9	95.0	95.0	95.0	95.0
189.99	*	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.2
194.99	*	95.5	95.5	95.6	95.5	95.6	95.5	95.5	95.5	95.4
199.99	*	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.7

\*\*\*\*\*



Wavefront Plot-Q Polarization

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis



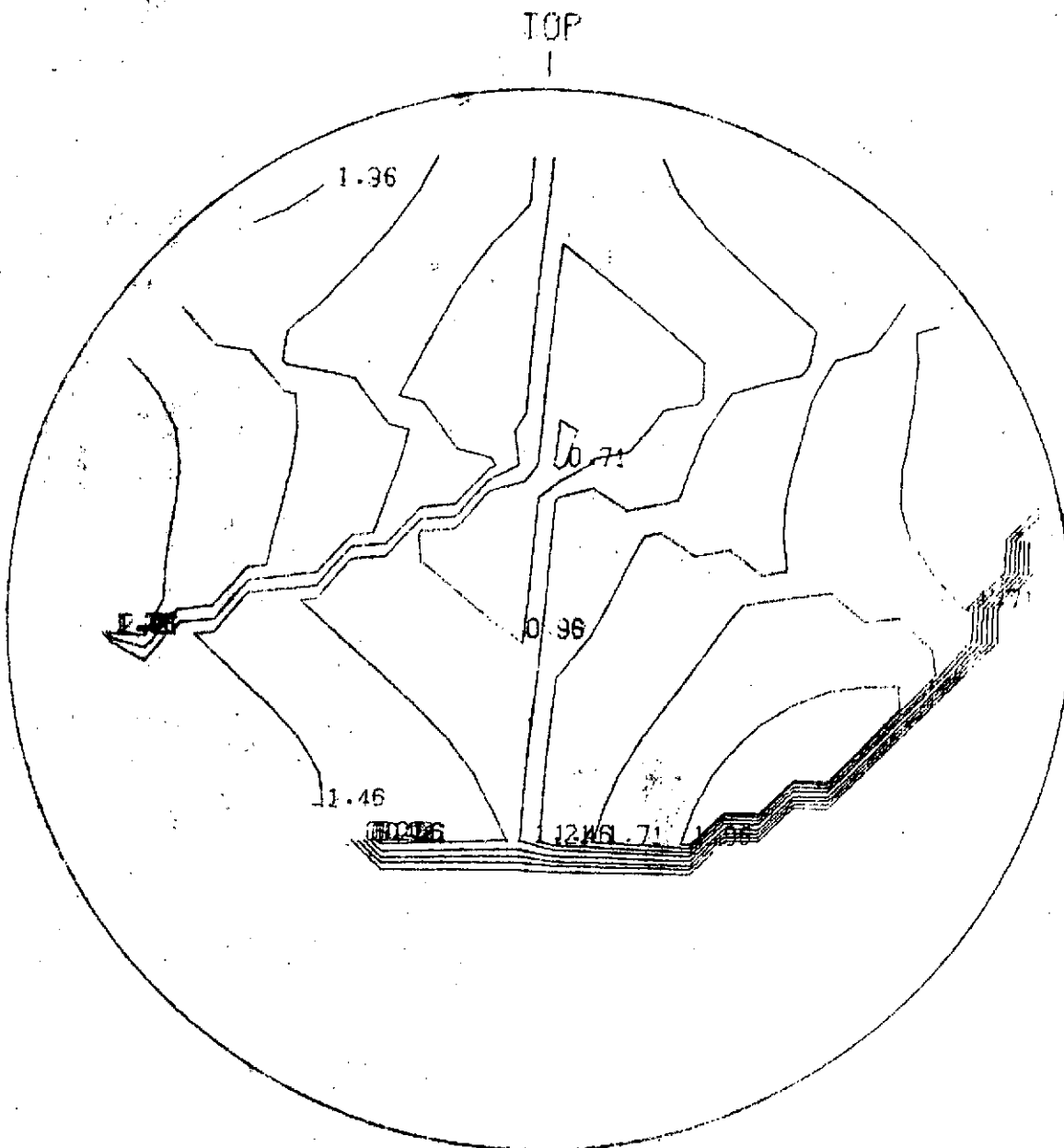
PROPERTY OF THE  
CAROLINA STATE UNIV



FIGURE 66

Wavefront Plot-P Polarization

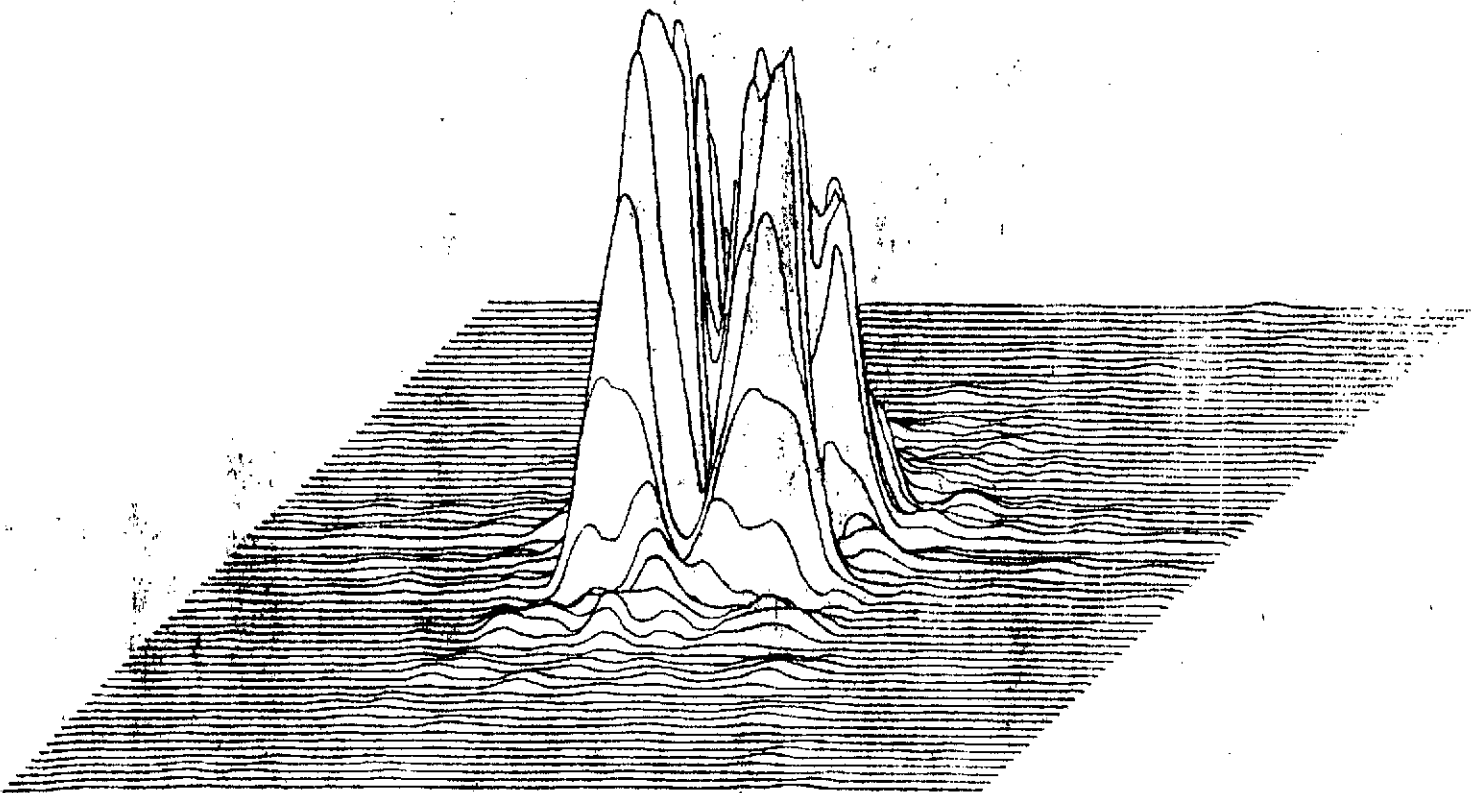
Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis



C-2



FIGURE 68

**Point Spread Function****Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis**



Intensity Distribution - Central 129 Microradians

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

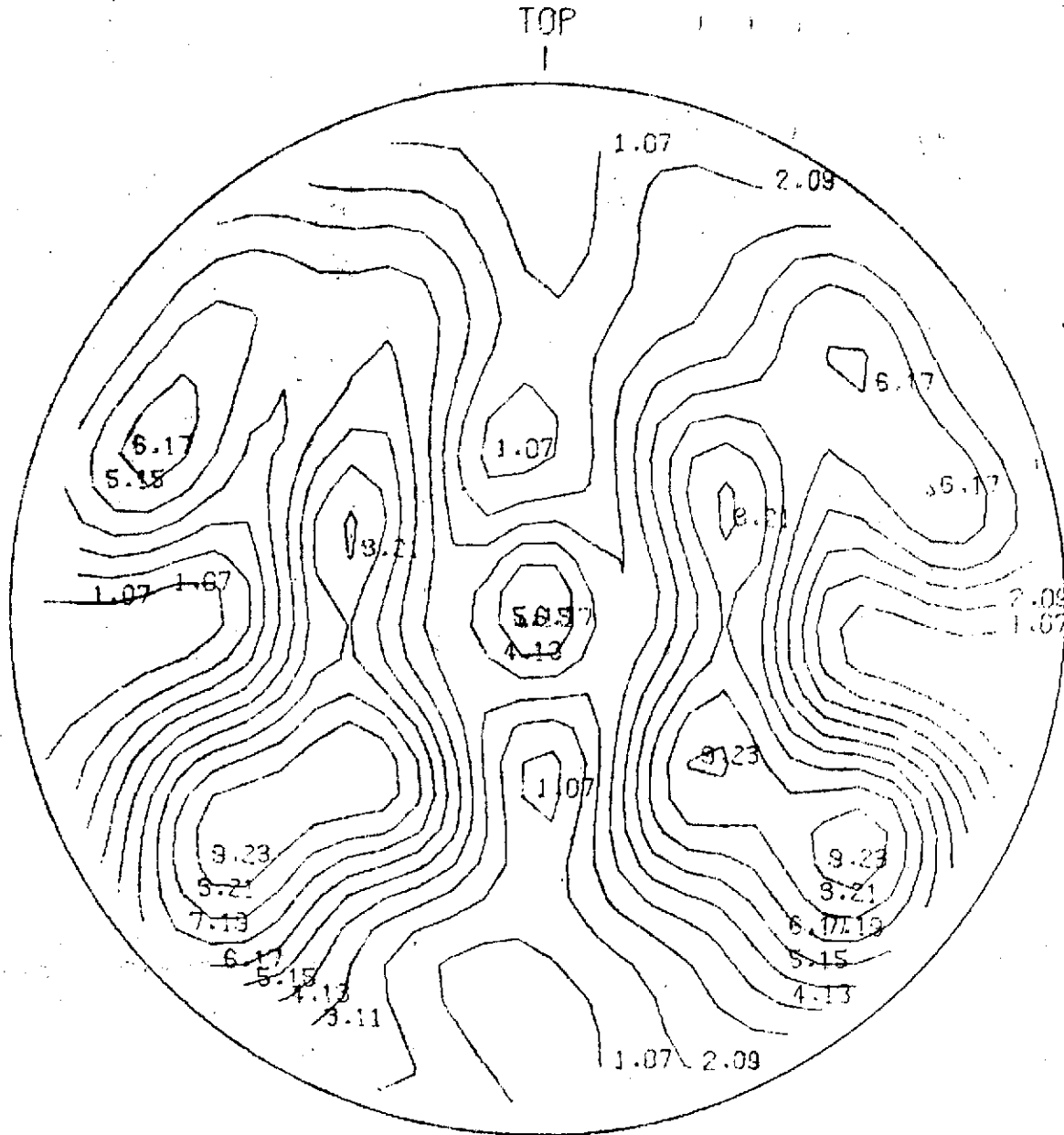
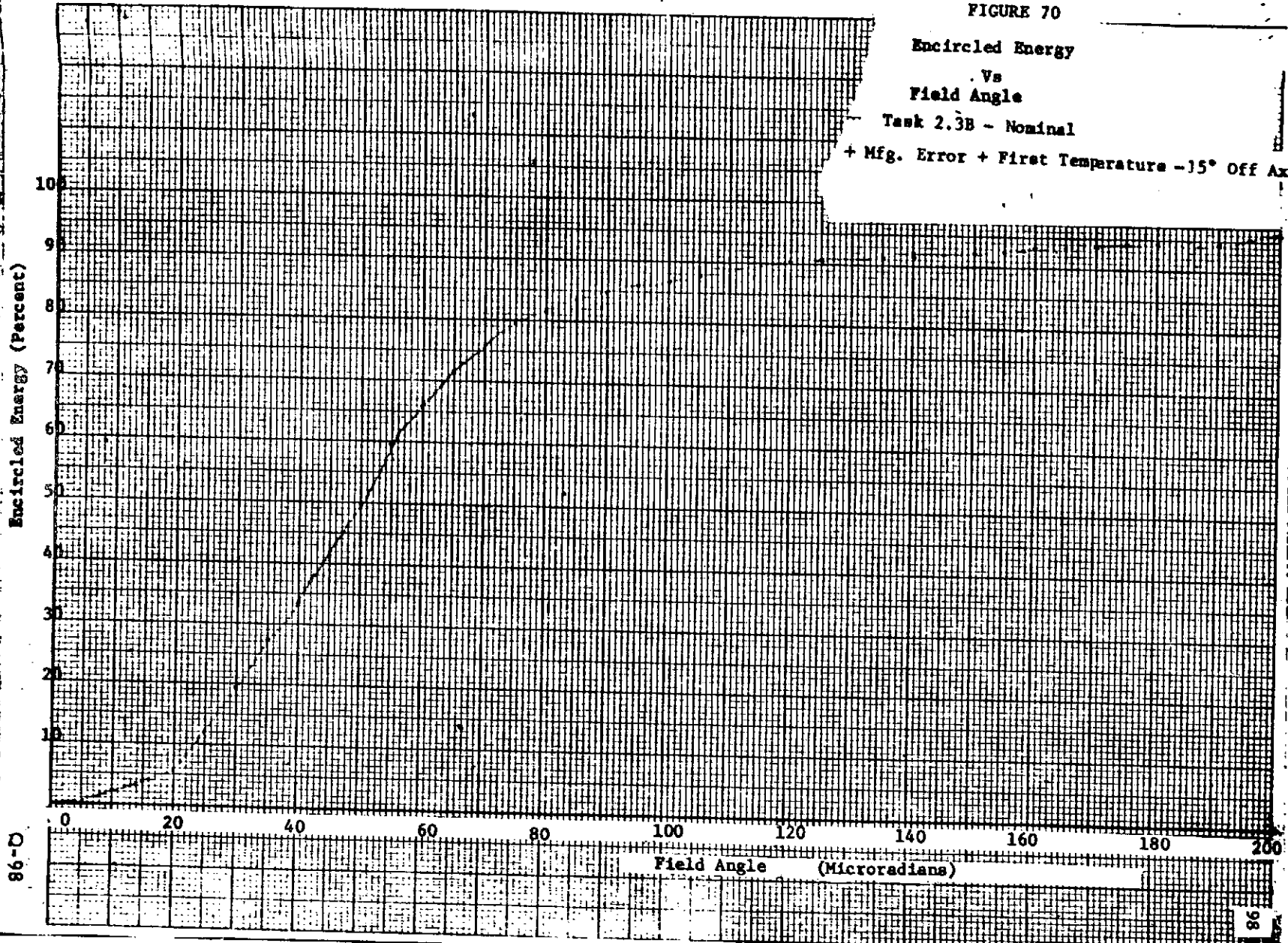


FIGURE 70

Encircled Energy  
Vs  
Field Angle

Task 2.3B - Nominal

+ Mfg. Error + First Temperature -15° Off Axis



86-D

86

TABLE 16

E N C I R C L E D E N E R G Y

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

\*\*\*\*\*

\*\*\*\*\*

CIRCLE \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*

(MI-  
CRENS)

\* CENTER (MICRONS):

\* X= -10.13 0.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

2.00	*	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
4.00	*	0.3	0.3	0.2	0.1	0.0	0.0	0.2	0.4	0.3
6.00	*	0.3	0.3	0.7	0.3	0.2	0.1	0.7	0.4	0.3
8.00	*	0.9	1.1	1.1	0.5	0.2	0.2	1.2	1.3	0.9
10.00	*	1.2	1.5	1.7	0.8	0.6	0.4	1.9	1.7	1.3
12.00	*	2.8	3.2	2.6	1.2	0.7	0.8	2.9	3.6	2.7
14.00	*	2.8	3.2	3.7	2.3	1.6	1.9	4.2	3.6	2.7
16.00	*	4.7	5.4	5.0	2.9	2.3	2.5	5.6	5.9	4.6
18.00	*	5.7	6.2	6.3	4.4	5.3	4.1	6.8	6.9	5.7
20.00	*	7.6	8.3	8.5	5.7	5.3	5.6	9.2	9.1	7.7
22.00	*	8.4	9.1	10.0	8.2	9.5	8.1	10.7	10.1	8.8
24.00	*	11.0	11.8	12.0	9.4	11.0	9.5	12.8	12.9	11.7
26.00	*	12.3	13.1	13.9	12.7	15.2	12.7	14.7	14.5	13.3
28.00	*	15.7	16.9	17.5	16.0	16.2	16.1	18.8	18.3	17.0
30.00	*	18.0	19.1	19.4	19.4	20.6	19.5	20.6	21.0	19.8
32.00	*	22.7	24.1	23.0	22.0	22.4	22.1	24.7	25.9	24.6
34.00	*	23.6	25.2	25.5	26.5	26.3	26.6	27.7	27.1	25.7
36.00	*	28.6	30.3	29.4	29.4	29.5	29.4	32.2	32.2	30.7
38.00	*	30.7	32.5	32.5	33.4	34.8	33.4	35.1	34.8	33.1
40.00	*	35.0	36.6	36.2	36.5	37.2	36.5	39.3	38.9	37.4
42.00	*	36.9	38.6	39.9	41.4	43.5	41.4	42.7	40.9	39.4
44.00	*	41.5	42.7	43.2	43.8	46.3	43.5	46.0	45.0	43.9
46.00	*	44.4	45.3	46.7	49.0	52.2	48.8	49.1	47.5	46.8
48.00	*	48.7	49.1	51.1	52.7	53.5	52.4	53.1	51.3	50.8
50.00	*	51.9	52.0	53.4	55.9	58.4	55.6	55.1	54.0	53.8
52.00	*	56.1	55.5	57.5	59.2	60.6	58.9	58.6	57.2	57.5
54.00	*	58.3	57.7	60.0	62.3	64.0	62.2	60.9	59.3	59.5
56.00	*	62.3	61.4	64.0	65.2	66.0	65.2	64.4	62.4	62.9
58.00	*	64.8	64.0	65.9	67.2	69.1	67.1	66.3	64.7	65.2
60.00	*	67.5	66.5	68.8	69.5	71.0	69.5	69.0	67.0	67.7
62.00	*	69.2	68.3	70.6	71.5	73.1	71.5	70.8	68.6	69.3
64.00	*	71.9	71.0	72.4	72.9	74.6	72.9	72.6	71.0	71.9
66.00	*	73.3	72.5	74.2	74.9	76.4	74.8	74.4	72.6	73.4
68.00	*	75.3	74.4	75.8	76.1	77.1	76.1	75.8	74.5	75.4
70.00	*	76.4	75.6	77.1	77.4	78.4	77.4	77.1	75.6	76.5
72.00	*	78.0	77.2	78.2	78.5	79.2	78.4	78.2	77.2	78.1
74.00	*	78.9	78.0	79.3	79.5	80.1	79.5	79.3	78.0	78.9
76.00	*	80.2	79.4	80.3	80.4	80.7	80.4	80.3	79.4	80.2
78.00	*	81.0	80.3	81.0	81.1	81.5	81.1	81.0	80.3	81.0
80.00	*	81.0	81.2	81.8	81.9	82.1	81.9	81.0	81.2	81.9

\*\*\*\*\*

TABLE 17

ENCIRCLED ENERGY

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

\*\*\*\*\*  
 CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CRONS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	0.3	0.3	0.5	0.2	0.1	0.1	0.5	0.4	0.3
10.00	1.2	1.5	1.7	0.8	0.6	0.4	1.9	1.7	1.3
15.00	3.9	4.5	4.7	2.5	2.3	2.1	5.2	5.0	3.8
20.00	7.6	8.3	8.5	5.7	5.3	5.6	9.2	9.1	7.7
25.00	11.9	12.7	13.3	12.4	13.0	12.4	14.1	14.0	12.8
30.00	18.0	19.1	19.4	19.4	20.6	19.5	20.6	21.0	19.8
35.00	26.7	28.2	27.7	27.2	28.6	27.3	29.9	30.0	28.7
40.00	35.0	36.6	36.2	36.5	37.2	36.5	39.3	38.9	37.4
45.00	43.2	44.3	45.0	47.3	49.9	47.1	47.8	46.6	45.4
50.00	51.9	52.0	53.4	55.9	58.4	55.6	55.1	54.0	53.8
55.00	60.9	61.0	62.4	63.8	65.6	63.6	63.1	61.1	61.7
60.00	67.5	68.5	68.8	69.5	71.0	69.5	69.0	67.0	67.7
65.00	72.6	71.6	73.6	74.1	75.7	74.1	73.7	71.8	72.6
70.00	76.4	75.6	77.1	77.4	78.4	77.4	77.1	75.6	76.5
75.00	79.6	78.8	79.9	80.0	80.4	80.0	79.9	78.9	79.6
80.00	81.9	81.2	81.8	81.9	82.1	81.9	81.9	81.2	81.9
85.00	83.5	82.9	83.5	83.7	83.8	83.7	83.7	83.1	83.6
90.00	84.8	84.7	85.0	85.2	85.3	85.2	85.2	84.9	85.1
95.00	86.2	86.4	86.4	86.6	86.8	86.6	86.5	86.4	86.4
100.00	87.3	87.7	87.7	87.7	88.2	87.8	87.7	87.6	87.4
105.00	88.3	88.7	88.8	88.8	89.1	88.9	88.8	88.6	88.3
110.00	89.3	89.6	89.7	89.6	89.8	89.6	89.6	89.5	89.3
115.00	90.2	90.3	90.3	90.3	90.4	90.3	90.3	90.3	90.2
120.00	90.8	90.9	90.8	90.9	90.9	90.9	91.0	91.0	90.9
125.00	91.3	91.3	91.4	91.5	91.5	91.4	91.5	91.5	91.4
130.00	91.9	91.8	91.9	92.0	92.0	92.0	92.0	91.9	92.0
135.00	92.3	92.4	92.4	92.4	92.6	92.4	92.4	92.4	92.3
140.00	92.8	92.8	92.9	92.9	92.9	92.9	92.9	92.8	92.8
145.00	93.1	93.2	93.2	93.3	93.2	93.2	93.3	93.2	93.1
150.00	93.5	93.5	93.5	93.6	93.6	93.6	93.5	93.5	93.5
155.00	93.9	93.9	93.9	93.9	93.9	93.9	93.8	93.8	93.8
160.00	94.2	94.2	94.2	94.2	94.1	94.2	94.1	94.1	94.2
165.00	94.5	94.5	94.5	94.5	94.4	94.5	94.5	94.4	94.5
170.00	94.7	94.7	94.8	94.8	94.8	94.8	94.8	94.7	94.7
175.00	95.0	95.0	95.0	95.0	95.1	95.0	95.1	95.0	95.0
180.00	95.3	95.3	95.3	95.3	95.4	95.3	95.4	95.3	95.3
184.99	95.5	95.6	95.5	95.6	95.6	95.6	95.5	95.6	95.6
189.99	95.8	95.8	95.8	95.8	95.8	95.9	95.8	95.8	95.8
194.99	96.0	96.0	96.0	96.0	96.1	96.0	96.0	96.0	96.0
199.99	96.3	96.3	96.2	96.2	96.3	96.3	96.2	96.3	96.3

\*\*\*\*\*







FIGURE 74

Wavefront Plot-P Polarization

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

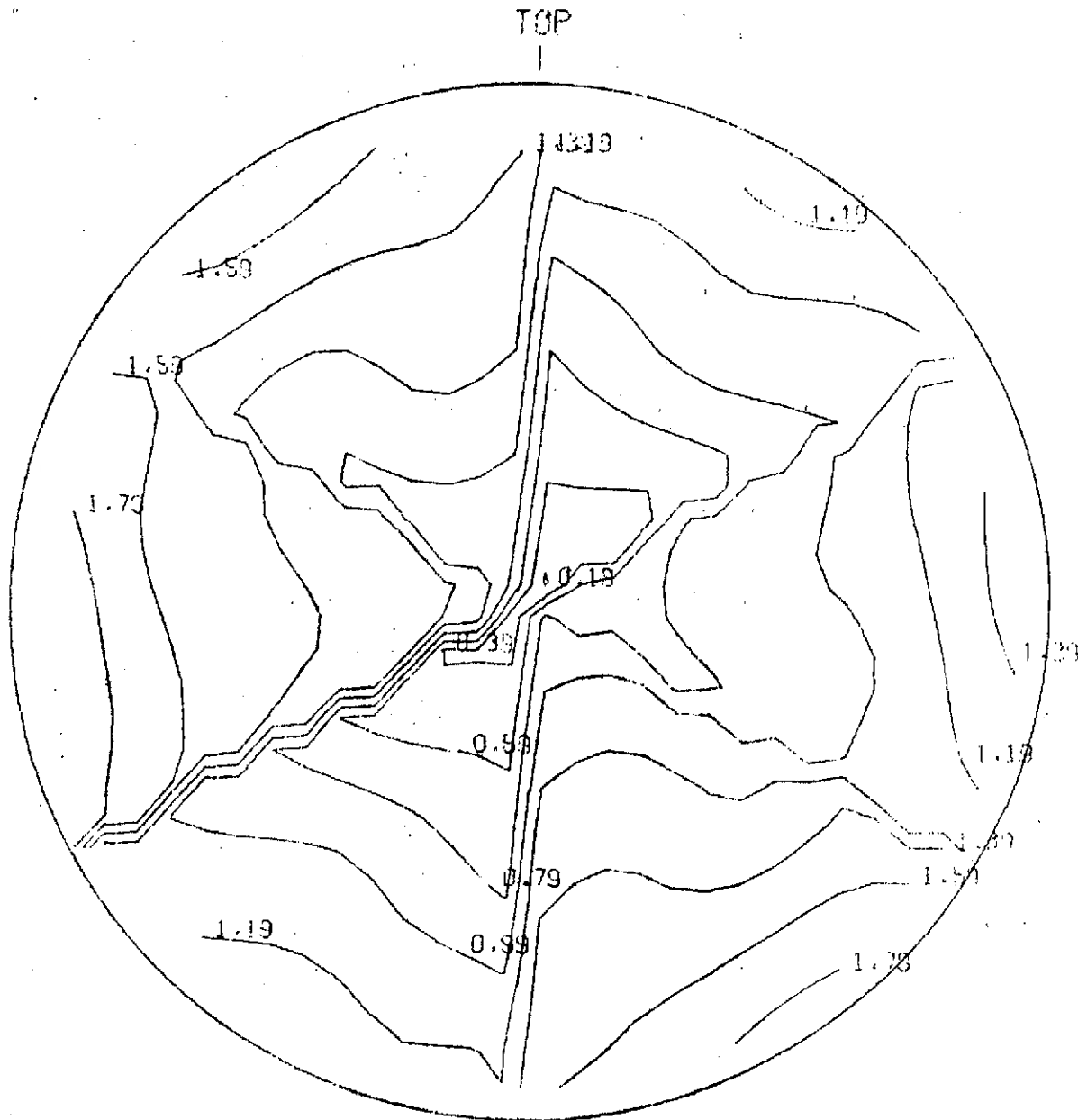






FIGURE 76

## Point Spread Function

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

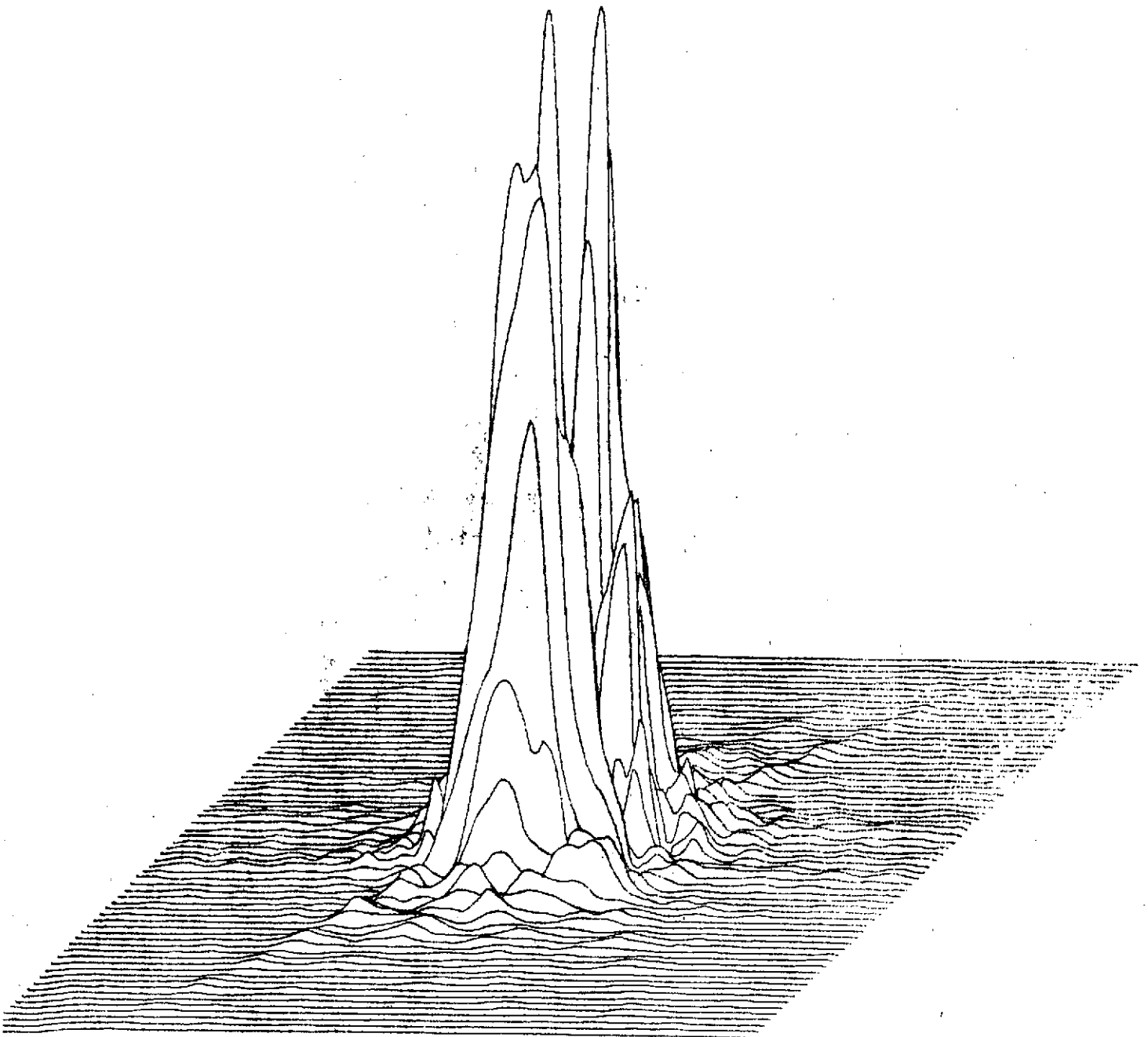


FIGURE 77

Intensity Distribution - Central 129 Microradians

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

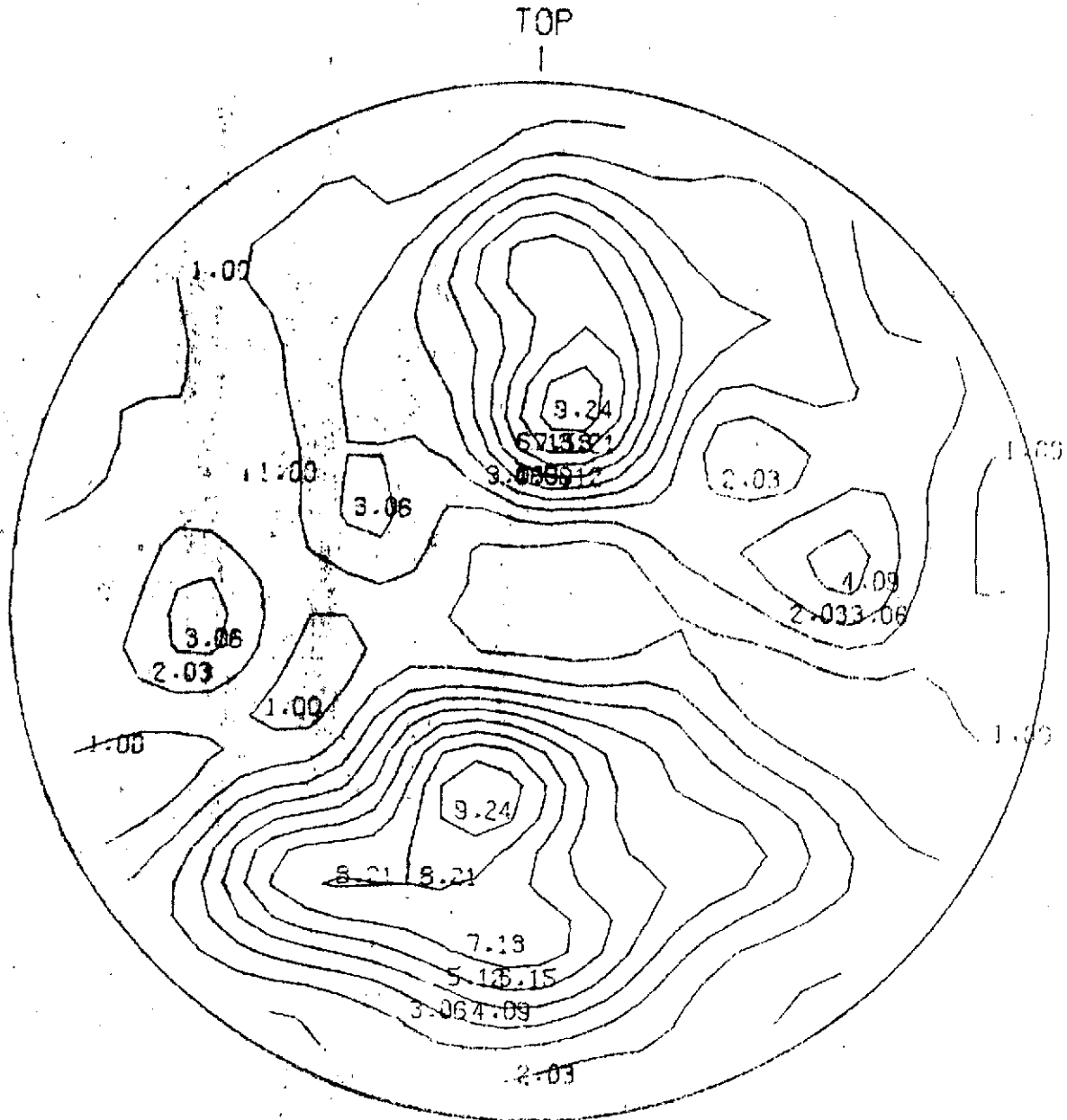
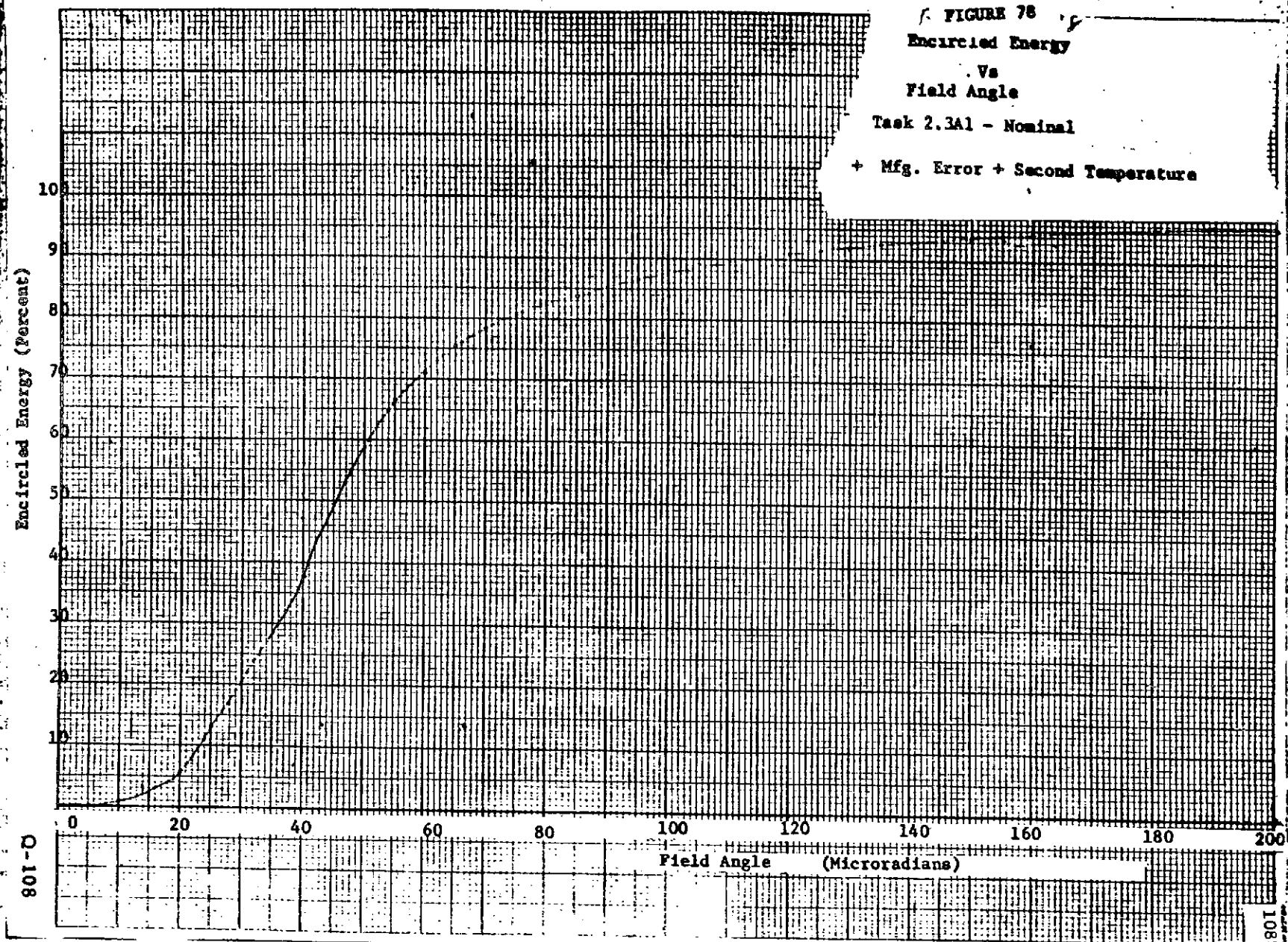


FIGURE 78  
Encircled Energy  
Vs  
Field Angle

Task 2.3A1 - Nominal

+ Mfg. Error + Second Temperature



Encircled Energy (Percent)

Field Angle (Microradians)

801-D

801

ENCIRCLED ENERGY

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

\*\*\*\*\*  
 CIRCLE \*  
 ----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*  
 (M- \* CENTER (MICRONS):  
 CIRCNS) \* X= -10.13 0.13 0.0 -10.13 0.0 10.13 0.0 -10.13 0.13  
 \* Y= -10.13 -0.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
4.00	*	0.3	0.3	0.2	0.1	0.0	0.0	0.2	0.4	0.3
6.00	*	0.3	0.3	0.7	0.3	0.2	0.1	0.7	0.4	0.3
8.00	*	0.9	1.0	1.2	0.5	0.2	0.3	1.3	1.3	0.9
10.00	*	1.3	1.4	1.7	0.8	0.6	0.5	1.9	1.8	1.3
12.00	*	2.9	3.2	2.7	1.3	0.8	0.9	3.0	3.7	2.9
14.00	*	2.9	3.2	3.8	2.4	1.7	2.0	4.3	3.7	2.9
16.00	*	4.9	5.5	5.1	3.0	2.4	2.7	5.8	6.1	4.9
18.00	*	5.9	6.3	6.4	4.6	5.4	4.3	7.0	7.0	5.9
20.00	*	7.8	8.4	8.6	5.9	5.4	5.8	9.5	9.3	8.0
22.00	*	8.7	9.2	10.2	8.5	9.7	8.4	11.0	10.2	9.1
24.00	*	11.2	12.0	12.1	9.7	11.3	9.9	13.0	13.1	11.9
26.00	*	12.5	13.2	14.1	13.0	15.6	13.1	14.9	14.6	13.6
28.00	*	15.8	16.9	17.6	16.4	16.7	16.5	18.9	18.3	17.1
30.00	*	18.1	19.2	19.6	19.7	21.1	19.9	20.7	21.0	19.9
32.00	*	22.8	24.1	23.1	22.3	22.9	22.5	24.7	25.9	24.6
34.00	*	23.7	25.2	25.7	26.7	26.7	26.8	27.7	27.1	25.7
36.00	*	28.7	30.3	29.6	29.5	29.7	29.6	32.1	32.2	30.7
38.00	*	30.8	32.6	32.6	33.4	34.7	33.4	35.0	34.8	33.1
40.00	*	35.1	36.7	36.3	36.5	37.0	36.4	39.2	38.9	37.4
42.00	*	37.0	38.7	39.9	41.2	43.1	41.1	42.6	40.9	39.3
44.00	*	41.6	42.7	43.2	43.6	45.8	43.2	46.0	44.9	43.8
46.00	*	44.4	45.3	46.5	48.7	51.7	48.4	49.1	47.4	46.7
48.00	*	48.6	48.9	50.8	52.3	53.0	51.9	53.0	51.1	50.7
50.00	*	51.7	51.8	53.1	55.5	58.0	55.2	54.9	53.8	53.7
52.00	*	55.8	55.2	57.1	58.8	60.2	58.5	58.5	57.0	57.4
54.00	*	58.0	57.4	59.6	61.9	63.7	61.8	60.8	59.1	59.3
56.00	*	61.9	61.1	63.7	64.9	65.8	64.9	64.2	62.2	62.8
58.00	*	64.5	63.7	65.5	66.9	68.9	66.9	66.1	64.6	65.0
60.00	*	67.2	66.3	68.6	69.3	70.8	69.4	68.9	66.9	67.6
62.00	*	69.0	68.2	70.4	71.5	73.0	71.5	70.7	68.6	69.2
64.00	*	71.8	71.0	72.4	72.9	74.5	72.9	72.6	71.1	71.8
66.00	*	73.2	72.6	74.2	74.9	76.4	74.9	74.4	72.7	73.3
68.00	*	75.2	74.5	75.9	76.1	77.2	76.2	75.9	74.6	75.3
70.00	*	76.3	75.7	77.2	77.5	78.5	77.5	77.1	75.7	76.4
72.00	*	78.0	77.4	78.4	78.6	79.5	78.6	78.3	77.3	78.1
74.00	*	78.9	78.2	79.5	79.7	80.4	79.7	79.4	78.2	78.9
76.00	*	80.3	79.5	80.6	80.6	81.1	80.6	80.5	79.5	80.2
78.00	*	81.1	80.4	81.2	81.3	81.8	81.3	81.1	80.4	81.0
80.00	*	82.1	81.3	82.1	82.1	82.4	82.1	82.1	81.4	82.0

\*\*\*\*\*

TABLE 19

ENCIRCLED ENERGY

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

\*\*\*\*\*

\*\*\*\*\*

CIRCLE \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*

(M)- CENTER (MICRONS):

(RADIUS) X= -10.13 0.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

5.00	0.3	0.3	0.5	0.3	0.1	0.1	0.5	0.4	0.3
10.00	1.3	1.4	1.7	0.8	0.6	0.5	1.9	1.8	1.3
15.00	4.1	4.6	4.7	2.6	2.4	2.3	5.3	5.1	4.0
20.00	7.8	8.4	8.6	5.9	5.4	5.8	9.5	9.3	8.0
25.00	12.0	12.8	13.5	12.7	13.4	12.8	14.3	14.1	13.0
30.00	18.1	19.2	19.6	19.7	21.1	19.9	20.7	21.0	19.9
35.00	26.8	28.3	27.8	27.4	28.9	27.5	29.8	30.0	28.7
40.00	35.1	36.7	36.3	36.5	37.0	36.4	39.2	38.9	37.4
45.00	43.2	44.3	45.0	47.0	49.4	46.7	47.7	46.5	45.4
50.00	51.7	51.8	53.1	55.5	58.0	55.2	54.9	53.8	53.7
55.00	60.6	59.7	62.0	63.5	65.4	63.3	62.9	60.9	61.6
60.00	67.2	66.3	68.6	69.3	70.8	69.4	68.9	66.9	67.6
65.00	72.4	71.7	73.6	74.1	75.7	74.1	73.7	71.8	72.5
70.00	76.3	75.7	77.2	77.5	78.5	77.5	77.1	75.7	76.4
75.00	79.7	79.0	80.1	80.2	80.8	80.2	80.0	79.0	79.7
80.00	82.1	81.3	82.1	82.1	82.4	82.1	82.1	81.4	82.0
85.00	83.7	83.1	83.8	83.9	83.9	83.9	83.9	83.2	83.7
90.00	85.0	84.7	85.1	85.3	85.4	85.3	85.3	84.9	85.2
95.00	86.2	86.3	86.4	86.5	86.8	86.6	86.5	86.4	86.4
100.00	87.3	87.6	87.6	87.6	88.0	87.7	87.6	87.5	87.3
105.00	88.2	88.6	88.7	88.6	88.9	88.7	88.7	88.5	88.2
110.00	89.2	89.4	89.5	89.4	89.6	89.5	89.4	89.4	89.2
115.00	90.0	90.1	90.1	90.1	90.2	90.1	90.1	90.2	90.0
120.00	90.6	90.7	90.7	90.8	90.8	90.7	90.8	90.8	90.7
125.00	91.2	91.2	91.3	91.3	91.4	91.3	91.4	91.3	91.3
130.00	91.8	91.7	91.8	91.9	92.0	91.9	91.9	91.8	91.9
135.00	92.3	92.3	92.3	92.4	92.5	92.4	92.3	92.3	92.3
140.00	92.7	92.8	92.8	92.9	92.9	92.9	92.9	92.8	92.8
145.00	93.1	93.1	93.2	93.2	93.2	93.2	93.3	93.2	93.1
150.00	93.5	93.5	93.6	93.6	93.6	93.6	93.6	93.5	93.5
155.00	93.9	93.9	93.9	93.9	93.9	93.9	93.8	93.8	93.8
160.00	94.2	94.2	94.2	94.2	94.2	94.2	94.1	94.2	94.2
165.00	94.5	94.5	94.6	94.5	94.5	94.5	94.5	94.5	94.5
170.00	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8
175.00	95.1	95.0	95.1	95.1	95.1	95.1	95.2	95.1	95.1
180.00	95.3	95.3	95.3	95.4	95.5	95.4	95.4	95.4	95.4
184.99	95.6	95.6	95.5	95.6	95.6	95.7	95.6	95.6	95.6
189.99	95.8	95.8	95.8	95.9	95.9	95.9	95.8	95.9	95.9
194.99	96.0	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1
199.99	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3

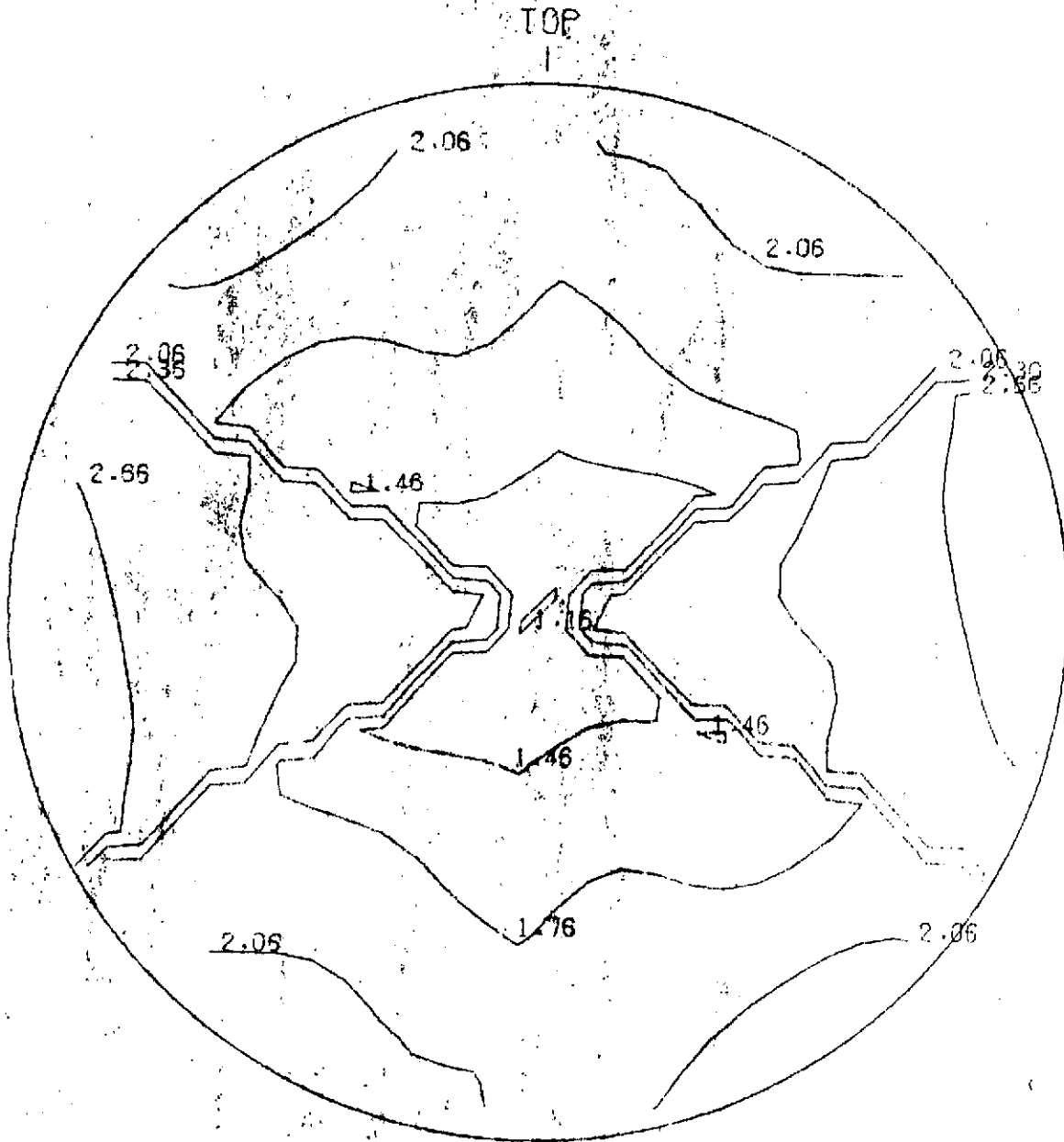
\*\*\*\*\*



FIGURE 80

Wavefront Plot-Q Polarization

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



## FIGURE 81

## Wavefront Map-P Polarization

Task 7.3A2 - Nominal + Mfg. Error + Third Temperature

MAP IN UNITS OF 0.01 WAVES

270 263 258 253 249 212 214 215 216 220

287 280 272 265 259 254 249 245 211 214 215 216 219 226 235 243

285 283 273 266 260 255 251 246 241 206 209 211 212 216 223 231 237 241

282 277 272 265 259 254 251 249 246 241 199 203 205 207 212 218 224 228 230 230

274 273 269 263 257 252 249 248 247 245 241 191 196 200 203 207 212 216 218 219 219 218

263 265 263 259 253 248 245 245 244 244 242 238 182 187 193 198 203 207 210 210 209 209 210 211

252 254 256 254 249 244 240 238 238 239 239 237 233 174 180 186 192 199 203 205 204 203 202 204 205 208

269 247 248 248 245 240 235 231 229 231 233 234 232 228 168 173 179 186 192 197 200 200 199 197 198 200 203 238

270 268 265 241 239 233 226 222 222 225 229 230 227 222 163 168 173 179 184 188 191 193 194 193 193 228 234 239

274 270 267 263 234 227 219 214 215 223 224 224 221 216 158 162 165 165 174 177 181 185 188 185 223 228 235 240

283 278 273 267 263 259 253 212 208 209 213 216 217 214 208 153 155 157 159 162 166 171 177 205 213 221 229 237 244 247

289 282 274 267 261 257 251 246 240 202 205 207 207 205 200 146 147 148 148 151 156 192 197 205 214 221 229 238 246 251

285 287 276 267 260 255 253 246 241 236 233 197 198 196 193 139 140 139 139 186 191 196 201 207 214 221 228 237 247 254

300 291 279 268 261 255 251 248 244 239 236 233 190 189 187 131 132 131 182 189 195 199 203 208 213 220 226 236 247 256

304 294 282 271 263 257 254 251 247 243 238 234 229 221 181 122 165 176 184 190 195 200 203 206 211 217 224 234 246 256

306 296 284 274 267 261 256 253 250 245 240 234 226 215 134 193 171 179 184 188 193 197 201 204 207 213 221 232 244 254

305 297 286 276 270 263 258 253 249 245 239 232 143 143 143 199 200 201 183 186 190 194 198 201 205 211 218 229 241 250

304 297 287 278 271 264 257 251 246 241 236 151 151 151 151 205 208 209 209 183 186 191 196 200 205 210 217 226 237 245

301 296 288 279 271 264 255 247 242 167 163 160 159 159 158 212 217 219 219 216 214 190 196 201 207 211 217 225 232 239

297 294 287 279 271 263 255 188 183 178 174 173 168 167 164 220 225 229 228 224 221 229 224 203 209 213 217 223 228 233

290 285 278 270 201 200 197 193 189 185 181 177 174 170 227 233 236 235 231 227 226 230 239 246 213 217 220 224

289 284 278 204 205 206 205 203 203 196 191 135 180 175 234 239 241 241 237 234 234 238 245 250 253 215 218 220

288 215 212 210 209 213 211 211 205 204 198 191 185 179 239 244 246 245 243 241 242 247 252 257 259 259 258 219

219 217 215 214 214 216 217 215 215 204 197 191 185 244 249 251 251 249 249 251 255 261 265 268 266 264

222 222 221 221 221 221 219 215 210 204 199 193 249 253 256 256 256 257 260 265 270 275 276 275

233 233 233 229 227 224 219 214 211 208 202 252 254 255 260 261 264 268 274 280 285 285

242 242 243 235 229 223 219 217 215 210 253 257 260 263 266 271 277 284 289 293

253 249 242 235 229 224 222 221 217 253 258 262 267 272 278 285 291 297

254 247 235 231 227 226 225 223 256 261 265 271 277 284 292 299

232 228 227 226 224 261 265 269 275 282

FIGURE 82 2

Wavefront Plot-P Polarization

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

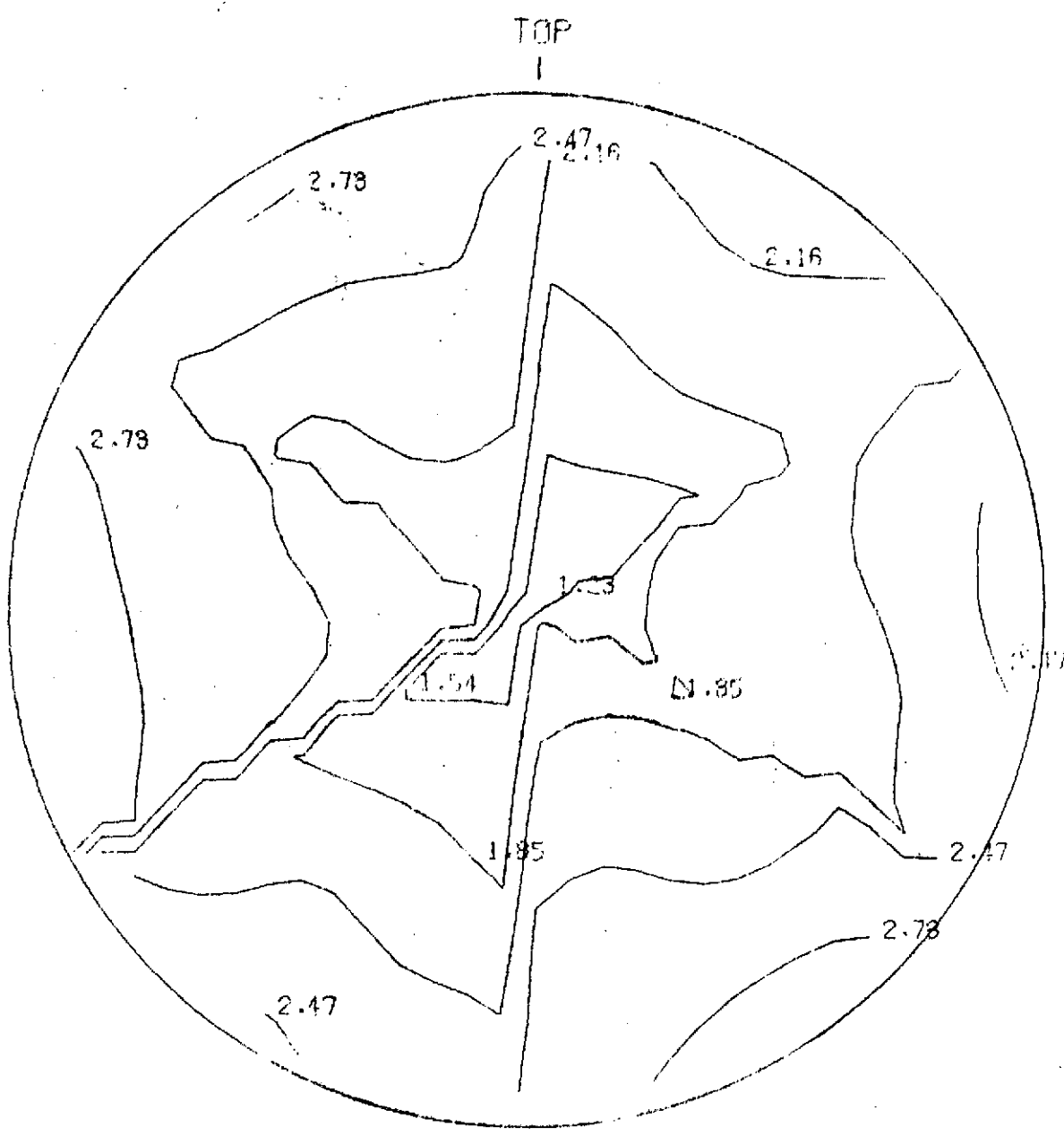


FIGURE 83

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

PRINTER MAP OF POINT SPREAD FUNCTION

ONE SPACE REPRESENTS 8.04 MICRONS  
NORMALIZED SO LARGEST VALUE = 0.3327 = 100

TOTAL ENERGY = 3.2161JJD\*J1  
MAP REPRESENTS 0.2316395D\*01 OR 94.1241 PERCENT OF TOTAL ENERGY

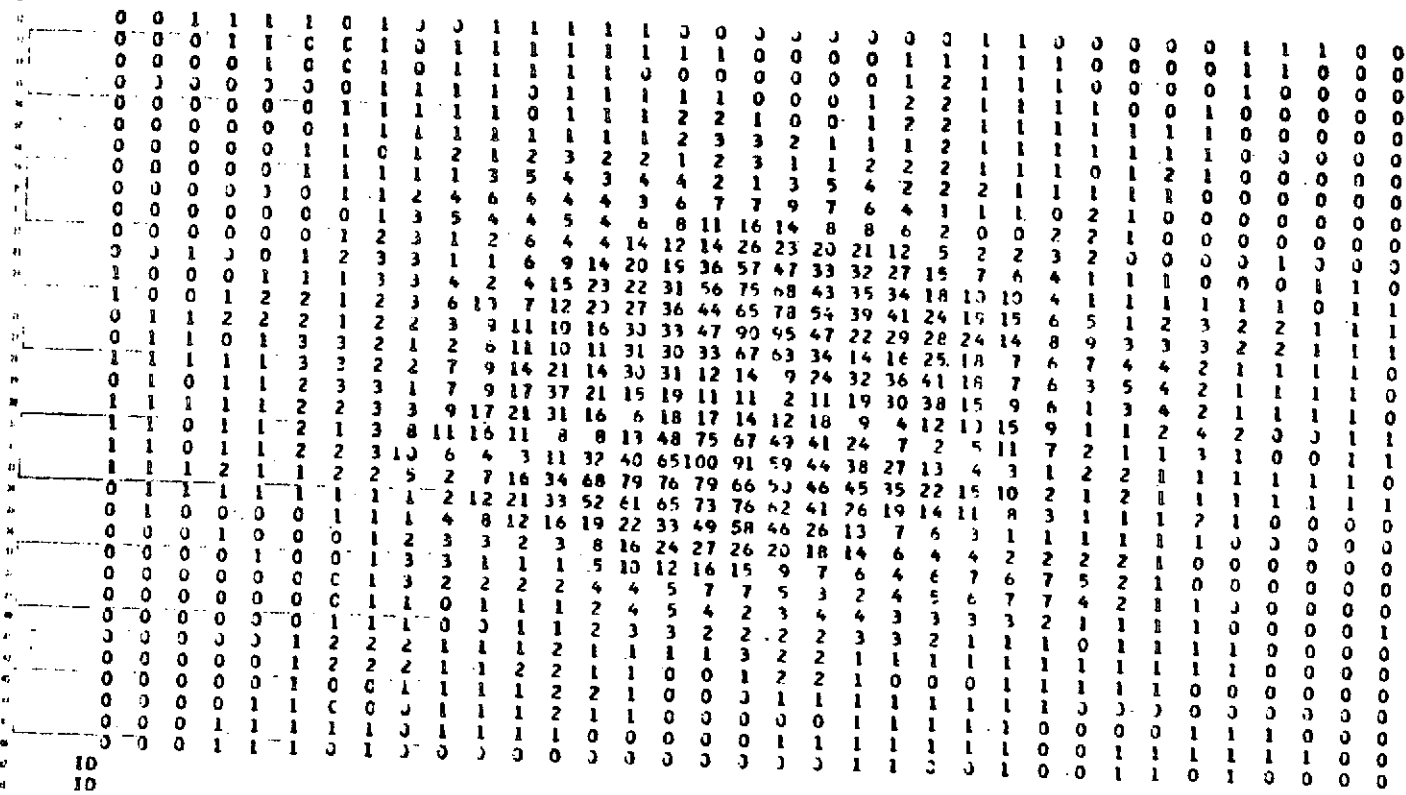


FIGURE 84

## Point Spread Function

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

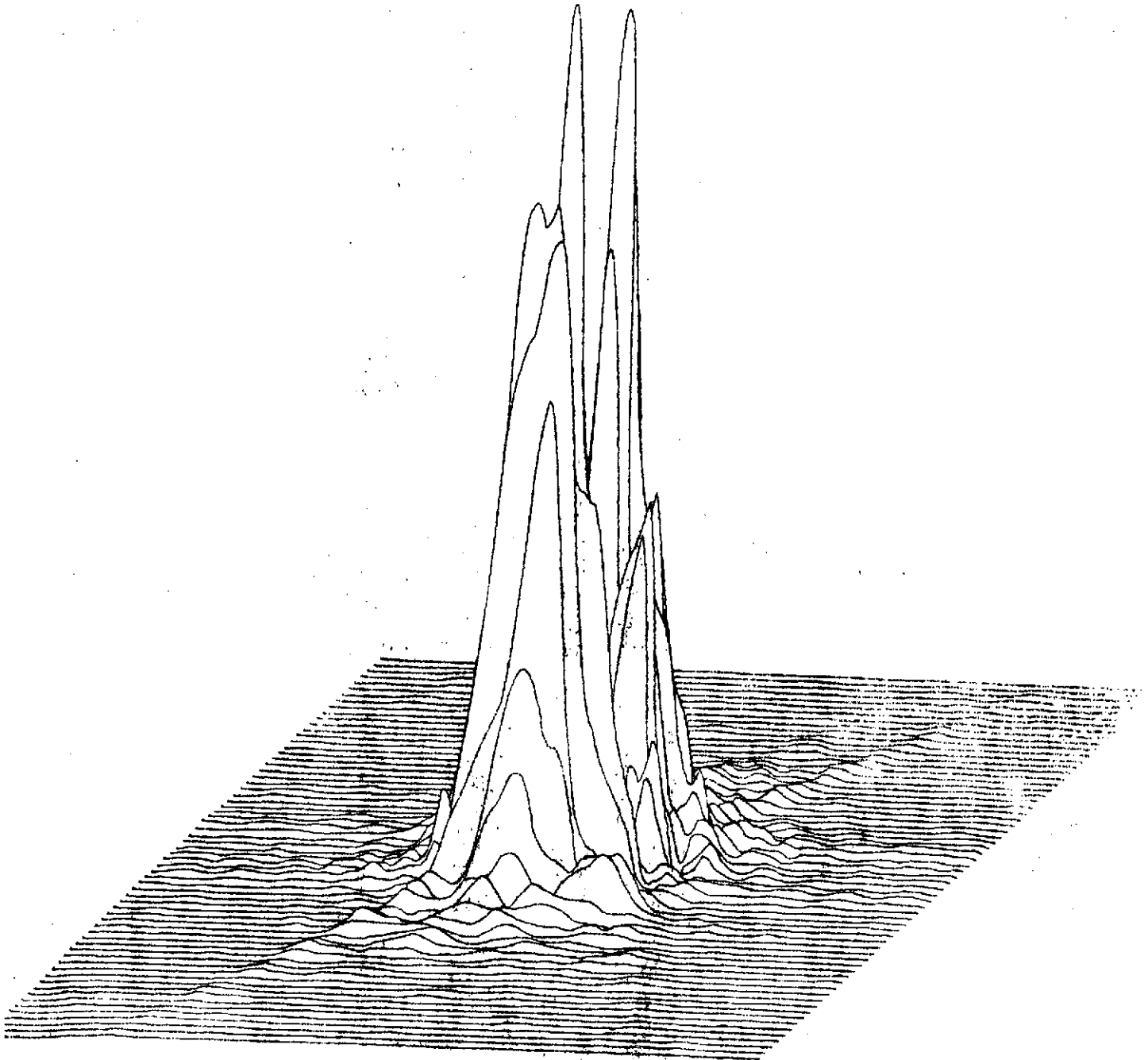


FIGURE 85

Intensity Distribution - Central 129 Microradians  
Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

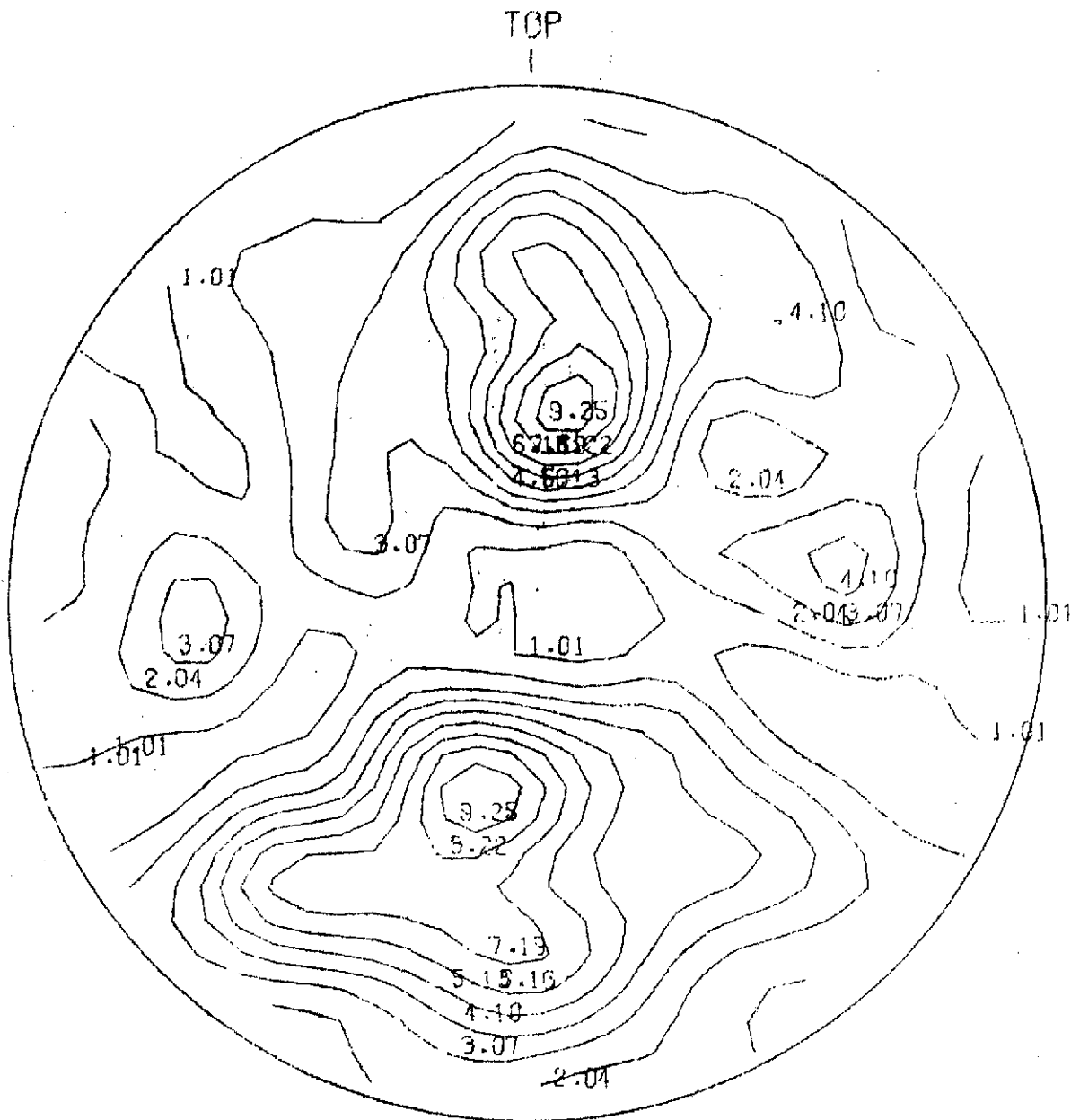
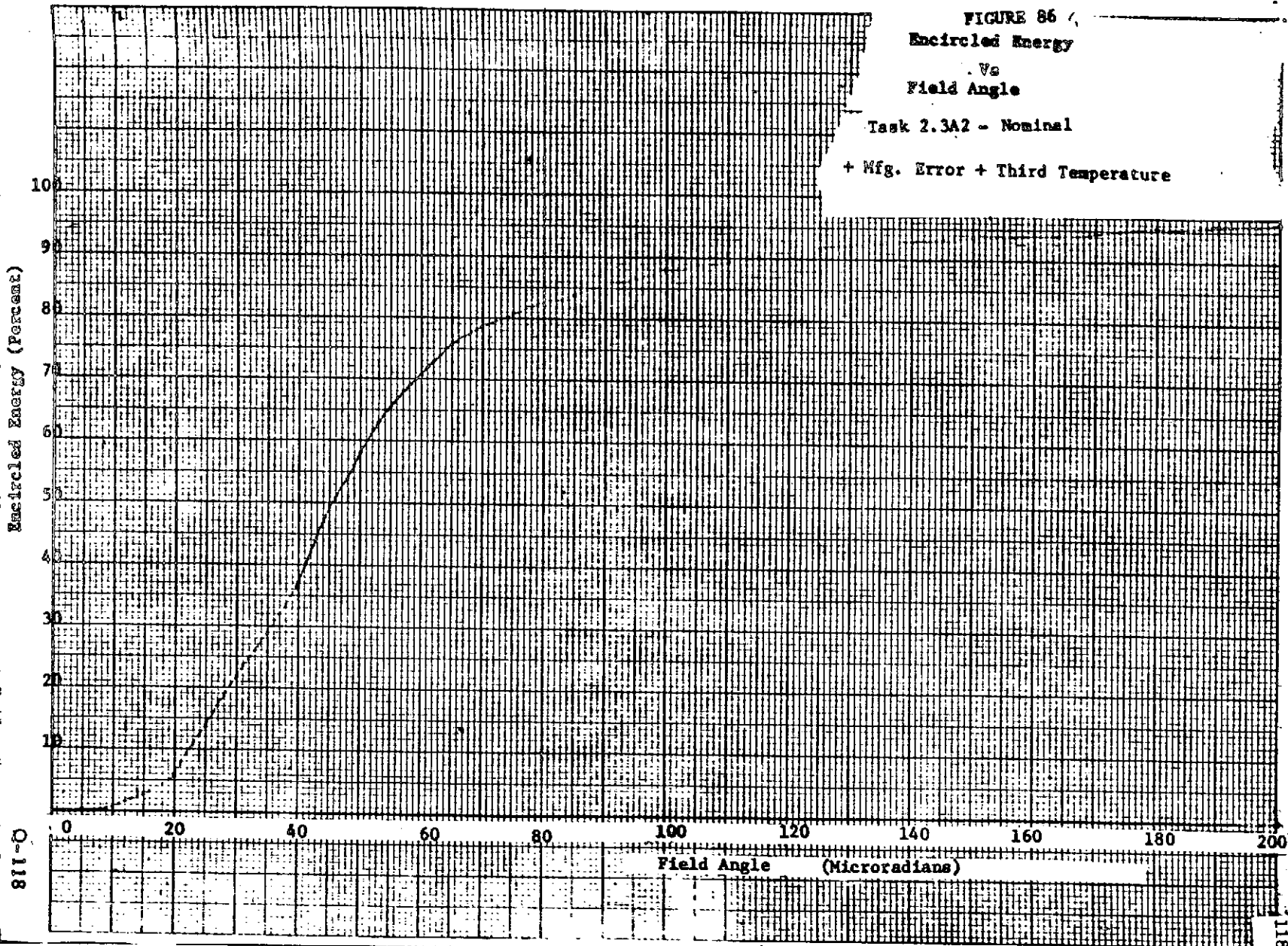


FIGURE 86  
Encircled Energy  
Vs  
Field Angle

Task 2.3A2 - Nominal

+ Mfg. Error + Third Temperature



Encircled Energy (Percent)

Field Angle (Microradians)

811-0

118

TABLE 20

E N C I R C L E D E N E R G Y

Task 2.5A - Nominal + Mfg. Error + Axial Gradient

```

*****
CIRCLE *
----- *
RADIUS *
----- *
(MI- *
CRONS) * CENTER (MICRONS):
* X= -10.13  0.13  0.0 -10.13  0.0  10.13  0.0 -10.13  10.13
* Y= -10.13 -10.13 -10.13  0.0  0.0  0.0  10.13  10.13  10.13
*
*****
*
2.00 * 0.0 0.0 0.3 0.1 0.2 0.1 0.3 0.0 0.0
4.00 * 0.4 0.6 0.5 0.2 0.2 0.1 0.5 1.0 0.6
6.00 * 0.4 0.6 1.8 0.8 1.6 0.5 1.9 1.0 0.6
8.00 * 1.6 2.0 3.1 1.5 1.6 1.1 3.4 3.0 2.1
10.00 * 2.3 2.8 4.3 2.1 3.3 1.6 4.9 4.1 3.0
12.00 * 5.6 6.4 6.7 3.5 3.8 2.9 7.6 8.3 6.6
14.00 * 5.6 6.4 8.6 5.9 6.0 5.2 10.5 8.3 6.6
16.00 * 9.8 10.9 11.5 7.5 7.3 7.0 13.8 13.1 11.1
18.00 * 11.6 12.7 13.5 10.5 13.2 10.1 16.3 15.1 13.2
20.00 * 15.1 16.4 17.4 13.5 13.2 13.3 20.7 18.9 17.0
22.00 * 16.8 18.0 19.7 18.2 21.2 18.2 23.2 20.7 19.1
24.00 * 20.9 22.2 22.8 20.4 23.8 20.6 26.2 24.9 23.4
26.00 * 22.9 24.1 25.7 26.1 31.6 26.4 28.8 27.0 25.9
28.00 * 27.4 28.8 30.4 31.5 33.4 31.9 33.7 31.4 30.2
30.00 * 30.6 31.9 33.3 36.4 40.2 36.8 35.7 34.9 33.9
32.00 * 36.6 38.0 38.0 40.0 42.5 40.4 40.4 40.5 39.5
34.00 * 37.7 39.2 41.3 45.3 47.0 45.6 43.4 41.9 40.6
36.00 * 44.0 45.4 46.3 48.6 50.1 48.7 48.5 47.5 46.2
38.00 * 46.4 48.0 49.6 52.2 54.2 52.2 51.0 50.1 48.6
40.00 * 51.2 52.3 53.7 55.1 56.2 55.0 55.4 54.0 53.0
42.00 * 53.3 54.5 56.8 58.6 60.5 58.5 58.4 56.1 54.9
44.00 * 57.7 58.2 59.8 60.5 62.6 60.1 61.4 59.5 59.0
46.00 * 60.0 60.2 62.2 63.8 66.5 63.4 63.7 61.4 61.3
48.00 * 63.4 63.0 65.0 66.2 67.3 65.7 66.4 64.3 64.6
50.00 * 65.6 65.0 66.6 68.0 70.4 67.7 67.8 66.2 66.8
52.00 * 68.4 67.1 69.0 70.2 71.6 69.9 69.9 68.1 69.3
54.00 * 69.9 68.5 70.6 71.9 73.4 71.8 71.3 69.4 70.6
56.00 * 72.3 70.8 73.0 73.7 74.4 73.7 73.2 71.4 72.7
58.00 * 73.9 72.5 74.2 74.8 75.8 74.8 74.2 72.9 74.0
60.00 * 75.5 74.1 75.8 76.1 76.8 76.2 75.7 74.3 75.4
62.00 * 76.5 75.3 76.8 77.1 77.7 77.2 76.8 75.4 76.3
64.00 * 77.9 76.9 77.9 77.9 78.5 78.1 77.7 77.0 77.7
66.00 * 78.7 78.0 78.9 79.0 79.4 79.0 78.8 78.0 78.5
68.00 * 79.7 79.1 79.7 79.7 80.0 79.7 79.6 79.1 79.7
70.00 * 80.3 79.9 80.6 80.6 80.8 80.5 80.6 79.9 80.3
72.00 * 81.2 80.9 81.2 81.4 81.5 81.3 81.3 81.0 81.4
74.00 * 81.7 81.5 82.0 82.1 82.3 82.0 82.1 81.5 81.9
76.00 * 82.5 82.4 82.6 82.8 82.9 82.8 82.9 82.4 82.7
78.00 * 83.1 83.0 83.2 83.4 83.7 83.3 83.4 83.1 83.3
80.00 * 83.7 83.7 83.8 84.0 84.3 84.1 84.1 83.7 83.9
*
*****

```

ENCIRCLED ENERGY

Task 2.5A - Nominal + Mfg. Error + Axial Gradient

\*\*\*\*\*

CIRCLE	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
RADIUS	CENTER (MICRONS):									
(MICRONS)	X= -10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13	
	Y= -10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13	
5.00	0.4	0.6	1.3	0.7	0.9	0.4	1.5	1.0	0.6	
10.00	2.3	2.8	4.3	2.1	3.3	1.6	4.9	4.1	3.0	
15.00	8.0	9.2	10.9	6.5	7.3	6.1	12.8	11.2	9.2	
20.00	15.1	16.4	17.4	13.5	13.2	13.3	20.7	18.9	17.0	
25.00	22.2	23.6	24.8	25.7	27.9	25.9	28.1	26.3	25.0	
30.00	30.6	31.9	33.3	36.4	40.2	36.8	35.7	34.9	33.9	
35.00	41.8	43.1	44.2	46.2	49.2	46.4	45.9	45.0	44.0	
40.00	51.2	52.3	53.7	55.1	56.2	55.0	55.4	54.0	53.0	
45.00	59.1	59.5	61.0	62.7	64.9	62.3	62.7	60.9	60.4	
50.00	65.6	65.0	66.6	68.0	70.4	67.7	67.8	66.2	66.8	
55.00	71.5	69.9	72.0	73.0	74.2	72.8	72.4	70.5	71.9	
60.00	75.5	74.1	75.8	76.1	76.8	76.2	75.7	74.3	75.4	
65.00	78.3	77.4	78.5	78.5	79.1	78.6	78.4	77.4	78.1	
70.00	80.3	79.9	80.6	80.6	80.8	80.5	80.6	79.9	80.3	
75.00	82.2	82.0	82.3	82.5	82.6	82.5	82.5	82.1	82.3	
80.00	83.7	83.7	83.8	84.0	84.3	84.1	84.1	83.7	83.9	
85.00	85.0	85.1	85.4	85.5	85.9	85.7	85.6	85.2	85.2	
90.00	86.3	86.5	86.8	86.8	87.1	86.9	86.8	86.5	86.5	
95.00	87.6	87.7	87.9	87.8	88.0	87.8	87.8	87.7	87.6	
100.00	88.5	88.7	88.7	88.7	88.9	88.7	88.7	88.7	88.5	
105.00	89.3	89.4	89.5	89.5	89.6	89.5	89.6	89.4	89.3	
110.00	90.0	90.0	90.1	90.1	90.3	90.2	90.2	90.1	90.1	
115.00	90.6	90.7	90.7	90.8	90.9	90.8	90.8	90.8	90.7	
120.00	91.2	91.2	91.2	91.4	91.4	91.3	91.3	91.3	91.3	
125.00	91.7	91.7	91.8	91.8	91.9	91.8	91.8	91.7	91.7	
130.00	92.2	92.1	92.2	92.2	92.3	92.2	92.2	92.2	92.2	
135.00	92.6	92.6	92.5	92.6	92.6	92.6	92.6	92.6	92.6	
140.00	93.0	93.0	93.0	93.0	92.9	93.0	93.0	93.0	92.9	
145.00	93.3	93.3	93.4	93.3	93.3	93.3	93.3	93.3	93.3	
150.00	93.7	93.6	93.7	93.7	93.7	93.7	93.6	93.6	93.6	
155.00	94.0	94.0	94.0	94.0	94.1	94.0	94.0	93.9	94.0	
160.00	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	
165.00	94.6	94.5	94.6	94.6	94.6	94.6	94.6	94.6	94.6	
170.00	94.8	94.8	94.8	94.9	94.9	94.9	94.9	94.9	94.8	
175.00	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	
180.00	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	
184.99	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	
189.99	95.8	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	
194.99	96.0	96.0	96.1	96.0	96.2	96.1	96.1	96.1	96.1	
199.99	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	

\*\*\*\*\*

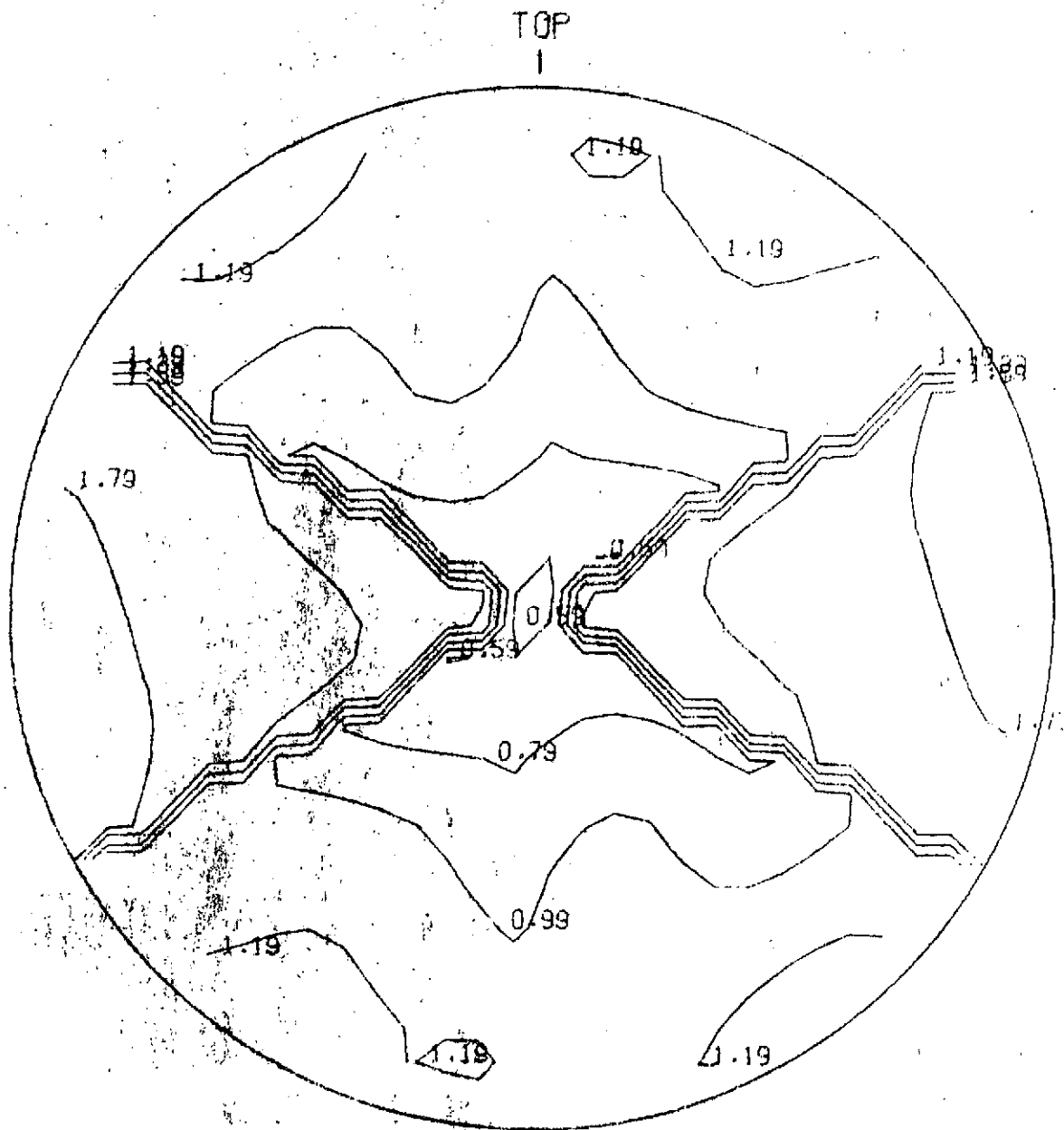




FIGURE 88

## Wavefront Plot-Q Polarization

Task 2.5A - Nominal + Mfg. Error + Axial Gradient





AVERAGE      AVERAGE      AVERAGE      AXIAL CR  
RMS      0.30      PK-PK      1.54

FIGURE 90

Wavefront Plot-P Polarization

Task 2.5A - Nominal + Mfg. Error + Axial Gradient

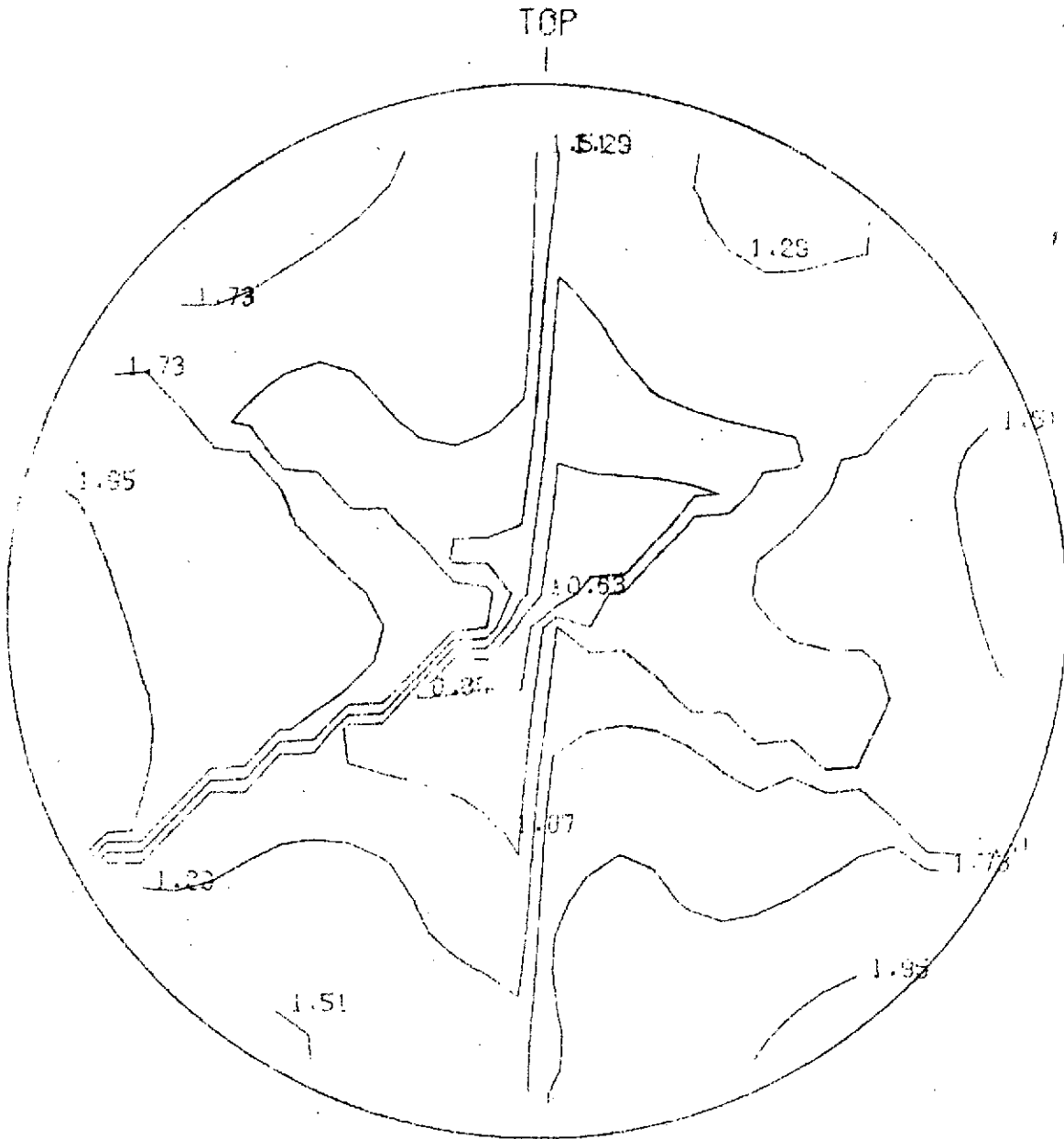
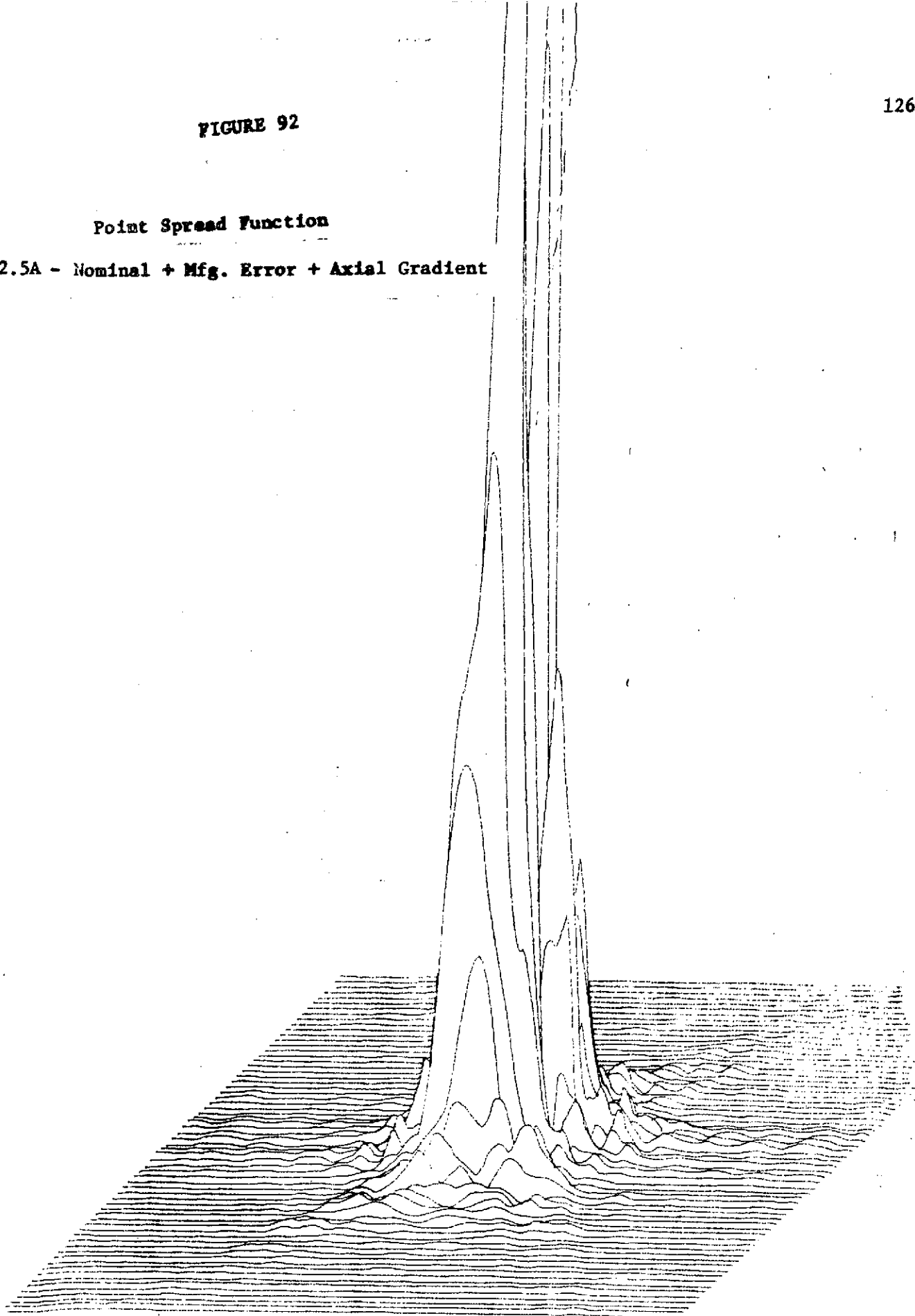




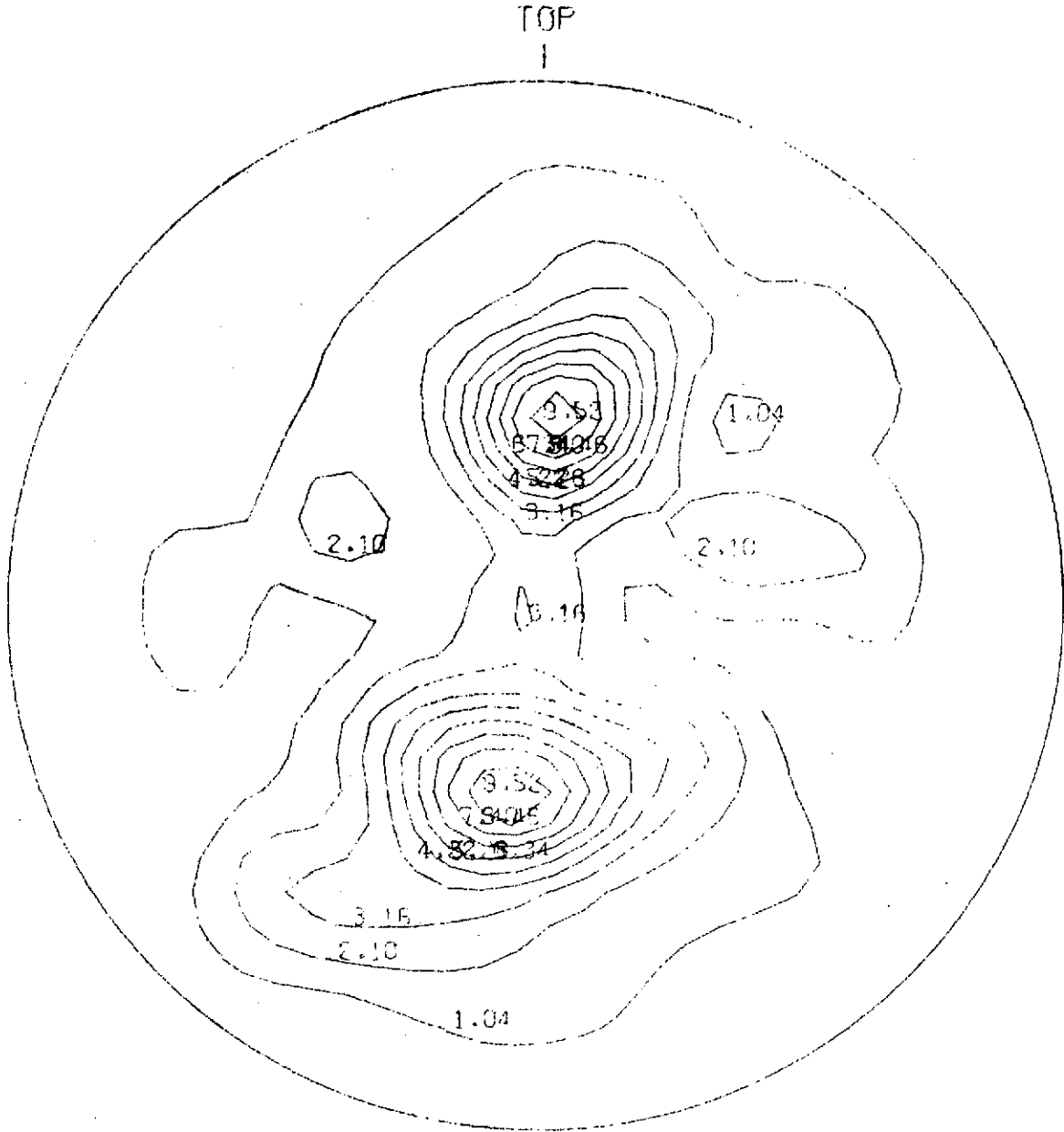
FIGURE 92

Point Spread Function

Mask 2.5A - Nominal + Mfg. Error + Axial Gradient



Intensity Distribution - Central 120 Microradians  
Task 2.5A - Nominal + Mfg. Error + Axial Gradient



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIGURE 94

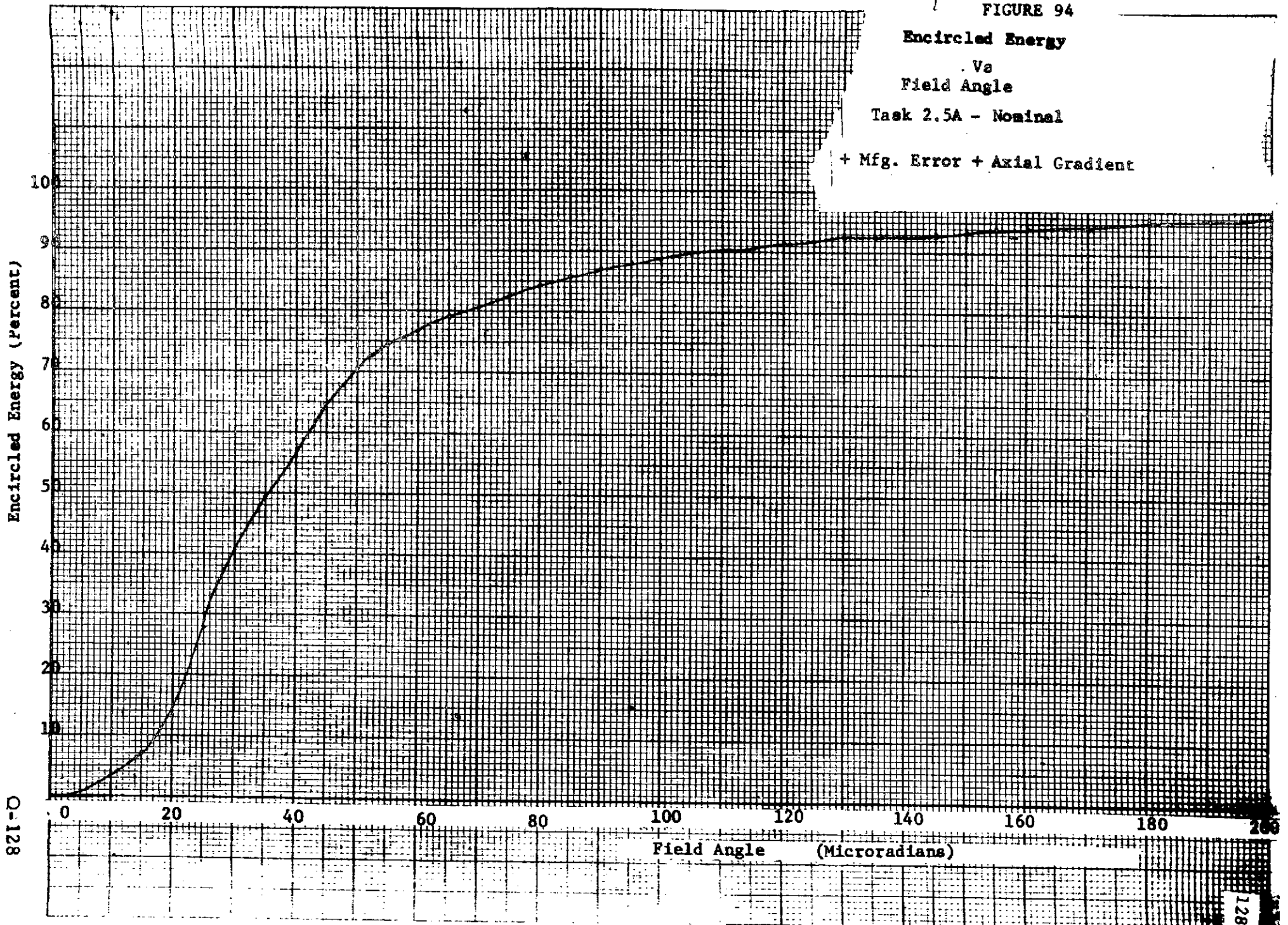
Encircled Energy

.Vs

Field Angle

Task 2.5A - Nominal

+ Mfg. Error + Axial Gradient





TABL R 22

F N C I R C L E D E N E R G Y

Task 2.5B - Nominal + Mfg. Error + Radial Gradient

\*\*\*\*\*

CIRCLE \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*

(MI-  
CRONS)

\* CENTER (MICRONS):

\* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13

\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
6.00	*	0.1	0.0	0.1	0.1	0.3	0.1	0.2	0.1	0.1
8.00	*	0.2	0.1	0.3	0.2	0.3	0.2	0.3	0.2	0.2
10.00	*	0.3	0.1	0.3	0.3	0.6	0.3	0.4	0.2	0.3
12.00	*	0.6	0.3	0.5	0.4	0.6	0.4	0.6	0.5	0.6
14.00	*	0.6	0.3	0.7	0.6	0.8	0.6	0.8	0.5	0.6
16.00	*	0.9	0.6	0.9	0.8	0.9	0.8	1.0	0.8	0.9
18.00	*	1.1	0.7	1.0	1.0	1.2	0.9	1.2	0.9	1.1
20.00	*	1.4	1.1	1.4	1.2	1.2	1.2	1.5	1.2	1.4
22.00	*	1.6	1.3	1.6	1.5	1.5	1.4	1.7	1.4	1.6
24.00	*	2.1	1.8	1.9	1.7	1.6	1.6	2.0	1.9	2.1
26.00	*	2.4	2.1	2.2	2.0	1.9	1.9	2.2	2.2	2.4
28.00	*	3.1	2.8	2.8	2.4	2.0	2.3	2.8	2.9	3.1
30.00	*	3.5	3.3	3.2	2.9	2.6	2.8	3.2	3.4	3.5
32.00	*	4.4	4.4	3.8	3.2	2.9	3.1	3.8	4.4	4.4
34.00	*	4.7	4.7	4.5	4.0	3.7	4.0	4.5	4.7	4.7
36.00	*	5.8	6.0	5.4	4.6	4.4	4.5	5.5	6.2	5.9
38.00	*	6.4	6.7	6.3	5.6	5.6	5.6	6.5	7.0	6.6
40.00	*	7.8	8.4	7.6	6.5	6.2	6.5	7.9	8.9	8.2
42.00	*	8.5	9.1	9.1	8.1	8.0	8.1	9.5	9.7	8.9
44.00	*	10.5	11.3	10.5	9.3	9.0	9.2	11.0	12.1	11.1
46.00	*	12.0	12.9	12.2	11.6	11.3	11.5	13.0	13.9	12.7
48.00	*	14.2	15.2	14.6	13.6	12.3	13.5	15.6	16.4	15.0
50.00	*	16.2	17.2	16.2	15.8	15.3	15.6	17.6	18.7	17.2
52.00	*	19.0	20.0	18.6	18.2	17.2	17.9	20.1	21.6	20.1
54.00	*	20.5	21.6	20.9	21.1	21.2	20.9	22.7	23.3	21.6
56.00	*	23.6	24.6	24.3	24.2	23.6	23.9	26.1	26.3	24.8
58.00	*	26.1	27.0	26.9	26.9	27.9	26.6	28.6	28.8	27.4
60.00	*	29.3	30.2	30.2	30.3	31.2	30.0	31.9	32.0	30.7
62.00	*	31.5	32.3	33.6	34.2	34.9	33.9	35.1	33.9	32.8
64.00	*	35.9	36.5	36.4	37.2	38.2	36.9	37.7	38.0	37.1
66.00	*	38.5	39.1	40.0	41.5	42.0	41.2	41.2	40.5	39.7
68.00	*	42.6	43.0	43.2	44.2	44.3	44.0	44.2	44.2	43.6
70.00	*	45.2	45.6	46.6	47.9	48.2	47.7	47.5	46.7	46.1
72.00	*	49.1	49.3	49.3	50.7	51.8	50.6	50.1	50.1	49.9
74.00	*	51.2	51.3	53.0	53.9	55.3	53.9	53.6	52.1	51.9
76.00	*	54.7	54.7	56.0	56.6	58.0	56.6	56.6	55.2	55.3
78.00	*	57.2	57.0	58.4	58.8	61.2	58.9	59.0	57.4	57.8
80.00	*	59.9	59.6	61.2	61.7	63.4	61.8	61.7	59.9	60.4

\*\*\*\*\*

TABLE 23  
ENCIRCLED ENERGY

Task 2.5B - Nominal + Mfg. Error + Radial Gradient

\*\*\*\*\*

```

CIRCLE *
----- *
RADIUS *
----- *
(MI- * CENTER (MICRONS):
GRONS) * X= -10.13  0.13  0.0  -10.13  0.0  10.13  0.0  -10.13  10.13
      * Y= -10.13 -10.13 -10.13  0.0  0.0  0.0  10.13  10.13  10.13
      *
  
```

\*\*\*\*\*

CIRCLE RADIUS (MICRONS)	0.1	0.0	0.1	0.1	0.2	0.1	0.2	0.1	0.1
5.00	0.1	0.0	0.1	0.1	0.2	0.1	0.2	0.1	0.1
10.00	0.3	0.1	0.3	0.3	0.6	0.3	0.4	0.2	0.3
15.00	0.8	0.5	0.8	0.7	0.9	0.7	1.0	0.7	0.8
20.00	1.4	1.1	1.4	1.2	1.2	1.2	1.5	1.2	1.4
25.00	2.3	2.0	2.1	2.0	1.8	1.8	2.1	2.1	2.3
30.00	3.5	3.3	3.2	2.9	2.6	2.8	3.2	3.4	3.5
35.00	5.3	5.5	4.9	4.1	4.2	4.1	5.0	5.6	5.4
40.00	7.8	8.4	7.6	6.5	6.2	6.5	7.9	8.9	8.2
45.00	11.3	12.1	11.3	10.7	10.3	10.6	12.1	13.1	11.9
50.00	16.2	17.2	16.2	15.8	15.3	15.6	17.6	18.7	17.7
55.00	22.5	23.6	22.7	22.6	22.9	22.3	24.4	25.2	23.8
60.00	29.3	30.2	30.2	30.3	31.2	30.0	31.9	32.0	30.7
65.00	37.1	37.7	38.6	39.6	40.5	39.3	39.8	39.1	38.3
70.00	45.2	45.6	46.6	47.9	48.2	47.7	47.5	46.7	46.1
75.00	53.2	53.3	54.4	55.4	56.7	55.4	55.0	53.9	53.8
80.00	59.9	59.6	61.2	61.7	63.4	61.8	61.7	59.9	60.4
85.00	65.8	65.1	67.2	67.7	69.0	67.8	67.3	65.2	66.2
90.00	71.1	70.1	71.6	72.1	73.0	72.2	71.5	70.1	71.7
95.00	75.3	74.3	75.2	75.6	76.1	75.7	75.1	74.2	75.2
100.00	78.3	77.4	78.2	78.5	78.8	78.5	78.3	77.4	78.4
105.00	80.6	80.0	80.7	81.0	81.3	81.0	80.9	80.2	80.9
110.00	82.7	82.5	82.9	83.1	83.6	83.2	83.1	82.7	83.0
115.00	84.6	84.8	84.8	85.0	85.4	85.1	85.0	84.8	84.8
120.00	86.3	86.5	86.7	86.8	87.1	86.8	86.7	86.5	86.4
125.00	87.6	87.9	88.2	88.1	88.5	88.1	88.1	87.9	87.6
130.00	88.9	89.1	89.4	89.2	89.6	89.2	89.3	89.1	88.8
135.00	90.1	89.9	90.1	90.1	90.3	90.0	90.1	89.9	90.1
140.00	90.9	90.8	91.0	91.0	91.0	91.0	91.0	90.8	90.8
145.00	91.6	91.5	91.6	91.6	91.5	91.6	91.5	91.4	91.6
150.00	92.2	92.1	92.3	92.2	92.3	92.2	92.2	92.1	92.1
155.00	92.7	92.7	92.8	92.7	93.0	92.7	92.8	92.7	92.7
160.00	93.2	93.3	93.3	93.3	93.4	93.3	93.3	93.3	93.2
165.00	93.7	93.7	93.8	93.8	93.8	93.8	93.8	93.7	93.7
170.00	94.1	94.0	94.1	94.1	94.2	94.1	94.2	94.1	94.1
175.00	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5
180.00	94.8	94.8	94.8	94.8	94.8	94.9	94.8	94.8	94.8
184.99	95.1	95.2	95.1	95.1	95.1	95.1	95.1	95.1	95.1
189.99	95.4	95.4	95.5	95.5	95.5	95.5	95.5	95.4	95.4
194.99	95.7	95.7	95.7	95.7	95.8	95.7	95.8	95.7	95.7
199.99	96.0	96.0	96.0	96.1	96.1	96.1	96.1	96.1	96.1

\*\*\*\*\*



FIGURE 96

Wavefront Plot-Q Polarization  
Task 2.5B - Nominal + Mfg. Error + Radial Gradient

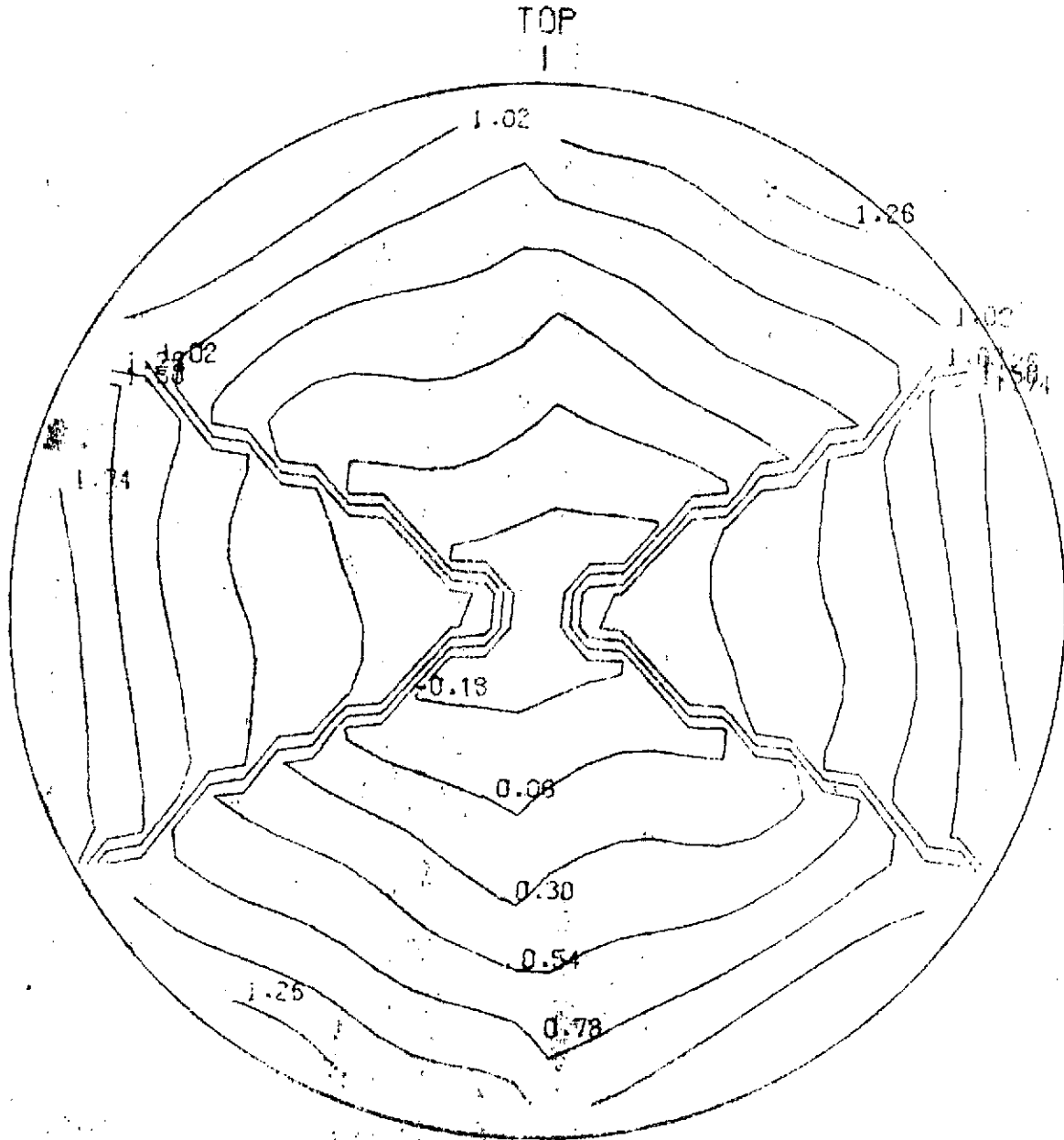
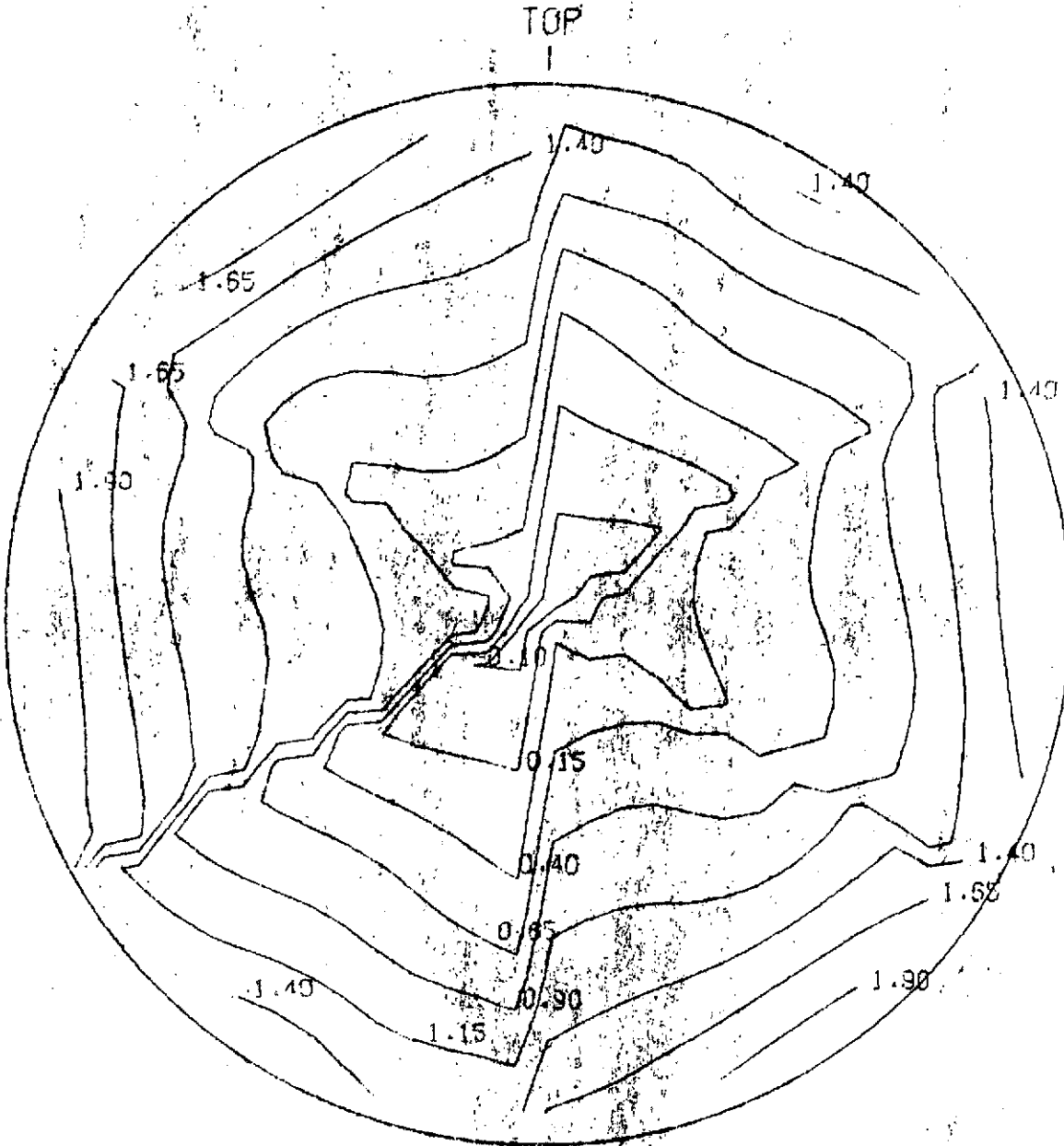




FIGURE 98

Wavefront Plot-P Polarization

Task 2.5B - Nominal + Mfg. Error + Radial Gradient



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FIGURE 100

## Point Spread Function

Task 2.5B - Nominal + Mfg. Error + Radial Gradient

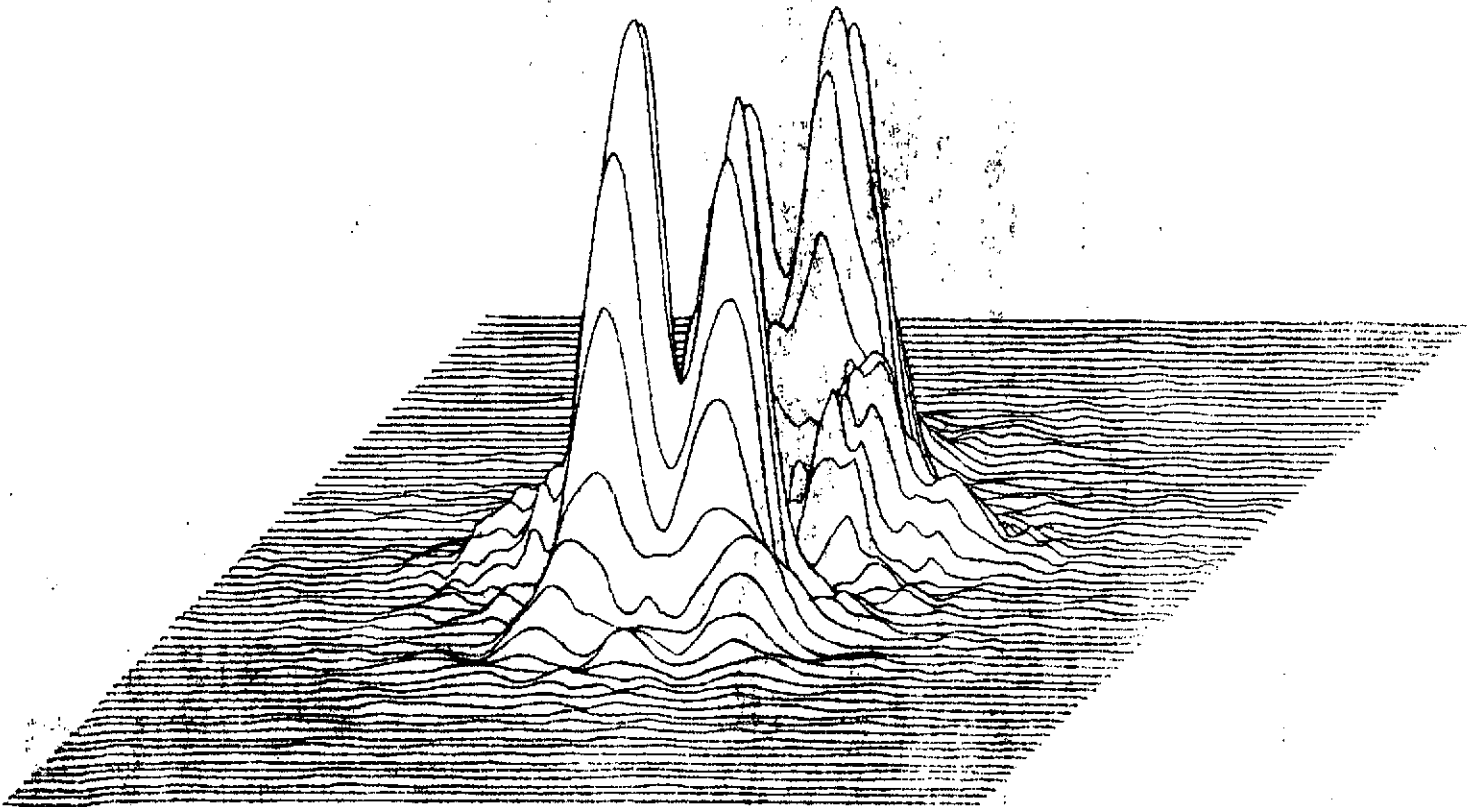
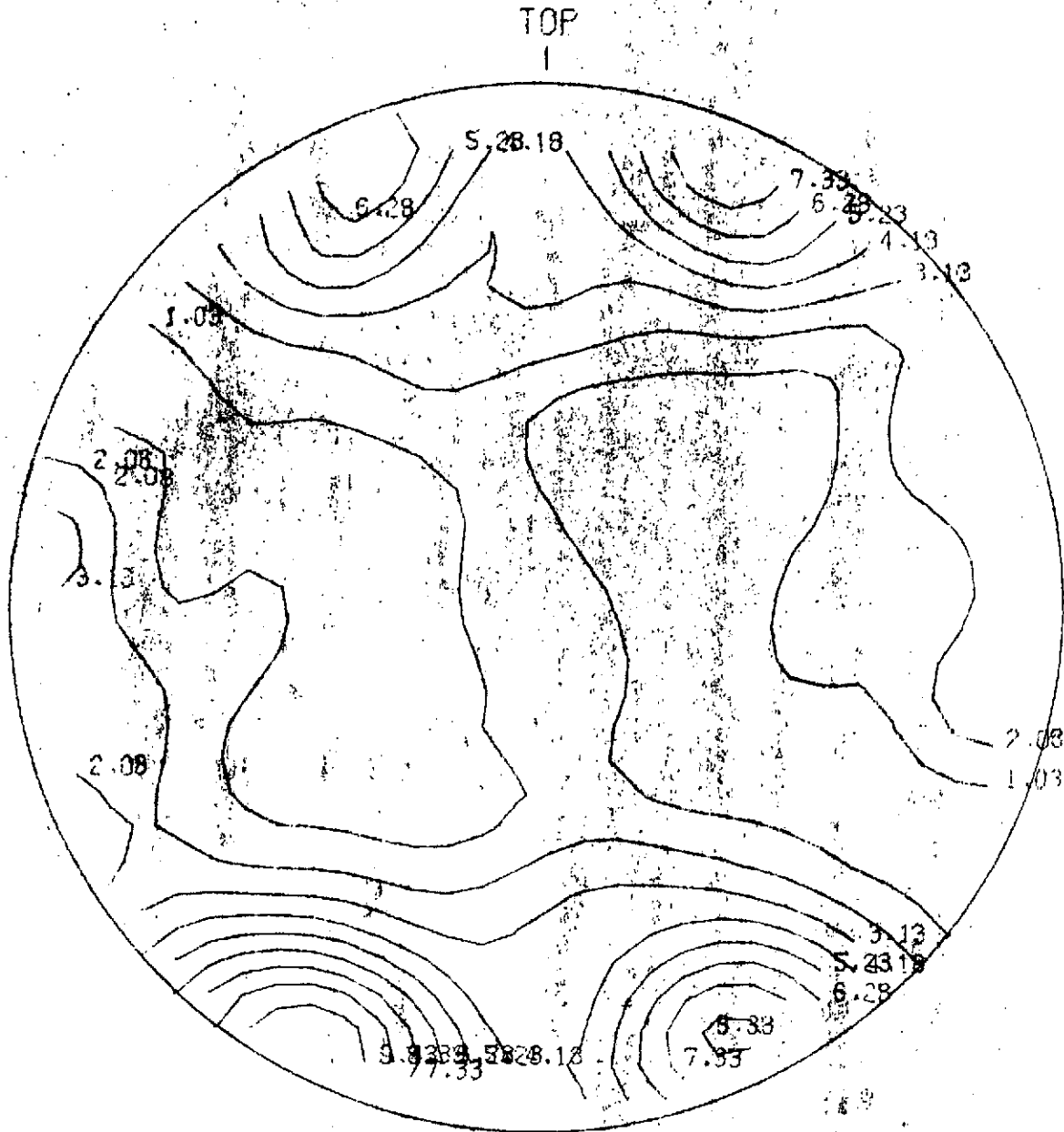




FIGURE 101 31

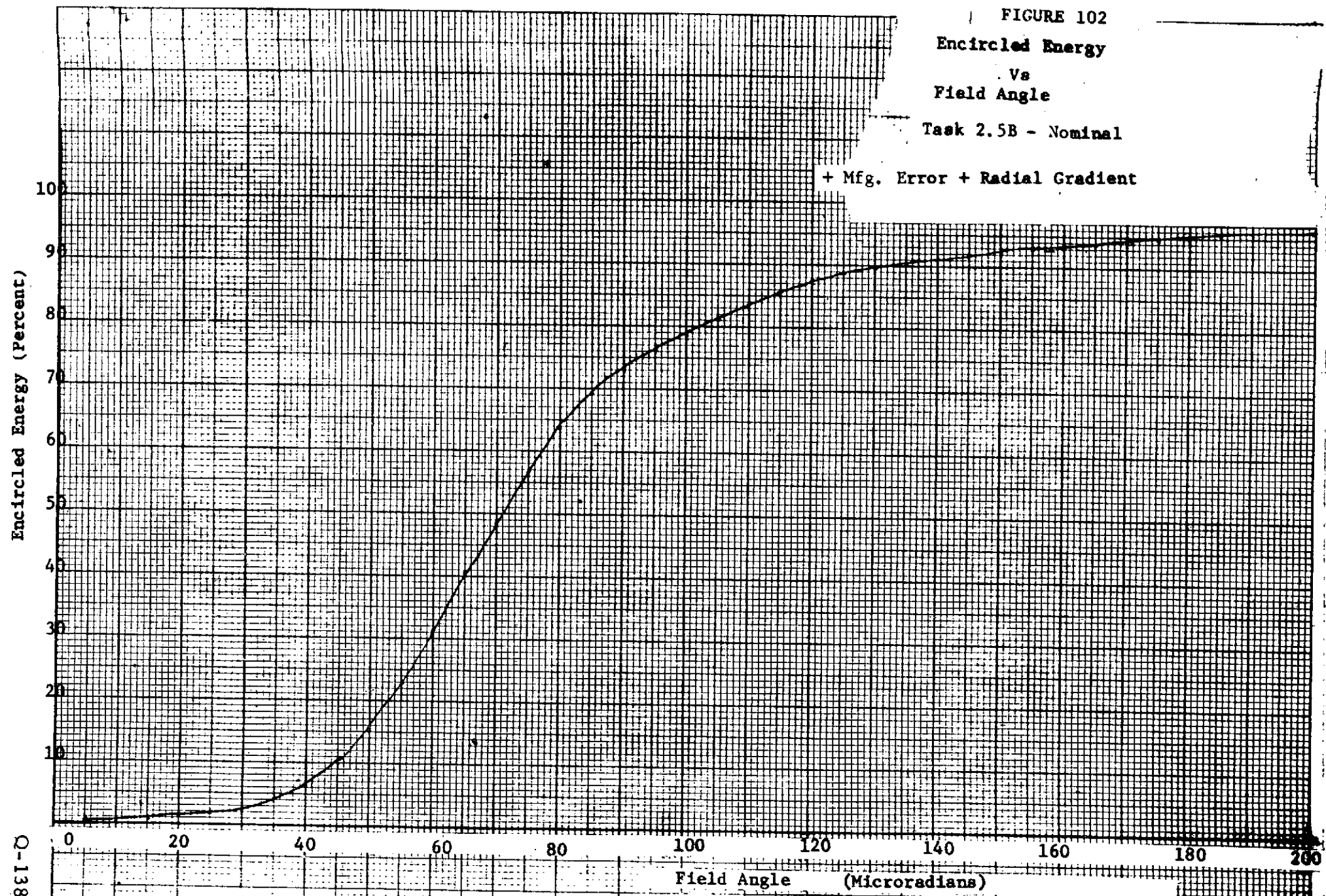
Intensity Distribution - Central 129 Microradians

Task 2.5B - Nominal + Mfg. Error + Radial Gradient



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIGURE 102  
Encircled Energy  
Vs  
Field Angle  
Task 2.5B - Nominal  
+ Mfg. Error + Radial Gradient



Q-138

### OFF NOMINAL CUBE

The cube was then analyzed with the three dihedral angles of the cube having different dihedral angles as shown in Figure 8. The off nominal cube was then analyzed with manufacturing error (Task 2.4A of Table 7) and also with manufacturing error and the temperature distribution of Figure 46, (Task 2.4B2 of Table 7).

### SUMMARY

The major parameter of interest in this study was the percent energy between 32 and 42 microradians. Table 32 gives the percent energy in this region for all of the analyzed cases. The energy in that ring stayed between 20.0 and 22.0 percent in all of the on-axis cases except for the unit gradient cases. The axial gradient effect shifted the spread of the far field pattern in the opposite direction from the dihedral angle effect and the annulus in the far field pattern narrowed such that the percent energy dropped in the 32-42 microradian ring. The assumed temperature profiles, however, had little effect on the encircled energy. The accuracy with which the encircled energy was determined is  $\sim 1.1\%$  (cf. Table 33). The Itek proprietary computer codes used in the analysis are listed in Table 34. Appendix B gives the effect of a variation in the dihedral angle (the angle between the faces). Appendix C provides the viewgraphs which were used in the 4 September PDR briefing in which Itek participated.

ENCIRCLED ENERGY

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

```

*****
CIRCLE *
----- *
RADIUS *
----- *
(MI- * CENTER (MICRONS):
CRONS) * X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13
* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13
*
*****
2.00 * 0.0 0.0 0.1 0.0 0.0 0.0 0.1 0.0 0.0
4.00 * 0.2 0.3 0.1 0.1 0.0 0.0 0.1 0.3 0.2
6.00 * 0.2 0.3 0.5 0.3 0.1 0.1 0.5 0.3 0.2
8.00 * 0.8 0.9 0.8 0.4 0.1 0.2 0.9 0.9 0.7
10.00 * 1.1 1.2 1.3 0.7 0.4 0.4 1.4 1.3 1.0
12.00 * 2.3 2.6 2.0 1.0 0.6 0.7 2.2 2.8 2.0
14.00 * 2.3 2.6 3.0 1.8 1.3 1.5 3.2 2.8 2.0
16.00 * 3.8 4.4 4.0 2.2 1.8 2.0 4.3 4.6 3.5
18.00 * 4.5 5.0 5.1 3.4 4.2 3.2 5.3 5.4 4.3
20.00 * 6.1 6.9 7.0 4.4 4.2 4.3 7.3 7.4 6.0
22.00 * 6.8 7.6 8.3 6.3 7.4 6.3 8.6 8.3 6.9
24.00 * 9.0 10.1 10.1 7.4 8.6 7.5 10.5 10.9 9.4
26.00 * 10.2 11.2 11.7 10.1 11.9 10.2 12.2 12.3 10.9
28.00 * 13.2 14.7 14.8 12.9 12.8 13.0 15.9 15.9 14.3
30.00 * 15.2 16.7 16.5 15.9 16.6 16.0 17.6 18.3 16.7
32.00 * 19.4 21.2 19.7 18.2 18.2 18.3 21.3 22.8 21.1
34.00 * 20.2 22.2 22.0 22.5 22.0 22.6 24.2 23.9 22.1
36.00 * 24.7 26.9 25.5 25.0 25.2 25.1 28.2 28.7 26.7
38.00 * 26.7 29.0 28.4 29.0 30.3 29.1 31.1 31.1 29.1
40.00 * 30.8 32.9 32.0 32.1 32.8 32.1 35.0 35.1 33.2
42.00 * 32.6 34.8 35.6 36.9 39.0 37.0 38.3 37.0 35.1
44.00 * 37.2 38.8 38.9 39.4 41.8 39.2 41.7 41.2 39.6
46.00 * 40.0 41.4 42.4 44.7 47.6 44.5 44.8 43.7 42.5
48.00 * 44.5 45.3 47.0 48.5 49.1 48.2 48.9 47.6 46.5
50.00 * 47.8 48.4 49.4 51.8 54.0 51.6 51.1 50.5 49.7
52.00 * 52.1 52.0 53.6 55.3 56.3 55.0 54.8 53.8 53.7
54.00 * 54.5 54.2 56.3 58.5 60.1 58.4 57.4 56.0 55.6
56.00 * 58.6 57.9 60.5 61.7 62.4 61.5 61.1 59.1 59.4
58.00 * 61.4 60.6 62.6 63.9 65.8 63.6 63.2 61.6 61.9
60.00 * 64.3 63.2 65.6 66.4 68.1 66.3 66.0 63.9 64.7
62.00 * 66.3 65.2 67.7 68.9 70.6 68.7 68.1 65.7 66.5
64.00 * 69.3 68.0 69.7 70.4 72.4 70.3 70.0 68.2 69.4
66.00 * 70.9 69.8 71.8 72.7 74.3 72.6 72.0 69.9 71.1
68.00 * 73.2 71.9 73.5 74.1 75.2 74.0 73.6 72.0 73.3
70.00 * 74.5 73.2 75.0 75.6 76.6 75.5 75.1 73.3 74.6
72.00 * 76.4 75.1 76.4 76.7 77.6 76.8 76.3 75.1 76.4
74.00 * 77.3 76.0 77.7 77.9 78.6 78.0 77.7 76.1 77.3
76.00 * 78.8 77.6 78.9 78.9 79.4 79.0 78.8 77.7 78.7
78.00 * 79.7 78.7 79.6 79.7 80.2 79.7 79.6 78.7 79.6
80.00 * 80.7 79.7 80.6 80.6 80.9 80.6 80.6 79.8 80.7
*****

```

ENCIRCLED ENERGY

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

\*\*\*\*\*

CIRCLE	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
RADIUS										
(MILS)	CENTER (MICRONS):									
	X= -10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13	
	Y= -10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13	
5.00	0.2	0.3	0.3	0.2	0.1	0.1	0.4	0.3	0.2	
10.00	1.1	1.2	1.3	0.7	0.4	0.4	1.4	1.3	1.0	
15.00	3.1	3.7	3.7	1.9	1.8	1.7	3.9	3.9	2.9	
20.00	6.1	6.9	7.0	4.4	4.2	4.3	7.3	7.4	6.0	
25.00	9.7	10.9	11.2	9.8	10.2	9.9	11.6	11.8	10.4	
30.00	15.2	16.7	16.5	15.9	16.6	16.0	17.6	18.3	16.7	
35.00	23.0	25.0	23.9	23.0	24.2	23.1	26.1	26.7	24.9	
40.00	30.8	32.9	32.0	32.1	32.8	32.1	35.0	35.1	33.2	
45.00	38.8	40.4	40.7	43.0	45.4	42.8	43.4	42.7	41.1	
50.00	47.8	48.4	49.4	51.8	54.0	51.6	51.1	50.5	49.7	
55.00	57.2	56.5	58.8	60.1	61.9	59.9	59.6	57.8	58.1	
60.00	64.3	63.2	65.6	66.4	68.1	66.3	66.0	63.9	64.7	
65.00	70.1	68.8	71.0	71.8	73.6	71.7	71.3	69.0	70.2	
70.00	74.5	73.2	75.0	75.6	76.6	75.5	75.1	73.3	74.6	
75.00	78.2	77.0	78.3	78.5	79.0	78.5	78.3	77.0	78.1	
80.00	80.7	79.7	80.6	80.6	80.9	80.6	80.6	79.8	80.7	
85.00	82.4	81.8	82.5	82.6	82.7	82.6	82.7	82.0	82.6	
90.00	84.0	83.8	84.2	84.4	84.4	84.4	84.4	84.0	84.2	
95.00	85.5	85.6	85.7	85.9	86.2	85.9	85.9	85.7	85.7	
100.00	86.7	87.1	87.1	87.2	87.7	87.3	87.2	87.0	86.8	
105.00	87.8	88.2	88.4	88.4	88.7	88.5	88.4	88.1	87.9	
110.00	88.9	89.2	89.3	89.3	89.5	89.3	89.3	89.1	89.0	
115.00	89.9	90.0	90.0	90.0	90.1	90.0	90.0	90.0	89.9	
120.00	90.5	90.6	90.6	90.7	90.7	90.6	90.7	90.7	90.6	
125.00	91.1	91.1	91.2	91.2	91.2	91.2	91.3	91.3	91.2	
130.00	91.7	91.7	91.7	91.8	91.9	91.8	91.9	91.8	91.8	
135.00	92.2	92.2	92.3	92.3	92.4	92.3	92.2	92.2	92.2	
140.00	92.6	92.7	92.7	92.8	92.8	92.8	92.8	92.7	92.7	
145.00	93.0	93.1	93.1	93.2	93.2	93.2	93.2	93.1	93.0	
150.00	93.4	93.4	93.5	93.5	93.5	93.5	93.5	93.5	93.4	
155.00	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.7	
160.00	94.2	94.1	94.1	94.1	94.1	94.1	94.0	94.1	94.1	
165.00	94.4	94.4	94.5	94.4	94.4	94.4	94.4	94.4	94.4	
170.00	94.7	94.7	94.8	94.7	94.7	94.7	94.8	94.6	94.7	
175.00	95.0	95.0	95.0	95.0	95.0	95.0	95.1	95.0	95.0	
180.00	95.2	95.2	95.2	95.3	95.4	95.3	95.3	95.3	95.3	
184.99	95.5	95.5	95.4	95.6	95.5	95.6	95.5	95.6	95.5	
189.99	95.7	95.8	95.7	95.8	95.8	95.8	95.8	95.8	95.8	
194.99	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	
199.99	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.3	

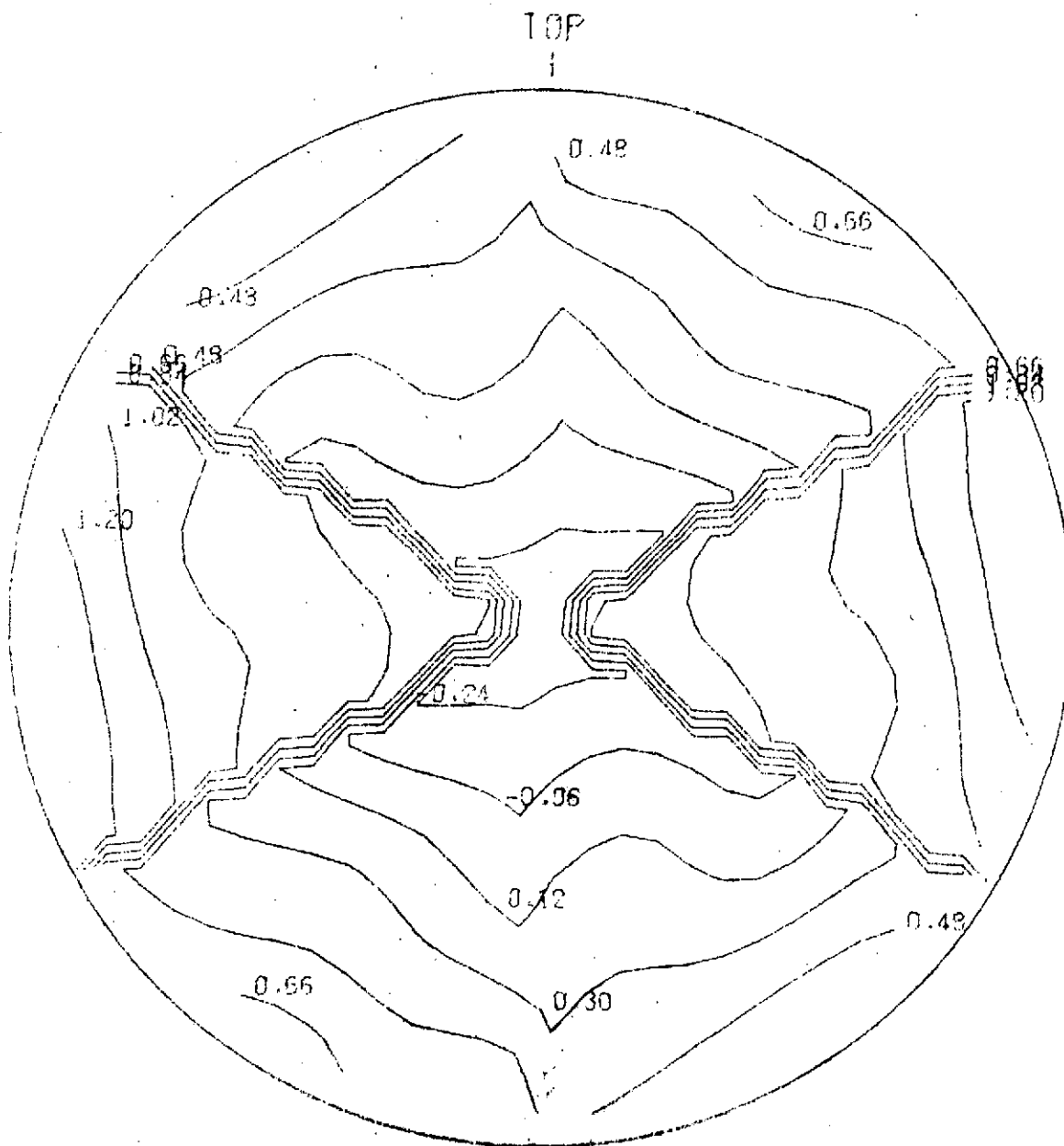
\*\*\*\*\*



FIGURE 104 .

Wavefront Plot-Q Polarization

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis







Wavefront Plot-P Polarization

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

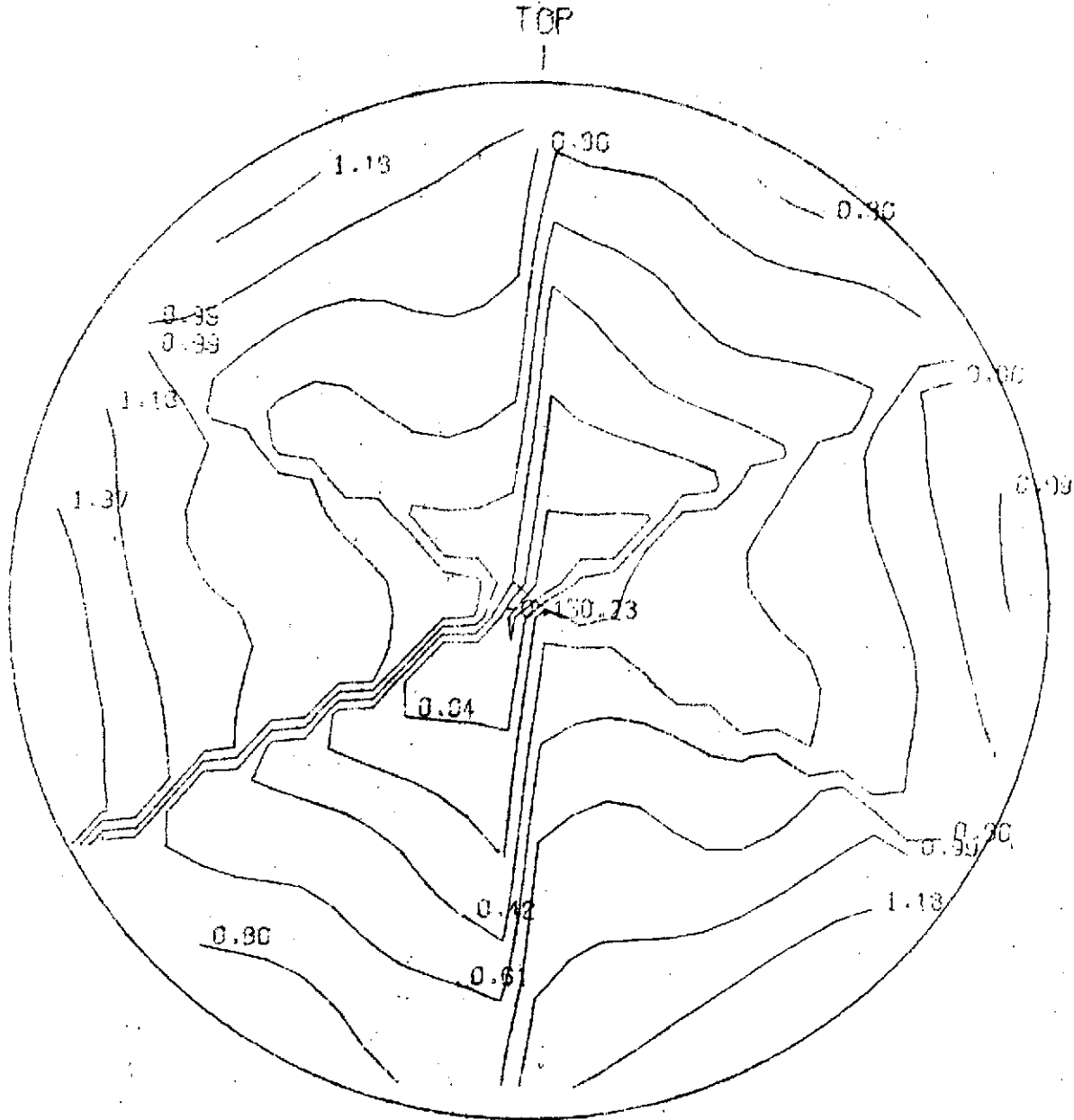




FIGURE 108

Point Spread Function

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

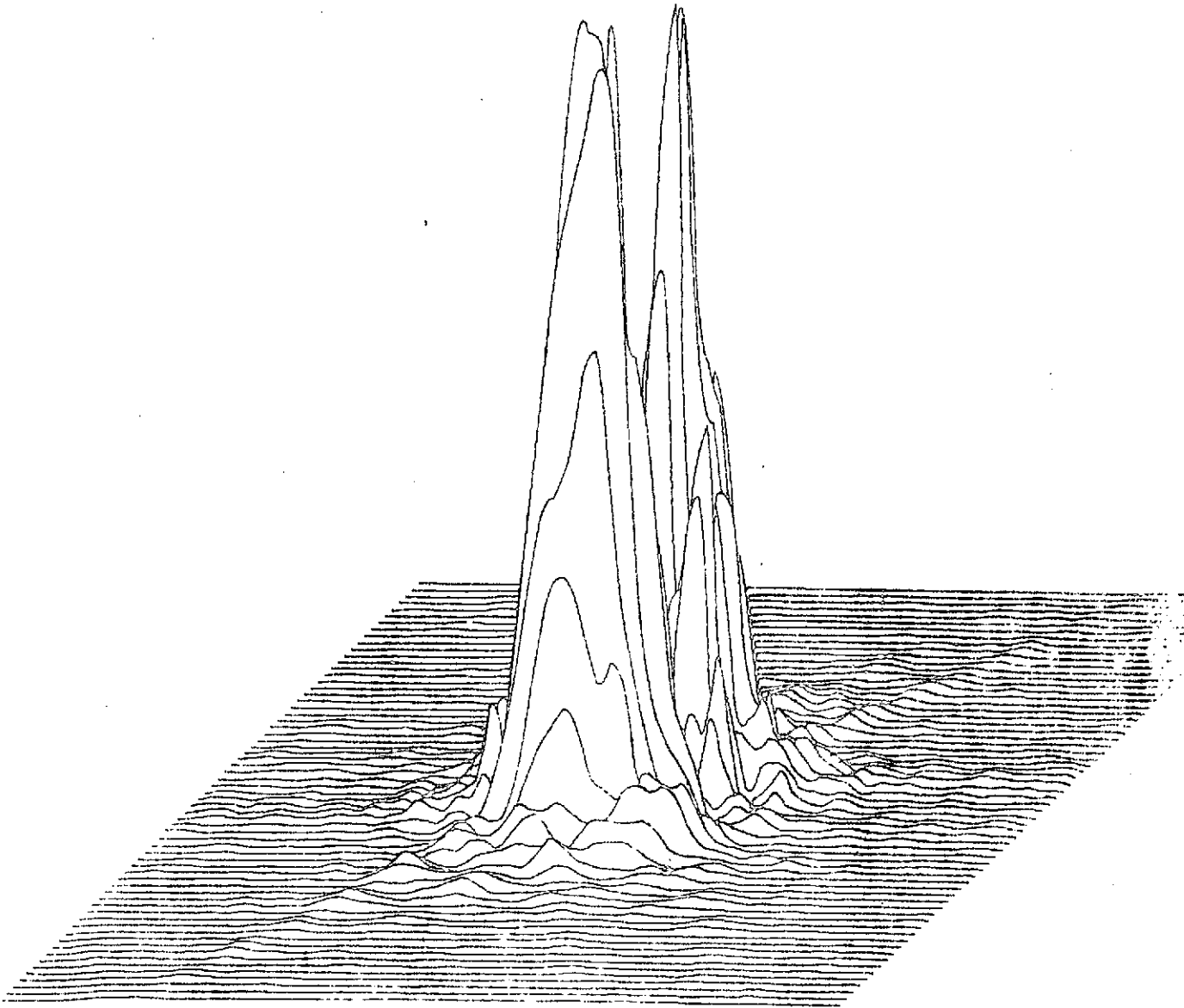


FIGURE 109

Intensity Distribution - Central 129 Microradians  
Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

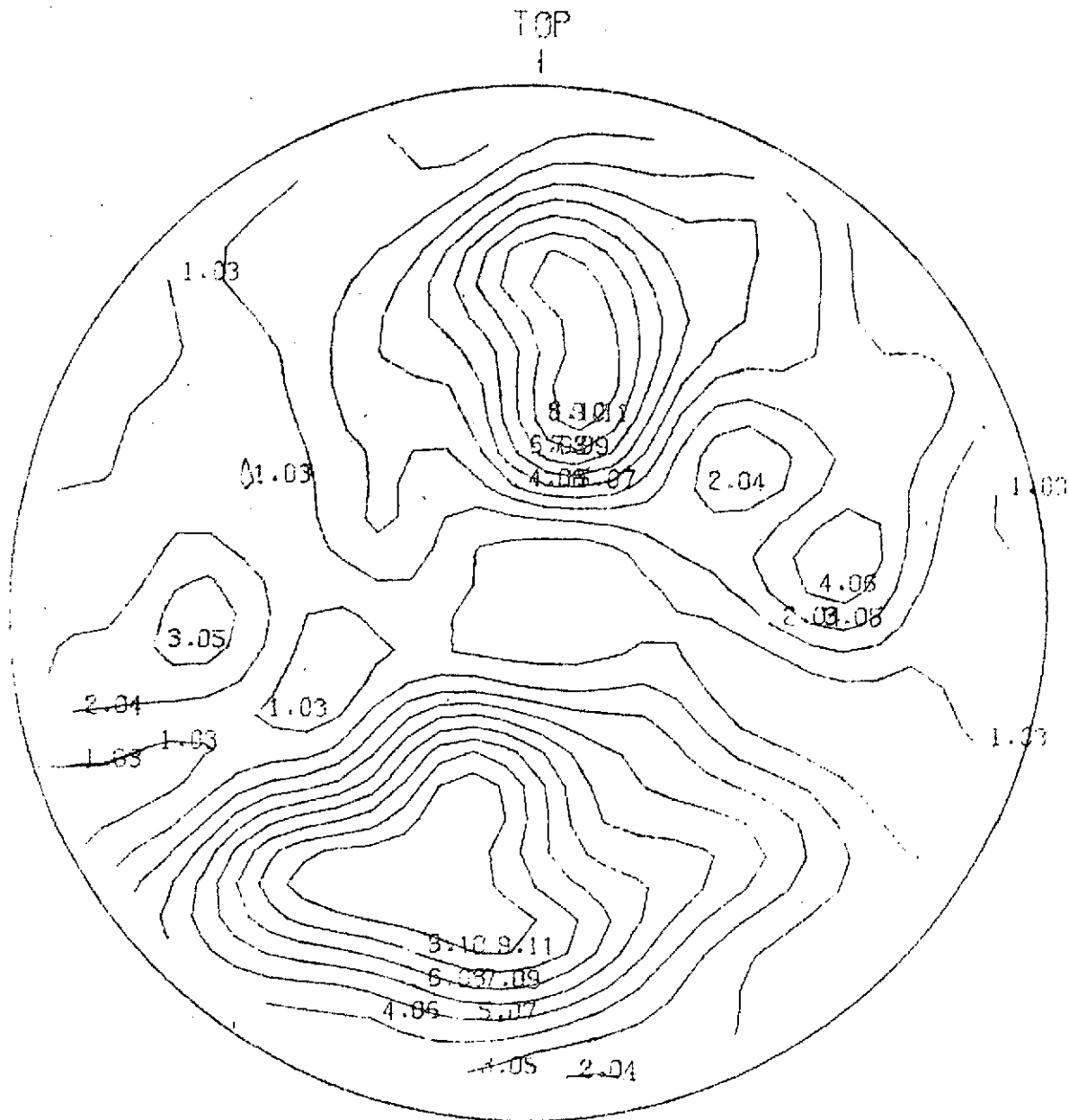


FIGURE 110

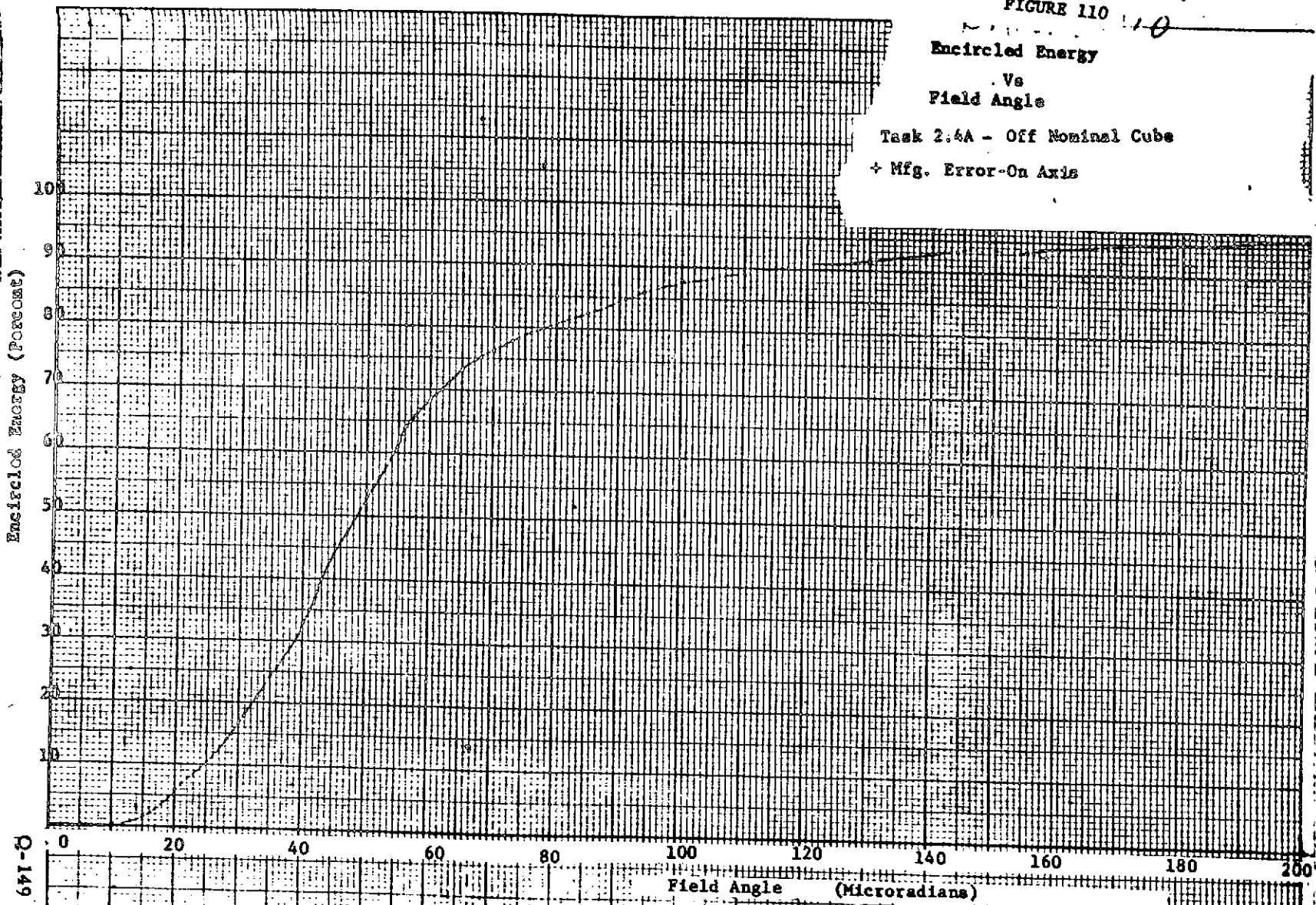
Encircled Energy

.Vs

Field Angle

Task 2.4A - Off Nominal Cube

+ Mfg. Error-On Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Q-149

149

ENCIRCLED ENERGY

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CPONS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0
4.00	*	0.3	0.4	0.2	0.2	0.2	0.2	0.2	0.5	0.4
6.00	*	0.3	0.4	0.6	0.6	1.4	0.6	0.7	0.5	0.4
8.00	*	1.0	1.2	1.2	1.3	1.4	1.3	1.3	1.4	1.4
10.00	*	1.4	1.6	1.5	1.8	2.8	1.8	1.7	2.0	1.9
12.00	*	3.2	3.6	2.4	3.1	3.1	3.1	2.7	4.2	4.0
14.00	*	3.2	3.6	3.4	4.5	4.1	4.5	4.2	4.2	4.0
16.00	*	5.6	5.9	4.4	5.9	4.8	5.9	5.3	6.9	6.6
18.00	*	6.6	6.9	5.7	7.3	7.0	7.4	6.9	8.1	7.7
20.00	*	8.5	8.8	7.4	9.4	7.0	9.5	9.0	10.4	10.0
22.00	*	9.6	9.8	9.6	11.3	10.1	11.3	11.5	11.6	11.1
24.00	*	12.0	12.1	10.9	12.5	12.1	12.5	12.9	14.3	13.8
26.00	*	13.1	13.2	13.8	14.9	15.8	14.8	16.0	15.7	15.3
28.00	*	15.8	15.8	16.7	17.5	17.1	17.4	19.3	18.5	18.1
30.00	*	17.9	17.9	19.3	19.8	21.2	19.6	22.0	21.1	20.6
32.00	*	21.8	21.8	21.5	22.2	23.8	21.9	24.2	24.8	24.4
34.00	*	22.7	22.6	24.7	25.5	26.3	25.2	27.6	25.7	25.4
36.00	*	27.2	27.1	27.3	28.6	30.1	28.4	30.3	29.8	29.5
38.00	*	29.4	29.5	30.2	31.8	33.3	31.5	32.9	32.2	31.9
40.00	*	33.2	33.4	33.2	35.2	35.4	35.2	35.9	35.6	35.5
42.00	*	35.3	35.4	37.0	39.1	38.8	39.0	39.4	37.6	37.5
44.00	*	39.4	39.6	38.9	41.1	41.8	41.2	41.4	41.4	41.4
46.00	*	42.3	42.4	43.1	44.9	45.7	45.1	45.4	44.4	44.5
48.00	*	45.4	45.5	46.4	48.1	47.4	48.4	49.0	47.5	47.5
50.00	*	48.4	48.6	49.3	50.5	51.7	50.8	51.4	50.8	50.9
52.00	*	51.4	51.7	52.1	53.3	54.9	53.5	54.7	53.9	53.9
54.00	*	53.3	53.4	55.7	56.3	58.2	56.5	57.7	55.9	56.0
56.00	*	56.6	56.8	58.8	59.6	61.4	59.7	61.2	59.0	59.0
58.00	*	59.2	59.4	61.1	61.8	64.6	61.8	63.1	61.7	61.8
60.00	*	61.7	61.9	63.9	64.8	67.2	64.8	66.1	64.0	64.0
62.00	*	63.8	63.9	66.5	67.3	69.3	67.2	68.4	66.0	66.0
64.00	*	67.1	67.2	68.2	69.2	71.4	69.1	70.3	68.6	68.8
66.00	*	69.2	69.2	70.9	71.6	73.5	71.5	72.6	70.5	70.8
68.00	*	71.5	71.3	72.9	73.3	74.4	73.3	74.1	72.3	72.7
70.00	*	73.4	73.1	74.7	74.9	76.2	75.0	75.6	73.8	74.3
72.00	*	75.4	75.1	76.1	76.1	77.6	76.3	76.8	75.4	75.9
74.00	*	76.5	76.1	77.8	77.6	78.8	77.8	78.1	76.4	76.9
76.00	*	78.3	77.9	79.2	78.8	79.8	79.0	79.1	77.8	78.3
78.00	*	79.4	79.1	80.0	79.7	80.9	79.9	79.8	78.9	79.3
80.00	*	80.5	80.2	81.2	80.8	81.7	80.9	80.8	79.9	80.2

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis

\*\*\*\*\*

CIRCLE	RADIUS	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
(MILS)	(MILS)	CENTER (MICRONS):									
		X=	Y=	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13
		-10.13	-10.13	0.0	0.0	-10.13	0.0	10.13	10.13	0.0	0.0
5.00	*	0.3	0.4	0.6	0.5	0.9	0.5	0.6	0.5	0.4	
10.00	*	1.4	1.6	1.5	1.8	2.8	1.8	1.7	2.0	1.9	
15.00	*	4.6	5.0	4.0	5.4	4.8	5.4	4.8	5.8	5.5	
20.00	*	8.5	8.8	7.4	9.4	7.0	9.5	9.0	10.4	10.0	
25.00	*	12.7	12.8	13.4	14.4	13.3	14.4	15.6	15.2	14.8	
30.00	*	17.9	17.9	19.3	19.8	21.2	19.6	22.0	21.1	20.6	
35.00	*	25.5	25.4	25.5	26.6	29.1	26.3	28.3	28.0	27.7	
40.00	*	33.2	33.4	33.2	35.2	35.4	35.2	35.9	35.6	35.5	
45.00	*	40.8	40.9	41.6	43.4	43.4	43.6	43.8	42.9	42.9	
50.00	*	48.4	48.6	49.3	50.5	51.7	50.8	51.4	50.8	50.9	
55.00	*	55.4	55.7	56.9	57.7	60.7	57.9	59.2	57.9	57.9	
60.00	*	61.7	61.9	63.9	64.8	67.2	64.8	66.1	64.0	64.0	
65.00	*	68.0	67.9	70.1	70.8	72.4	70.7	71.8	69.4	69.7	
70.00	*	73.4	73.1	74.7	74.9	76.2	75.0	75.6	73.8	74.3	
75.00	*	77.7	77.3	78.4	78.2	79.4	78.4	78.6	77.2	77.8	
80.00	*	80.5	80.2	81.2	80.8	81.7	80.9	80.8	79.9	80.2	
85.00	*	82.4	82.3	83.2	83.0	83.5	83.0	82.8	82.2	82.2	
90.00	*	84.0	84.1	84.5	84.5	84.8	84.4	84.3	84.0	83.9	
95.00	*	85.3	85.5	85.6	85.7	85.8	85.6	85.7	85.6	85.4	
100.00	*	86.4	86.5	86.5	86.7	86.8	86.7	86.8	86.7	86.6	
105.00	*	87.3	87.4	87.5	87.6	87.7	87.6	87.7	87.6	87.5	
110.00	*	88.2	88.3	88.4	88.4	88.6	88.5	88.6	88.4	88.4	
115.00	*	89.1	89.2	89.2	89.2	89.4	89.2	89.2	89.1	89.2	
120.00	*	89.9	89.9	89.9	89.9	90.1	89.9	89.9	89.7	89.8	
125.00	*	90.5	90.5	90.6	90.5	90.6	90.5	90.4	90.3	90.3	
130.00	*	91.0	91.0	91.1	91.0	91.1	91.0	90.9	90.9	90.8	
135.00	*	91.4	91.4	91.4	91.4	91.5	91.5	91.5	91.5	91.5	
140.00	*	91.8	91.8	91.9	91.9	91.8	91.9	91.9	91.8	91.9	
145.00	*	92.3	92.3	92.3	92.2	92.2	92.3	92.2	92.2	92.2	
150.00	*	92.6	92.7	92.7	92.6	92.7	92.6	92.6	92.6	92.6	
155.00	*	93.0	93.0	93.1	93.0	93.1	93.0	93.0	93.0	92.9	
160.00	*	93.4	93.4	93.4	93.4	93.4	93.4	93.3	93.4	93.4	
165.00	*	93.7	93.7	93.8	93.8	93.8	93.8	93.8	93.8	93.7	
170.00	*	94.0	94.0	94.0	94.1	94.2	94.1	94.1	94.1	94.1	
175.00	*	94.3	94.3	94.4	94.4	94.4	94.4	94.4	94.4	94.4	
180.00	*	94.6	94.7	94.7	94.7	94.7	94.7	94.8	94.7	94.7	
184.99	*	95.0	95.0	94.9	94.9	94.9	95.0	95.0	95.0	95.0	
189.99	*	95.2	95.3	95.3	95.2	95.3	95.2	95.2	95.2	95.2	
194.99	*	95.5	95.5	95.6	95.5	95.5	95.5	95.5	95.5	95.4	
199.99	*	95.8	95.8	95.8	95.8	95.8	95.8	95.7	95.8	95.7	

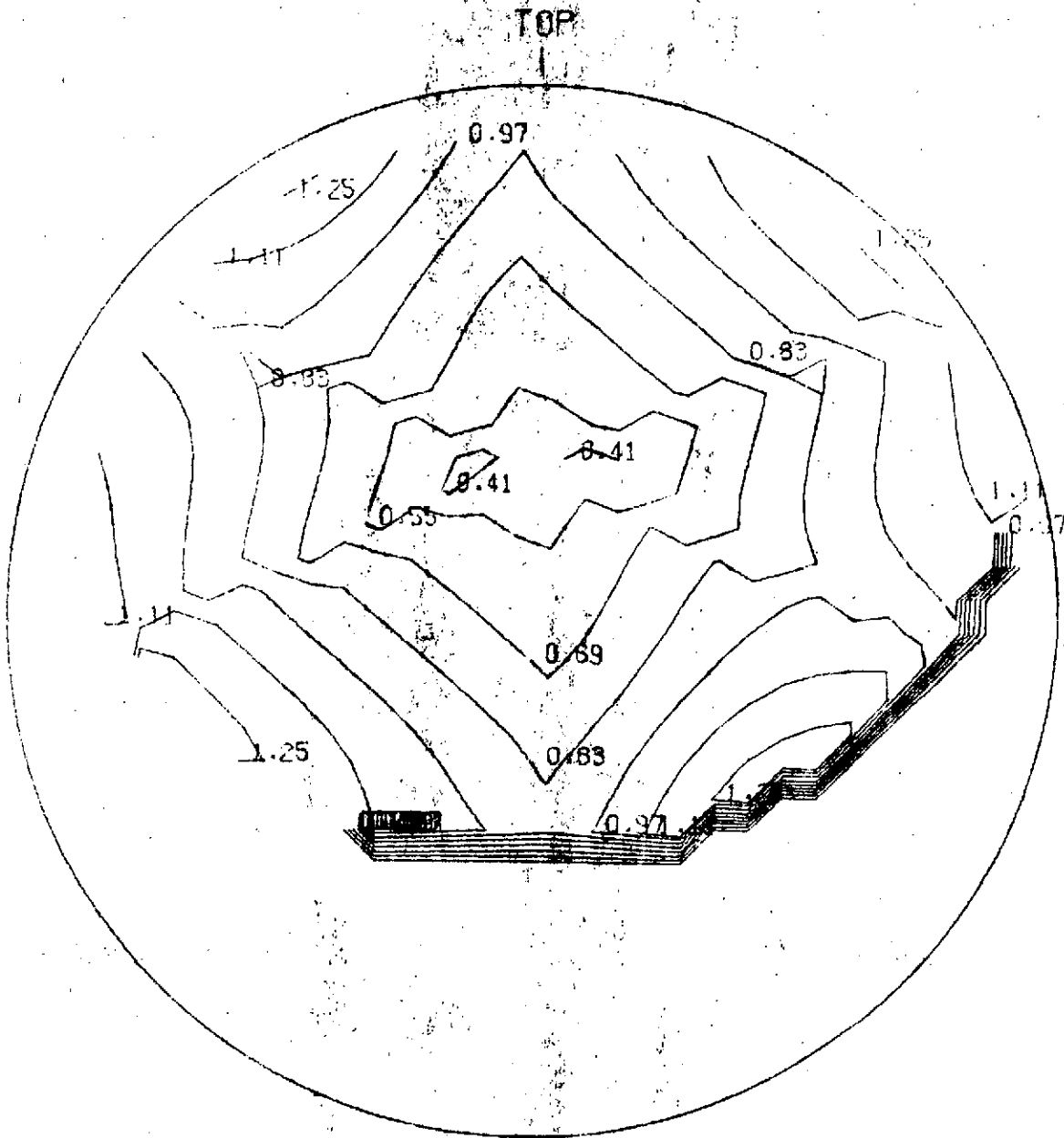
\*\*\*\*\*





Wavefront Plot-Q Polarization

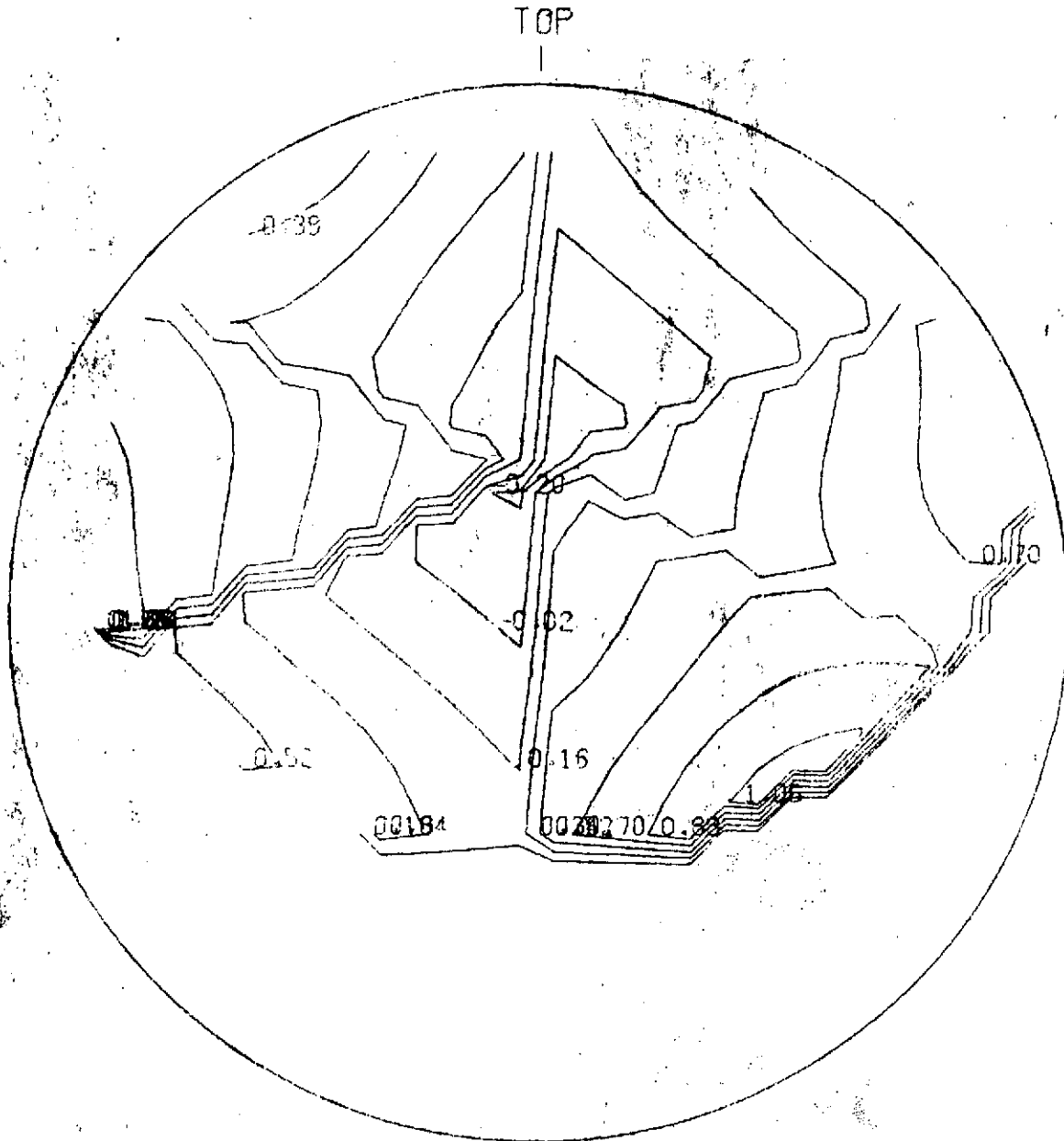
Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis





Wavefront Plot-P Polarization

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis



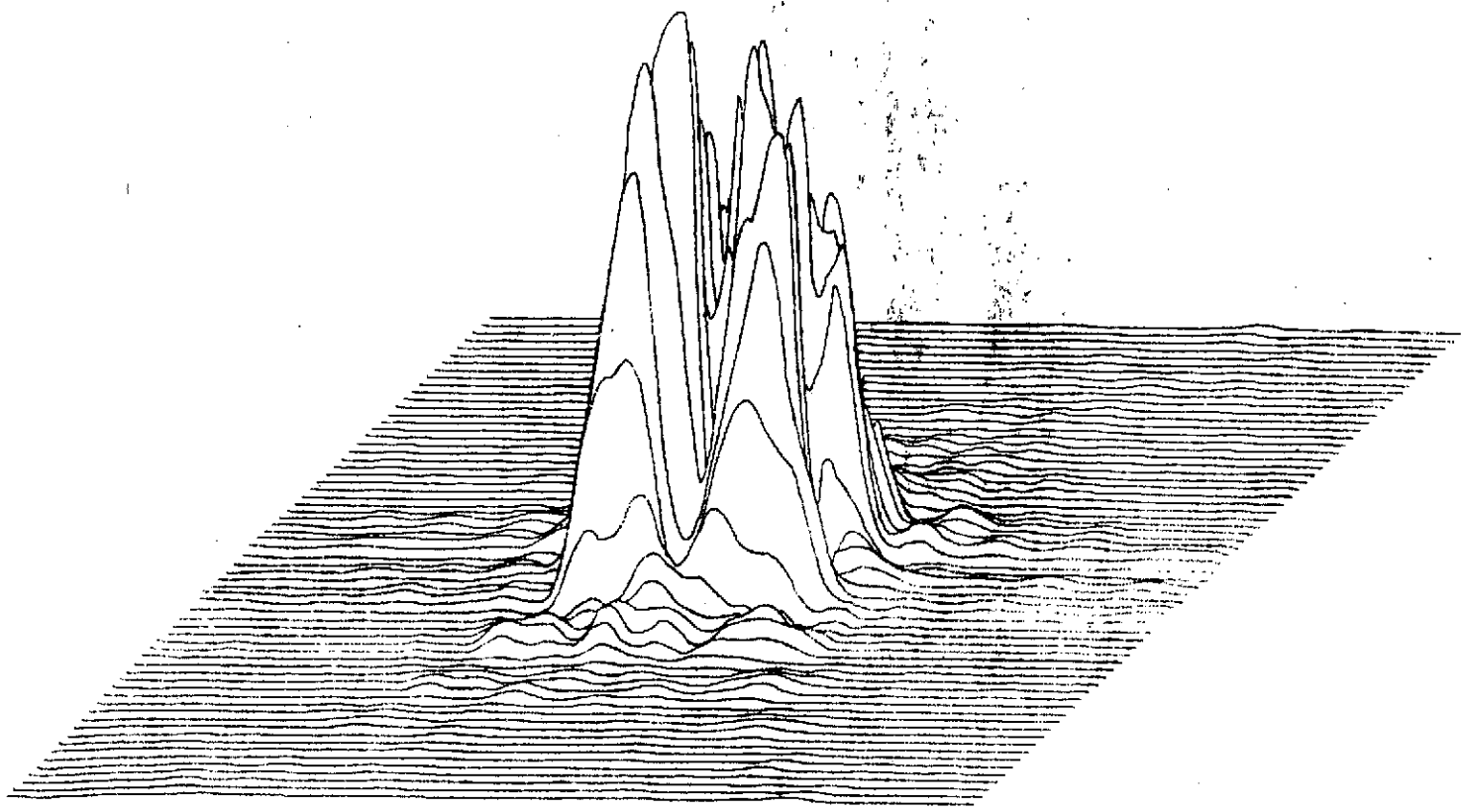
REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FIGURE 116

Point Spread Function

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis



Intensity Distribution - Central 129 Microradians  
Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis

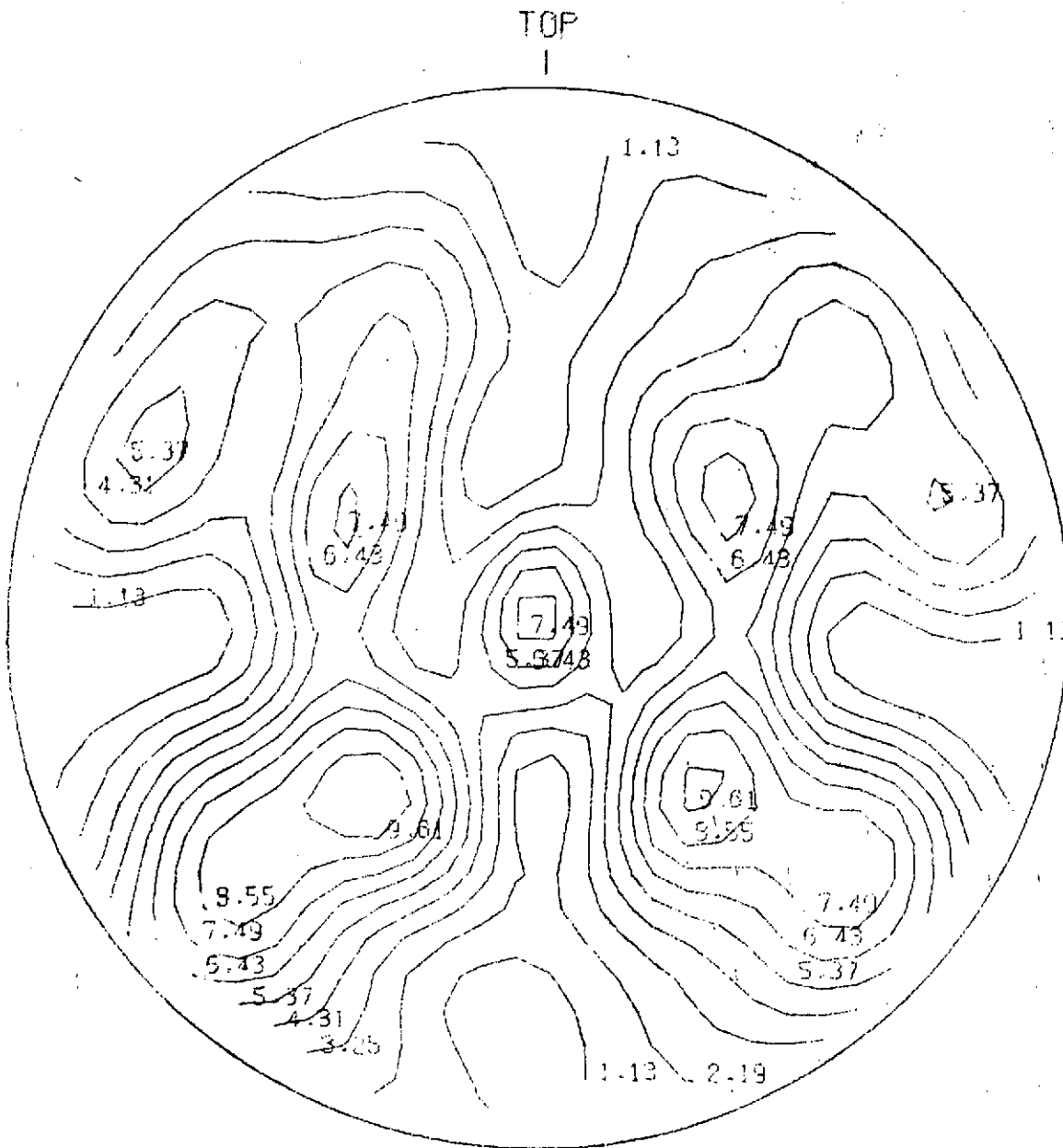
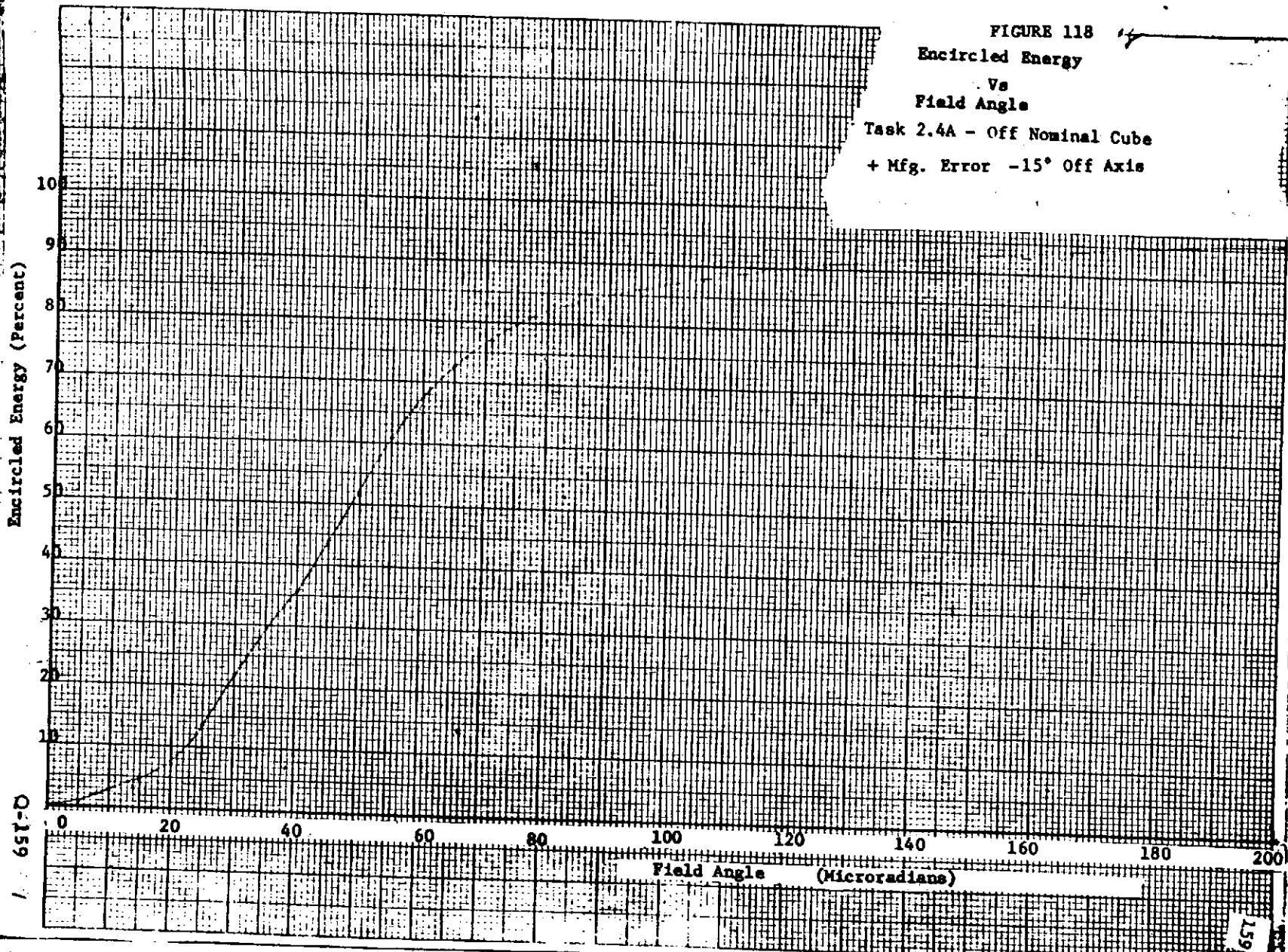


FIGURE 118  
Encircled EnergyVs  
Field AngleTask 2.4A - Off Nominal Cube  
+ Mfg. Error -15° Off Axis





E N C I R C L E D E N E R G Y

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis \*\*\*\*\*

CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CRONS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	*	0.2	0.2	0.3	0.2	0.1	0.1	0.3	0.3	0.2
10.00	*	1.1	1.1	1.1	0.7	0.4	0.4	1.2	1.2	1.0
15.00	*	3.1	3.5	3.4	2.0	1.7	1.8	3.7	3.6	2.9
20.00	*	5.9	6.6	6.6	4.3	4.0	4.3	6.9	7.0	5.8
25.00	*	9.4	10.4	10.7	9.4	9.8	9.6	11.0	11.2	9.9
30.00	*	14.6	16.0	15.9	15.2	15.9	15.3	16.8	17.4	16.0
35.00	*	22.3	24.2	23.2	22.0	23.1	22.1	25.0	25.6	24.0
40.00	*	29.9	32.0	31.0	30.8	31.3	30.7	33.9	34.0	32.1
45.00	*	37.8	39.4	39.6	41.5	43.8	41.4	42.3	41.6	40.0
50.00	*	46.7	47.3	48.3	50.5	52.7	50.3	50.1	49.5	48.6
55.00	*	56.2	55.7	57.9	59.2	61.0	59.0	58.9	57.2	57.3
60.00	*	63.6	62.8	65.1	65.9	67.6	65.8	65.7	63.6	64.2
65.00	*	69.7	68.6	70.8	71.8	73.6	71.7	71.3	69.0	70.0
70.00	*	74.4	73.3	75.2	75.9	77.1	75.9	75.3	73.5	74.6
75.00	*	78.4	77.3	78.8	79.0	79.7	79.0	78.7	77.4	78.4
80.00	*	81.2	80.2	81.2	81.2	81.6	81.2	81.1	80.2	81.1
85.00	*	83.0	82.2	83.1	83.2	83.3	83.2	83.2	82.4	83.1
90.00	*	84.5	84.1	84.6	84.8	84.8	84.8	84.8	84.3	84.7
95.00	*	85.9	85.9	86.0	86.2	86.4	86.2	86.2	86.0	86.1
100.00	*	87.0	87.3	87.3	87.4	87.8	87.5	87.4	87.2	87.1
105.00	*	88.0	88.4	88.5	88.5	88.9	88.6	88.5	88.3	88.1
110.00	*	89.1	89.3	89.5	89.4	89.6	89.4	89.4	89.3	89.1
115.00	*	90.0	90.1	90.2	90.1	90.2	90.1	90.1	90.1	90.0
120.00	*	90.6	90.7	90.7	90.7	90.8	90.7	90.8	90.8	90.7
125.00	*	91.2	91.2	91.3	91.3	91.3	91.3	91.4	91.3	91.3
130.00	*	91.8	91.7	91.8	91.9	91.9	91.9	91.9	91.8	91.8
135.00	*	92.3	92.3	92.3	92.3	92.5	92.3	92.3	92.3	92.2
140.00	*	92.7	92.7	92.8	92.8	92.9	92.8	92.8	92.8	92.7
145.00	*	93.1	93.1	93.1	93.2	93.2	93.2	93.2	93.1	93.1
150.00	*	93.4	93.5	93.5	93.5	93.6	93.5	93.5	93.5	93.4
155.00	*	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8
160.00	*	94.2	94.2	94.2	94.1	94.1	94.1	94.1	94.1	94.1
165.00	*	94.5	94.4	94.5	94.4	94.4	94.4	94.4	94.4	94.4
170.00	*	94.7	94.7	94.8	94.7	94.8	94.7	94.8	94.7	94.7
175.00	*	95.0	95.0	95.0	95.0	95.1	95.0	95.1	95.0	95.0
180.00	*	95.3	95.3	95.3	95.3	95.4	95.3	95.3	95.3	95.3
184.99	*	95.5	95.5	95.5	95.6	95.6	95.6	95.5	95.6	95.6
189.99	*	95.7	95.8	95.8	95.8	95.8	95.9	95.8	95.8	95.8
194.99	*	96.0	96.0	96.0	96.0	96.1	96.0	96.0	96.0	96.0
199.99	*	96.3	96.3	96.2	96.2	96.3	96.3	96.2	96.3	96.3

\*\*\*\*\*

Wavefront Map- $\sigma$  Polarisation  
 Task 2.482 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

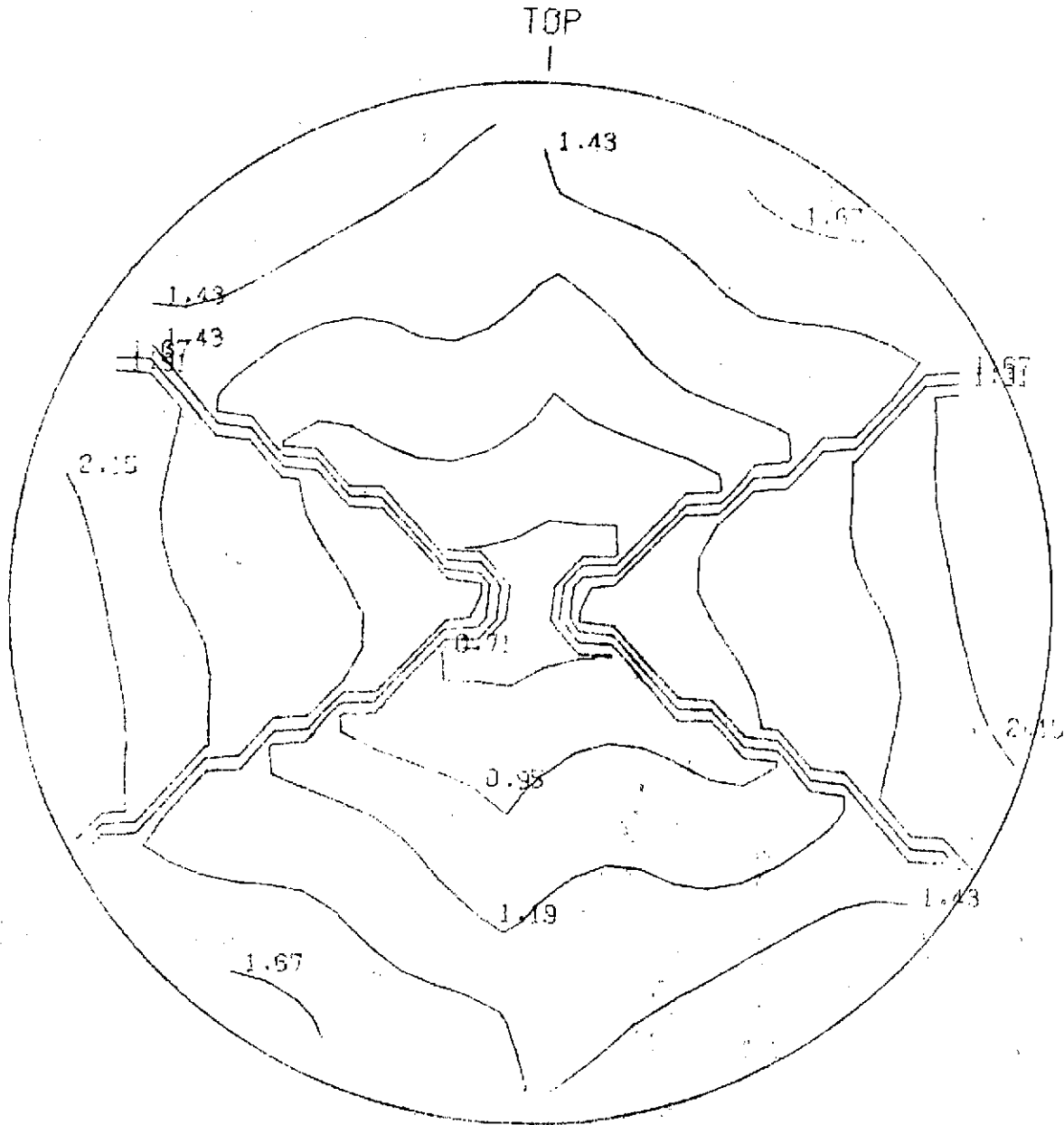
MAP IN UNITS OF 0.01 WAVES

159	153	148	144	140	134	136	137	138	161																					
173	168	159	153	148	143	139	135	132	134	135	156	159	166	175	183															
171	165	159	152	147	143	139	135	131	145	149	150	152	156	163	170	177	181													
168	163	157	151	145	141	138	135	132	128	136	141	143	146	150	157	163	167	170	172											
161	159	154	148	142	137	134	132	131	129	125	125	131	135	139	144	150	154	157	159	160	161									
150	151	149	144	138	132	128	127	127	125	121	116	122	127	133	138	143	147	149	149	150	152	155								
145	141	142	140	134	127	122	120	120	122	120	116	107	114	121	127	134	138	141	142	142	143	146	149	152						
199	134	134	134	130	124	117	112	112	114	117	117	115	111	101	107	114	122	128	133	135	136	137	138	140	143	147	226			
201	197	194	127	122	115	108	104	105	108	112	112	109	104	96	101	107	114	119	124	127	129	130	132	134	212	220	225			
204	199	195	190	116	107	100	96	97	101	105	105	103	97	90	94	98	103	108	112	117	121	124	126	202	211	220	226			
214	208	202	195	189	183	177	93	89	90	94	97	98	95	90	85	87	89	92	95	100	106	112	182	191	201	211	220	227	231	
219	212	203	195	187	181	176	170	163	83	85	88	89	87	82	78	80	80	81	84	89	169	175	183	191	200	210	220	229	234	
224	216	205	194	185	179	176	171	165	159	156	78	79	77	74	71	72	72	72	162	167	172	178	184	191	199	208	219	229	236	
229	220	208	156	186	180	177	173	168	163	159	157	70	70	68	62	64	64	64	157	164	170	175	180	185	190	196	205	215	227	237
233	223	211	198	189	183	180	176	172	167	162	158	152	144	62	53	139	150	158	164	169	174	179	183	187	193	202	214	226	236	
236	226	214	202	153	187	183	179	174	169	164	158	150	139	53	62	144	152	158	162	167	172	176	180	183	189	198	211	223	233	
237	227	216	205	196	190	185	180	175	170	164	157	64	64	62	68	70	70	157	159	163	168	173	177	180	186	196	208	220	229	
236	229	219	208	199	191	184	178	172	167	162	72	72	72	71	74	77	79	78	156	159	165	171	176	179	185	194	205	216	224	
234	229	220	210	200	191	183	175	169	89	84	81	83	80	78	82	87	89	88	85	83	163	170	176	181	187	195	203	212	219	
231	227	220	211	201	191	182	112	106	100	95	92	89	87	85	90	95	98	97	94	90	89	93	177	183	189	195	202	208	214	
226	220	211	202	126	124	121	117	112	108	103	98	94	90	97	103	105	105	101	97	96	100	107	116	190	195	199	204			
225	223	212	134	132	130	129	127	124	119	114	107	101	96	104	109	112	112	108	105	104	108	115	122	127	194	197	201			
226	147	143	140	138	137	136	135	133	128	122	114	107	101	111	115	117	117	114	112	112	117	124	130	134	134	134	199			
152	149	146	143	142	142	141	138	134	127	121	114	107	116	120	122	122	120	120	122	127	134	140	142	141	143					
155	152	150	149	149	147	143	138	133	127	122	116	121	125	127	127	127	128	132	138	144	149	151	150							
161	160	159	157	154	150	144	139	135	131	125	125	129	131	132	134	137	142	148	154	159	161									
172	170	167	163	157	150	146	143	141	136	128	132	135	138	141	145	151	157	163	168											
181	177	170	163	156	152	153	149	145	131	135	139	143	147	152	159	165	171													
183	175	166	159	156	155	154	152	135	139	143	148	153	159	166	173															
161	158	157	156	154	140	144	148	153	159																					

FIGURE 120

Wavefront Plot-Q Polarization

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



Wavefront Plot-P Polarization

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

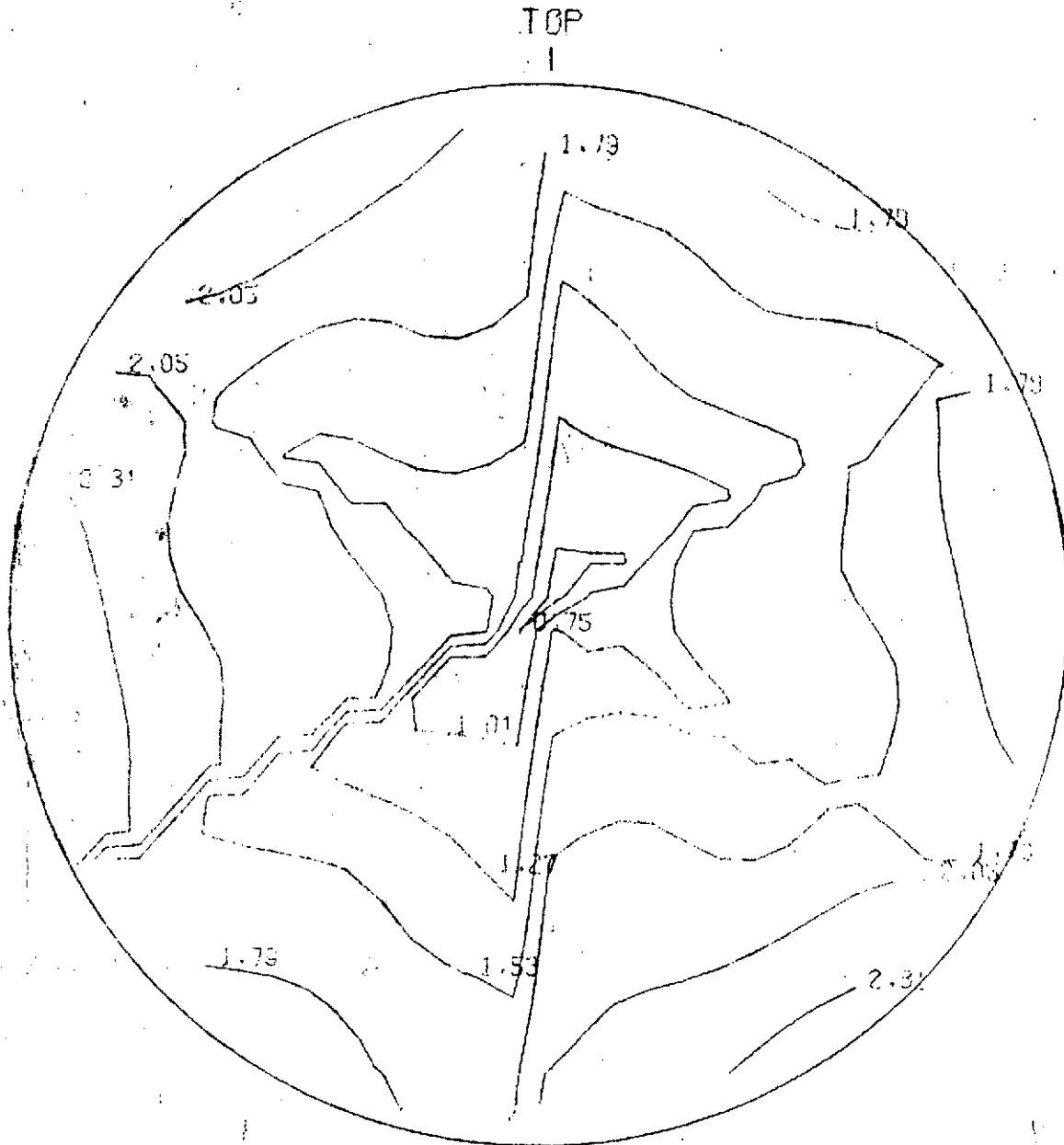




FIGURE 124

24

## Point Spread Function

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

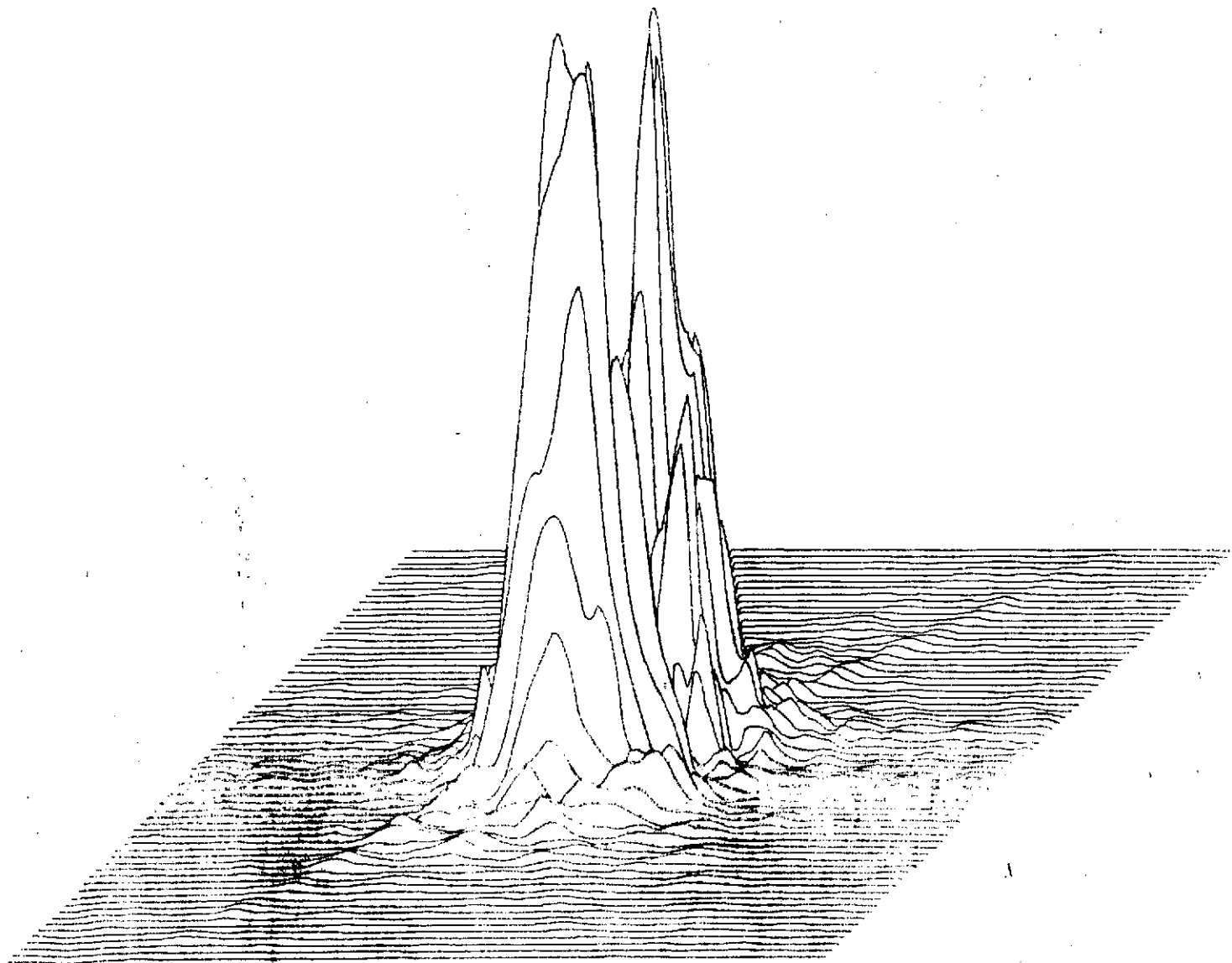
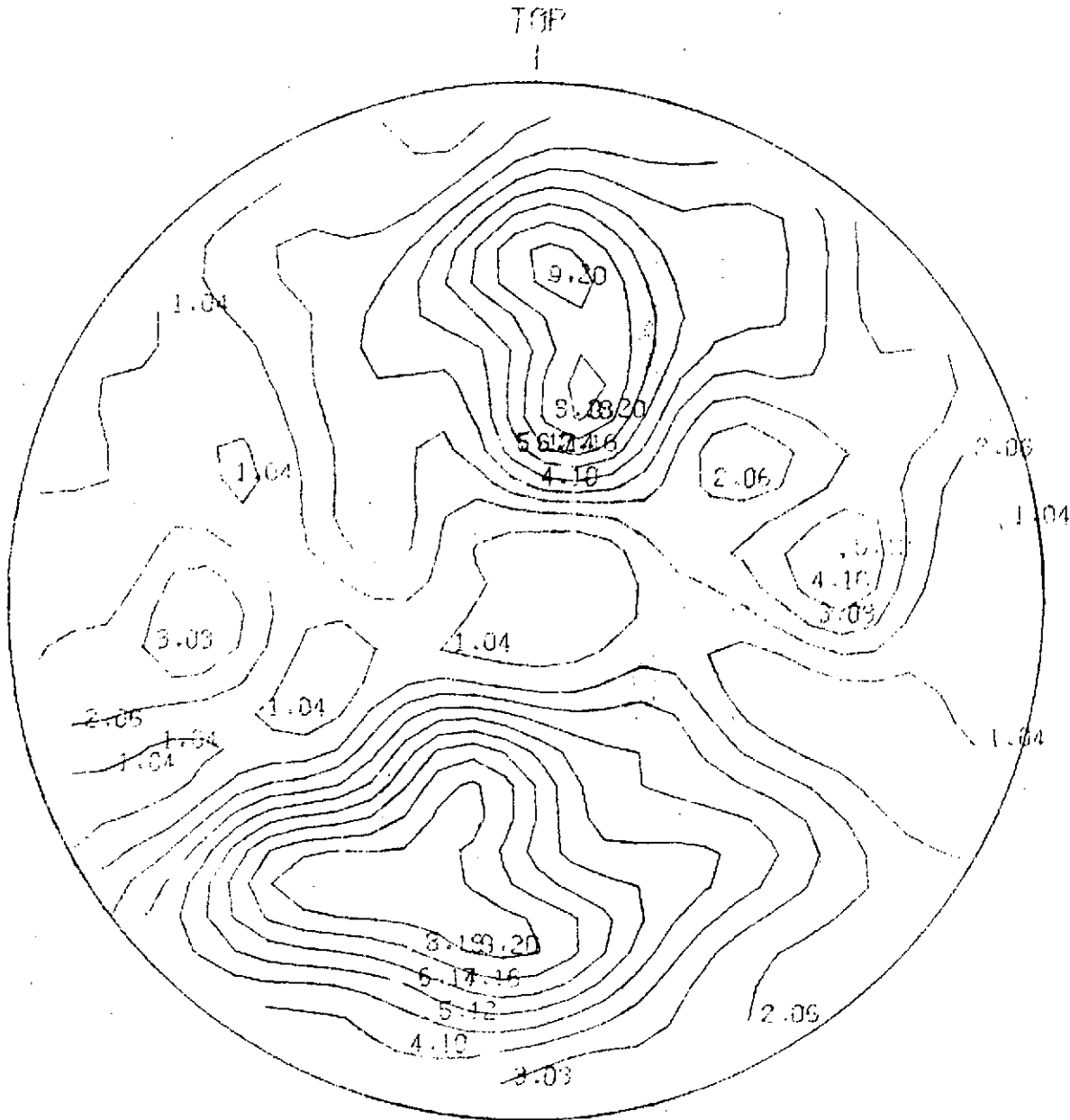


FIGURE 125

Intensity Distribution - Central 129 Microradians

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

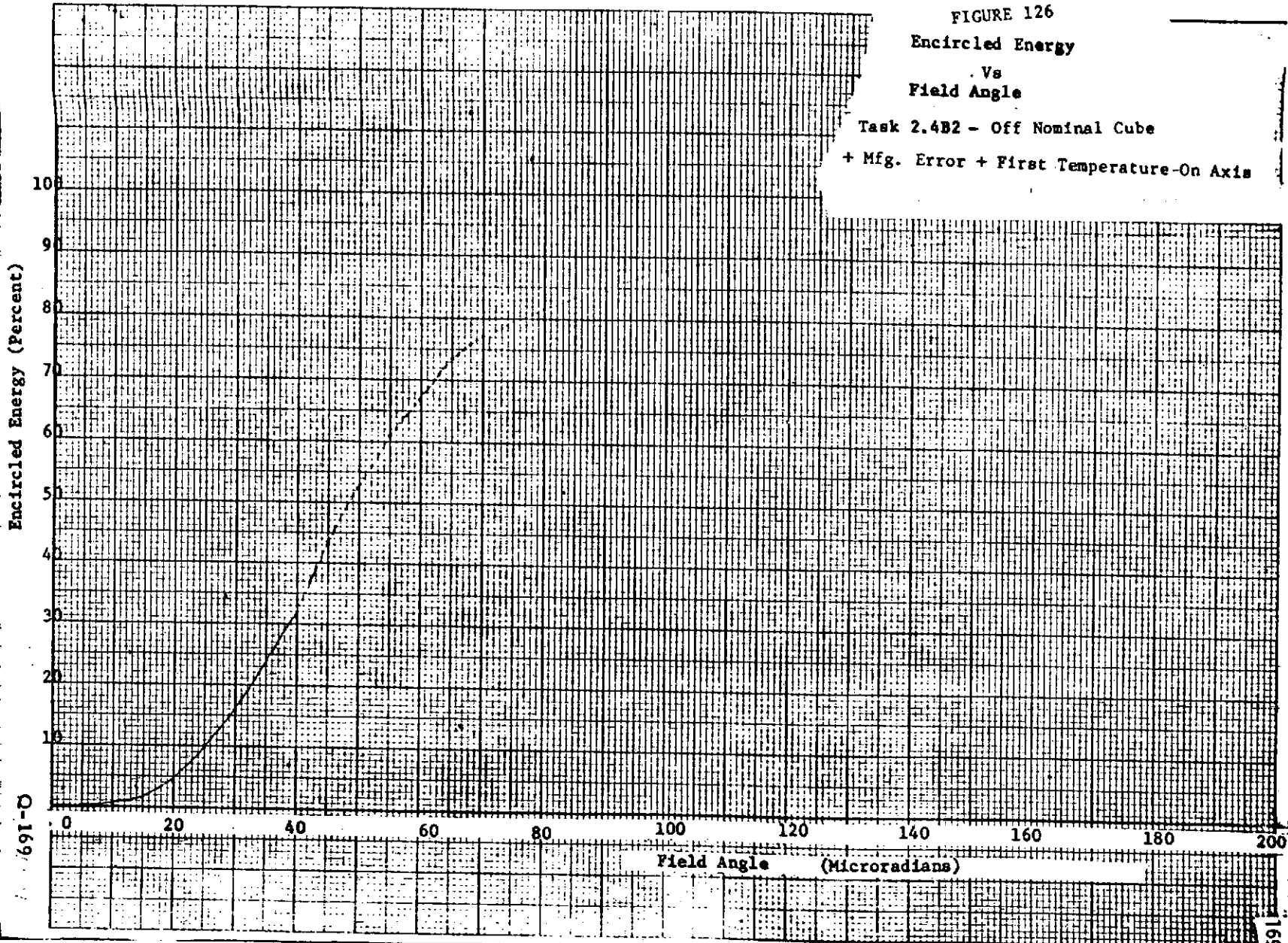


REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FIGURE 126  
Encircled Energy  
Vs  
Field Angle

Task 2.4B2 - Off Nominal Cube  
+ Mfg. Error + First Temperature-On Axis



691-D

169

TABLE 30

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

```

*****
CIRCLE *
----- *
RADIUS *
----- *
(MI- *
CENTERS) *
= CENTER (MICRONS):
= X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13
= Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13
*
*****
*
2.00 * 0.0 0.0 0.0 0.1 0.1 0.1 0.0 0.0 0.0
4.00 * 0.2 0.3 0.1 0.2 0.1 0.1 0.1 0.4 0.3
6.00 * 0.2 0.3 0.4 0.6 1.0 0.5 0.4 0.4 0.3
8.00 * 0.8 1.0 0.7 1.1 1.0 1.1 0.8 1.2 1.1
10.00 * 1.2 1.4 1.0 1.5 1.9 1.5 1.1 1.6 1.5
12.00 * 2.8 3.0 1.6 2.6 2.1 2.6 1.8 3.4 3.3
14.00 * 2.8 3.0 2.5 3.8 2.9 3.8 3.0 3.4 3.3
16.00 * 4.8 5.0 3.2 5.0 3.5 5.1 3.9 5.7 5.6
18.00 * 5.6 5.8 4.5 6.2 5.4 6.3 5.3 6.8 6.5
20.00 * 7.3 7.5 5.9 8.1 5.4 8.1 7.0 8.8 8.5
22.00 * 8.2 8.3 8.0 9.6 8.4 9.7 9.4 9.8 9.5
24.00 * 10.3 10.4 9.1 10.8 10.2 10.8 10.6 12.3 11.9
26.00 * 11.3 11.4 11.9 12.8 13.7 12.8 13.7 13.6 13.2
28.00 * 13.8 13.8 14.5 15.3 14.9 15.2 16.6 16.3 15.9
30.00 * 15.7 15.9 17.0 17.4 18.7 17.2 19.3 18.6 18.2
32.00 * 19.5 19.6 19.0 19.7 21.1 19.5 21.4 22.2 21.8
34.00 * 20.3 20.4 22.1 22.8 23.4 22.5 24.8 23.1 22.7
36.00 * 24.6 24.7 24.5 25.9 26.9 25.7 27.2 27.0 26.7
38.00 * 26.9 27.0 27.3 28.9 30.0 28.6 29.8 29.4 29.1
40.00 * 30.6 30.7 30.1 32.4 32.0 32.3 32.7 32.7 32.6
42.00 * 32.6 32.7 33.9 36.1 35.3 36.0 36.1 34.7 34.6
44.00 * 36.6 36.7 35.7 38.1 38.4 38.2 38.2 38.5 38.4
46.00 * 39.5 39.5 40.1 41.8 42.4 42.0 42.2 41.5 41.5
48.00 * 42.6 42.6 43.4 45.2 44.2 45.4 45.9 44.5 44.6
50.00 * 45.7 45.8 46.5 47.5 48.7 47.7 48.5 47.9 48.0
52.00 * 48.8 49.0 49.3 50.4 52.1 50.6 51.8 51.2 51.1
54.00 * 50.6 50.8 53.1 53.5 55.5 53.6 55.0 53.2 53.2
56.00 * 54.0 54.3 56.3 57.1 58.8 57.1 58.7 56.5 56.4
58.00 * 56.8 57.0 58.6 59.4 62.2 59.4 60.7 59.4 59.3
60.00 * 59.4 59.7 61.6 62.6 65.0 62.5 64.0 61.8 61.8
62.00 * 61.6 61.8 64.4 65.2 67.3 65.2 66.5 64.0 64.0
64.00 * 65.2 65.2 66.2 67.3 69.6 67.2 68.6 66.9 67.0
66.00 * 67.4 67.4 69.2 69.9 71.9 69.9 71.1 69.0 69.2
68.00 * 69.9 69.7 71.2 71.8 72.8 71.9 72.8 70.9 71.4
70.00 * 71.9 71.6 73.3 73.6 74.9 73.7 74.5 72.6 73.1
72.00 * 74.1 73.8 74.9 75.0 76.6 75.2 75.9 74.3 74.9
74.00 * 75.3 74.9 76.9 76.7 78.0 76.9 77.3 75.5 76.1
76.00 * 77.3 76.9 78.4 78.1 79.3 78.3 78.5 77.0 77.6
78.00 * 78.6 78.3 79.3 79.1 80.5 79.3 79.3 78.3 78.7
80.00 * 79.8 79.6 80.8 80.3 81.5 80.5 80.4 79.4 79.7
*
*****

```

ENCIRCLED ENERGY

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

\*\*\*\*\*

```

CIRCLE *
----- *
RADIUS *
----- *
(MI- *
CIRONS) *
CENTER (MICRONS):
* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13
* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13
    
```

\*\*\*\*\*

5.00	*	0.2	0.3	0.4	0.4	0.6	0.4	0.4	0.4	0.3
10.00	*	1.2	1.4	1.0	1.5	1.9	1.5	1.1	1.6	1.5
15.00	*	4.0	4.2	2.9	4.6	3.5	4.6	3.4	4.8	4.6
20.00	*	7.3	7.5	5.9	8.1	5.4	8.1	7.0	8.8	8.5
25.00	*	11.0	11.1	11.5	12.4	11.4	12.4	13.3	13.1	12.8
30.00	*	15.7	15.9	17.0	17.4	18.7	17.2	19.3	18.6	18.2
35.00	*	23.0	23.1	22.8	24.0	26.0	23.7	25.3	25.4	25.0
40.00	*	30.6	30.7	30.1	32.4	32.0	32.3	32.7	32.7	32.6
45.00	*	38.0	38.0	38.6	40.3	40.0	40.5	40.6	39.9	40.0
50.00	*	45.7	45.8	46.5	47.5	48.7	47.7	48.5	47.9	48.0
55.00	*	52.9	53.1	54.3	55.0	58.1	55.1	56.6	55.3	55.2
60.00	*	59.4	59.7	61.6	62.6	65.0	62.5	64.0	61.8	61.8
65.00	*	66.1	66.1	68.2	69.0	70.6	69.0	70.2	67.8	68.0
70.00	*	71.9	71.6	73.3	73.6	74.9	73.7	74.5	72.6	73.1
75.00	*	76.6	76.2	77.5	77.3	78.8	77.5	77.9	76.4	77.0
80.00	*	79.8	79.6	80.8	80.3	81.5	80.5	80.4	79.4	79.7
85.00	*	82.1	82.0	83.1	82.8	83.5	82.8	82.7	81.9	81.9
90.00	*	83.9	84.0	84.5	84.5	84.9	84.4	84.4	83.9	83.8
95.00	*	85.4	85.5	85.6	85.7	85.9	85.7	85.7	85.6	85.4
100.00	*	86.5	86.6	86.6	86.7	86.8	86.7	86.8	86.7	86.6
105.00	*	87.4	87.5	87.6	87.6	87.8	87.7	87.7	87.6	87.5
110.00	*	88.3	88.4	88.5	88.4	88.6	88.5	88.5	88.4	88.4
115.00	*	89.2	89.2	89.3	89.2	89.3	89.2	89.2	89.1	89.2
120.00	*	89.9	89.9	89.9	89.9	90.1	89.9	89.9	89.7	89.8
125.00	*	90.5	90.5	90.6	90.5	90.7	90.5	90.5	90.3	90.3
130.00	*	91.0	91.0	91.1	91.1	91.2	91.1	91.0	90.9	90.9
135.00	*	91.4	91.4	91.4	91.5	91.5	91.5	91.5	91.5	91.5
140.00	*	91.9	91.9	91.9	91.9	91.9	91.9	91.9	91.9	91.9
145.00	*	92.3	92.3	92.3	92.3	92.2	92.3	92.3	92.2	92.2
150.00	*	92.7	92.7	92.7	92.7	92.7	92.6	92.6	92.6	92.6
155.00	*	93.0	93.0	93.1	93.0	93.1	93.0	93.0	93.0	93.0
160.00	*	93.4	93.4	93.4	93.4	93.4	93.4	93.4	93.4	93.4
165.00	*	93.8	93.7	93.8	93.8	93.8	93.8	93.8	93.8	93.8
170.00	*	94.1	94.0	94.1	94.2	94.2	94.2	94.1	94.1	94.1
175.00	*	94.4	94.4	94.4	94.4	94.5	94.4	94.4	94.4	94.4
180.00	*	94.7	94.7	94.7	94.7	94.8	94.7	94.8	94.7	94.7
184.99	*	95.0	95.0	95.0	94.9	94.9	95.0	95.0	95.0	95.0
189.99	*	95.2	95.3	95.3	95.2	95.3	95.3	95.3	95.2	95.2
194.99	*	95.5	95.5	95.6	95.5	95.6	95.5	95.5	95.5	95.4
199.99	*	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.7

\*\*\*\*\*

FIGURE 127

Wavefront Map-( $\sigma$ ) Polarization

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

MAP IN UNITS OF 0.01 WAVES

195 188 195 199

230 220 209 200 191 185 191 196 201 206 211 216

240 233 225 216 206 196 188 183 189 194 199 205 210 216 222 227

236 232 226 218 210 200 192 184 179 185 190 196 202 208 214 220 225 231

~~228 228 226 223 218 211 203 194 186 179 175 180 185 191 197 203 209 215 221 227 233 238~~

218 218 218 217 214 210 203 196 188 181 174 170 175 179 185 190 196 203 209 215 221 227 233 239

210 211 211 210 207 203 197 190 183 176 170 165 169 174 179 184 190 196 202 208 214 220 226 233

~~202 197 193 205 204 202 197 192 185 179 172 166 161 164 168 173 178 183 189 195 201 206 214 204 212 220~~

211 206 202 197 192 186 197 193 187 181 175 169 162 157 159 163 167 172 177 182 188 195 186 155 204 211 219 226

215 210 206 201 196 185 181 174 166 178 172 165 159 153 155 158 162 166 171 160 168 178 187 156 204 211 218 224

~~222 218 214 209 204 198 191 183 174 166 158 151 161 155 149 150 153 157 145 153 161 170 180 185 197 205 211 218 223 228~~

225 221 216 211 205 199 191 182 173 165 157 149 142 135 144 144 133 140 148 156 164 172 181 150 158 205 211 217 222 226

227 222 217 211 205 198 190 181 171 163 155 147 139 150 147 147 153 143 150 158 166 174 183 191 195 205 210 215 220 224

~~224 218 211 204 197 188 179 169 160 152 164 159 155 152 151 157 163 169 159 166 174 182 150 197 203 206 212 217~~

225 218 211 204 196 187 177 168 179 174 169 165 160 157 155 161 167 173 179 185 173 181 188 154 200 204 209 213

219 212 204 195 204 198 191 185 179 174 170 165 161 158 164 170 177 183 189 195 199 202 190 195 200 204

221 213 223 217 211 204 198 192 186 180 176 171 166 162 168 174 180 187 194 200 204 206 207 207 195 200

235 229 223 217 211 205 199 193 187 181 176 172 167 172 178 185 193 200 206 210 213 214 214 213

235 229 223 218 212 206 199 193 187 182 177 172 177 183 191 199 207 213 218 221 222 222

235 229 223 217 211 205 199 193 189 183 177 182 189 197 206 214 221 227 231 232

232 226 221 215 209 203 197 197 187 181 186 194 203 212 221 229 236 240

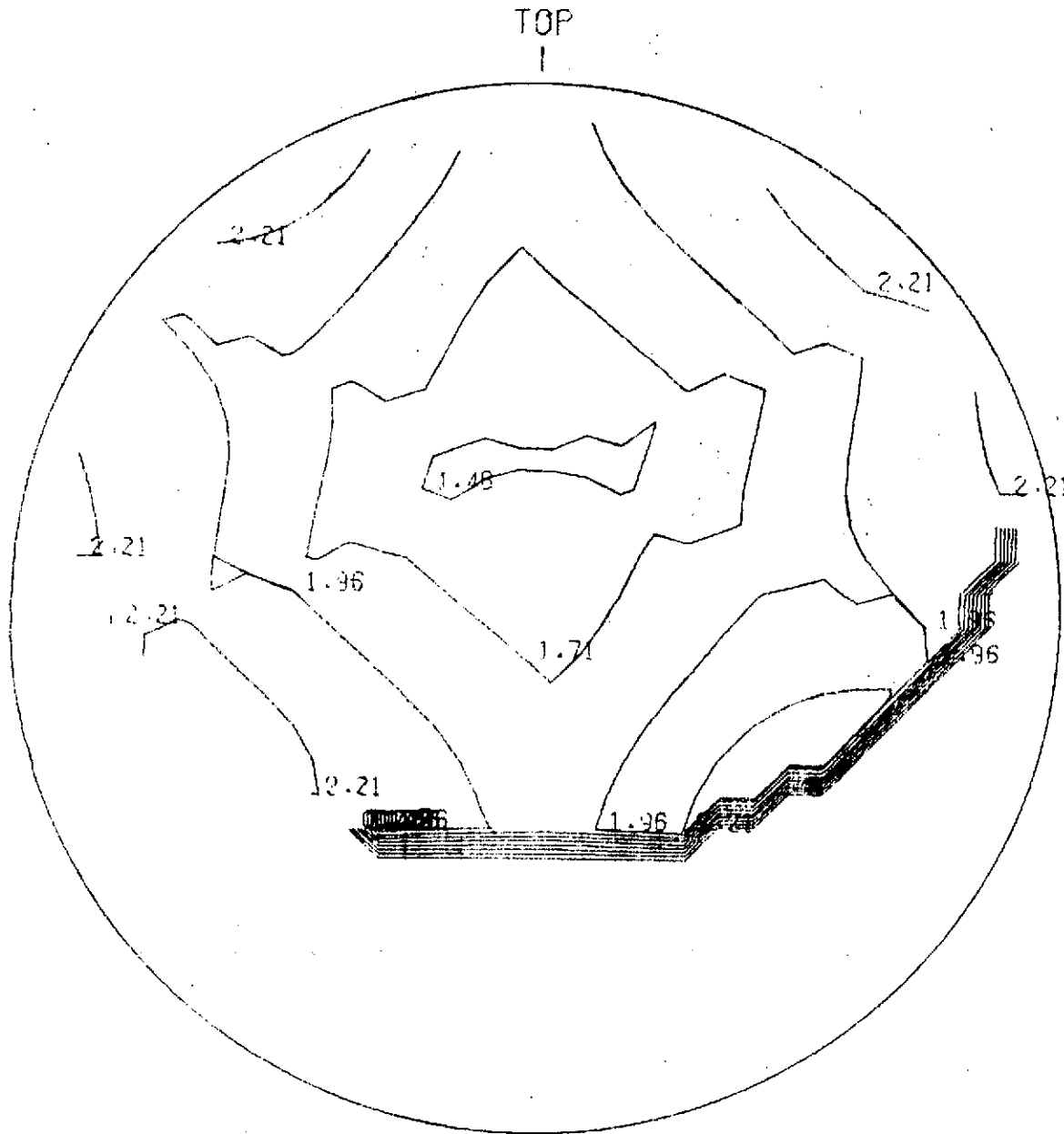
222 216 211 205 200 195 190 184 190 198 208 218 227 236

211 206 202 197 192 186 192 201 211 221

FIGURE 128

Wavefront Plot-Q Polarization

Task 2.4B2 - OFF Nominal Cube + Mfg. Error + First Temperature -15° Off Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FIGURE 130

## Wavefront Plot-P Polarization

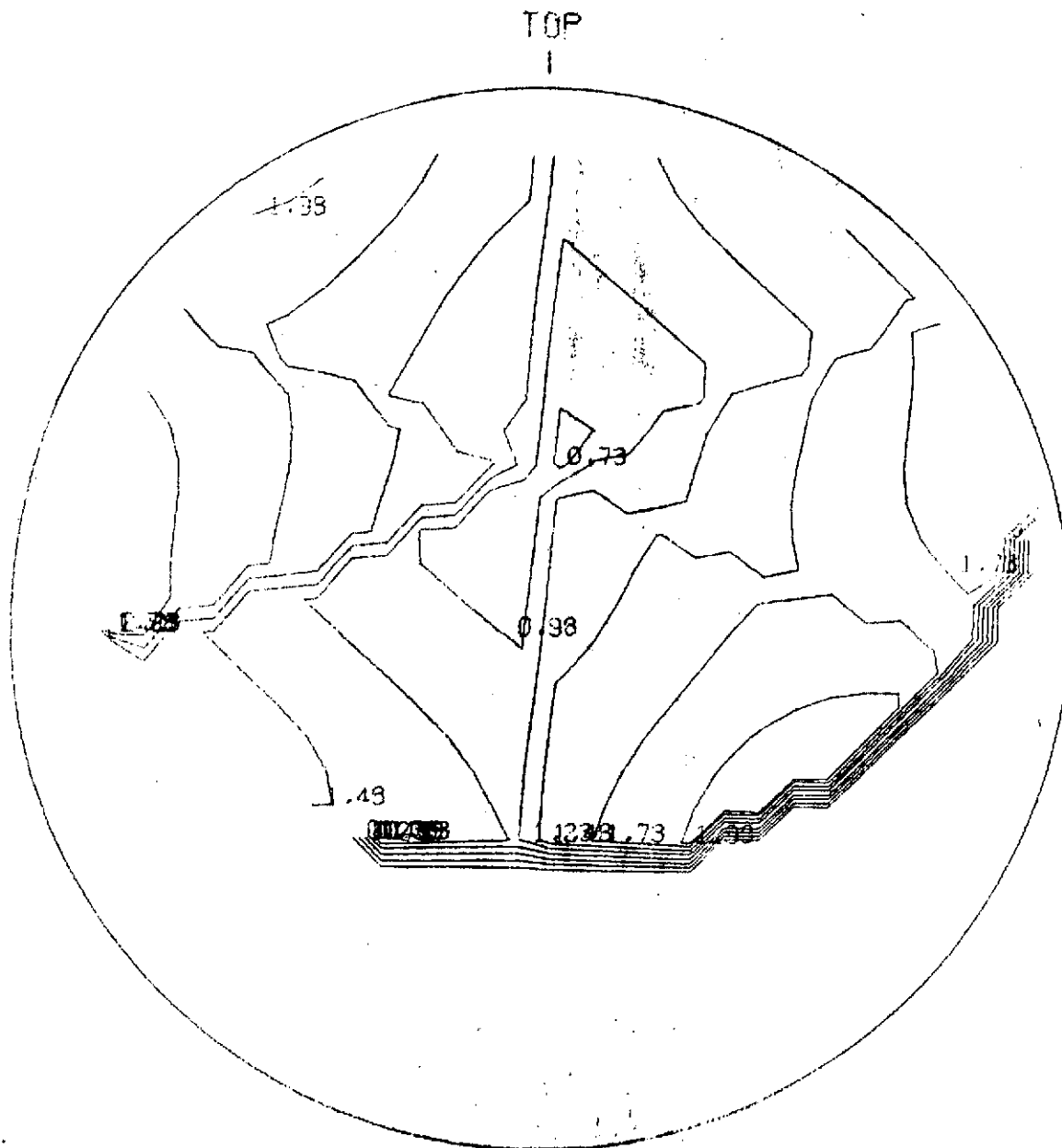
Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature  $-15^\circ$  Off Axis

FIGURE 131

Task 2.482 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

PRINTER MAP OF POINT SPREAD FUNCTION

(ONE SPACE REPRESENTS 8.04 MICRONS)
NORMALIZED SO LARGEST VALUE = 0.0171 = 100
TOTAL ENERGY = 0.18704000+01
MAP REPRESENTS 0.17432000+01 OR 93.1993 PERCENT OF TOTAL ENERGY

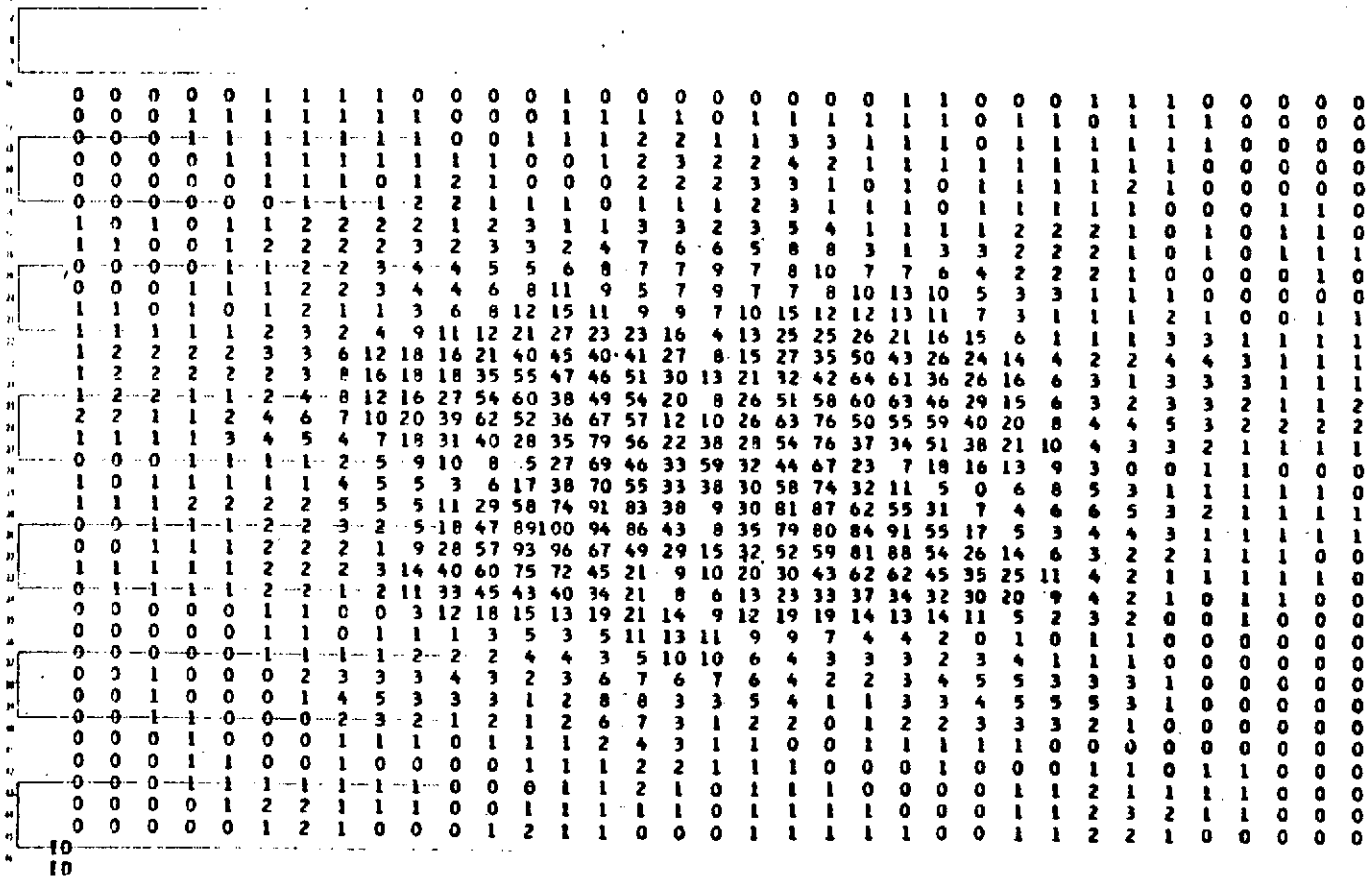




FIGURE 132

Point Spread Function

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

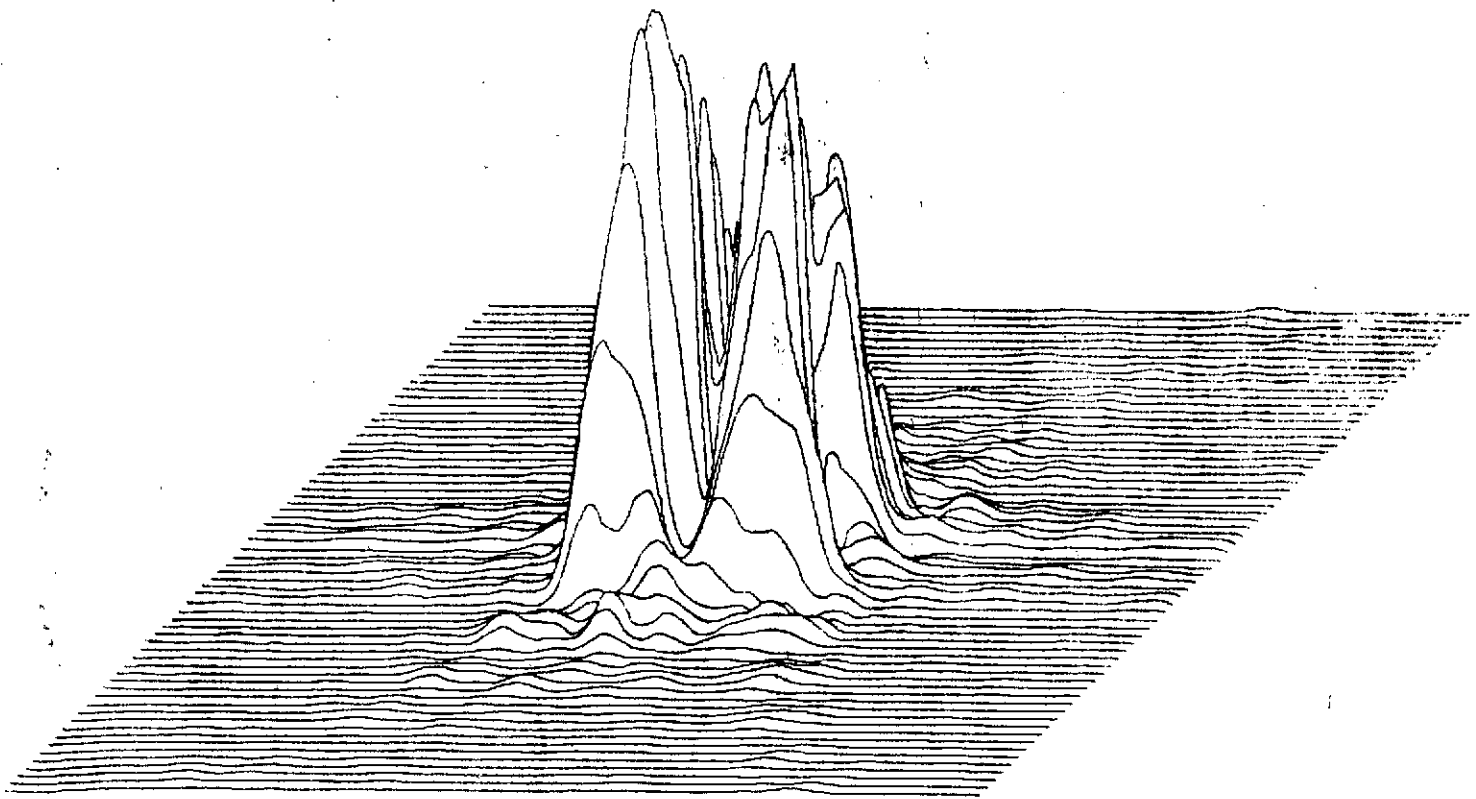


FIGURE 133

Intensity Distribution - Central 129 Microradians

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

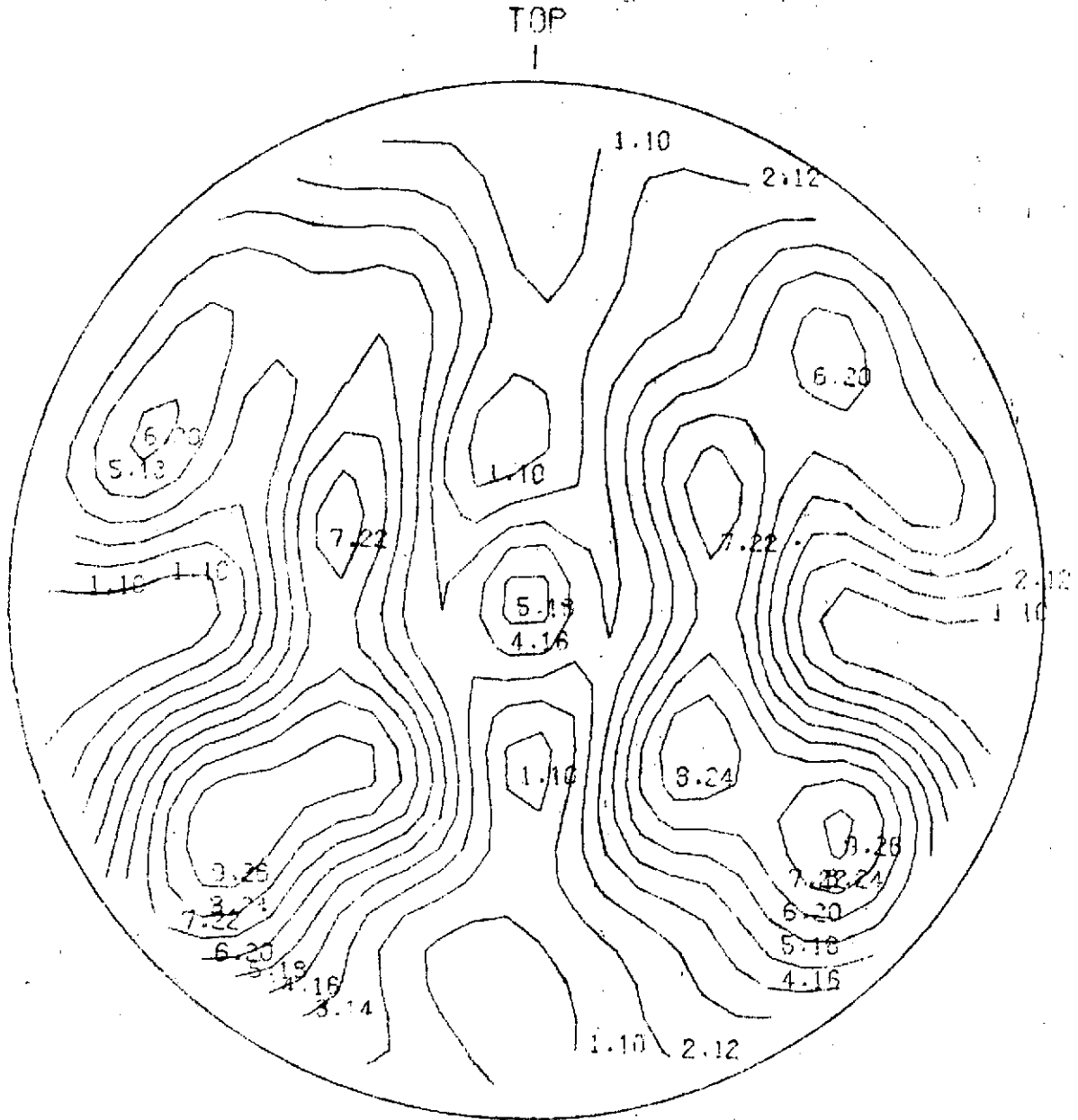


FIGURE 134

Encircled Energy

Vs

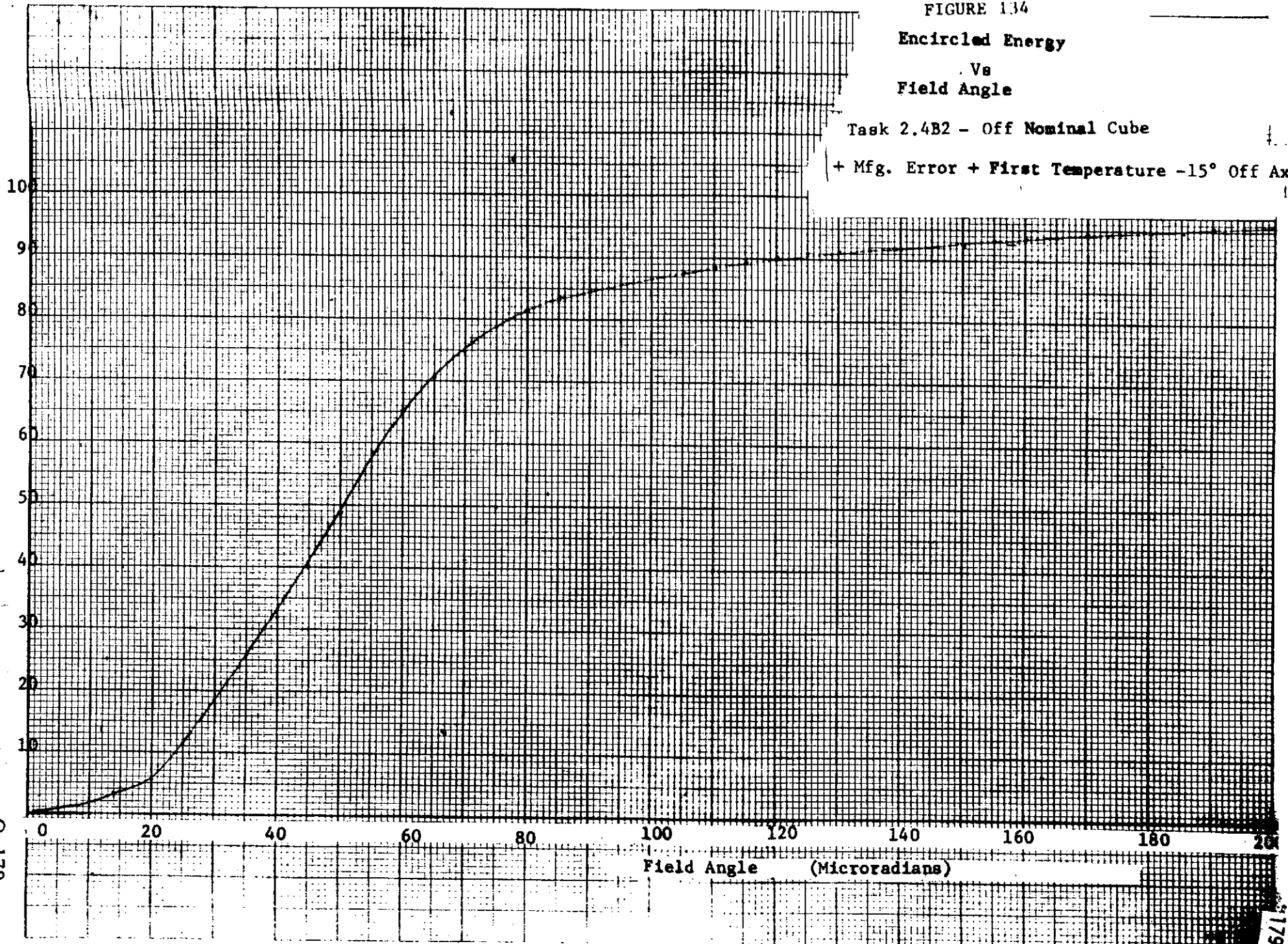
Field Angle

Task 2.4B2 - Off Nominal Cube

+ Mfg. Error + First Temperature  $-15^{\circ}$  Off Axis

Encircled Energy (Percent)

Q-179



Field Angle (Microradians)

179

TABLE 32  
 Encircled Energy in the  
 32-42 Microradian Range

Task	Case	Percent Energy 32-42 Microradians	
		On Axis	-15° *
2.1	Nominal Cube	21.6	10.8
2.2	Nominal Cube + $\lambda/4$	21.2	9.8
2.3B	Nominal Cube + $\lambda/4$ + Temp 1	20.4	9.4
2.3A1	Nominal Cube + $\lambda/4$ + Temp 2	21.1	
2.3A2	Nominal Cube + $\lambda/4$ + Temp 3	20.2	
2.4A	Off Nominal Cube + $\lambda/4$	20.8	9.8
2.4B2	Off Nominal Cube + $\lambda/4$ + Temp 1	20.0	9.2
2.5A	Nominal Cube + $\lambda/4$ + Axial Grad.	18.0	
2.5B	Nominal Cube + $\lambda/4$ + Radial Grad.	5.1	

\* values shown have been multiplied by 65% as per text.

TABLE 33

One Sigma Error Sources in Calculation  
of Encircled Energy and  
Point Spread Function

Error Source/Parameter	Point Spread Function	Encircled Energy
N3D, Thermal Phase Error $\approx 0.01\lambda$	0.02%	0.004%
Polarization $\sim 0.0002\lambda_{RMS}$	$\sim 0$	$\sim 0$
Fourier Transform Point Spread Function	5%	0.4%
Intergration (finite grid)	--	1%
RSSed Total	$\sim 5\%$	$\sim 1.1\%$

Table 34  
 Corner Cube Study  
 Selected Computer Code Abstracts

(Note: All codes may be executed sequentially in various combinations in a single computer run; no's 4-5 can provide data in both printed and plotted output format, e.g. 3-D or contour OPD maps)

No.	Name	Function	Computer	Mathematical Process	Input	Output
1	CLIC/SAVE-FIND	Optical geometry and refractive index (N) input	IBM 370, 158	Puts data into computer storage, calls it as necessary	Optical geometry*, N vs. Wavelength ( $\lambda$ )*, SAVE/FIND commands	Echo Print
2	THRM/N3D	Input of temp. (T), material properties, and thermo-optical geometry	IBM 370, 158	Transform optical geometry and indices into perturbed state in storage	Expansion coefficients; temperature coefficients of N ( $\lambda, T$ ); atmospheric data such as pressures, relative humidities, etc.*; T (X,Y,Z)*; thermo-optical geometry*, output of No.1	New Optical geometry N( $\lambda, X, Y, Z$ )
3	ZINT	Raytracing	IBM 370, 158	Three dimensional raytracing, stores optical path differences (OPD's) on a user specified grid for field angles of interest ( $\bar{H}$ )	Output of No. 2, grid and raytracing specifications	OPD ( $\bar{H}, X', Y', Z'$ )
4	FRED	Specification of unusual apertures	IBM 370, 158	Scaling and weighting of OPD's on desired grids	Output of No's. 2 and 3, aperture geometry*, OPD generation commands	New OPD Map
5	POINT	Diffraction computations	IBM 370, 158	New OPD's used to get normalized point spread function, PSF (Int. - I vs. X'', Y'', Z''), through fourier transform	Output of No. 4, I scale commands	Normalized PSF, i.e. I ( $\bar{H}, X'', Y'', Z''$ )
6.	ENEN	Encircled Energy	IBM 370,158	Intensity distribution used to obtain encircled energy in desired inclements, spline interpolation of intensity used for increased accuracy	Output of No. 5	Encircled energy vs. radius

When the effects of the beveled edges are included, the analysis becomes more interesting. To begin with these ground-down edges do not exactly result in a pupil function with simple spoked obstructions. Fortunately, these are small, high order effects, and the spoked obstruction can be assumed to lie in the plane of the diffracting aperture. (For non-Normal incidence the angles between the spokes, and their apparent location in the aperture, will vary with the incident beam angle, a case which is not considered here).

If the general form of Kirchhoff's diffraction integral is examined, it will be seen that the complex amplitude at P, i.e.,  $U(P)$ , for a circular aperture with obstructing spokes in it, is just the complex amplitude due to integrating over the unobstructed aperture minus the complex amplitude  $U(P)$  due to integrating over the area of the obstructions alone. The desired amplitude  $U(P)$  can thus be written as

$$U(P)_{\text{total}} = U(P)_{\text{circle}} - U(P)_{\text{obstructions}}$$

$U(P)_{\text{circle}}$  can be given by,  $C \left[ \frac{2J_1(v)}{v} \right]$  and  $U(P)_{\text{obstructions}}$  is readily obtained. The three full-diameter spoked obstructions are situated at  $\theta = 0^\circ$ ,  $\theta = 60^\circ$ , and  $\theta = 120^\circ$ . If the small curvature at the ends of each spoke, due to the circular aperture, is ignored, then each of the three obstructions is a thin rectangle of length  $2a$  (the diameter of the cube corner) and width  $w$  (some small number). If the small common area at their intersection in the center of the aperture is ignored, then the effect of one spoke can be evaluated, and then summed three times to get the total effect of the obstructions.

The amplitude  $U(P)$  due to a single rectangle of length  $2a$  and width  $w$  is well known and easy to calculate:

$$U(P) = \frac{\sin\left(\frac{2\pi}{\lambda} \cdot 2a \cdot \sin\psi_a\right)}{\left(\frac{2\pi}{\lambda} \cdot 2a \cdot \sin\psi_a\right)} \cdot \frac{\sin\left(\frac{2\pi}{\lambda} \cdot w \cdot \sin\psi_w\right)}{\left(\frac{2\pi}{\lambda} \cdot w \cdot \sin\psi_w\right)}$$

where  $\psi_a$  and  $\psi_w$  are the components of the angle  $\psi$ , which are normal to the length and width of the rectangle. Assuming that  $\sin\psi = \psi$ , this simplifies to

$$U(P)_{\text{rectangle}} = \frac{\sin(2va)}{2va} \cdot \frac{\sin\left(\frac{vw}{a}\right)}{\frac{vw}{a}}$$

If the proportionality constant is determined and the effects of the three spokes in the appropriate orientations are successively subtracted away from  $U(P)_{\text{circle}}$ , the final result obtained for the obstructed aperture is

$$U(P)_{\text{total}} = U(P)_{\text{circle}} - U(P)_{\text{obstructions}}$$

$$= \frac{\sqrt{\pi a^2 E_{\text{circle}}}}{\lambda} \left[ \frac{2J_1(v)}{v} \right] - \frac{\sqrt{2awE_{\text{obs}}}}{\lambda} \left[ \frac{\sin(2v\cos\theta)}{2v\cos\theta} \cdot \frac{\sin\left(\frac{w}{a} v \sin\theta\right)}{\frac{w}{a} v \sin\theta} \right. \\ \left. + \frac{\sin 2v \cos(\theta-60^\circ)}{2v \cos(\theta-60^\circ)} \right] \cdot \frac{\sin\left[\frac{w}{a} v \sin(\theta-60^\circ)\right]}{\frac{w}{a} v \sin(\theta-60^\circ)} + \frac{\sin 2v \cos(\theta+60^\circ)}{2v \cos(\theta+60^\circ)} \\ \left. \frac{\sin\left[\frac{w}{a} v \sin(\theta+60^\circ)\right]}{\frac{w}{a} v \sin(\theta+60^\circ)} \right]$$

where  $v\cos\theta$  and  $v\sin\theta$  define the angular position of the observation point P relative to the coordinate system that has been set up in the entrance face of the cube corner. The second, third, and fourth terms above represent the effects of the three thin rectangular obstructions in the aperture, while  $E_{\text{obs}}$  is the



energy intercepted by each one. One can easily show that, for rectangles much thinner than their length ( $w \ll 2a$ ), as is the case here, each of the last three terms above becomes significant only in the immediate vicinity of the respective angles of  $\theta = 90^\circ$ ,  $\theta = 150^\circ$  and  $\theta = 30^\circ$ , in which case the other terms can be neglected. Therefore at  $\theta = 90^\circ$

$$U(P) = \frac{\sqrt{\pi a^2 E_{\text{circle}}}}{\lambda} \left[ \frac{2J_1(v)}{v} \right] - \frac{\sqrt{2awE_{\text{obs}}}}{\lambda} \left[ \frac{\sin\left(\frac{w}{a}v\right)}{\frac{w}{a}v} \right]$$

with the same result in the immediate vicinity of  $\theta = 150^\circ$  and  $\theta = 30^\circ$ . For values of  $\theta$  away from these values, the effect of the obscurations is negligible and only the Airy pattern term remains. The intensity at P is just the square of U(P) as given above.

The function  $\frac{\sin x}{x}$  behaves very much like  $\frac{2J_1(x)}{x}$ . The latter damps out very quickly, as in the Airy pattern, where after a few rings away from the Airy disk, the intensity is very low. The factor

$$\frac{\sin\left(\frac{wv}{a}\right)}{\frac{wv}{a}}$$

will, therefore, damp out about the same way as  $\frac{2J_1(v)}{v}$  does, but since  $\frac{w}{2a}$  (width/length) of the spokes is a very small number, a much larger value of  $v$  will be required to damp out the spoke effects to the same degree. The effect can be seen in Figure A-1, which shows how each of the three full diameter rectangular obstructions (due to the beveled edges) gives rise to a narrow fan of light, extending far out into the region where the bright rings of the Airy pattern are too dim to be visible on the plot. These fans are oriented, as mentioned above, at right angles to the long direction of the rectangles which caused them.

Since the intensity  $I(P)$  is the square of  $U(P)$ , the Airy pattern term and the rectangle term due to the spokes will interact in the squaring and give a cross product term. However, the rectangle term is much smaller than the Airy term, due to the small relative amount of energy  $E_{obs}$  intercepted by the obstruction, and the square of the rectangle term can be ignored and just the cross product retained. Therefore, the result is that

$$I(P) = \frac{\pi a^2 E_{circle}}{\lambda^2} \left[ \frac{2J_1(v)}{v} \right]^2 - \frac{\sqrt{8\pi a^3 w E_c E_{obs}}}{\lambda^2} \left[ \frac{2J_1(v)}{v} \right] \frac{\sin\left(\frac{w}{a} v\right)}{\frac{w}{a} v}$$

in the vicinity of  $\theta = 90^\circ$  or  $\pm 30^\circ$ , with the second term negligible at other values of  $\theta$ . The effect of the slowly decaying rectangle term, is to slowly modulate the amplitude of the Airy pattern in a highly angularly dependent manner. That is why the light fans shooting out in the plot go through maxima along their lengths; they represent narrow angular corridors through the Airy ring pattern, given a high local "magnification" by the rectangle term above. Note that these results apply equally well to perfect cat's-eye retro-reflectors having radial struts, spider supports, etc.

The diffraction pattern of Figure A1 is plotted for a circular aperture where the three spoked obstructions had a length to width ratio of about 13 to 1, much smaller than for the ground edges of an actual cube corner. The latter case produced effects too weak compared to the central maximum of the Airy disk to show up well on the plot. The peak intensity in the actual cube was found to be reduced by 1.7% due to obstructions as compared with a perfect cube corner.

It is worth noting that the approximate expression given for the airy diffracting pattern for regions away from the central maximum can also be

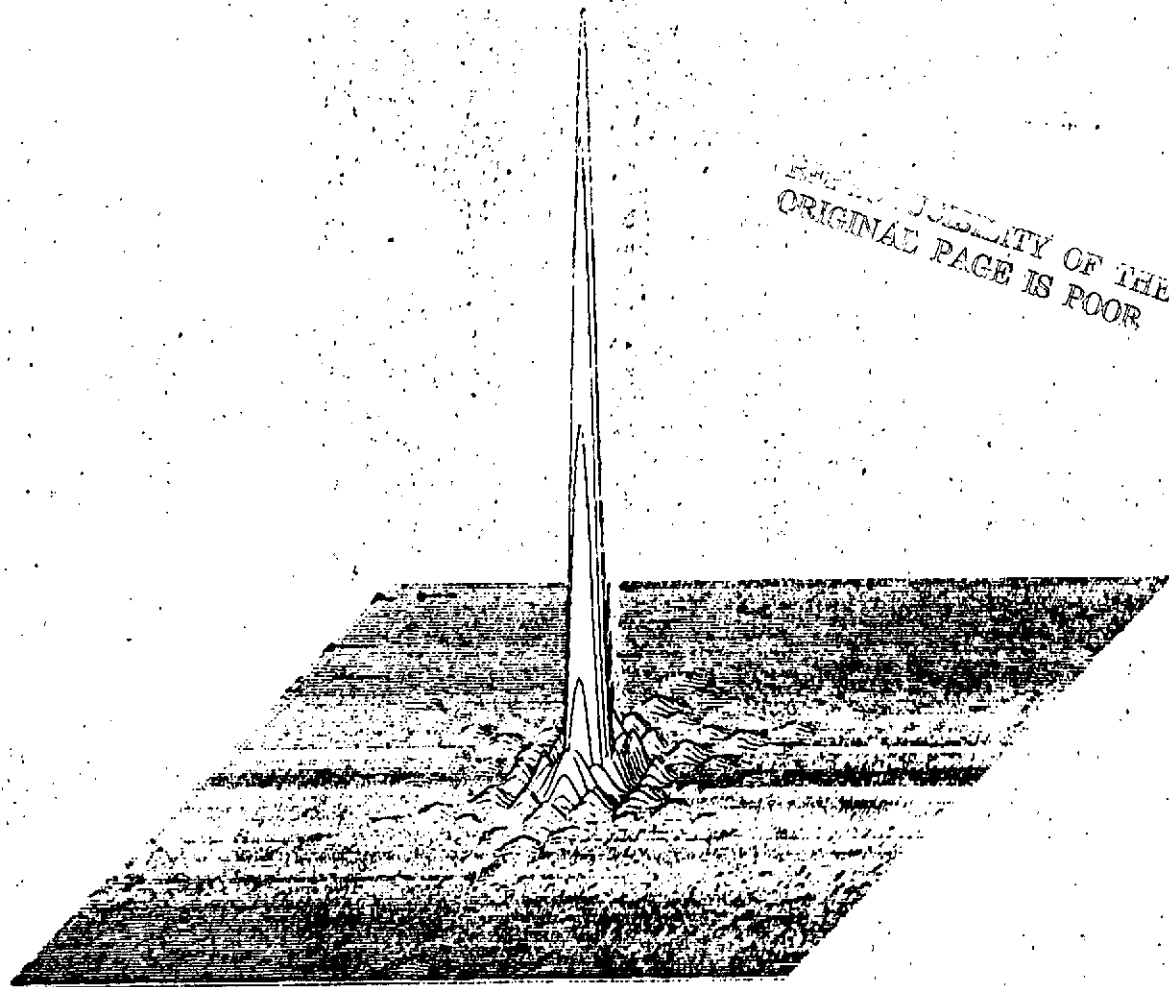


Fig. A-1 — Intensity contours including leveled edge effects

easily calculated using Keller's "geometrical theory of diffraction," and the nature and spacing of the bright and dark rings is due to simple interference between two critical points of the second kind on the rim of the diffracting aperture. The same theory also allows one to quickly and (without any paper work or detailed mathematics) correctly predict the qualitative effects of the spoked obstructions on the diffraction pattern as well as the relative orientation of the light fans in the pattern to the obstructions in the aperture.

Dihedral Angle Variation

If each of the dihedral angles of the corner were increased to a 2.1 sec from the nominal design of 1.5 sec the divergence of the energy would increase and the encircled energy in the 32-42 microradian ring would decrease. Table B1 provides a reference for locating figures and tables that apply to different cases. Table B 30 lists the encircled energy in the 32 to 42 microradian ring for the specified cases.

Figure Numbers and Tables that Give the Performance of the Specified Cases

Task	Case	Wavefront Maps	Wavefront Plots	Intensity Map	Intensity Plot	Encircled Energy Plot	Encircled Energy Tables
2.1	Nominal Cube-On Axis	B1, B3	B2, B4	B5	B6	B7	B2, B3
2.1	Nominal Cube- 15° Off Axis	B8, B10	B9, B11	B12	B13	B14	B4, B5
2.2	Nominal Cube - On Axis + 0.278λ mfg error	B15, B17	B16, B18	B19	B20	B21	B6, B7
2.2	Nominal Cube 15° Off Axis + 0.278λ mfg error	B22, B24	B23, B25	B26	B27	B28	B8, B9
2.3B	Nominal Cube On Axis + 0.278λ mfg error + first temperature case	B19, B31	B30, B32	B33	B34	B35	B10, B11
2.3B	Nominal Cube 15° Off Axis + 0.278λ mfg error + first temperature case	B36, B38	B37, B39	B40	B41	B42	B12, B13
2.3A1	Nominal Cube On Axis + 0.278λ mfg error + second temperature case	B43, B45	B44, B46	B47	B48	B49	B14, B15
2.3A2	Nominal Cube On Axis + 0.278λ mfg error + third temperature case	B50, B52	B51, B53	B54	B55	B56	B16, B17
2.5A	Nominal Cube On Axis + 0.278λ mfg error + axial gradient	B57, B59	B58, B60	B61	B62	B63	B18, B19
2.5B	Nominal Cube On Axis + 0.278λ mfg error + radial gradient	B64, B66	B65, B67	B68	B69	B70	B20, B21
2.4A	Off Nominal Cube On Axis + 0.278λ mfg error	B71, B73	B72, B74	B75	B76	B77	B22, B23
2.4A	Off Nominal Cube 15° Off Axis + 0.278λ mfg error	B78, B80	B79, B81	B82	B83	B84	B24, B25
2.4B2	Off Nominal Cube On Axis + 0.278λ mfg error, + 1st ΔT case	B85, B87	B86, B88	B89	B90	B91	B26, B27
2.4B2	Off Nominal Cube 15° Off Axis + 0.278λ mfg error + first temperature case	B92, B94	B93, B95	B96	B97	B98	B28, B29

TABLE B2

ENCIRCLED ENERGY

Task 2.1 - Nominal Cube-On Axis

\*\*\*\*\*

CIRCLE \*  
----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
RADIUS \*  
----- \*

(MI- \* CENTER (MICRONS):  
CRONS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
\*

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.2	0.2
6.00	*	0.1	0.1	0.1	0.1	0.3	0.1	0.2	0.2	0.2
8.00	*	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.5
10.00	*	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.6	0.6
12.00	*	1.0	1.0	0.7	0.7	0.6	0.7	0.9	1.3	1.3
14.00	*	1.0	1.0	1.0	1.2	0.8	1.2	1.4	1.3	1.3
16.00	*	1.8	1.8	1.3	1.5	1.1	1.5	1.7	2.0	2.0
18.00	*	2.2	2.2	1.8	2.0	2.0	2.0	2.3	2.4	2.4
20.00	*	3.0	3.0	2.5	2.5	2.0	2.5	2.9	3.2	3.2
22.00	*	3.4	3.4	3.4	3.2	3.2	3.2	3.7	3.7	3.7
24.00	*	4.6	4.6	4.2	3.7	3.9	3.7	4.4	5.0	5.0
26.00	*	5.3	5.3	5.4	4.7	5.0	4.7	5.5	5.8	5.8
28.00	*	7.2	7.2	7.3	6.1	5.4	6.1	7.5	7.8	7.8
30.00	*	8.5	8.5	8.5	7.5	7.0	7.5	8.8	9.2	9.2
32.00	*	11.4	11.4	10.4	8.9	8.1	8.9	10.9	12.1	12.1
34.00	*	12.0	12.0	12.3	11.3	9.9	11.3	13.1	12.8	12.8
36.00	*	15.2	15.2	14.5	13.2	12.4	13.2	15.7	16.1	16.0
38.00	*	16.9	16.9	16.6	15.8	16.1	15.8	18.0	18.0	18.0
40.00	*	20.0	20.0	19.3	18.2	18.1	18.2	20.9	21.2	21.2
42.00	*	21.5	21.5	22.6	22.1	23.0	22.1	24.1	22.9	22.9
44.00	*	25.2	25.2	25.0	24.1	25.8	24.1	26.7	26.8	26.7
46.00	*	28.0	28.0	28.7	29.0	30.9	29.0	30.3	29.8	29.7
48.00	*	31.8	31.8	33.0	32.9	32.4	32.9	34.6	33.5	33.5
50.00	*	35.2	35.2	35.8	36.5	37.5	36.5	37.4	37.1	37.0
52.00	*	39.5	39.5	39.8	40.5	40.5	40.5	41.4	41.2	41.2
54.00	*	41.9	41.9	43.2	44.7	45.2	44.7	45.0	43.6	43.6
56.00	*	46.4	46.4	47.9	49.0	48.8	49.0	49.6	47.9	47.9
58.00	*	49.8	49.8	50.8	52.0	54.0	52.0	52.6	51.3	51.3
60.00	*	53.3	53.3	54.7	56.1	57.9	56.0	56.5	54.7	54.7
62.00	*	55.9	55.9	58.3	59.9	62.2	59.9	59.8	57.2	57.2
64.00	*	60.2	60.2	61.0	62.7	65.6	62.7	62.6	61.3	61.3
66.00	*	62.8	62.7	64.8	66.6	69.3	66.6	66.0	63.9	63.9
68.00	*	66.2	66.2	67.7	69.2	71.1	69.2	68.6	67.2	67.2
70.00	*	68.4	68.4	70.7	71.9	73.9	71.9	71.2	69.2	69.2
72.00	*	71.6	71.6	72.9	74.1	76.1	74.1	73.3	72.2	72.2
74.00	*	73.2	73.2	75.6	76.3	78.0	76.3	75.6	73.6	73.7
76.00	*	75.8	75.8	77.6	78.0	79.3	78.0	77.5	76.1	76.1
78.00	*	77.5	77.5	78.9	79.2	80.7	79.2	78.9	77.6	77.6
80.00	*	79.1	79.1	80.4	80.6	81.7	80.6	80.4	79.2	79.2

\*\*\*\*\*

M  
C

ENCIRCLED ENERGY

Task 2.1 - Nominal Cube-On Axis

\*\*\*\*\*

CIRCLE \*  
 -----+ PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 -----\*  
 (MI- \* CENTER (MICRONS):  
 (RENS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	*	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2
10.00	*	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.6	0.6
15.00	*	1.5	1.5	1.2	1.3	1.1	1.3	1.6	1.7	1.7
20.00	*	3.0	3.0	2.5	2.5	2.0	2.5	2.9	3.2	3.2
25.00	*	5.1	5.1	5.1	4.5	4.3	4.5	5.2	5.5	5.5
30.00	*	8.5	8.5	8.5	7.5	7.0	7.5	8.8	9.2	9.2
35.00	*	13.9	13.9	13.2	11.8	11.7	11.8	14.1	14.6	14.6
40.00	*	20.0	20.0	19.3	18.2	18.1	18.2	20.9	21.2	21.2
45.00	*	26.7	26.7	27.0	27.3	28.6	27.3	28.6	28.3	28.3
50.00	*	35.2	35.2	35.8	36.5	37.5	36.5	37.4	37.1	37.0
55.00	*	44.9	44.8	45.7	46.8	47.9	46.8	47.4	46.4	46.4
60.00	*	53.3	53.3	54.7	56.1	57.9	56.0	56.5	54.7	54.7
65.00	*	61.3	61.3	63.4	65.1	67.8	65.1	64.7	62.5	62.5
70.00	*	68.4	68.4	70.7	71.9	73.9	71.9	71.2	69.2	69.2
75.00	*	74.8	74.8	76.6	77.2	78.7	77.2	76.6	75.1	75.1
80.00	*	79.1	79.1	80.4	80.6	81.7	80.6	80.4	79.2	79.2
85.00	*	82.0	82.0	83.1	83.0	83.9	83.0	83.2	82.1	82.1
90.00	*	84.2	84.2	84.8	84.7	85.2	84.7	85.0	84.3	84.3
95.00	*	85.9	85.9	86.1	86.1	86.2	86.1	86.2	86.0	86.0
100.00	*	87.0	87.0	87.1	87.2	87.3	87.2	87.1	87.1	87.1
105.00	*	87.9	87.9	88.0	88.2	88.3	88.2	88.1	88.0	88.0
110.00	*	88.8	88.8	88.9	89.1	89.2	89.1	89.0	88.9	88.9
115.00	*	89.6	89.6	89.7	89.7	90.0	89.7	89.8	89.7	89.7
120.00	*	90.3	90.3	90.5	90.4	90.6	90.4	90.5	90.4	90.4
125.00	*	90.9	90.9	91.1	91.0	91.1	91.0	91.1	90.9	90.9
130.00	*	91.4	91.4	91.5	91.5	91.6	91.5	91.6	91.5	91.5
135.00	*	92.0	92.0	91.9	92.0	92.0	92.0	91.9	91.9	91.9
140.00	*	92.4	92.4	92.4	92.5	92.4	92.5	92.4	92.4	92.4
145.00	*	92.8	92.8	92.8	92.9	92.8	92.9	92.9	92.8	92.8
150.00	*	93.2	93.2	93.2	93.2	93.3	93.2	93.3	93.2	93.2
155.00	*	93.5	93.5	93.6	93.5	93.7	93.5	93.6	93.5	93.5
160.00	*	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9
165.00	*	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2
170.00	*	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5
175.00	*	94.8	94.8	94.8	94.8	94.7	94.8	94.8	94.8	94.8
180.00	*	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
184.99	*	95.4	95.4	95.3	95.4	95.4	95.4	95.4	95.4	95.4
189.99	*	95.6	95.6	95.6	95.7	95.7	95.7	95.7	95.6	95.6
194.99	*	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9
199.99	*	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.2	96.2

\*\*\*\*\*





FIGURE B2

B6

Wavefront Plot-Q Polarization  
Task 2.1 - Nominal Cube-On Axis

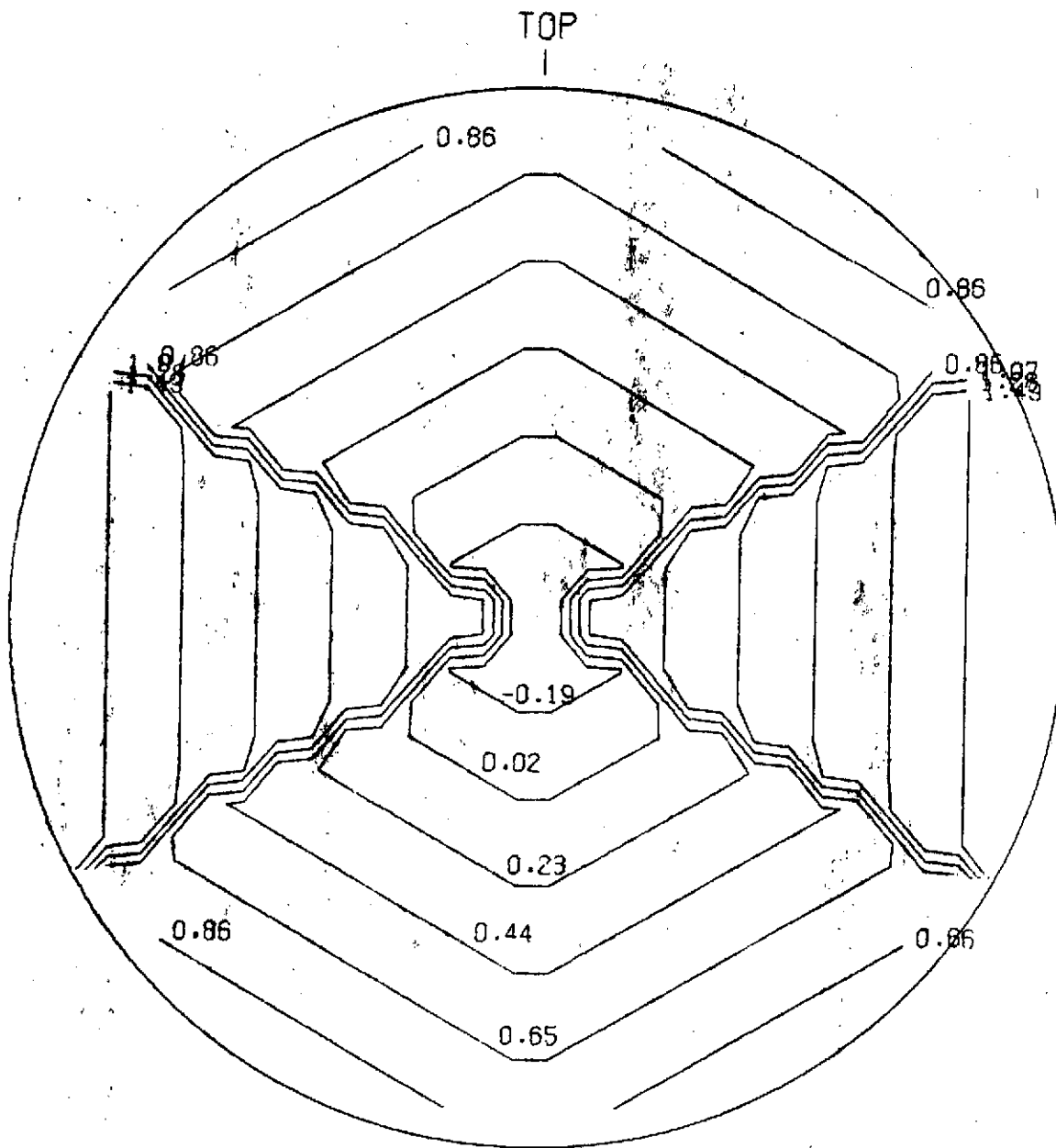
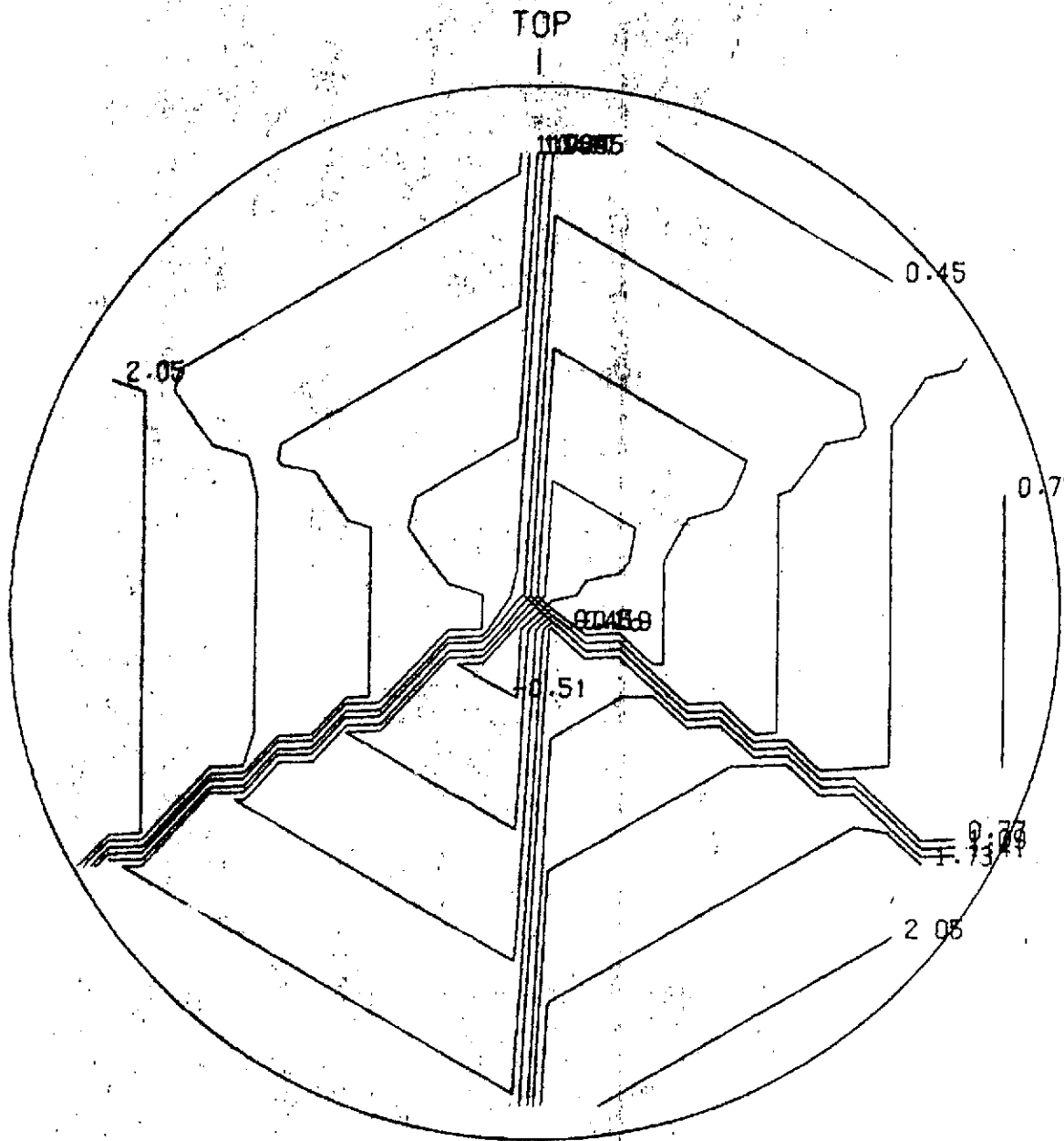




FIGURE B4

B8

Wavefront Plot-P Polarization  
Task 2.1 - Nominal Cube-On Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



FIGURE B6

B10

Intensity Distribution - Central 129 Microradians

Task 2.1 - Nominal Cube-On Axis

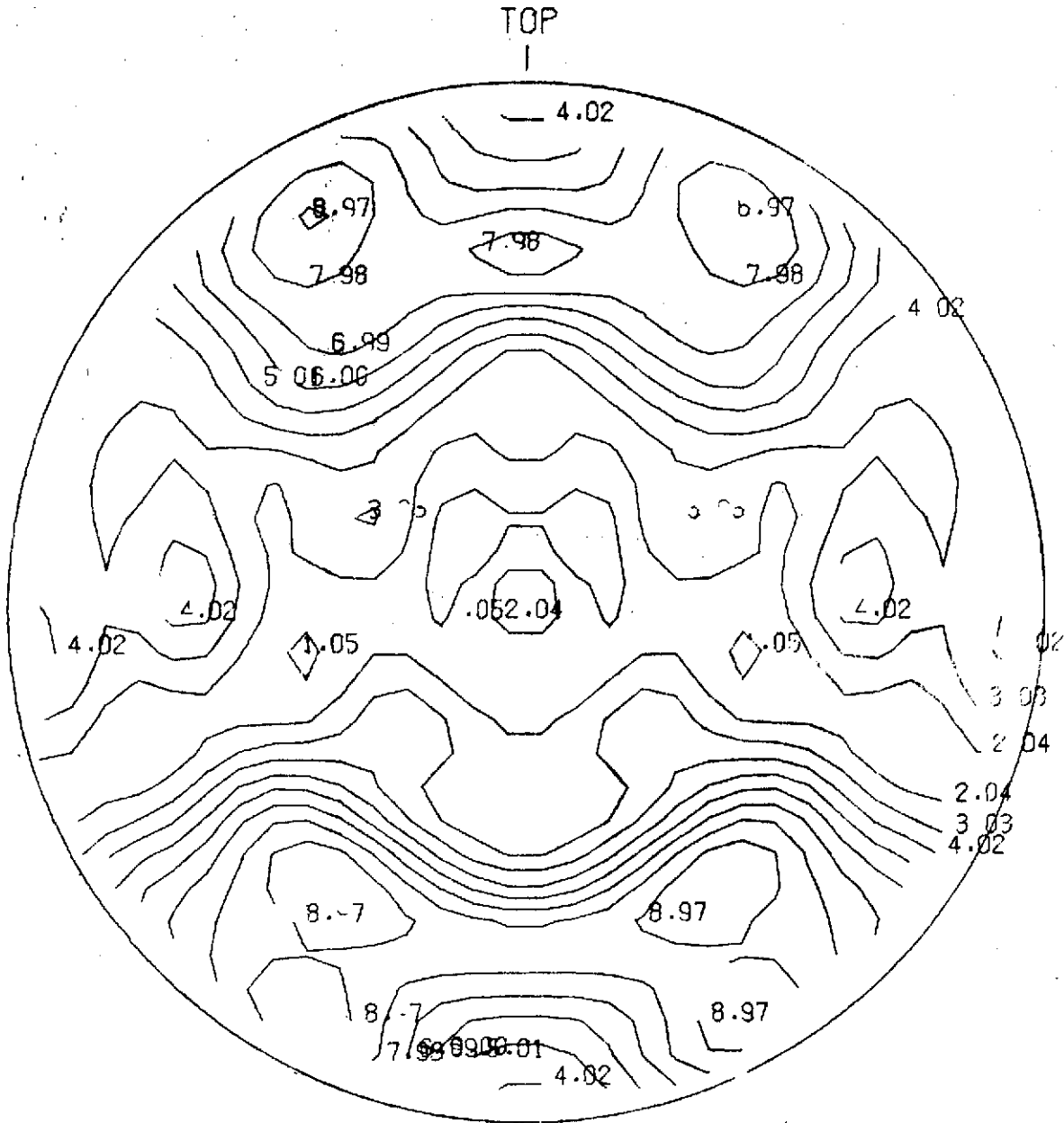
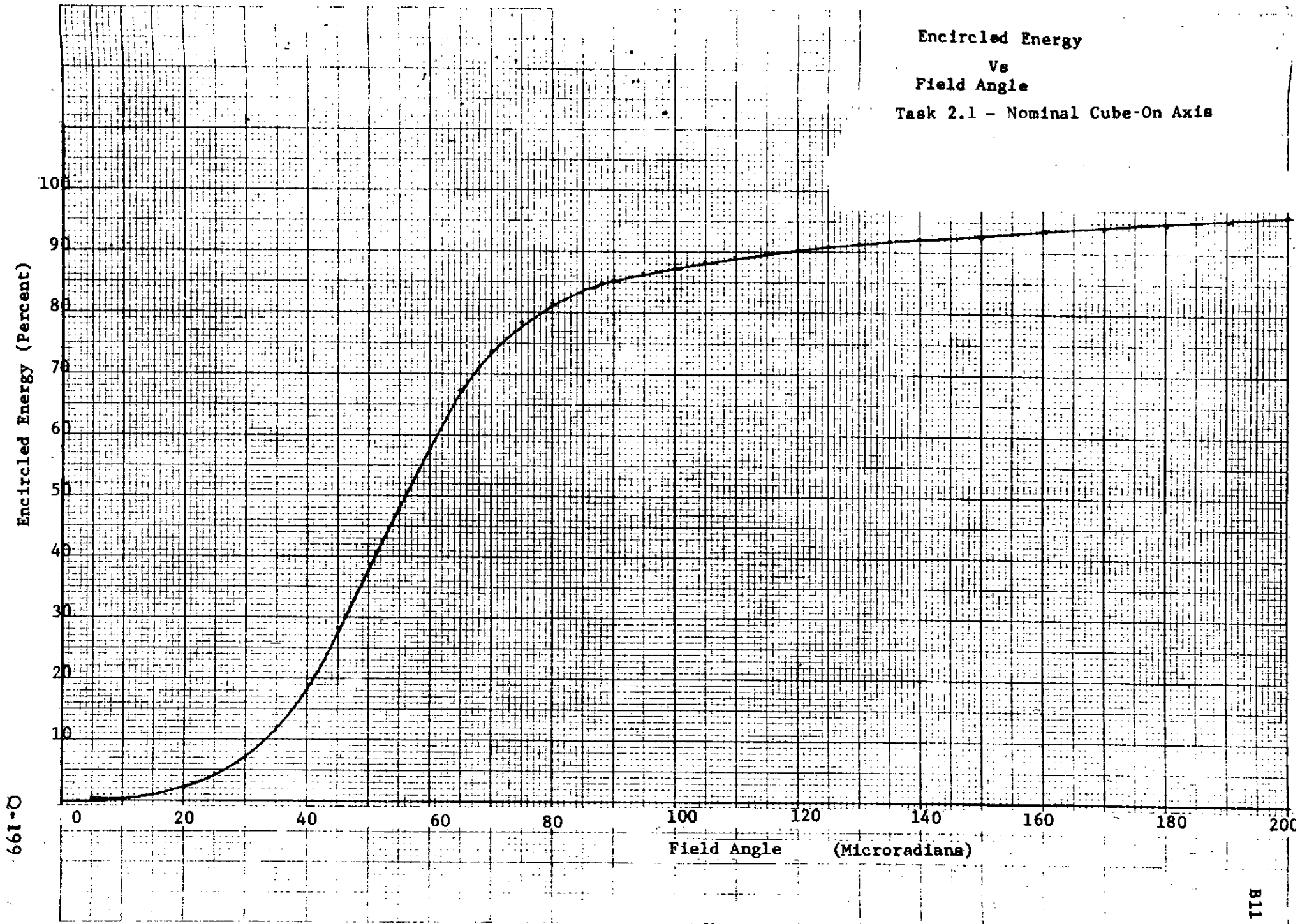


FIGURE B7

Encircled Energy  
Vs  
Field Angle  
Task 2.1 - Nominal Cube-On Axis



661-0

ENCIRCLED ENERGY

Task 2.1 - Nominal Cube -15° Off Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 GRNS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.2	0.2
6.00	*	0.1	0.1	0.1	0.1	0.4	0.1	0.2	0.2	0.2
8.00	*	0.4	0.4	0.3	0.3	0.4	0.3	0.3	0.6	0.6
10.00	*	0.6	0.6	0.4	0.5	0.7	0.5	0.5	0.8	0.8
12.00	*	1.4	1.4	0.7	0.9	0.8	0.9	0.9	1.7	1.7
14.00	*	1.4	1.4	1.1	1.5	1.0	1.5	1.5	1.7	1.7
16.00	*	2.5	2.5	1.6	2.1	1.2	2.0	2.0	2.9	2.9
18.00	*	2.9	2.9	2.3	2.8	2.1	2.8	2.8	3.4	3.4
20.00	*	3.9	3.9	3.1	3.6	2.1	3.6	3.9	4.5	4.5
22.00	*	4.4	4.4	4.3	4.6	3.8	4.6	5.2	5.1	5.1
24.00	*	5.7	5.7	5.0	5.2	5.0	5.2	5.9	6.5	6.5
26.00	*	6.3	6.3	6.6	6.6	7.2	6.6	7.5	7.4	7.4
28.00	*	8.1	8.1	8.3	8.2	8.0	8.2	9.4	9.2	9.2
30.00	*	9.5	9.5	9.8	9.7	10.4	9.7	10.8	10.8	10.8
32.00	*	12.3	12.3	11.3	11.3	11.9	11.3	12.4	13.4	13.4
34.00	*	12.9	12.9	13.4	13.7	13.6	13.7	14.6	14.1	14.1
36.00	*	16.2	16.2	15.5	15.9	16.0	15.9	16.7	17.2	17.2
38.00	*	18.0	18.0	17.7	18.2	18.4	18.2	18.8	19.2	19.2
40.00	*	21.0	21.0	20.3	20.8	20.0	20.8	21.6	22.1	22.1
42.00	*	22.6	22.6	23.5	23.9	23.1	23.9	24.8	23.8	23.8
44.00	*	25.9	25.9	25.4	25.6	25.8	25.6	27.0	27.3	27.3
46.00	*	28.5	28.4	29.0	29.3	29.9	29.3	30.8	30.3	30.3
48.00	*	31.3	31.3	32.3	32.5	31.5	32.5	34.7	33.3	33.3
50.00	*	34.3	34.3	34.9	35.2	36.2	35.2	37.2	36.7	36.7
52.00	*	37.5	37.5	37.8	38.3	39.6	38.3	40.6	40.2	40.2
54.00	*	39.5	39.5	41.0	41.9	43.4	41.9	43.9	42.3	42.3
56.00	*	43.2	43.2	44.7	45.8	47.0	45.8	47.9	46.0	46.0
58.00	*	46.3	46.3	47.3	48.5	50.9	48.5	50.2	49.2	49.2
60.00	*	49.5	49.5	51.0	52.3	54.1	52.3	53.8	52.1	52.1
62.00	*	52.0	52.0	54.2	55.8	57.2	55.8	56.8	54.5	54.5
64.00	*	56.2	56.2	56.8	58.3	60.2	58.3	59.3	58.2	58.2
66.00	*	58.9	58.9	60.5	61.9	63.4	61.9	62.5	60.8	60.8
68.00	*	61.9	62.0	63.4	64.3	64.9	64.3	65.0	63.5	63.5
70.00	*	64.5	64.5	66.1	67.0	67.9	67.0	67.5	65.9	65.9
72.00	*	67.3	67.3	68.4	69.0	70.8	69.0	69.4	68.5	68.4
74.00	*	68.9	68.9	71.1	71.5	73.0	71.5	72.0	70.0	70.0
76.00	*	71.5	71.5	73.3	73.5	75.1	73.5	73.9	72.4	72.4
78.00	*	73.5	73.5	74.6	75.1	77.1	75.1	75.3	74.2	74.2
80.00	*	75.1	75.1	76.6	77.0	78.7	77.0	77.1	75.7	75.7

\*\*\*\*\*



TABLE B5

ENCIRCLED ENERGY

Task 2.1 - Nominal Cube -15° Off Axis

\*\*\*\*\*

CIRCLE	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
RADIUS										
(41- CRONS)	CENTER (MICRONS):									
	X=	-10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13
	Y=	-10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13
5.00	*	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.2	0.2
10.00	*	0.6	0.6	0.4	0.5	0.7	0.5	0.5	0.8	0.8
15.00	*	2.1	2.1	1.4	1.8	1.2	1.8	1.8	2.4	2.4
20.00	*	3.9	3.9	3.1	3.6	2.1	3.6	3.9	4.5	4.5
25.00	*	6.1	6.1	6.3	6.4	5.6	6.4	7.3	7.1	7.1
30.00	*	9.5	9.5	9.8	9.7	10.4	9.7	10.8	10.8	10.8
35.00	*	14.9	14.9	14.2	14.4	15.3	14.4	15.2	15.9	15.9
40.00	*	21.0	21.0	20.3	20.8	20.0	20.8	21.6	22.1	22.1
45.00	*	27.1	27.1	27.6	28.0	27.6	28.0	29.3	28.7	28.7
50.00	*	34.3	34.3	34.9	35.2	36.2	35.2	37.2	36.7	36.7
55.00	*	41.9	41.9	42.7	43.6	46.2	43.6	45.6	44.7	44.7
60.00	*	49.5	49.5	51.0	52.3	54.1	52.3	53.8	52.1	52.1
65.00	*	57.3	57.3	59.1	60.5	61.7	60.5	61.4	59.3	59.3
70.00	*	64.5	64.5	66.1	67.0	67.9	67.0	67.5	65.9	65.9
75.00	*	70.6	70.6	71.9	72.4	74.2	72.4	72.8	71.5	71.4
80.00	*	75.1	75.1	76.6	77.0	78.7	77.0	77.1	75.7	75.7
85.00	*	78.7	78.7	80.1	80.7	81.8	80.7	80.5	79.2	79.2
90.00	*	81.7	81.7	82.5	82.9	83.6	82.9	82.6	81.9	81.9
95.00	*	83.9	83.9	84.3	84.4	84.7	84.4	84.2	83.9	83.9
100.00	*	85.4	85.4	85.5	85.5	85.5	85.5	85.4	85.2	85.2
105.00	*	86.3	86.3	86.3	86.4	86.4	86.4	86.3	86.2	86.2
110.00	*	87.2	87.2	87.2	87.3	87.3	87.3	87.2	87.2	87.2
115.00	*	88.0	88.0	88.1	88.1	88.2	88.1	88.2	88.1	88.1
120.00	*	88.8	88.8	89.0	88.9	89.1	88.9	89.1	88.9	88.9
125.00	*	89.5	89.5	89.7	89.7	89.9	89.7	89.8	89.6	89.6
130.00	*	90.2	90.2	90.3	90.4	90.6	90.4	90.4	90.2	90.2
135.00	*	90.8	90.8	90.8	91.0	91.0	91.0	90.9	90.9	90.9
140.00	*	91.3	91.3	91.4	91.5	91.4	91.5	91.5	91.5	91.5
145.00	*	91.8	91.8	91.7	91.9	91.8	91.9	92.0	91.9	91.9
150.00	*	92.2	92.2	92.2	92.3	92.3	92.3	92.3	92.3	92.3
155.00	*	92.6	92.6	92.7	92.7	92.7	92.7	92.6	92.7	92.7
160.00	*	93.1	93.1	93.1	93.0	93.1	93.0	93.0	93.0	93.0
165.00	*	93.5	93.5	93.6	93.5	93.4	93.5	93.4	93.4	93.4
170.00	*	93.9	93.9	93.9	93.9	93.9	93.9	93.8	93.8	93.8
175.00	*	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.1	94.1
180.00	*	94.5	94.5	94.5	94.5	94.6	94.5	94.5	94.5	94.5
184.99	*	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8
189.99	*	95.1	95.1	95.1	95.1	95.2	95.1	95.2	95.1	95.1
194.99	*	95.3	95.3	95.4	95.4	95.4	95.4	95.4	95.4	95.4
199.99	*	95.6	95.7	95.7	95.7	95.7	95.7	95.7	95.6	95.6

\*\*\*\*\*



400

Q POLARI

AVERAGE

AVERAGE

1

NONE

RMS

0.28

PK-PK

1.20

FRED

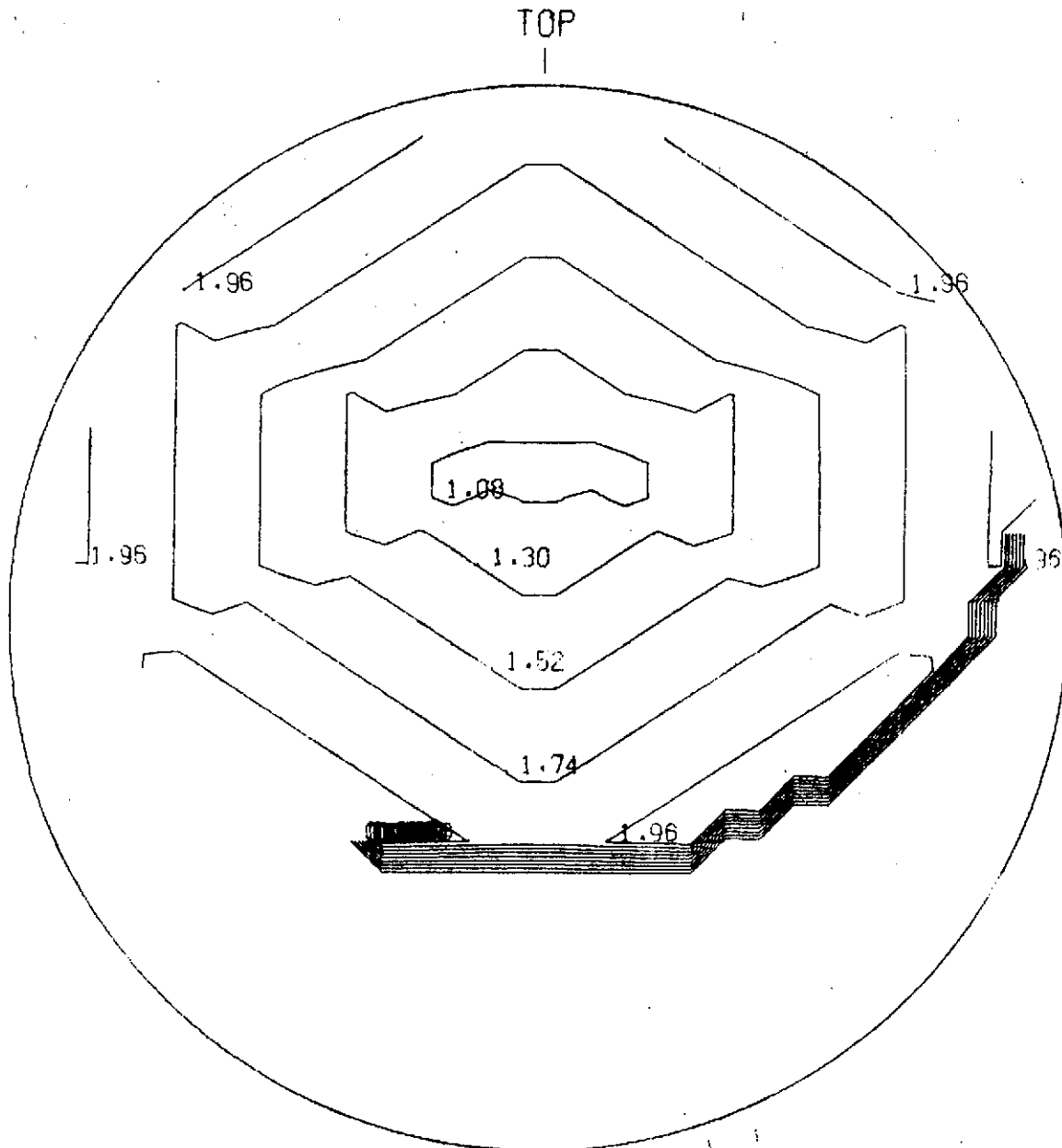
WAVEFRONT

FIGURE B9

B15

Wavefront Plot-Q Polarization

Task 2.1 - Nominal Cube -15° Off Axis





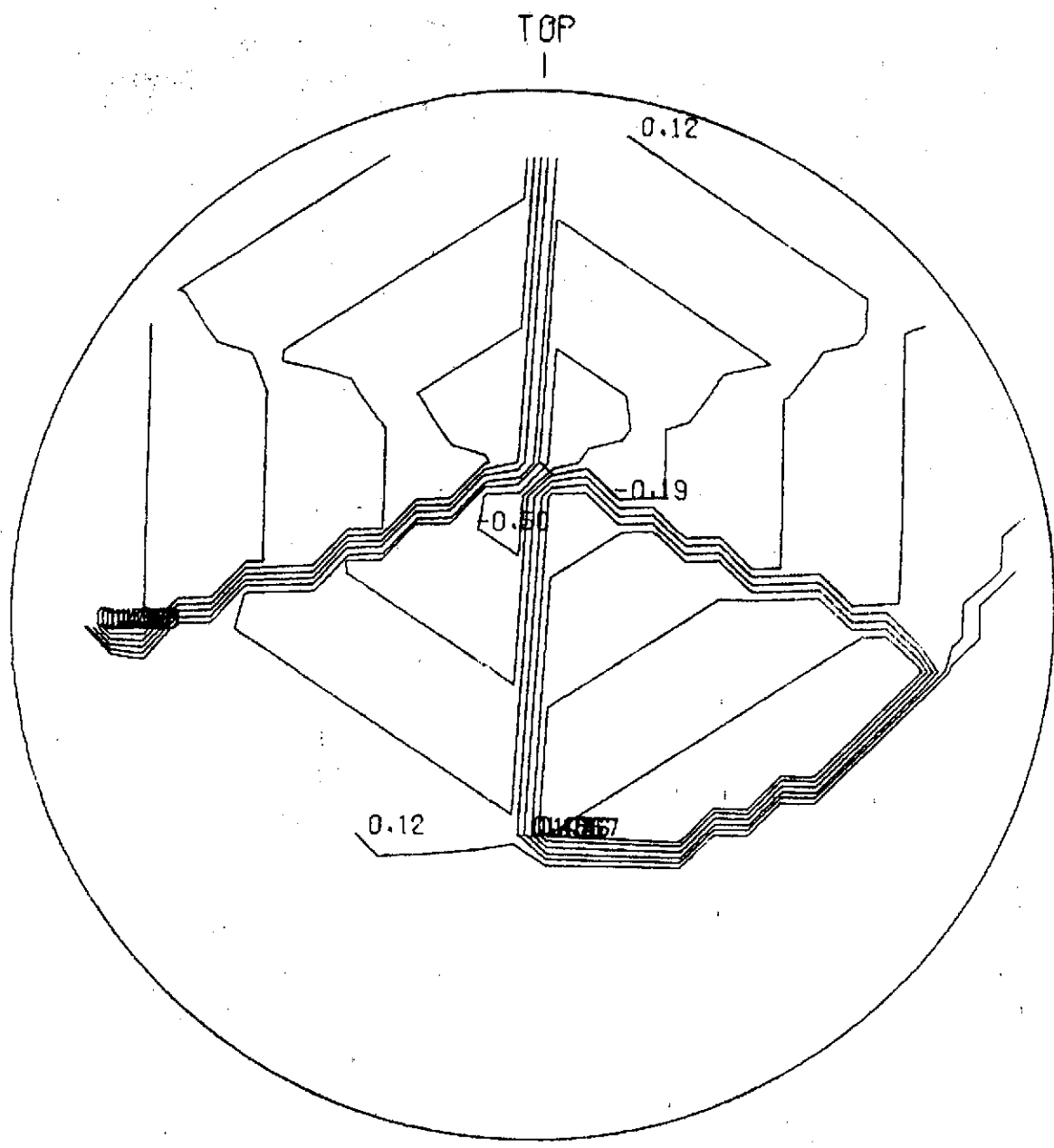
ADD	P POLARI	AVERAGE	AVERAGE	PLOT NUMBER 4	
1					
NONE		RMS 0.81	PK-PK 3.01	FRED	WAVEFRONT

FIGURE B11

B17

Wavefront Plot-P Polarization

Task 2.1 - Nominal Cube -15° Off Axis





10  
10  
NONE

RMS 2.08

PK-PK

9.66

FRED

WAVEFRONT

PLUT NUMBER 6

FIGURE B13

B19

Intensity Distribution - Central 129 Microradians

Task 2.1 - Nominal Cube -15° Off Axis

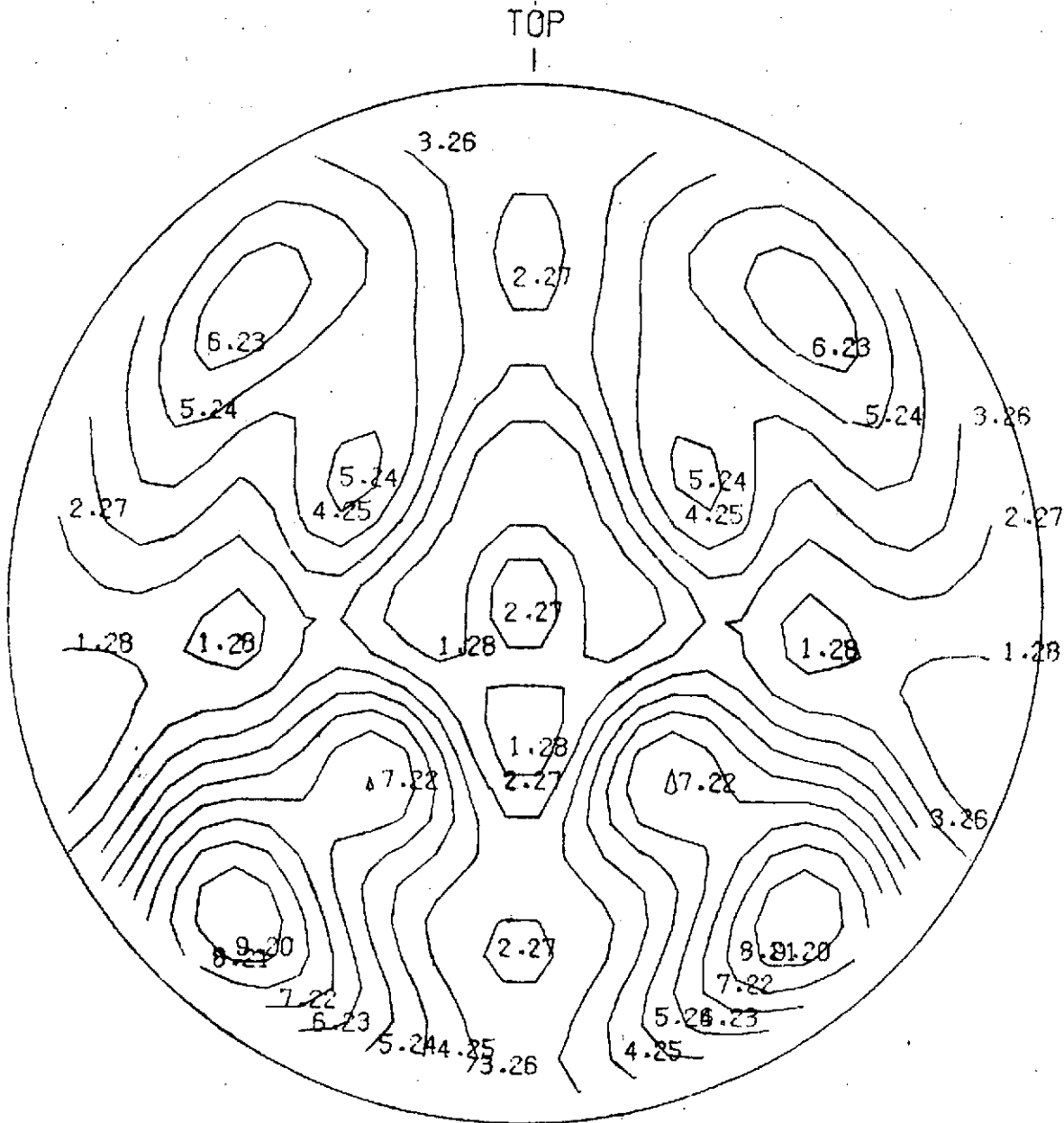
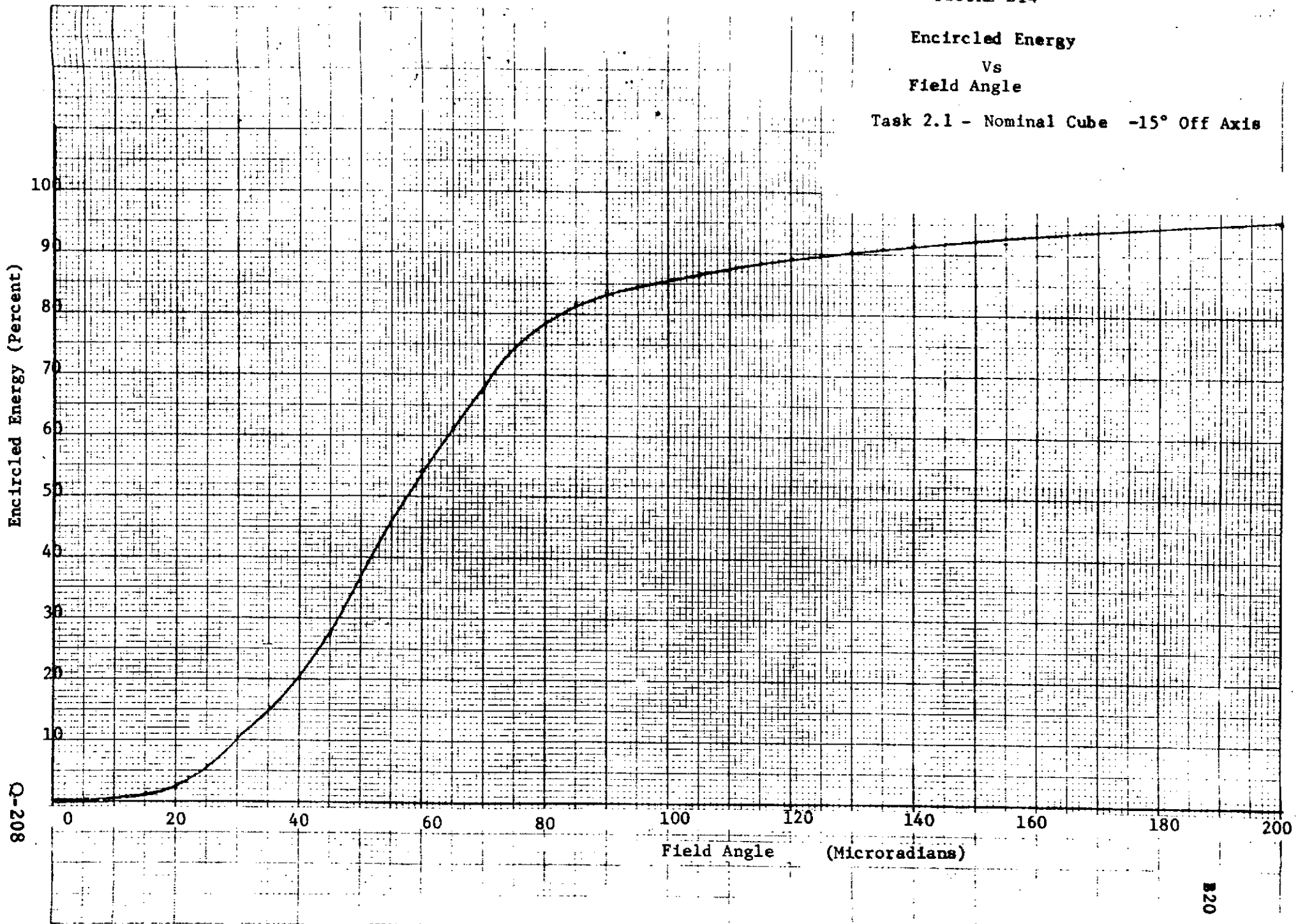


FIGURE B14

Encircled Energy  
Vs  
Field Angle

Task 2.1 - Nominal Cube -15° Off Axis



Q-208



ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error - On Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CIRCNS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.1
6.00	*	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.0	0.1
8.00	*	0.3	0.2	0.1	0.4	0.2	0.3	0.2	0.2	0.3
10.00	*	0.5	0.3	0.2	0.5	0.4	0.4	0.3	0.3	0.4
12.00	*	0.9	0.7	0.4	0.7	0.5	0.6	0.5	0.7	0.8
14.00	*	0.9	0.7	0.8	0.9	0.7	0.9	0.8	0.7	0.8
16.00	*	1.5	1.3	1.1	1.1	0.9	1.1	1.1	1.2	1.2
18.00	*	1.7	1.5	1.5	1.3	1.5	1.3	1.5	1.5	1.5
20.00	*	2.3	2.2	2.2	1.7	1.5	1.8	2.2	2.3	2.2
22.00	*	2.7	2.5	2.9	2.2	2.2	2.1	2.7	2.6	2.5
24.00	*	3.7	3.7	3.6	2.7	2.6	2.7	3.4	3.8	3.7
26.00	*	4.3	4.2	4.4	3.4	3.4	3.4	4.3	4.5	4.4
28.00	*	6.0	6.2	5.9	4.5	3.7	4.5	6.0	6.4	6.2
30.00	*	7.0	7.2	6.8	5.7	5.2	5.7	7.0	7.6	7.3
32.00	*	9.2	9.7	8.4	6.8	6.0	6.8	8.8	10.2	9.6
34.00	*	9.7	10.3	9.9	9.0	8.1	8.9	10.6	10.8	10.2
36.00	*	12.2	13.1	11.8	10.5	9.9	10.4	12.9	13.8	12.9
38.00	*	13.6	14.5	13.8	12.9	13.3	12.9	14.9	15.5	14.4
40.00	*	16.2	17.4	16.2	15.0	14.9	14.9	17.6	18.6	17.2
42.00	*	17.4	18.6	19.0	18.4	19.3	18.4	20.4	20.0	18.6
44.00	*	20.8	22.1	21.5	20.5	21.4	20.4	23.0	23.7	22.2
46.00	*	23.3	24.5	24.6	24.8	26.1	24.7	26.1	26.2	24.7
48.00	*	27.0	28.1	28.6	28.4	27.5	28.1	30.1	30.0	28.4
50.00	*	30.1	31.0	31.0	31.6	32.3	31.4	32.6	33.1	31.6
52.00	*	34.2	34.9	34.8	35.2	35.0	34.9	36.4	37.0	35.6
54.00	*	36.4	37.2	37.8	39.1	39.8	38.8	39.6	39.2	37.8
56.00	*	40.7	41.2	42.3	42.9	42.9	42.7	44.0	43.0	41.9
58.00	*	43.8	44.3	45.0	45.9	48.0	45.7	46.8	46.0	45.0
60.00	*	47.2	47.7	48.9	49.6	51.5	49.4	50.5	49.2	48.5
62.00	*	49.7	50.0	52.2	53.6	55.6	53.4	53.7	51.3	50.9
64.00	*	54.0	54.1	55.1	56.2	58.7	56.1	56.4	55.1	55.1
66.00	*	56.5	56.6	58.5	60.2	62.4	60.1	59.5	57.5	57.5
68.00	*	60.3	60.1	61.5	62.6	64.1	62.6	62.1	60.8	61.1
70.00	*	62.5	62.2	64.2	65.6	67.0	65.6	64.6	62.8	63.2
72.00	*	65.9	65.4	66.6	67.7	69.4	67.7	66.8	65.7	66.3
74.00	*	67.6	67.0	69.2	70.0	71.4	70.1	69.2	67.2	67.9
76.00	*	70.4	69.6	71.5	71.8	73.0	71.9	71.4	69.8	70.5
78.00	*	72.2	71.3	72.8	73.2	74.8	73.3	72.8	71.4	72.2
80.00	*	74.1	73.1	74.7	74.8	76.0	74.9	74.7	73.1	74.1

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error - On Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \*  
 CIRCNS) \* CENTER (MICRONS):  
 \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	*	0.1	0.1	0.0	0.2	0.1	0.2	0.1	0.0	0.1
10.00	*	0.5	0.3	0.2	0.5	0.4	0.4	0.3	0.3	0.4
15.00	*	1.2	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0
20.00	*	2.3	2.2	2.2	1.7	1.5	1.8	2.2	2.3	2.2
25.00	*	4.1	4.1	4.1	3.3	2.9	3.2	4.0	4.3	4.1
30.00	*	7.0	7.2	6.8	5.7	5.2	5.7	7.0	7.6	7.3
35.00	*	11.1	12.0	10.8	9.3	9.4	9.3	11.6	12.6	11.8
40.00	*	16.2	17.4	16.2	15.0	14.9	14.9	17.6	18.6	17.2
45.00	*	22.2	23.4	23.1	23.4	24.2	23.2	24.6	25.1	23.5
50.00	*	30.1	31.0	31.0	31.6	32.3	31.4	32.6	33.1	31.6
55.00	*	39.2	39.8	40.3	40.9	42.1	40.6	42.0	41.6	40.5
60.00	*	47.2	47.7	48.9	49.6	51.5	49.4	50.5	49.2	48.5
65.00	*	55.2	55.2	57.2	58.7	60.9	58.5	58.3	56.2	56.2
70.00	*	62.5	62.2	64.2	65.6	67.0	65.6	64.6	62.8	63.2
75.00	*	69.2	68.5	70.4	71.0	72.3	71.0	70.4	68.7	69.4
80.00	*	74.1	73.1	74.7	74.8	76.0	74.9	74.7	73.1	74.1
85.00	*	77.6	76.5	78.0	78.2	78.9	78.3	78.2	76.6	77.7
90.00	*	80.3	79.4	80.4	80.8	81.0	80.8	80.6	79.6	80.5
95.00	*	82.6	82.1	82.5	82.8	82.9	82.8	82.6	82.2	82.7
100.00	*	84.3	84.0	84.3	84.5	84.7	84.6	84.4	84.1	84.4
105.00	*	85.6	85.7	85.9	86.1	86.4	86.2	86.1	85.7	85.8
110.00	*	87.0	87.2	87.4	87.4	87.8	87.5	87.4	87.3	87.1
115.00	*	88.2	88.6	88.6	88.5	88.9	88.6	88.6	88.5	88.3
120.00	*	89.3	89.6	89.6	89.5	89.8	89.6	89.6	89.5	89.3
125.00	*	90.1	90.4	90.5	90.4	90.6	90.4	90.5	90.4	90.1
130.00	*	90.9	91.1	91.1	91.1	91.2	91.1	91.1	91.1	90.9
135.00	*	91.7	91.6	91.7	91.7	91.8	91.6	91.6	91.6	91.6
140.00	*	92.2	92.2	92.2	92.3	92.2	92.3	92.2	92.1	92.1
145.00	*	92.6	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.6
150.00	*	93.0	93.1	93.1	93.2	93.2	93.2	93.1	93.1	93.0
155.00	*	93.4	93.5	93.5	93.5	93.6	93.5	93.5	93.5	93.4
160.00	*	93.8	93.8	93.9	93.8	93.9	93.8	93.9	93.9	93.8
165.00	*	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2
170.00	*	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.4	94.5
175.00	*	94.8	94.8	94.8	94.8	94.7	94.8	94.8	94.7	94.8
180.00	*	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
184.99	*	95.3	95.4	95.3	95.4	95.4	95.4	95.4	95.4	95.4
189.99	*	95.6	95.6	95.6	95.7	95.7	95.7	95.7	95.6	95.6
194.99	*	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9
199.99	*	96.1	96.1	96.1	96.2	96.1	96.2	96.1	96.2	96.2

\*\*\*\*\*



CC R CLAS AV. AGE AVERAGE V. AGE

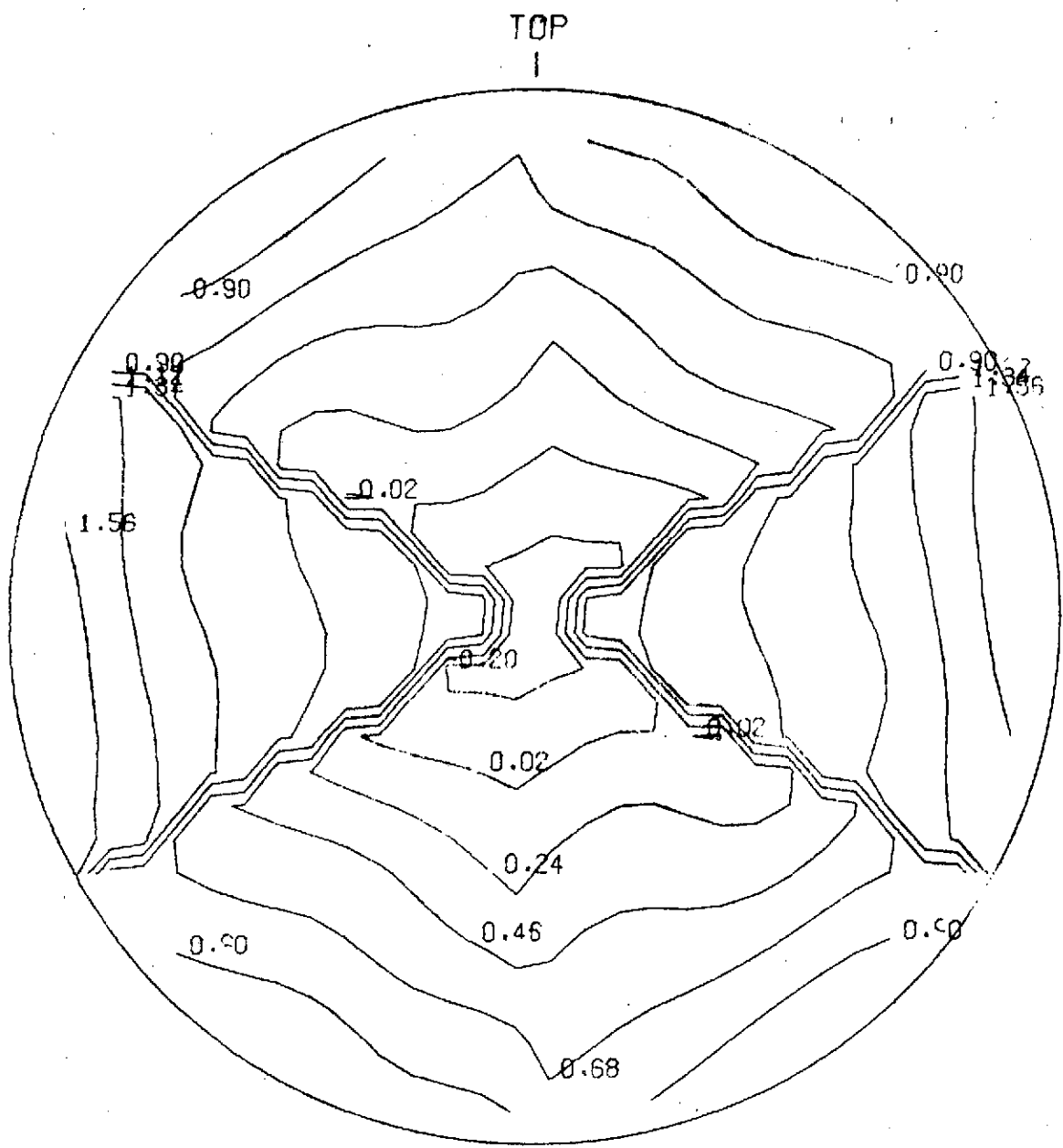
VON 15 0.7 PK-PK 2.14 RED WAV CNT

B24

FIGURE B16

Wavefront Plot-Q Polarization

Task 2.2 - Nominal + Mfg. Error - On Axis





DC	P POLARI	AV. AGE	VE AGE	V. AGE	
ION	0.5	0.82	PK-PK	0.2	RED 1 AV FRONT

B26

FIGURE B18

Wavefront Plot-P Polarization

Task 2.2 - Nominal + Mfg. Error - On Axis

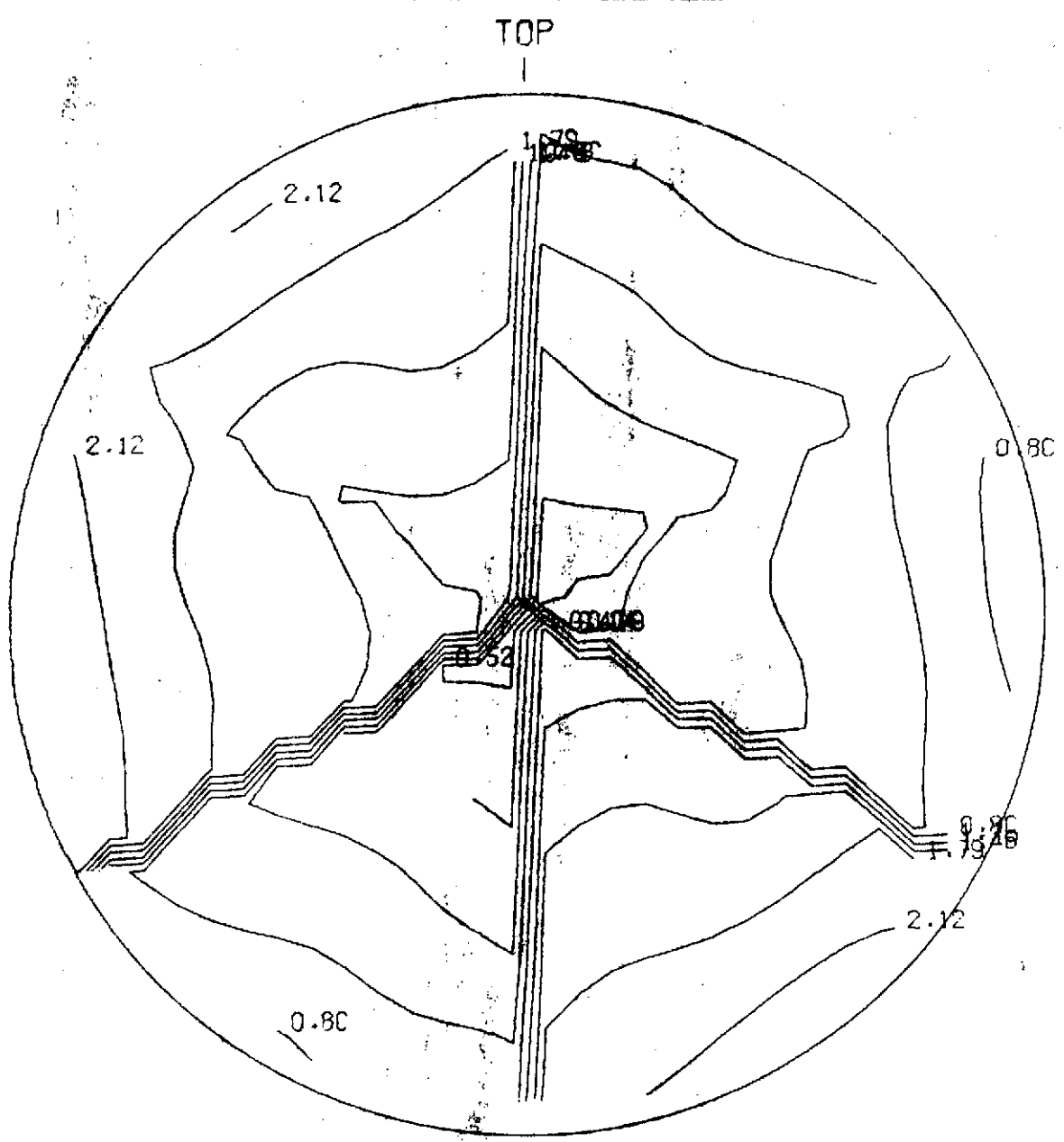




FIGURE B20

B28

Intensity Distribution - Central 129 Microradians

Task 2.2 - Nominal + Mfg. Error - On Axis

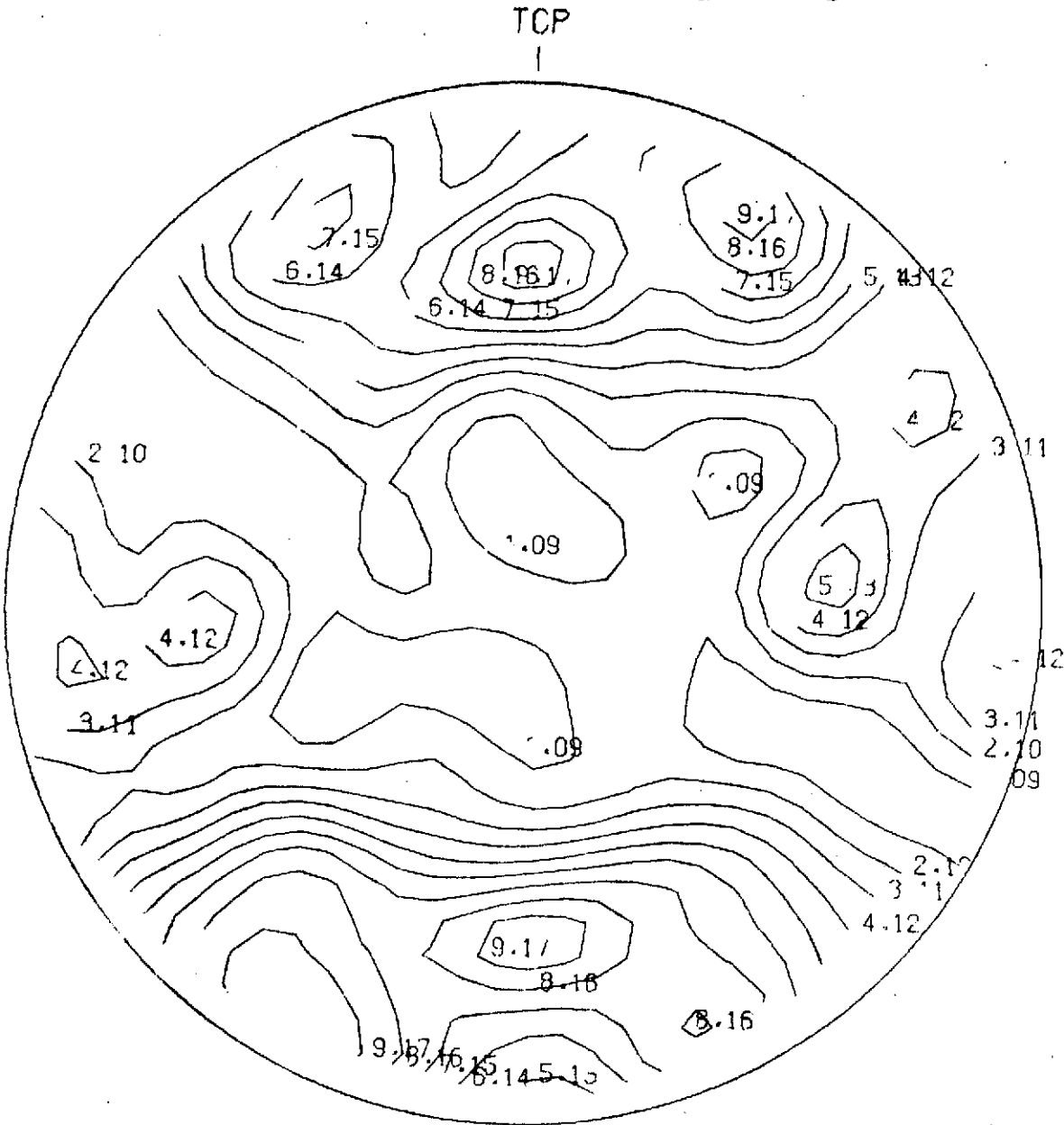


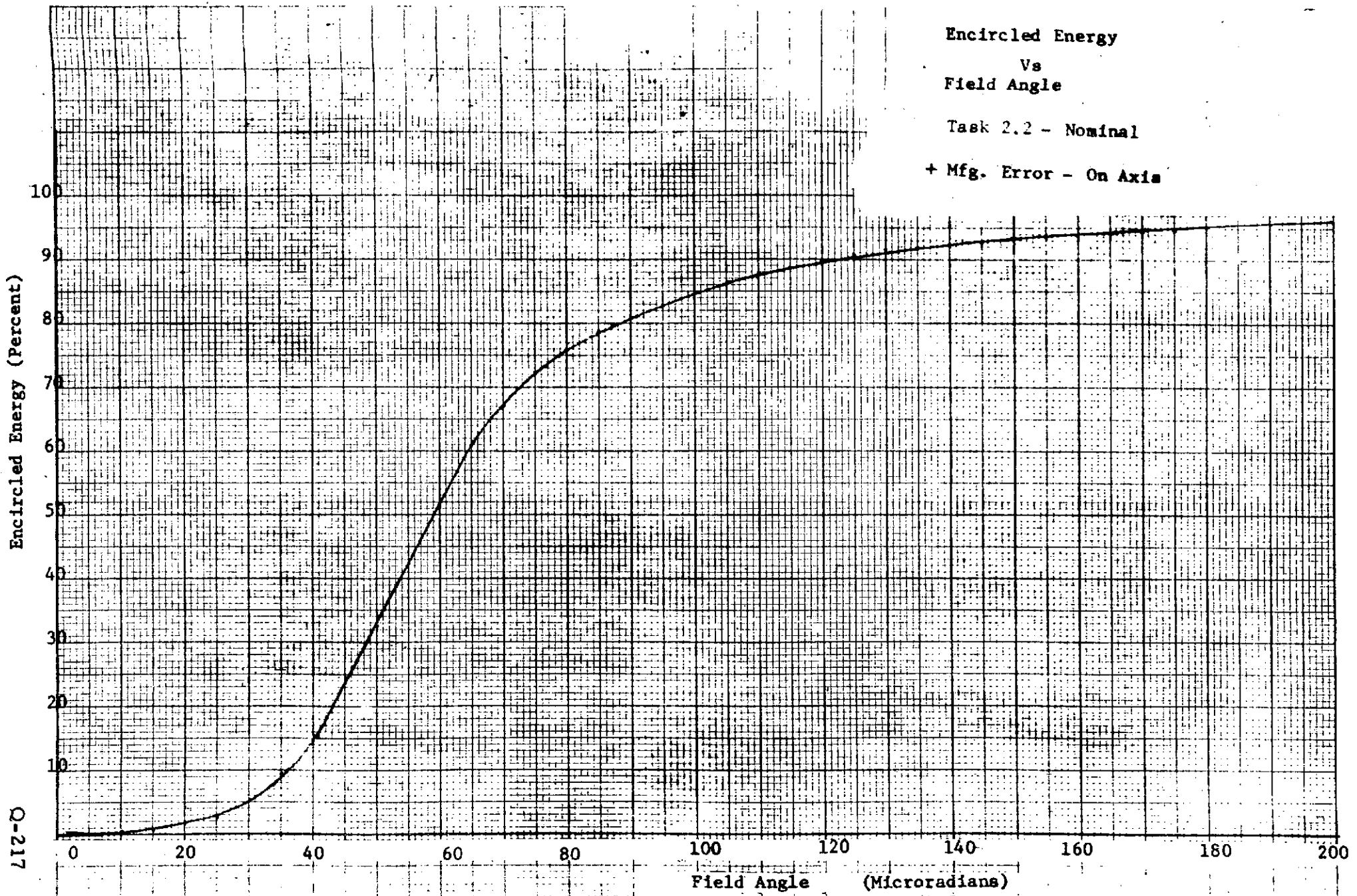


FIGURE B21

Encircled Energy  
Vs  
Field Angle

Task 2.2 - Nominal

+ Mfg. Error - On Axis



Q-217

ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error -15° Off Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \*  
 CENTERS) \*  
 \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

CIRCLE RADIUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
6.00	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.1	0.1	0.1
8.00	0.3	0.4	0.2	0.4	0.3	0.3	0.2	0.5	0.5	0.5
10.00	0.5	0.6	0.2	0.5	0.5	0.5	0.3	0.7	0.7	0.7
12.00	1.2	1.3	0.4	1.0	0.5	1.0	0.5	1.5	1.5	1.5
14.00	1.2	1.3	0.8	1.5	0.7	1.5	1.1	1.5	1.5	1.5
16.00	2.1	2.3	1.1	2.1	1.0	2.1	1.4	2.7	2.5	2.5
18.00	2.6	2.7	1.7	2.7	1.9	2.7	2.2	3.2	3.0	3.0
20.00	3.4	3.6	2.4	3.5	1.9	3.5	2.9	4.2	4.0	4.0
22.00	3.8	4.0	3.6	4.4	3.5	4.4	4.2	4.8	4.5	4.5
24.00	5.0	5.1	4.1	5.0	4.5	4.9	4.8	6.1	5.8	5.8
26.00	5.7	5.8	5.7	6.2	6.5	6.1	6.5	6.9	6.6	6.6
28.00	7.3	7.3	7.3	7.7	7.2	7.6	8.2	8.6	8.3	8.3
30.00	8.6	8.7	8.8	9.1	9.4	8.9	9.8	10.0	9.7	9.7
32.00	11.2	11.2	10.0	10.7	10.8	10.5	11.1	12.5	12.3	12.3
34.00	11.8	11.8	12.1	12.9	12.2	12.6	13.4	13.1	12.9	12.9
36.00	14.9	14.8	13.8	15.1	14.6	14.9	15.1	16.0	15.9	15.9
38.00	16.7	16.6	15.9	17.2	16.9	17.0	17.2	17.9	17.7	17.7
40.00	19.5	19.4	18.2	19.9	18.5	19.7	19.6	20.7	20.4	20.4
42.00	21.0	20.9	21.3	22.8	21.4	22.7	22.7	22.3	22.0	22.0
44.00	24.1	24.1	22.9	24.4	24.2	24.3	24.5	25.5	25.2	25.2
46.00	26.6	26.5	26.8	27.7	28.1	27.6	28.4	28.4	28.1	28.1
48.00	29.2	29.2	29.8	30.8	29.7	30.7	31.9	31.2	30.8	30.8
50.00	32.2	32.1	32.6	33.2	34.0	33.0	34.4	34.5	34.2	34.2
52.00	35.2	35.2	35.3	36.1	37.3	35.9	37.7	37.8	37.4	37.4
54.00	37.2	37.1	38.8	39.4	40.6	39.1	41.1	39.8	39.6	39.6
56.00	40.7	40.6	42.2	43.3	44.1	43.0	44.9	43.3	43.1	43.1
58.00	43.8	43.7	44.6	45.8	47.6	45.5	47.1	46.5	46.4	46.4
60.00	46.8	46.7	48.0	49.5	50.8	49.3	50.8	49.2	49.3	49.3
62.00	49.3	49.1	51.3	52.7	53.6	52.6	53.8	51.6	51.8	51.8
64.00	53.4	53.1	53.5	55.1	56.7	55.1	56.4	55.1	55.6	55.6
66.00	56.1	55.9	57.3	58.4	60.0	58.6	59.7	57.8	58.3	58.3
68.00	59.0	58.7	60.0	61.0	61.5	61.3	62.1	60.4	61.0	61.0
70.00	61.7	61.4	63.0	63.5	64.8	63.9	64.7	62.8	63.5	63.5
72.00	64.5	64.3	65.2	65.6	67.8	66.0	66.8	65.3	66.0	66.0
74.00	66.1	65.9	68.2	68.3	70.2	68.7	69.3	67.0	67.7	67.7
76.00	68.9	68.8	70.7	70.5	72.4	71.0	71.3	69.5	70.0	70.0
78.00	71.0	71.0	72.2	72.1	74.5	72.5	72.9	71.4	71.9	71.9
80.00	72.8	72.8	74.5	74.4	76.3	74.6	74.8	73.1	73.6	73.6

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.2 - Nominal + Mfg. Error -15° Off Axis

\*\*\*\*\*

CIRCLE \*

RADIUS \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

(MT- CENTER (MICRONS):

CPDYS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

5.00	*	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
10.00	*	0.5	0.6	0.2	0.5	0.5	0.5	0.3	0.7	0.7
15.00	*	1.7	1.9	0.9	1.8	1.0	1.9	1.2	2.2	2.1
20.00	*	3.4	3.6	2.4	3.5	1.9	3.5	2.9	4.2	4.0
25.00	*	5.4	5.5	5.5	5.9	5.1	5.9	6.3	6.6	6.3
30.00	*	8.6	8.7	8.8	9.1	9.4	8.9	9.8	10.0	9.7
35.00	*	13.7	13.7	12.6	13.6	13.9	13.4	13.7	14.8	14.6
40.00	*	19.5	19.4	18.2	19.9	18.5	19.7	19.6	20.7	20.4
45.00	*	25.3	25.2	25.5	26.4	25.7	26.3	26.9	26.8	26.6
50.00	*	32.2	32.1	32.6	33.2	34.0	33.0	34.4	34.5	34.2
55.00	*	39.5	39.4	40.1	41.0	43.3	40.8	42.6	42.0	41.8
60.00	*	46.8	46.7	48.0	49.5	50.8	49.3	50.8	49.2	49.3
65.00	*	54.4	54.2	56.0	57.3	58.1	57.3	58.5	56.2	56.7
70.00	*	61.7	61.4	63.0	63.5	64.8	63.9	64.7	62.8	63.5
75.00	*	67.9	67.8	69.1	69.2	71.5	69.7	70.2	68.5	69.1
80.00	*	72.8	72.8	74.5	74.4	76.3	74.6	74.8	73.1	73.6
85.00	*	76.8	76.9	78.7	78.6	79.8	78.6	78.8	77.1	77.3
90.00	*	80.3	80.3	81.3	81.3	82.3	81.3	81.4	80.4	80.5
95.00	*	82.8	82.9	83.3	83.3	83.9	83.3	83.4	82.9	82.8
100.00	*	84.5	84.6	84.9	84.9	85.1	84.9	84.8	84.6	84.5
105.00	*	85.8	85.9	86.1	86.1	86.2	86.1	86.0	85.9	85.7
110.00	*	86.9	87.0	87.1	87.1	87.2	87.1	87.1	87.0	86.9
115.00	*	87.9	88.0	88.0	88.0	88.2	88.1	88.1	88.0	88.0
120.00	*	88.8	88.9	88.9	88.9	89.1	89.0	89.0	88.9	88.9
125.00	*	89.6	89.6	89.7	89.7	90.0	89.8	89.8	89.6	89.6
130.00	*	90.3	90.3	90.4	90.5	90.6	90.5	90.4	90.3	90.3
135.00	*	90.9	90.9	90.9	91.0	91.1	91.0	91.1	91.0	91.0
140.00	*	91.4	91.4	91.4	91.5	91.5	91.5	91.6	91.5	91.5
145.00	*	91.8	91.8	91.8	91.9	91.9	91.9	92.0	91.9	91.9
150.00	*	92.3	92.2	92.3	92.4	92.3	92.3	92.4	92.3	92.3
155.00	*	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
160.00	*	93.1	93.1	93.1	93.1	93.1	93.1	93.0	93.1	93.1
165.00	*	93.5	93.5	93.6	93.5	93.5	93.5	93.5	93.4	93.4
170.00	*	93.8	93.8	93.9	93.9	93.9	93.9	93.8	93.8	93.8
175.00	*	94.2	94.2	94.2	94.2	94.3	94.2	94.2	94.1	94.2
180.00	*	94.5	94.5	94.5	94.6	94.6	94.6	94.6	94.5	94.5
184.99	*	94.8	94.8	94.7	94.8	94.8	94.8	94.8	94.9	94.9
189.99	*	95.1	95.1	95.1	95.1	95.2	95.1	95.2	95.1	95.2
194.99	*	95.3	95.3	95.4	95.4	95.4	95.4	95.4	95.4	95.4
199.99	*	95.6	95.7	95.7	95.6	95.7	95.7	95.7	95.7	95.6

\*\*\*\*\*

FIGURE B22

Wavefront Map-0. Polarization  
Task 2.2 - Nominal + Mfg. Error -15° Off Axis

B32

MAP IN UNITS OF 0.01 WAVES

174 166 172 177

210 199 187 176 167 159 165 171 176 182 189 195

220 212 202 192 181 170 161 154 160 166 172 178 185 191 198 204

215 209 202 193 183 173 163 154 148 153 159 166 172 179 186 193 200 207

208 206 203 198 191 183 174 164 155 147 141 146 152 159 165 172 179 186 193 200 207 214

197 196 194 191 187 181 174 165 156 148 140 134 139 144 151 157 164 171 177 184 191 199 206 213

187 185 184 182 178 172 165 158 149 141 133 127 131 137 143 149 155 162 168 175 182 190 197 205

179 172 165 176 174 170 165 159 151 143 135 128 121 124 130 135 141 147 153 160 167 174 181 173 183 193

189 182 176 169 162 154 163 158 152 145 138 130 123 116 118 123 128 133 139 145 152 158 151 162 172 182 192 201

192 186 179 172 165 156 148 138 129 140 132 125 118 110 112 116 121 126 131 120 131 142 152 163 173 182 191 199

201 194 188 182 174 166 158 148 139 129 119 110 119 112 104 105 109 113 103 113 123 133 144 155 165 174 183 191 198 206

203 196 190 183 175 167 157 147 137 127 117 107 98 89 98 98 97 106 116 126 136 146 157 166 175 183 190 197 204

205 198 191 183 175 166 156 145 135 124 114 104 95 105 101 101 108 100 109 118 128 138 148 158 167 175 182 189 196 202

199 191 183 174 164 154 143 132 122 111 122 117 112 108 107 114 122 129 120 129 139 148 157 166 174 181 187 193

200 191 182 173 162 152 141 130 141 135 129 124 119 114 113 120 127 135 142 149 138 147 155 164 171 178 184 191

193 183 172 162 169 162 155 149 142 137 131 126 121 118 125 132 140 148 155 161 166 170 160 167 174 181

194 184 192 185 178 171 164 157 151 144 139 133 128 124 130 138 146 154 161 168 173 177 179 181 171 178

208 201 194 186 179 173 166 159 153 146 140 135 130 136 144 152 161 169 176 182 186 188 190 191

210 202 195 188 181 174 168 161 154 148 142 137 143 151 160 169 178 185 192 196 199 201

210 203 196 189 182 175 169 162 156 149 144 150 159 168 178 187 196 203 208 212

209 202 195 189 182 175 169 162 156 151 157 166 176 187 197 207 214 220

199 193 186 180 174 168 162 156 164 173 184 195 206 216

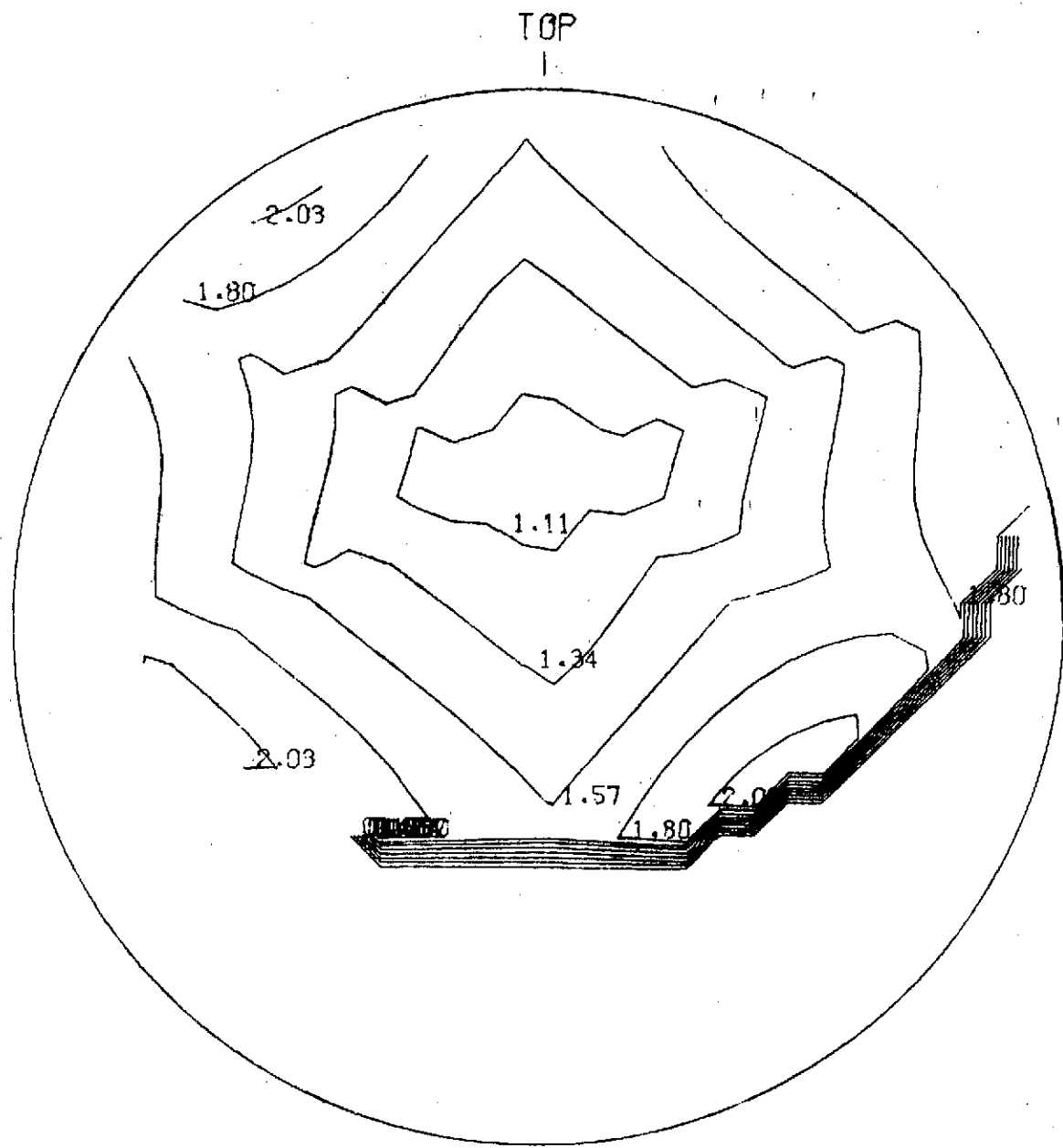
190 184 179 173 168 162 169 179 190 202

FIGURE B23

B33

Wavefront Plot-Q Polarization

Task 2.2 - Nominal + Mfg. Error -15° Off Axis





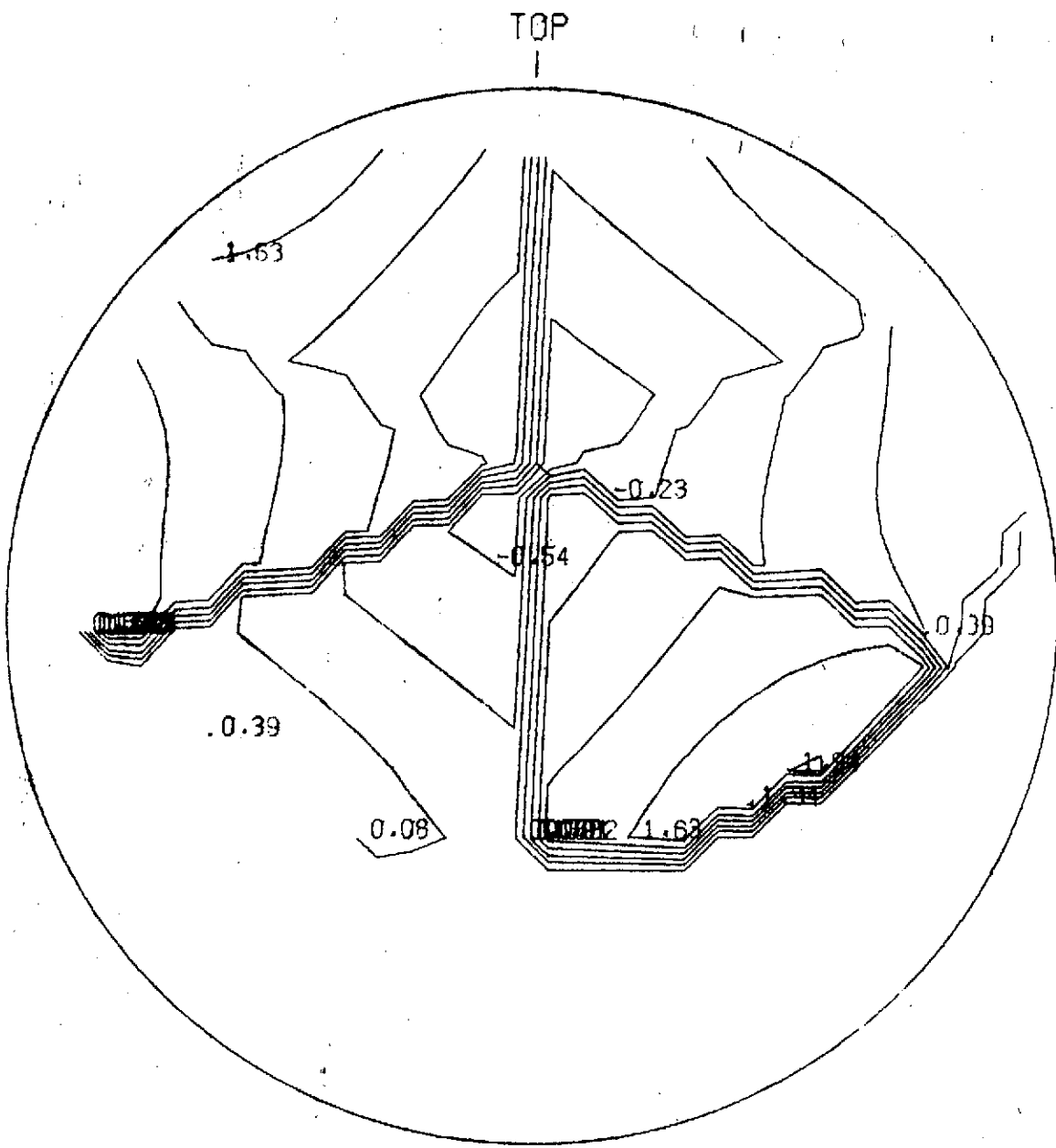
1  
NONE RMS 0.83 PK-PK 3.04 FRED WAVEFRONT

B35

FIGURE B25

Wavefront Plot-P Polarization

Task 2.2 - Nominal + Mfg. Error -15° Off Axis







ID

ID

NONE

RMS 2.21

PK-PK

10.16

FREQ

WAVEFRONT

B37

FIGURE B27

Intensity Distribution - Central 129 Microradians  
Task 2.2 - Nominal + Mfg. Error -15° Off Axis

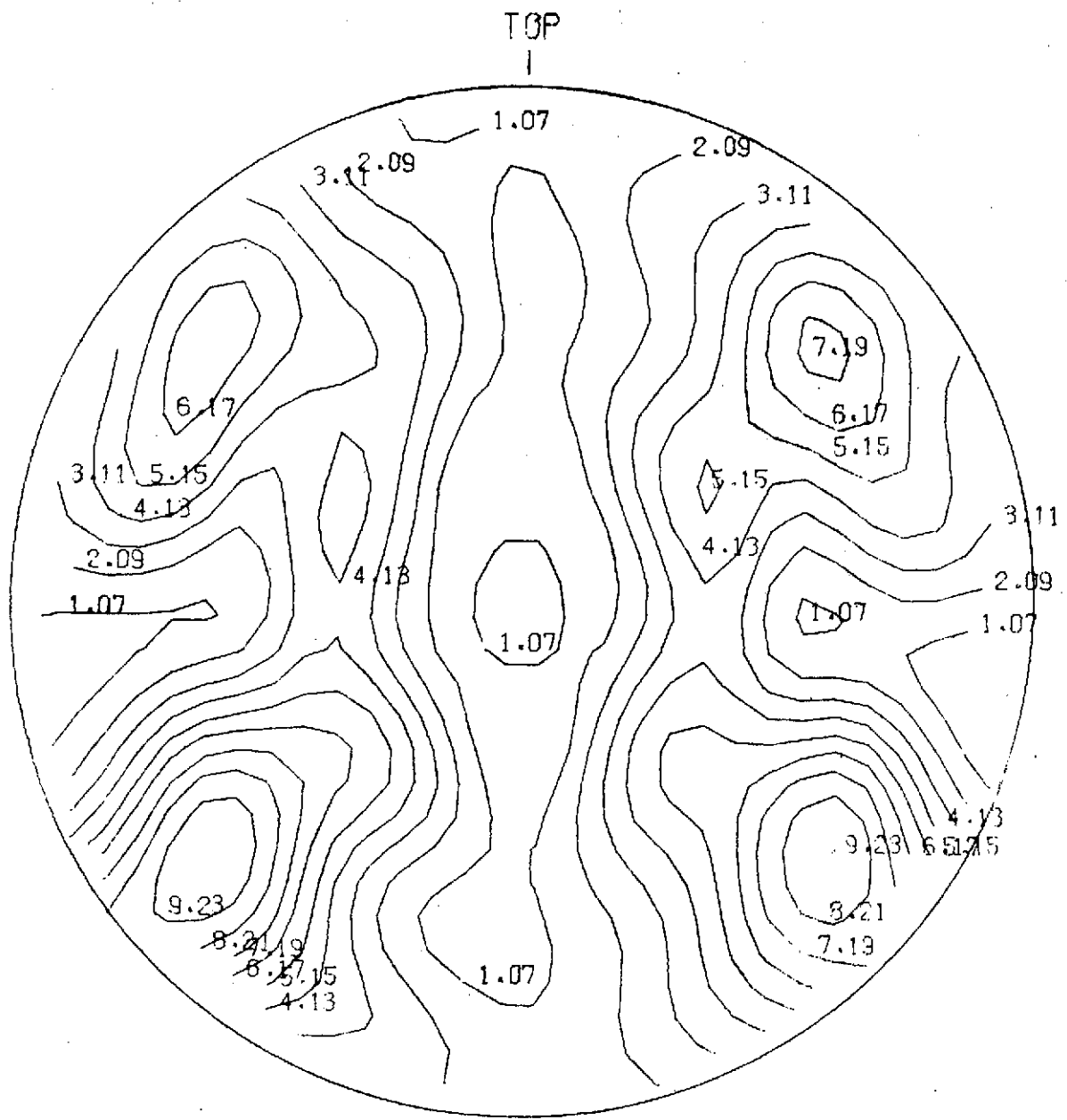
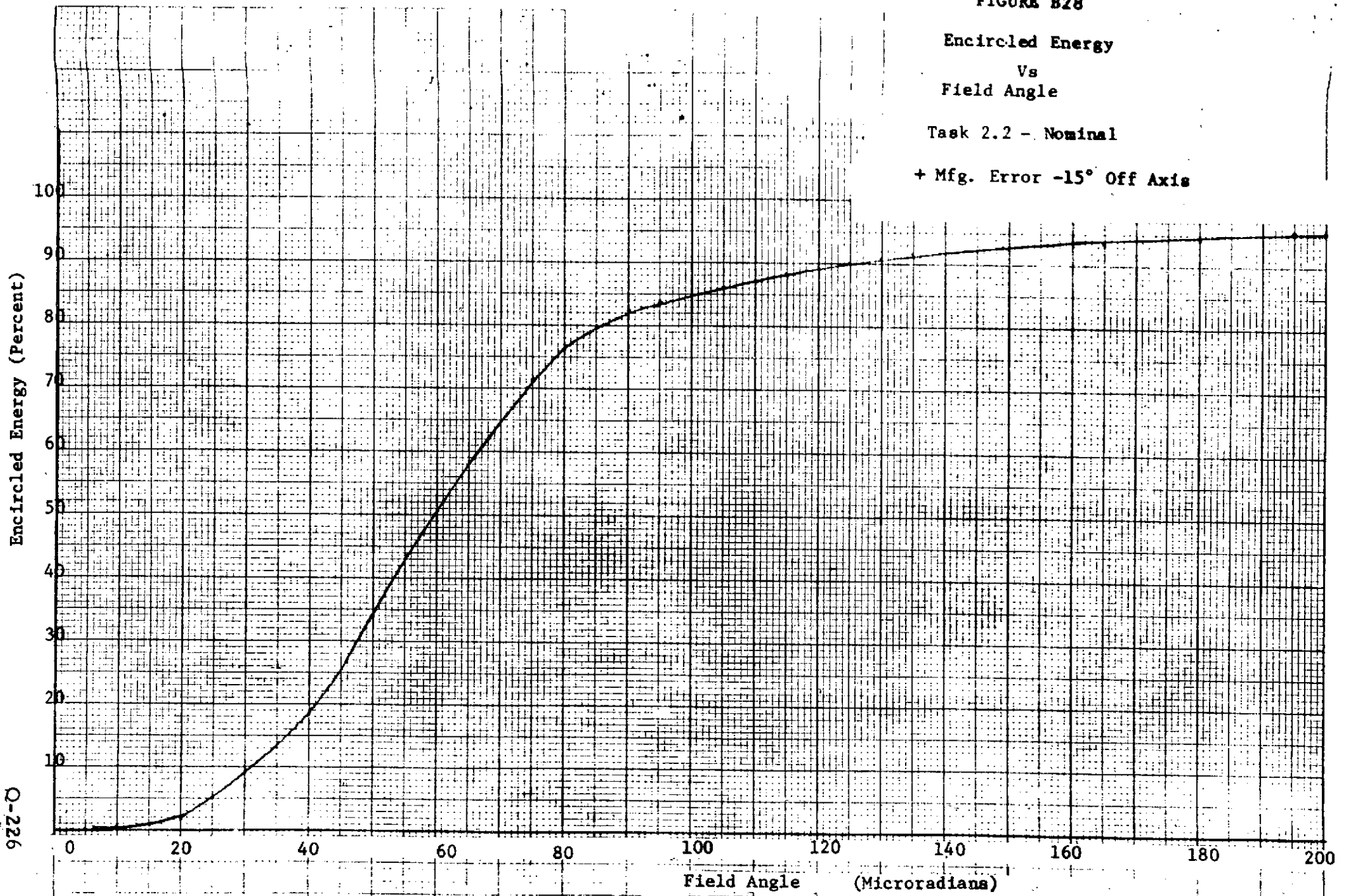


FIGURE B28

Encircled Energy  
Vs  
Field Angle

Task 2.2 - Nominal

+ Mfg. Error -15° Off Axis



9220

TABLE B10

ENCIRCLED ENERGY

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis

\*\*\*\*\*

\*\*\*\*\*

CIRCLE \*  
 ----- \*  
 PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 \*  
 RADIUS \*  
 ----- \*  
 \*  
 (MI- \* CENTER (MICRONS):  
 CIRCNS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*  
 \*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.1
6.00	*	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.0	0.1
8.00	*	0.3	0.2	0.2	0.4	0.3	0.3	0.2	0.2	0.4
10.00	*	0.5	0.3	0.2	0.5	0.5	0.5	0.3	0.3	0.5
12.00	*	0.9	0.7	0.5	0.7	0.5	0.7	0.6	0.7	0.8
14.00	*	0.9	0.7	0.8	0.9	0.8	0.9	0.9	0.7	0.8
16.00	*	1.5	1.3	1.1	1.2	1.0	1.2	1.2	1.2	1.3
18.00	*	1.8	1.5	1.5	1.4	1.6	1.5	1.5	1.5	1.6
20.00	*	2.3	2.2	2.2	1.9	1.6	1.9	2.1	2.2	2.2
22.00	*	2.6	2.5	2.8	2.3	2.3	2.3	2.6	2.5	2.5
24.00	*	3.6	3.6	3.4	2.8	2.7	2.9	3.3	3.7	3.6
26.00	*	4.2	4.1	4.2	3.5	3.5	3.5	4.0	4.3	4.2
28.00	*	5.8	5.9	5.6	4.6	3.8	4.6	5.6	6.1	5.9
30.00	*	6.7	6.9	6.5	5.6	5.1	5.6	6.6	7.2	7.0
32.00	*	8.9	9.3	8.0	6.7	5.8	6.7	8.2	9.6	9.2
34.00	*	9.4	9.9	9.5	8.6	7.7	8.5	10.0	10.2	9.8
36.00	*	11.8	12.6	11.3	10.0	9.3	9.9	12.1	13.1	12.3
38.00	*	13.1	13.9	13.1	12.2	12.4	12.2	14.1	14.6	13.8
40.00	*	15.6	16.6	15.4	14.2	13.9	14.1	16.6	17.6	16.4
42.00	*	16.8	17.8	18.2	17.4	18.1	17.3	19.3	18.9	17.7
44.00	*	20.0	21.0	20.5	19.4	20.1	19.2	21.8	22.5	21.2
46.00	*	22.4	23.3	23.5	23.5	24.6	23.3	24.9	25.0	23.7
48.00	*	25.9	26.8	27.4	27.0	26.0	26.7	28.7	28.7	27.3
50.00	*	29.0	29.7	29.7	30.1	30.7	29.9	31.3	31.7	30.4
52.00	*	33.0	33.7	33.5	33.6	33.3	33.4	35.0	35.7	34.4
54.00	*	35.2	35.9	36.4	37.5	38.1	37.2	38.3	37.9	36.6
56.00	*	39.4	40.0	40.9	41.4	41.2	41.1	42.7	41.8	40.7
58.00	*	42.6	43.1	43.7	44.4	46.3	44.2	45.6	44.9	43.8
60.00	*	46.0	46.6	47.6	48.2	50.0	48.0	49.4	48.2	47.4
62.00	*	48.6	49.0	51.0	52.3	54.2	52.1	52.7	50.4	49.7
64.00	*	52.9	53.2	54.0	55.1	57.5	54.9	55.5	54.4	54.1
66.00	*	55.5	55.8	57.6	59.3	61.4	59.2	58.7	56.8	56.6
68.00	*	59.4	59.4	60.7	61.8	63.3	61.8	61.5	60.3	60.3
70.00	*	61.7	61.7	63.6	65.0	66.5	65.0	64.1	62.3	62.5
72.00	*	65.2	65.0	66.1	67.3	69.1	67.3	66.5	65.5	65.8
74.00	*	67.1	66.7	68.9	69.8	71.4	69.9	69.0	67.1	67.5
76.00	*	70.1	69.5	71.4	71.8	73.1	71.9	71.4	69.8	70.4
78.00	*	72.0	71.4	72.9	73.4	75.0	73.4	72.9	71.5	72.1
80.00	*	74.1	73.3	74.9	75.1	76.4	75.2	75.0	73.4	74.2

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CRONS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.0	0.1
10.00	0.5	0.3	0.2	0.5	0.5	0.5	0.3	0.3	0.5
15.00	1.3	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
20.00	2.3	2.2	2.2	1.9	1.6	1.9	2.1	2.2	2.2
25.00	4.0	4.0	4.0	3.3	3.0	3.3	3.8	4.1	4.0
30.00	6.7	6.9	6.5	5.6	5.1	5.6	6.6	7.2	7.0
35.00	10.8	11.4	10.3	9.0	8.8	8.9	10.9	11.9	11.3
40.00	15.6	16.6	15.4	14.2	13.9	14.1	16.6	17.6	16.4
45.00	21.3	22.3	22.1	22.1	22.8	21.9	23.5	23.8	22.5
50.00	29.0	29.7	29.7	30.1	30.7	29.9	31.3	31.7	30.4
55.00	38.0	38.5	38.9	39.3	40.4	39.1	40.7	40.4	39.3
60.00	46.0	46.6	47.6	48.2	50.0	48.0	49.4	48.2	47.4
65.00	54.1	54.4	56.3	57.6	59.9	57.5	57.5	55.5	55.2
70.00	61.7	61.7	63.6	65.0	66.5	65.0	64.1	62.3	62.5
75.00	68.8	68.4	70.2	70.9	72.3	70.9	70.3	68.6	69.1
80.00	74.1	73.3	74.9	75.1	76.4	75.2	75.0	73.4	74.2
85.00	77.8	76.9	78.5	78.8	79.7	78.8	78.7	77.0	78.0
90.00	80.8	79.9	81.0	81.4	81.9	81.4	81.2	80.1	81.0
95.00	83.2	82.6	83.1	83.4	83.7	83.4	83.2	82.7	83.3
100.00	84.9	84.5	84.9	85.1	85.3	85.1	84.9	84.6	84.9
105.00	86.1	86.1	86.4	86.5	86.7	86.6	86.4	86.1	86.3
110.00	87.3	87.5	87.6	87.7	88.0	87.8	87.7	87.6	87.5
115.00	88.5	88.8	88.7	88.8	89.1	88.8	88.8	88.8	88.6
120.00	89.5	89.8	89.8	89.7	90.0	89.7	89.8	89.7	89.5
125.00	90.2	90.5	90.6	90.5	90.7	90.5	90.6	90.5	90.3
130.00	91.0	91.2	91.3	91.2	91.3	91.2	91.2	91.2	91.0
135.00	91.8	91.7	91.8	91.8	91.9	91.7	91.8	91.7	91.8
140.00	92.3	92.2	92.3	92.4	92.3	92.3	92.3	92.2	92.2
145.00	92.7	92.8	92.8	92.8	92.8	92.8	92.7	92.7	92.7
150.00	93.1	93.2	93.2	93.2	93.3	93.2	93.2	93.2	93.1
155.00	93.5	93.5	93.6	93.5	93.7	93.5	93.6	93.6	93.5
160.00	93.9	93.9	93.9	93.9	94.0	93.9	93.9	93.9	93.9
165.00	94.2	94.2	94.3	94.3	94.2	94.2	94.2	94.2	94.2
170.00	94.5	94.5	94.6	94.6	94.5	94.5	94.5	94.5	94.5
175.00	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8
180.00	95.1	95.1	95.1	95.1	95.2	95.1	95.1	95.1	95.1
184.99	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
189.99	95.6	95.6	95.6	95.7	95.7	95.7	95.7	95.7	95.7
194.99	95.9	95.9	95.9	95.9	96.0	95.9	95.9	95.9	95.9
199.99	96.2	96.1	96.1	96.2	96.2	96.2	96.2	96.2	96.2

\*\*\*\*\*

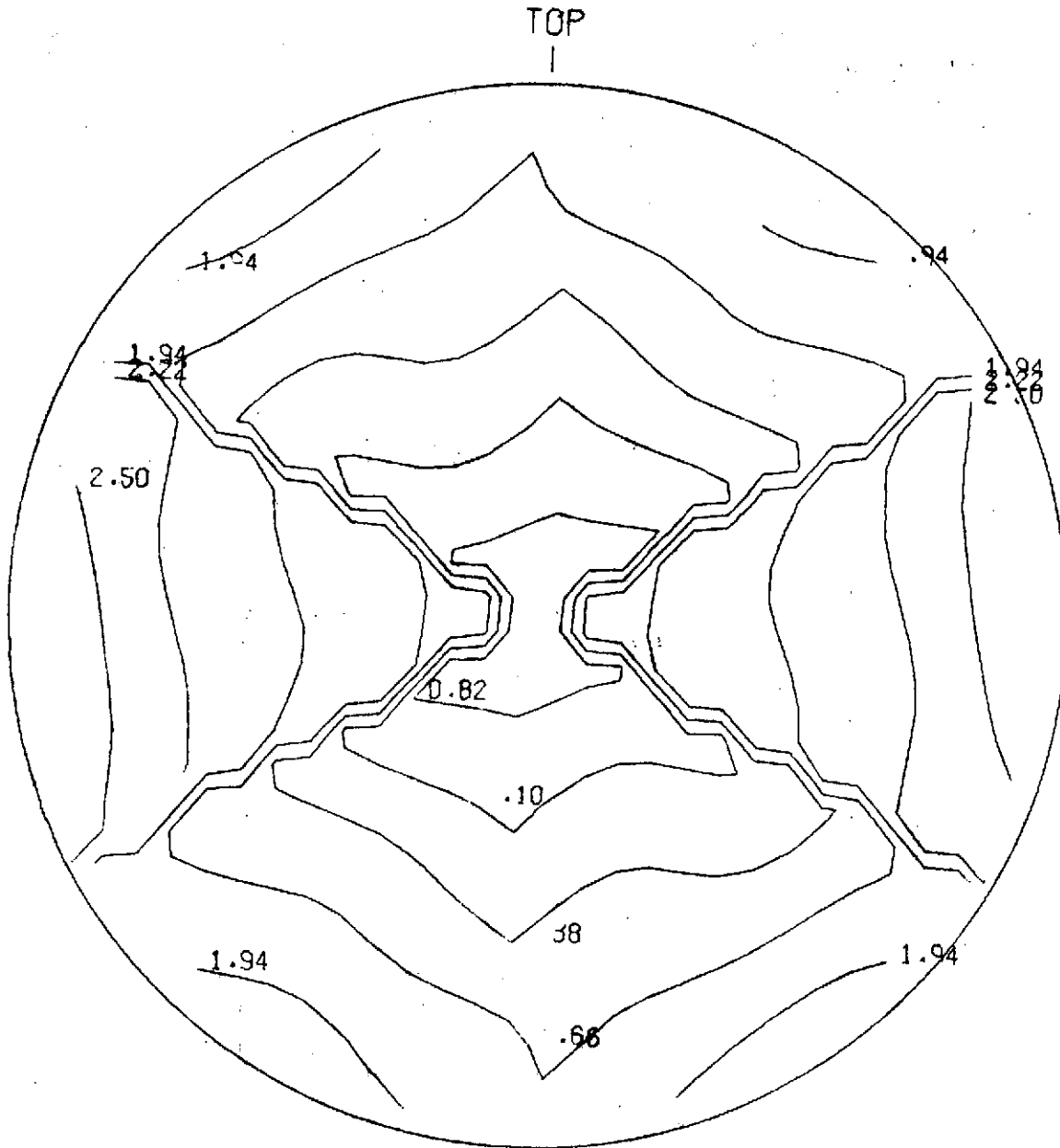


FIGURE B30

B42

Wavefront Plot-Q Polarization

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis





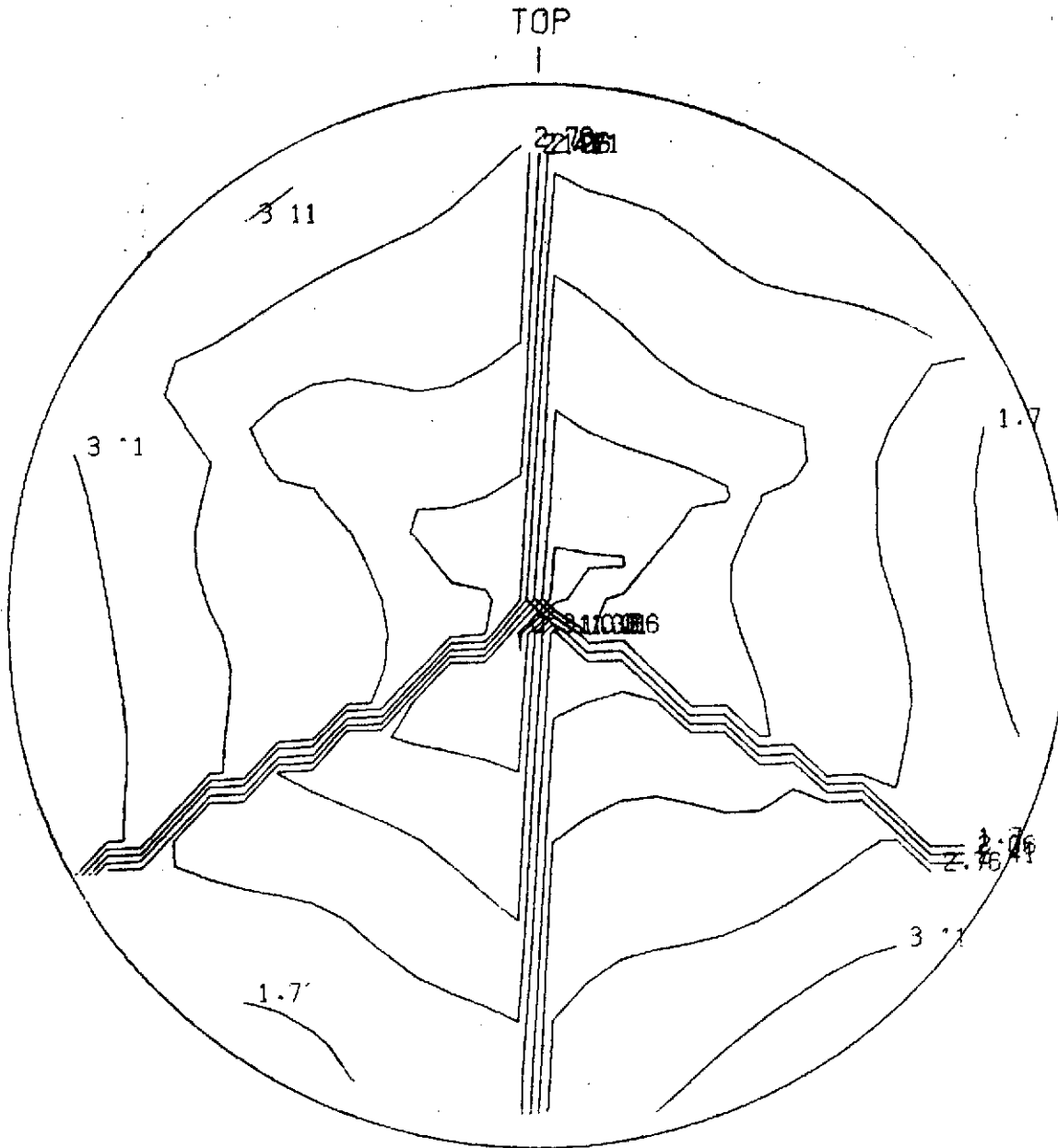
05 P PCLA I AV AGE E AG V. 7G. IPE 9  
NONE R.S. 0.82 PK-PK 3.27 FRED WAV RONT

B44

FIGURE B32

Wavefront Plot-P Polarization

Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Q-232





I  
IC  
NON

RS .65

PK-PK

C.09

r-RED

'AV ONT

FIGURE B34

B46

Intensity Distribution - Central 129 Microradians  
Task 2.3B - Nominal + Mfg. Error + First Temperature On Axis

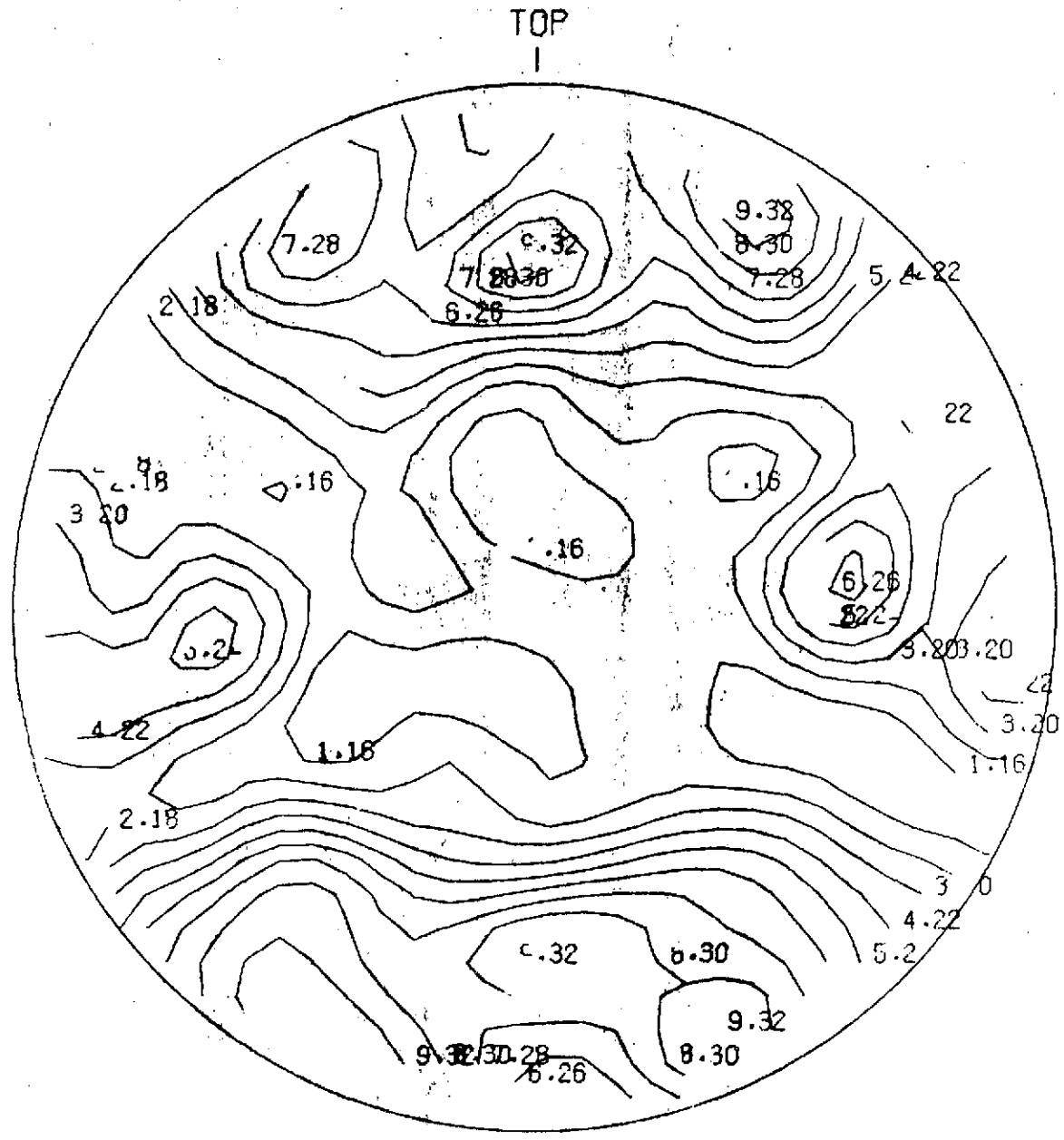


FIGURE B35

Encircled Energy

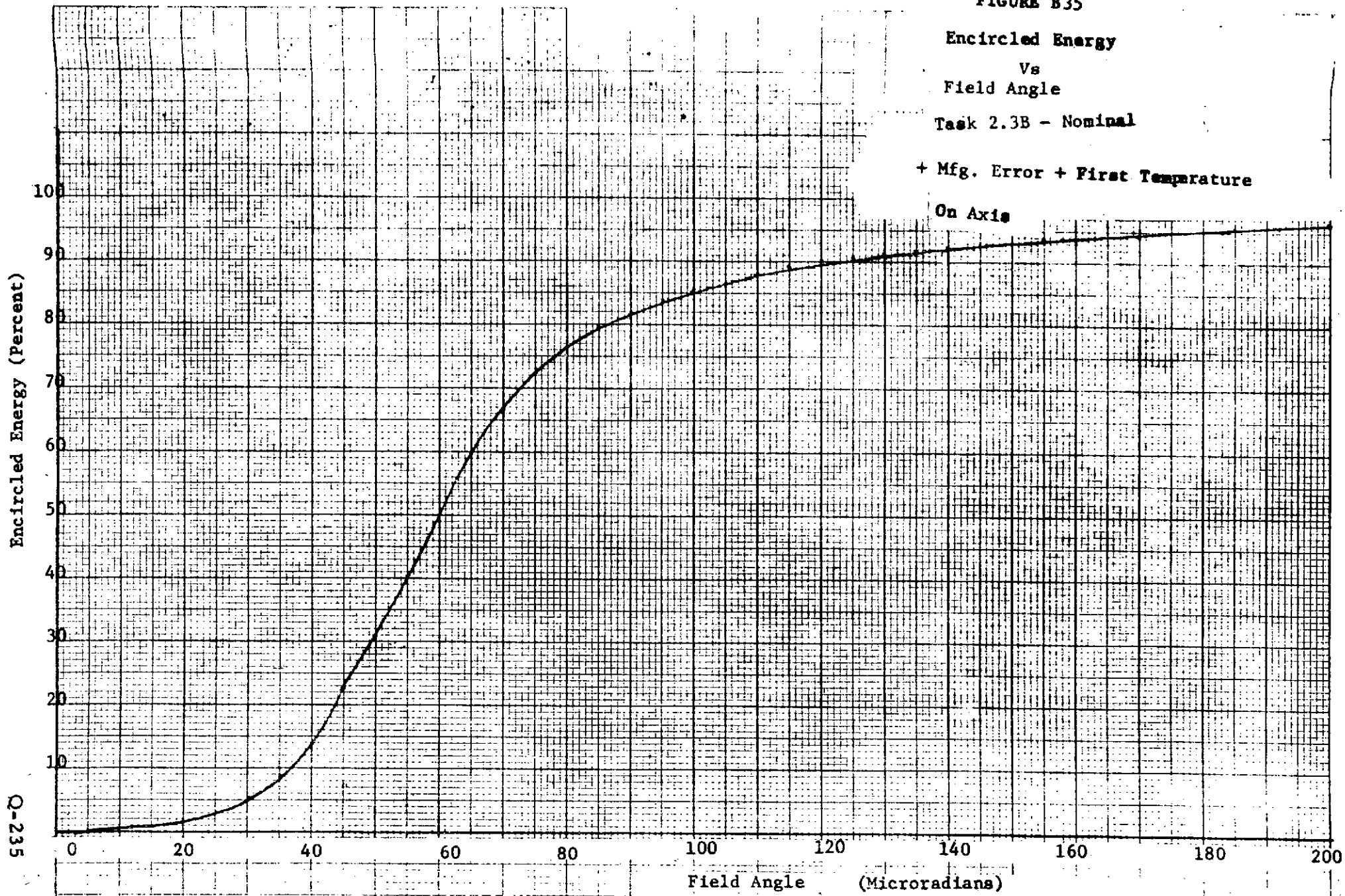
Vs

Field Angle

Task 2.3B - Nominal

+ Mfg. Error + First Temperature

On Axis



Q-235

TABLE B12  
ENCIRCLED ENERGY

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

CIRCLE \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*

(MI-  
CRONS)

\* CENTER (MICRONS):

\* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1
6.00	*	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1
8.00	*	0.3	0.3	0.2	0.3	0.2	0.3	0.2	0.4	0.4
10.00	*	0.4	0.5	0.2	0.5	0.4	0.4	0.3	0.5	0.5
12.00	*	1.0	1.1	0.4	0.9	0.4	0.8	0.4	1.3	1.2
14.00	*	1.0	1.1	0.7	1.3	0.6	1.3	0.9	1.3	1.2
16.00	*	1.8	1.9	0.9	1.8	0.8	1.8	1.1	2.2	2.1
18.00	*	2.2	2.3	1.5	2.3	1.6	2.3	1.8	2.7	2.5
20.00	*	2.9	3.1	2.0	3.0	1.6	3.1	2.4	3.6	3.4
22.00	*	3.3	3.4	3.0	3.8	3.0	3.8	3.5	4.0	3.8
24.00	*	4.3	4.4	3.5	4.3	3.9	4.3	4.0	5.2	5.0
26.00	*	4.8	5.0	4.8	5.3	5.5	5.2	5.4	5.9	5.6
28.00	*	6.3	6.4	6.1	6.7	6.1	6.6	6.8	7.4	7.1
30.00	*	7.4	7.6	7.4	7.8	7.9	7.7	8.2	8.7	8.4
32.00	*	9.8	9.8	8.4	9.3	9.1	9.2	9.3	10.9	10.7
34.00	*	10.3	10.4	10.3	11.2	10.3	11.0	11.4	11.5	11.3
36.00	*	13.1	13.1	11.8	13.3	12.3	13.1	12.9	14.1	13.9
38.00	*	14.8	14.8	13.7	15.2	14.4	15.0	14.9	15.8	15.6
40.00	*	17.4	17.3	15.8	17.6	15.9	17.5	17.0	18.4	18.2
42.00	*	18.7	18.7	18.8	20.3	18.6	20.2	19.9	19.8	19.6
44.00	*	21.7	21.6	20.2	21.9	21.4	21.8	21.5	22.9	22.6
46.00	*	24.1	24.0	24.0	24.9	25.1	24.8	25.3	25.6	25.3
48.00	*	26.6	26.5	26.9	28.0	26.6	27.8	28.6	28.3	28.0
50.00	*	29.5	29.4	29.7	30.2	30.9	30.0	31.2	31.5	31.2
52.00	*	32.5	32.4	32.3	33.0	34.1	32.8	34.4	34.8	34.4
54.00	*	34.3	34.3	35.8	36.3	37.4	36.0	37.8	36.8	36.5
56.00	*	37.9	37.8	39.1	40.2	40.8	39.9	41.7	40.3	40.0
58.00	*	40.9	40.8	41.5	42.7	44.3	42.4	43.9	43.5	43.4
60.00	*	44.0	43.8	44.9	46.5	47.5	46.3	47.6	46.3	46.3
62.00	*	46.4	46.2	48.3	49.8	50.3	49.6	50.9	48.8	48.9
64.00	*	50.6	50.3	50.6	52.3	53.6	52.3	53.5	52.4	52.8
66.00	*	53.4	53.1	54.5	55.7	57.1	55.8	57.1	55.2	55.7
68.00	*	56.4	56.1	57.3	58.4	58.7	58.7	59.6	57.9	58.6
70.00	*	59.2	58.9	60.5	61.1	62.2	61.4	62.4	60.5	61.2
72.00	*	62.2	61.9	62.8	63.3	65.6	63.7	64.6	63.2	63.9
74.00	*	63.9	63.7	66.1	66.2	68.1	66.5	67.4	65.0	65.7
76.00	*	66.9	66.7	68.7	68.7	70.6	69.1	69.6	67.7	68.2
78.00	*	69.2	69.2	70.4	70.4	73.0	70.7	71.3	69.8	70.3
80.00	*	71.2	71.2	73.0	72.9	75.0	73.1	73.5	71.7	72.1

ENCIRCLED ENERGY

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \*  
 CENRS) \* CENTER (MICRONS):  
 \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
10.00	0.4	0.5	0.2	0.5	0.4	0.4	0.3	0.5	0.5	0.5
15.00	1.5	1.6	0.8	1.6	0.8	1.6	1.0	1.8	1.7	1.7
20.00	2.9	3.1	2.0	3.0	1.6	3.1	2.4	3.6	3.4	3.4
25.00	4.6	4.8	4.6	5.0	4.4	5.0	5.2	5.6	5.4	5.4
30.00	7.4	7.6	7.4	7.8	7.9	7.7	8.2	8.7	8.4	8.4
35.00	12.0	12.1	10.6	11.9	11.8	11.8	11.7	13.0	12.8	12.8
40.00	17.4	17.3	15.8	17.6	15.9	17.5	17.0	18.4	18.2	18.2
45.00	22.8	22.7	22.8	23.7	22.8	23.6	23.9	24.1	23.9	23.9
50.00	29.5	29.4	29.7	30.2	30.9	30.0	31.2	31.5	31.2	31.2
55.00	36.6	36.6	37.1	38.0	40.0	37.7	39.4	39.0	38.7	38.7
60.00	44.0	43.8	44.9	46.5	47.5	46.3	47.6	46.3	46.3	46.3
65.00	51.7	51.4	53.1	54.5	55.1	54.5	55.7	53.5	54.0	54.0
70.00	59.2	58.9	60.5	61.1	62.2	61.4	62.4	60.5	61.2	61.2
75.00	65.9	65.7	67.0	67.2	69.6	67.6	68.4	66.6	67.2	67.2
80.00	71.2	71.2	73.0	72.9	75.0	73.1	73.5	71.7	72.1	72.1
85.00	75.6	75.7	77.7	77.6	79.0	77.6	78.0	76.1	76.3	76.3
90.00	79.5	79.6	80.8	80.7	81.9	80.7	80.9	79.7	79.9	79.9
95.00	82.4	82.5	83.1	83.0	83.8	83.1	83.2	82.5	82.6	82.6
100.00	84.4	84.5	84.9	84.8	85.2	84.8	84.8	84.4	84.4	84.4
105.00	85.8	85.9	86.2	86.1	86.4	86.1	86.0	85.9	85.7	85.7
110.00	87.0	87.2	87.3	87.2	87.4	87.2	87.1	87.1	86.9	86.9
115.00	88.0	88.1	88.1	88.1	88.2	88.2	88.1	88.1	88.0	88.0
120.00	88.9	88.9	88.9	89.0	89.1	89.0	89.1	88.9	88.9	88.9
125.00	89.6	89.6	89.7	89.8	90.0	89.8	89.8	89.6	89.6	89.6
130.00	90.3	90.3	90.5	90.5	90.6	90.5	90.5	90.3	90.3	90.3
135.00	90.9	90.9	91.0	91.0	91.1	91.0	91.1	91.0	91.0	91.0
140.00	91.4	91.4	91.5	91.6	91.6	91.5	91.6	91.6	91.5	91.5
145.00	91.9	91.8	91.9	92.0	91.9	92.0	92.0	92.0	91.9	91.9
150.00	92.3	92.3	92.3	92.4	92.4	92.4	92.4	92.3	92.4	92.4
155.00	92.8	92.7	92.8	92.8	92.8	92.8	92.8	92.7	92.7	92.7
160.00	93.2	93.2	93.2	93.1	93.1	93.1	93.1	93.1	93.1	93.1
165.00	93.5	93.6	93.6	93.5	93.5	93.6	93.5	93.5	93.5	93.5
170.00	93.9	93.9	93.9	93.9	94.0	93.9	93.8	93.8	93.8	93.8
175.00	94.2	94.2	94.2	94.2	94.3	94.2	94.2	94.2	94.2	94.2
180.00	94.5	94.5	94.5	94.6	94.6	94.6	94.6	94.5	94.6	94.6
184.99	94.8	94.8	94.8	94.8	94.8	94.8	94.9	94.9	94.9	94.9
189.99	95.1	95.1	95.1	95.1	95.2	95.2	95.2	95.2	95.2	95.2
194.99	95.3	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
199.99	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7

\*\*\*\*\*



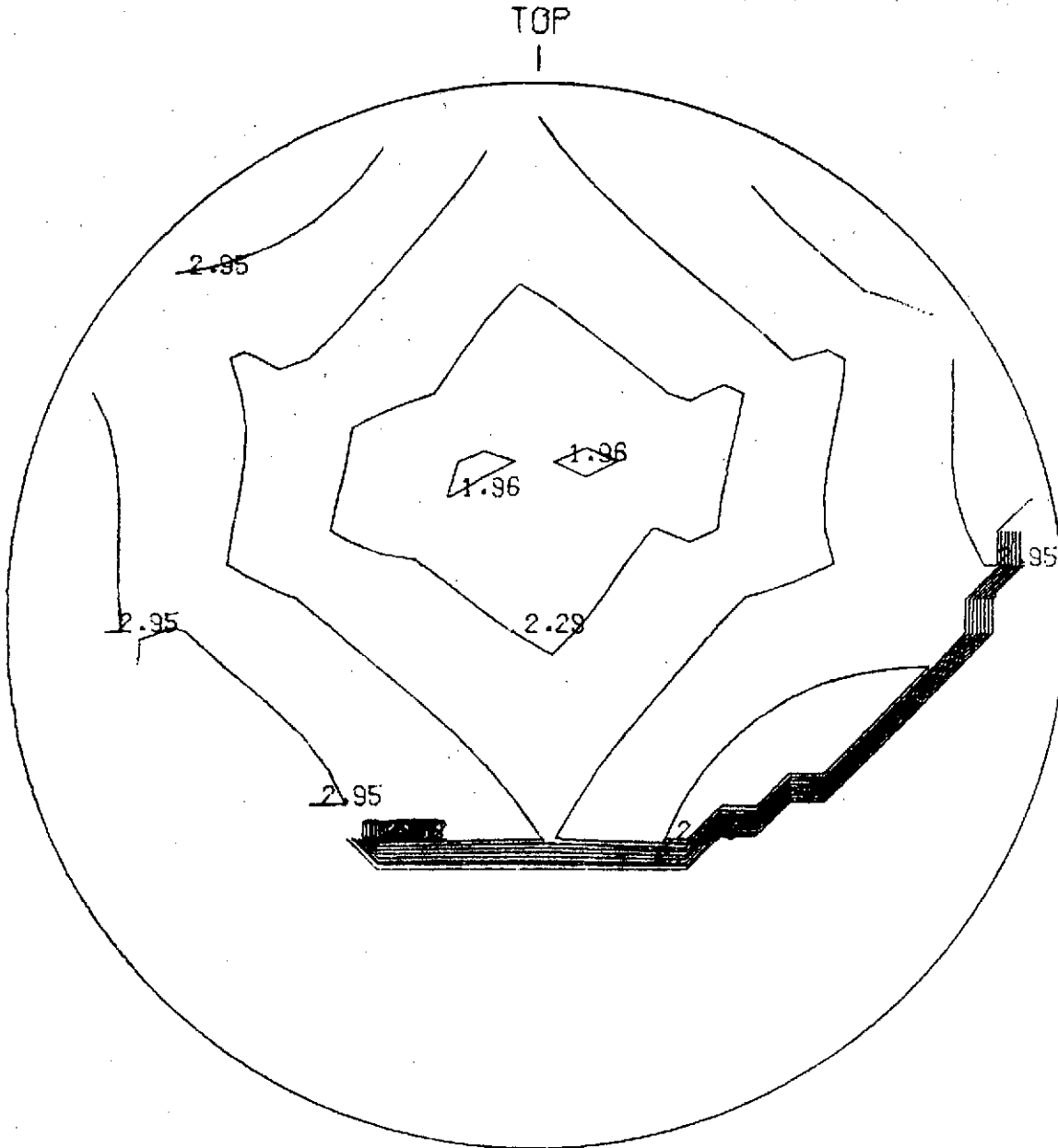
ADD	Q POLARI	AVERAGE	AVERAGE	QUARTER	TEMPERAT
1					
NONE		RMS 0.30	PK-PK	1.37	FREQ WAVEFRONT

B51

FIGURE B37

Wavefront Plot-Q Polarization

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis



Q-239





ADD	P POLARI	AVERAGE	AVERAGE	QUARTER	TEMPERAT
1					
NONE		RMS 0.84	PK-PK	3.13	FRED WAVEFRONT

FIGURE B39

B53

Wavefront Plot-P Polarization

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

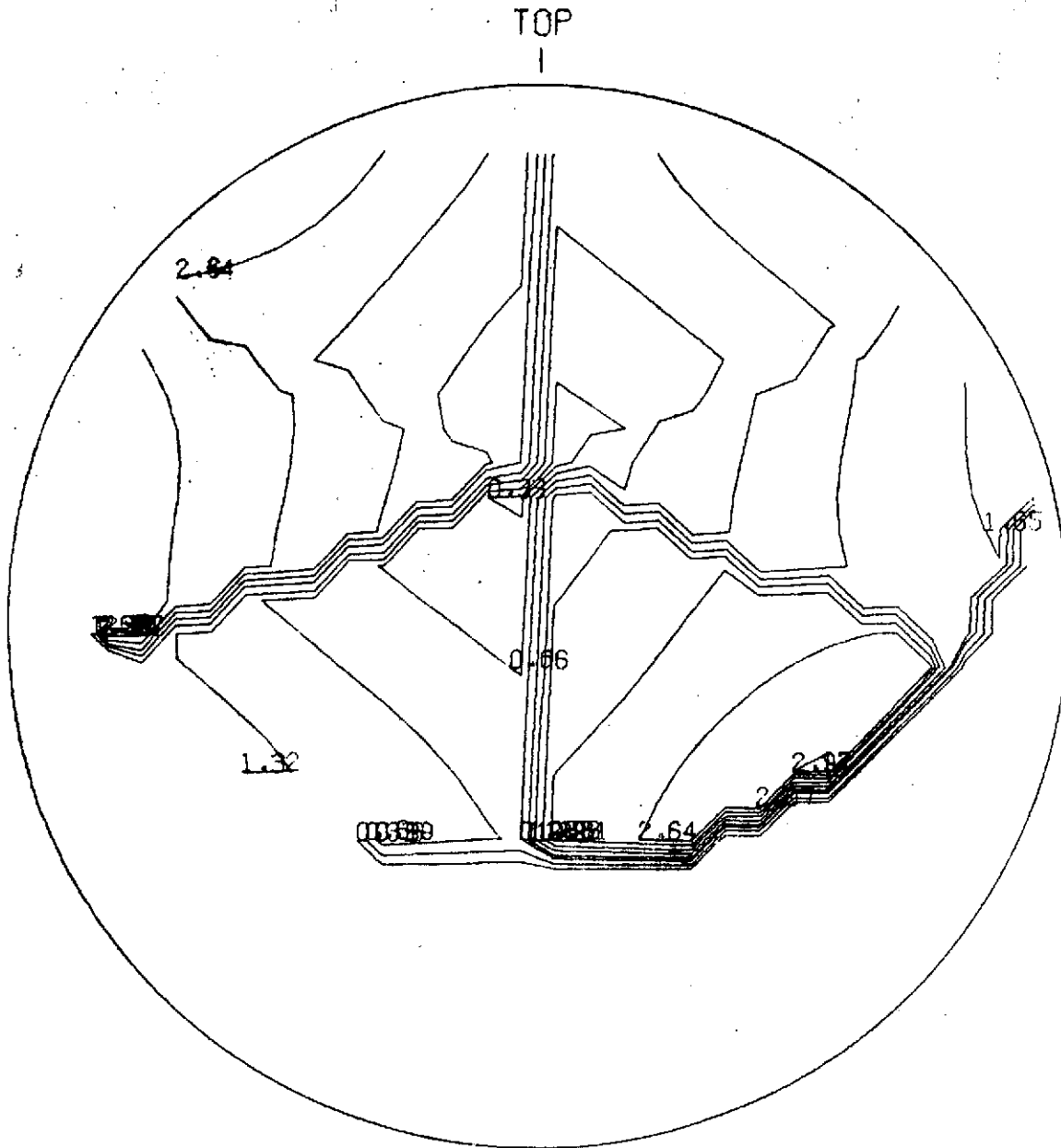


FIGURE B40

Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

PRINTER MAP OF POINT SPREAD FUNCTION

B34

(ONE SPACE REPRESENTS 8.04 MICRONS)  
 NORMALIZED SO LARGEST VALUE = 0.0195 = 100  
 TOTAL ENERGY = J.1870400D+J1  
 MAP REPRESENTS 0.1738362D+01 OR 92.9407 PERCENT OF TOTAL ENERGY

0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	2	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	0	0	1	1
0	1	1	1	1	1	1	0	1	1	1	0	0	0	0	1	1	0	1	2	1	0	1	0	0	0	1	1	0	1	1	1	1	1	0	0	1	1	
0	0	0	0	1	1	1	1	2	2	1	1	0	0	0	2	2	0	2	4	3	1	0	0	0	1	1	0	1	1	1	1	1	1	0	0	0	0	
0	0	0	0	1	1	0	1	2	2	1	2	1	0	0	1	3	4	2	3	5	3	1	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	
0	0	0	1	1	0	1	2	2	1	2	3	1	0	1	2	4	4	3	5	5	2	1	1	0	1	1	1	2	1	1	0	0	1	0	0	0	0	
0	0	1	1	1	2	2	1	1	2	2	3	2	1	2	3	3	5	4	1	2	3	1	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	
0	0	1	1	1	2	2	3	3	2	3	2	2	5	3	2	4	3	2	4	5	3	2	4	4	2	2	3	3	2	1	0	1	1	1	1	1	1	
0	1	1	1	1	2	2	3	3	2	3	4	7	8	5	7	8	4	3	5	9	8	5	6	8	5	3	2	3	2	1	2	0	0	1	0	0	0	
0	1	1	1	1	1	2	2	3	6	9	13	14	13	15	11	5	6	8	10	15	15	16	14	9	5	2	1	1	1	1	1	1	1	1	1	0	0	
1	1	1	2	1	1	2	3	5	8	14	19	21	23	21	10	6	8	7	10	18	24	28	23	13	8	4	1	1	1	1	1	2	1	1	1	0	0	
2	1	1	2	2	2	5	6	6	11	21	26	27	29	21	10	9	10	11	17	21	26	31	30	20	9	4	1	1	1	1	1	1	1	1	1	1	1	
2	2	1	2	3	6	16	10	11	22	34	34	37	39	26	15	11	7	14	24	28	33	35	36	32	15	6	4	3	3	3	3	2	2	2	2	2	2	
2	2	1	3	5	8	11	15	23	38	43	41	54	57	37	24	15	5	10	20	35	55	53	45	45	28	14	10	6	5	5	5	3	3	2	2	2	2	
1	1	2	3	5	6	8	14	27	39	38	45	68	63	39	30	18	8	10	16	36	73	71	53	46	33	18	11	4	3	4	4	4	2	1	1	1	1	
1	1	1	2	2	2	4	10	21	29	32	51	69	47	32	29	13	6	13	25	38	62	70	50	37	27	16	8	2	1	2	2	1	0	1	0	1	1	
1	1	0	1	2	2	4	7	15	24	34	54	56	29	33	30	5	3	10	33	44	42	56	51	35	25	15	6	1	1	1	2	1	1	1	1	1	1	
1	0	0	1	2	3	4	6	12	21	29	39	31	19	40	29	4	10	4	28	44	24	34	43	32	25	18	7	2	1	1	1	1	1	0	0	0	0	
0	0	1	1	1	1	2	6	10	14	14	15	11	15	39	23	6	18	4	21	38	13	14	19	16	19	17	9	3	0	0	1	1	0	0	1	1	0	0
0	1	2	1	1	0	3	9	9	8	7	13	24	31	42	27	7	10	7	28	38	21	21	12	4	10	12	11	7	3	1	1	1	1	1	1	1	0	0
0	1	2	1	1	1	4	8	5	5	14	35	63	64	54	41	14	1	14	39	44	50	59	33	9	4	5	9	9	5	2	1	1	1	1	1	1	1	0
0	1	1	1	0	1	2	4	2	9	29	58	93	88	56	37	18	5	20	38	46	75	90	55	23	9	2	4	5	4	2	1	1	1	1	1	1	1	0
1	1	1	1	1	2	2	4	9	25	55	80	100	87	43	17	9	9	18	27	43	78	89	66	48	29	10	3	2	2	2	3	2	2	3	2	1	0	0
1	2	2	2	2	2	3	7	17	39	74	92	88	69	37	14	5	6	12	20	40	66	75	76	72	49	23	10	4	2	2	2	2	2	1	1	1	1	1
1	1	1	1	1	2	2	7	15	31	60	74	60	42	34	27	15	8	11	22	36	48	59	70	66	42	24	15	8	3	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	3	8	13	27	38	33	23	23	26	20	12	13	21	27	31	35	42	32	19	15	13	8	3	1	1	1	0	1	0	1	0	0
0	1	0	1	1	1	1	1	3	4	8	15	22	18	14	14	14	11	9	13	18	21	23	16	9	6	7	6	4	2	2	1	0	0	0	0	0	0	0
0	0	0	0	1	2	1	1	3	3	5	9	16	18	13	8	8	7	5	7	12	14	13	7	4	3	1	1	1	1	1	1	0	0	0	0	0	0	0
0	0	0	0	1	2	2	3	2	2	5	7	8	10	12	10	5	3	4	7	8	8	7	4	4	2	1	2	1	0	1	0	0	0	0	0	0	0	0
0	0	0	0	1	2	2	5	6	4	3	4	3	3	8	10	4	2	4	6	4	3	2	2	3	4	5	5	3	1	1	0	0	0	0	0	0	0	0
0	0	0	0	1	2	2	3	5	4	1	2	2	1	4	7	5	2	3	3	1	1	1	1	1	3	5	6	4	2	2	2	1	0	0	0	0	0	0
1	0	0	0	0	1	1	1	2	2	0	0	1	0	2	5	5	3	2	3	1	1	0	0	2	3	3	2	1	1	2	2	1	0	0	0	0	0	0
0	0	0	1	1	C	0	0	0	0	0	0	1	1	2	3	3	1	2	2	1	0	0	1	1	1	1	0	1	1	1	0	0	1	1	0	0	0	0
0	0	0	1	1	1	C	0	0	0	0	0	0	1	3	3	1	0	2	2	1	0	0	1	1	1	1	0	1	1	1	0	0	1	1	0	0	0	0
0	0	0	1	1	2	2	1	0	0	0	0	0	1	1	2	2	1	0	1	1	0	0	1	1	1	0	0	1	1	0	1	2	2	2	1	0	0	0
0	0	0	1	1	2	2	1	0	0	0	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	2	3	2	1	1	1	0	0	0	0	0

0-242

FIGURE B41

B55

Intensity Distribution - Central 129 Microradians  
Task 2.3B - Nominal + Mfg. Error + First Temperature -15° Off Axis

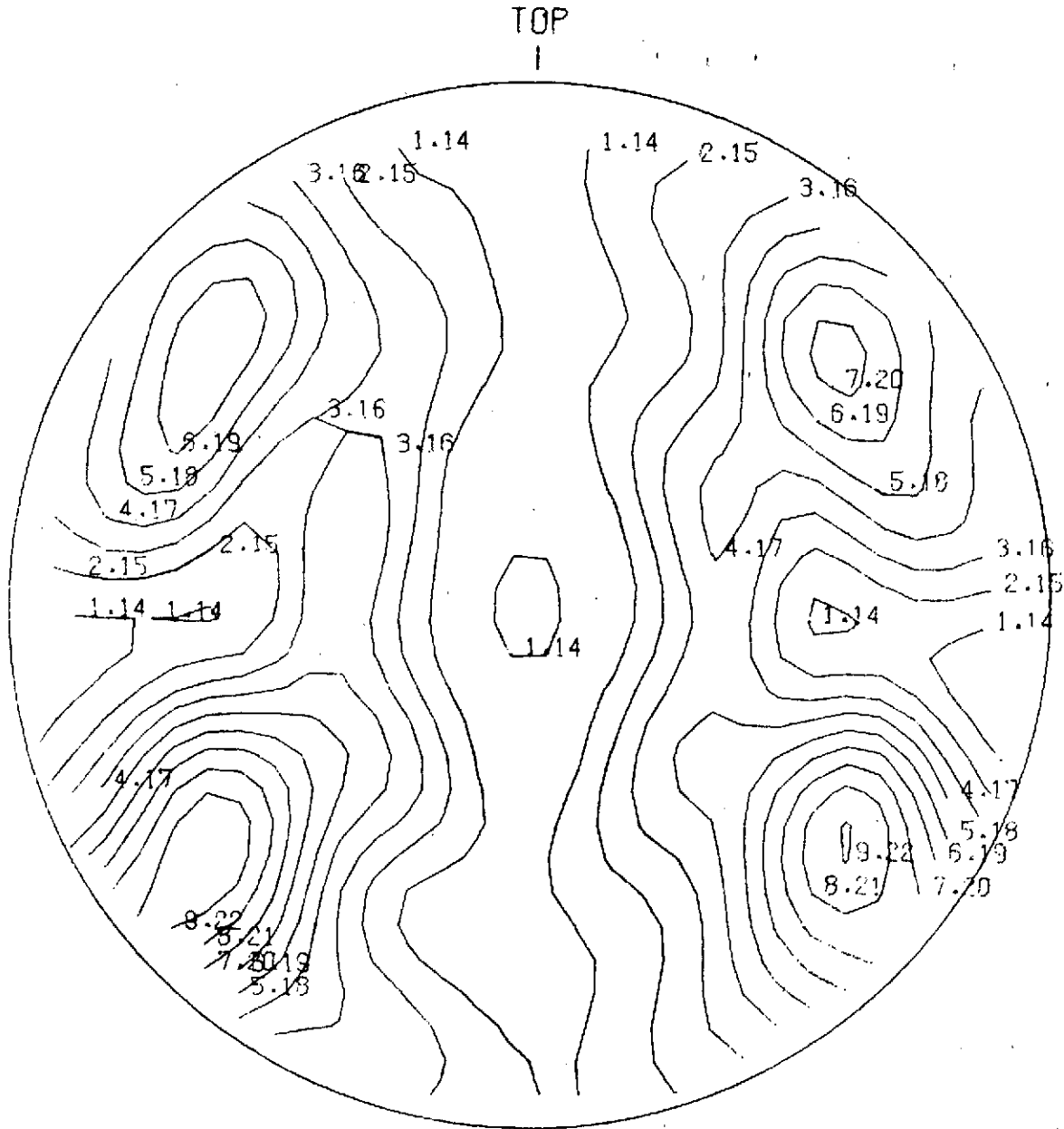
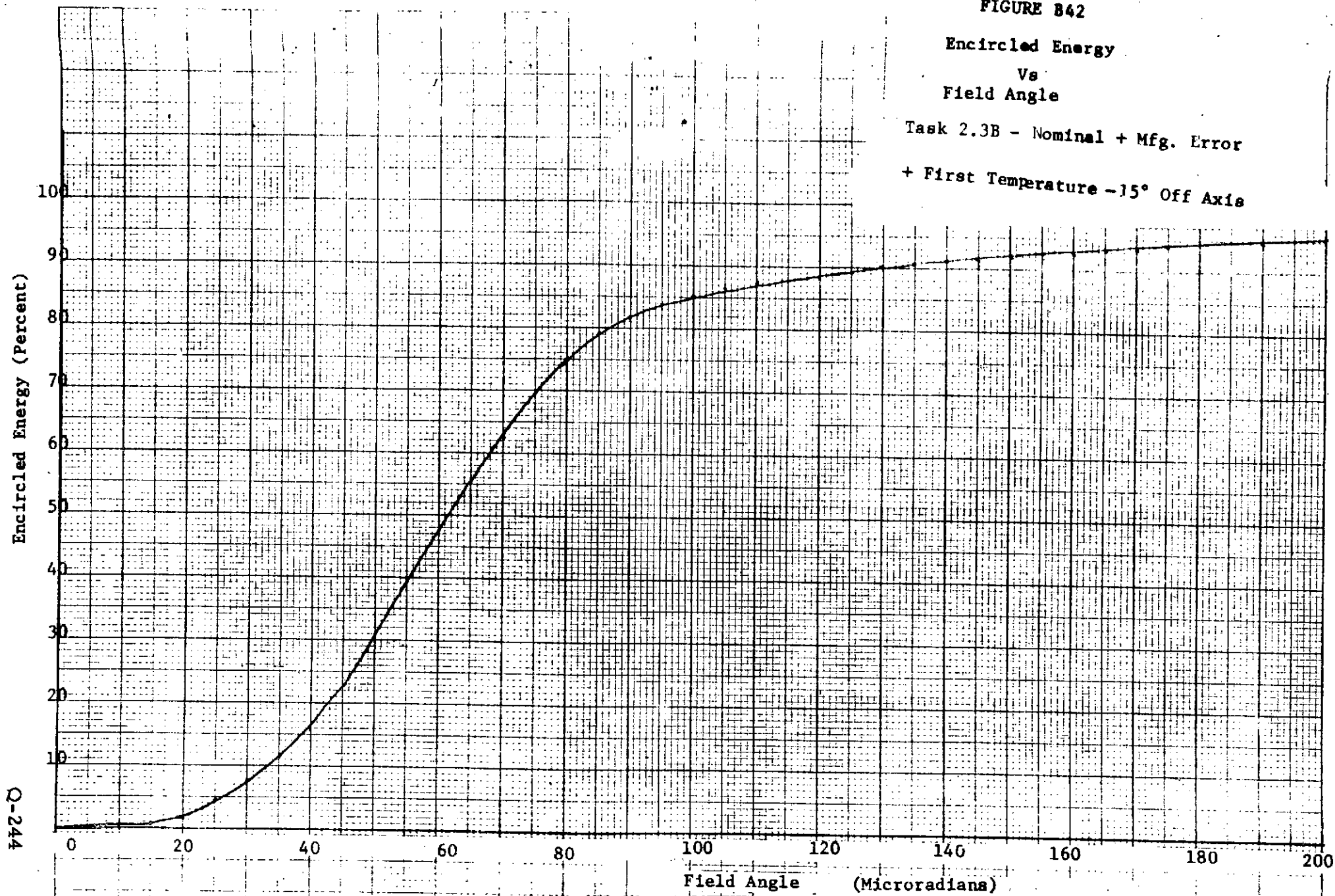


FIGURE B42

Encircled Energy  
Vs  
Field Angle

Task 2.3B - Nominal + Mfg. Error

+ First Temperature  $-15^{\circ}$  Off Axis



Q-244

ENCIRCLED ENERGY

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

\*\*\*\*\*

CIRCLE \*  
 ----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CIRCNS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1
6.00	*	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
8.00	*	0.4	0.3	0.2	0.4	0.2	0.3	0.2	0.2	0.4
10.00	*	0.5	0.4	0.3	0.5	0.4	0.5	0.3	0.4	0.5
12.00	*	1.1	0.9	0.5	0.8	0.5	0.7	0.6	0.8	1.0
14.00	*	1.1	0.9	1.0	1.0	0.8	1.0	1.0	0.8	1.0
16.00	*	1.8	1.6	1.3	1.3	1.0	1.3	1.4	1.5	1.5
18.00	*	2.1	1.9	1.9	1.6	1.8	1.6	1.8	1.9	1.8
20.00	*	2.8	2.7	2.6	2.1	1.8	2.1	2.6	2.7	2.6
22.00	*	3.1	3.0	3.4	2.7	2.8	2.6	3.3	3.1	3.0
24.00	*	4.3	4.3	4.2	3.3	3.3	3.3	4.0	4.5	4.3
26.00	*	4.9	5.0	5.2	4.1	4.4	4.1	5.0	5.2	5.0
28.00	*	6.8	7.1	6.9	5.5	4.7	5.5	6.9	7.3	7.0
30.00	*	7.9	8.3	7.9	6.8	6.4	6.8	8.1	8.7	8.3
32.00	*	10.4	11.0	9.6	8.1	7.2	8.1	10.1	11.6	11.0
34.00	*	11.0	11.7	11.3	10.4	9.5	10.3	12.1	12.2	11.6
36.00	*	13.8	14.8	13.4	12.1	11.4	12.0	14.6	15.5	14.5
38.00	*	15.2	16.2	15.5	14.7	15.0	14.6	16.8	17.2	16.2
40.00	*	18.0	19.2	18.1	16.9	16.8	16.8	19.6	20.5	19.1
42.00	*	19.4	20.6	21.1	20.5	21.6	20.5	22.5	21.9	20.6
44.00	*	22.9	24.1	23.6	22.7	23.8	22.5	25.2	25.7	24.3
46.00	*	25.5	26.5	26.8	27.2	28.8	27.0	28.4	28.3	27.0
48.00	*	29.2	30.2	31.0	30.9	30.2	30.6	32.5	32.2	30.7
50.00	*	32.4	33.2	33.4	34.2	35.1	34.0	35.1	35.3	34.0
52.00	*	36.6	37.2	37.4	37.9	37.8	37.6	38.9	39.3	38.1
54.00	*	39.0	39.5	40.3	41.7	42.6	41.5	42.1	41.6	40.3
56.00	*	43.3	43.7	44.9	45.6	45.7	45.4	46.6	45.5	44.5
58.00	*	46.4	46.8	47.6	48.6	50.7	48.4	49.4	48.5	47.6
60.00	*	49.8	50.2	51.5	52.2	54.1	52.1	53.1	51.7	51.1
62.00	*	52.3	52.6	54.7	56.1	58.1	56.0	56.2	53.8	53.4
64.00	*	56.5	56.5	57.6	58.7	61.2	58.6	58.9	57.5	57.5
66.00	*	58.9	59.0	60.9	62.6	64.8	62.5	61.9	59.8	59.9
68.00	*	62.5	62.4	63.8	64.9	66.5	64.9	64.4	63.1	63.4
70.00	*	64.7	64.4	66.4	67.8	69.3	67.7	66.8	64.9	65.4
72.00	*	67.9	67.5	68.8	69.8	71.5	69.8	69.0	67.8	68.4
74.00	*	69.6	69.0	71.2	72.0	73.4	72.1	71.2	69.3	69.9
76.00	*	72.3	71.6	73.4	73.7	74.9	73.8	73.3	71.7	72.5
78.00	*	74.0	73.2	74.7	75.1	76.5	75.1	74.6	73.2	74.0
80.00	*	75.8	74.9	76.4	76.5	77.6	76.6	76.4	74.9	75.9

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

\*\*\*\*\*  
 CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CRCNS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	*	0.1	0.1	0.0	0.2	0.1	0.2	0.1	0.1	0.1
10.00	*	0.5	0.4	0.3	0.5	0.4	0.5	0.3	0.4	0.5
15.00	*	1.5	1.3	1.2	1.2	1.0	1.2	1.2	1.3	1.3
20.00	*	2.8	2.7	2.6	2.1	1.8	2.1	2.6	2.7	2.6
25.00	*	4.7	4.8	4.9	4.0	3.7	4.0	4.7	5.0	4.8
30.00	*	7.9	8.3	7.9	6.8	6.4	6.8	8.1	8.7	8.3
35.00	*	12.6	13.5	12.3	10.8	10.8	10.8	13.2	14.2	13.3
40.00	*	18.0	19.2	18.1	16.9	16.8	16.8	19.6	20.5	19.1
45.00	*	24.3	25.4	25.3	25.7	26.8	25.5	27.0	27.2	25.7
50.00	*	32.4	33.2	33.4	34.2	35.1	34.0	35.1	35.3	34.0
55.00	*	41.8	42.2	43.0	43.6	44.9	43.4	44.6	44.0	43.1
60.00	*	49.8	50.2	51.5	52.2	54.1	52.1	53.1	51.7	51.1
65.00	*	57.6	57.7	59.7	61.1	63.4	60.9	60.8	58.6	58.6
70.00	*	64.7	64.4	66.4	67.8	69.3	67.7	66.8	64.9	65.4
75.00	*	71.2	70.5	72.3	72.9	74.2	73.0	72.3	70.7	71.4
80.00	*	75.8	74.9	76.4	76.5	77.6	76.6	76.4	74.9	75.9
85.00	*	79.1	78.0	79.5	79.7	80.3	79.7	79.6	78.2	79.2
90.00	*	81.6	80.7	81.6	82.0	82.3	82.0	81.9	80.9	81.8
95.00	*	83.7	83.2	83.5	83.8	84.0	83.9	83.7	83.3	83.8
100.00	*	85.2	85.0	85.2	85.4	85.6	85.5	85.3	85.0	85.3
105.00	*	86.4	86.5	86.7	86.8	87.1	86.9	86.8	86.5	86.5
110.00	*	87.6	87.8	88.0	88.0	88.3	88.1	88.0	87.9	87.7
115.00	*	88.7	89.0	89.0	89.0	89.3	89.0	89.1	89.0	88.8
120.00	*	89.7	90.0	90.0	89.9	90.1	89.9	90.0	89.9	89.7
125.00	*	90.4	90.7	90.7	90.7	90.8	90.7	90.8	90.7	90.5
130.00	*	91.2	91.3	91.4	91.3	91.4	91.3	91.4	91.3	91.2
135.00	*	91.9	91.8	91.9	91.9	92.0	91.9	91.9	91.8	91.8
140.00	*	92.3	92.3	92.4	92.5	92.4	92.4	92.4	92.3	92.3
145.00	*	92.8	92.8	92.8	92.9	92.8	92.9	92.8	92.8	92.7
150.00	*	93.1	93.2	93.2	93.3	93.3	93.3	93.3	93.2	93.1
155.00	*	93.5	93.6	93.6	93.6	93.7	93.6	93.6	93.6	93.5
160.00	*	93.9	93.9	93.9	93.9	94.0	93.9	93.9	93.9	93.9
165.00	*	94.3	94.2	94.3	94.3	94.2	94.3	94.3	94.2	94.2
170.00	*	94.6	94.5	94.6	94.6	94.5	94.6	94.5	94.5	94.5
175.00	*	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8
180.00	*	95.1	95.1	95.1	95.1	95.2	95.2	95.1	95.1	95.1
184.99	*	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
189.99	*	95.6	95.6	95.7	95.7	95.7	95.7	95.7	95.7	95.7
194.99	*	95.9	95.9	95.9	95.9	96.0	95.9	95.9	95.9	95.9
199.99	*	96.2	96.2	96.1	96.2	96.2	96.2	96.1	96.2	96.2

\*\*\*\*\*



D C POLARIZATION AVERAGE WAVELENGTH

REPEAT

CON VIS 0.46 K-PK 2.2 FREQ WAVEFRONT

B60

FIGURE B44

Wavefront Plot-Q Polarization

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature

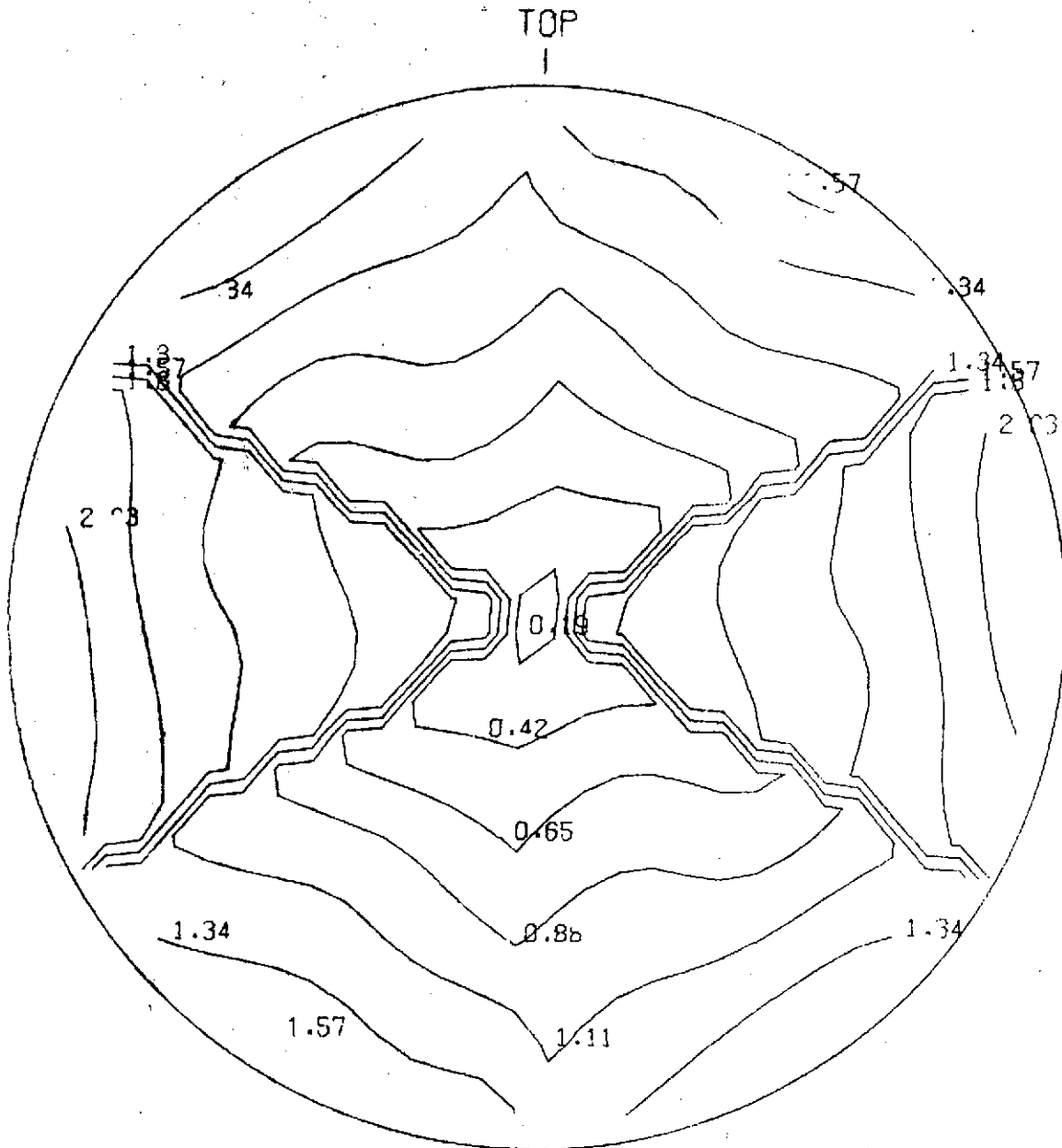




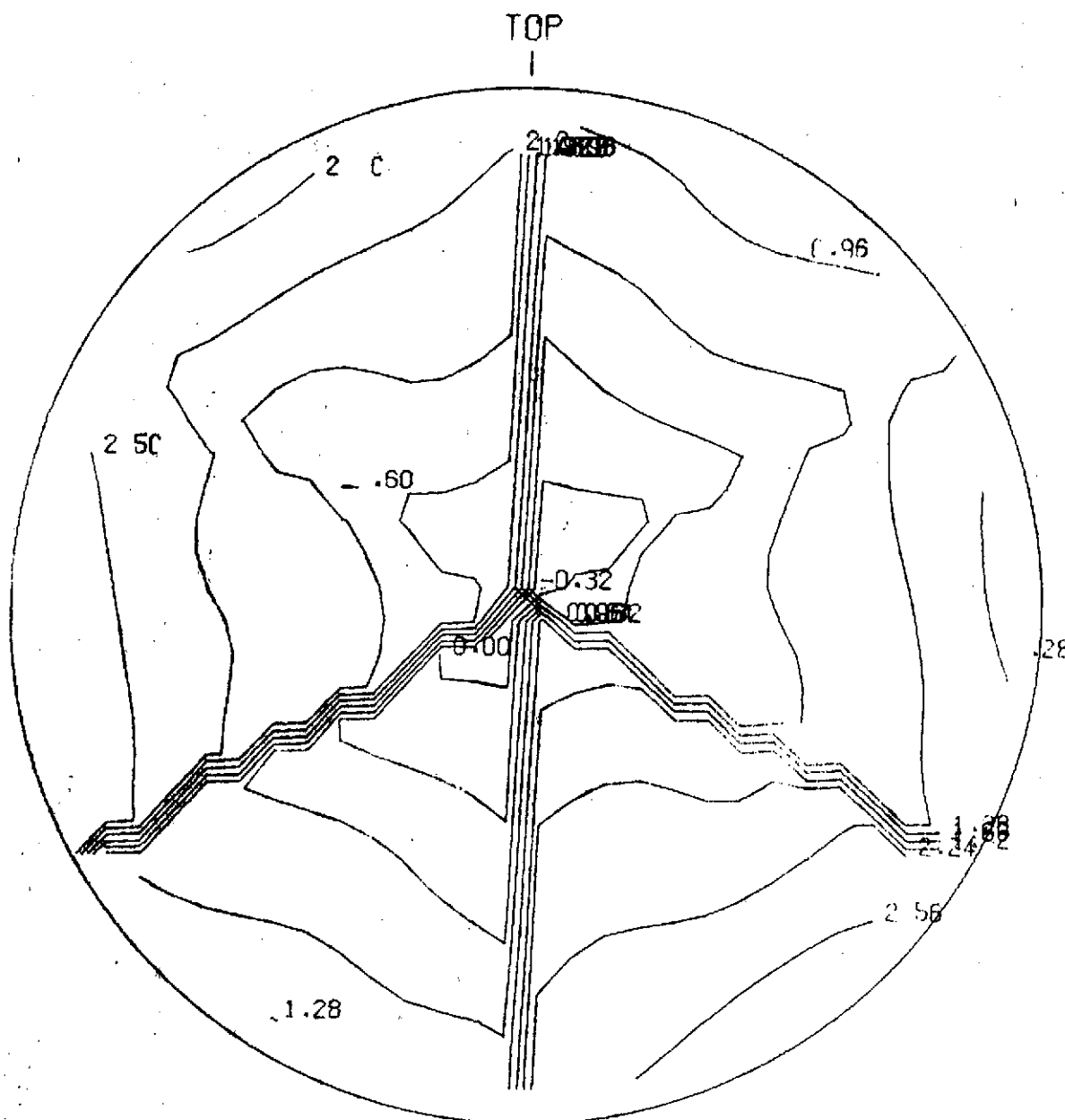


FIGURE 46

B62

Wavefront Plot-P Polarization

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature





IC  
IF  
NON

S 36

K-PK

9.75

RED

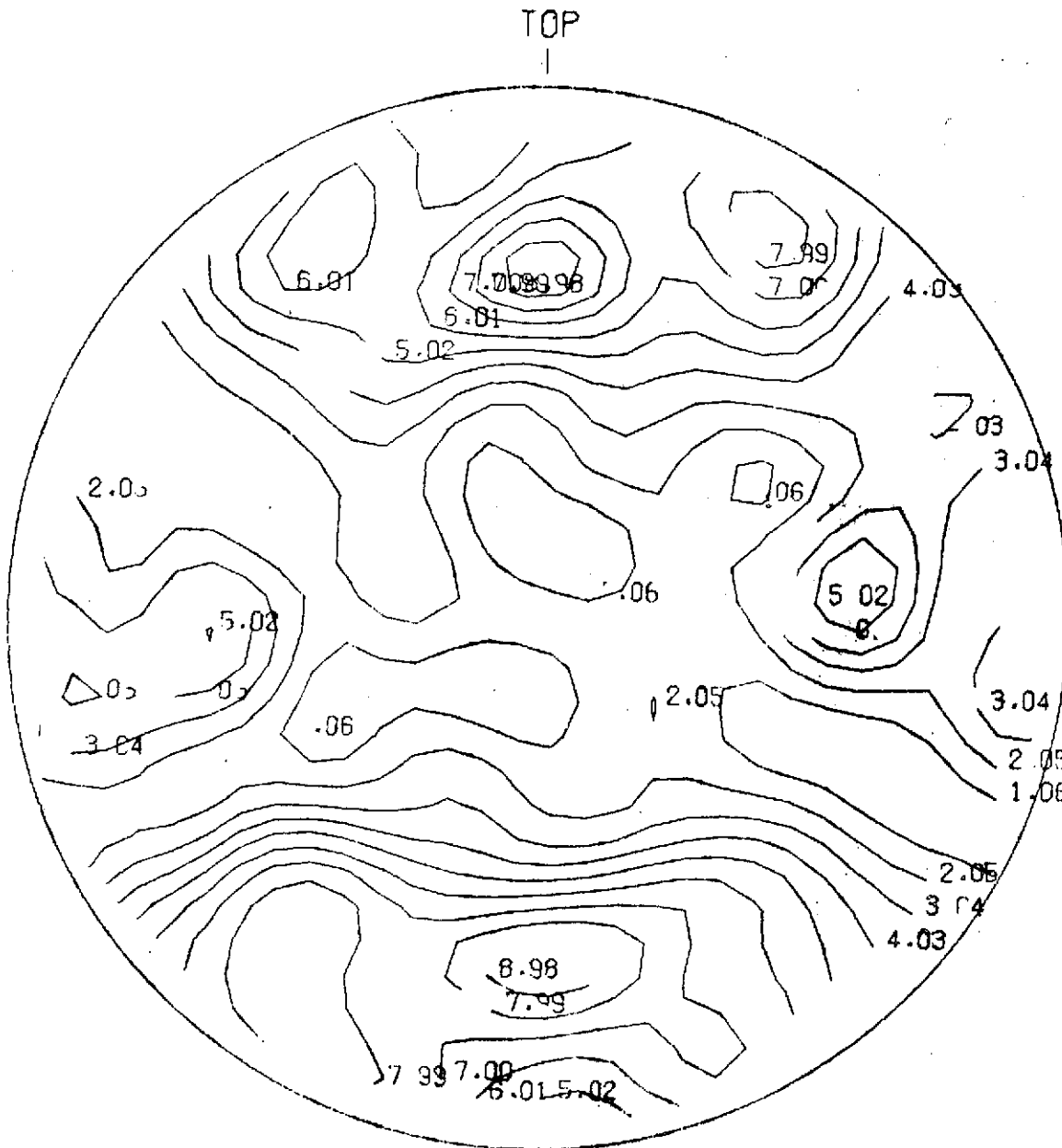
IV FRONT

FIGURE 48

B64

Intensity Distribution - Central 129 Microradians

Task 2.3A1 - Nominal + Mfg. Error + Second Temperature



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIGURE 49

Encircled Energy

Vs

Field Angle

Task 2.3A1 - Nominal

+ Mfg. Error + Second Temperature

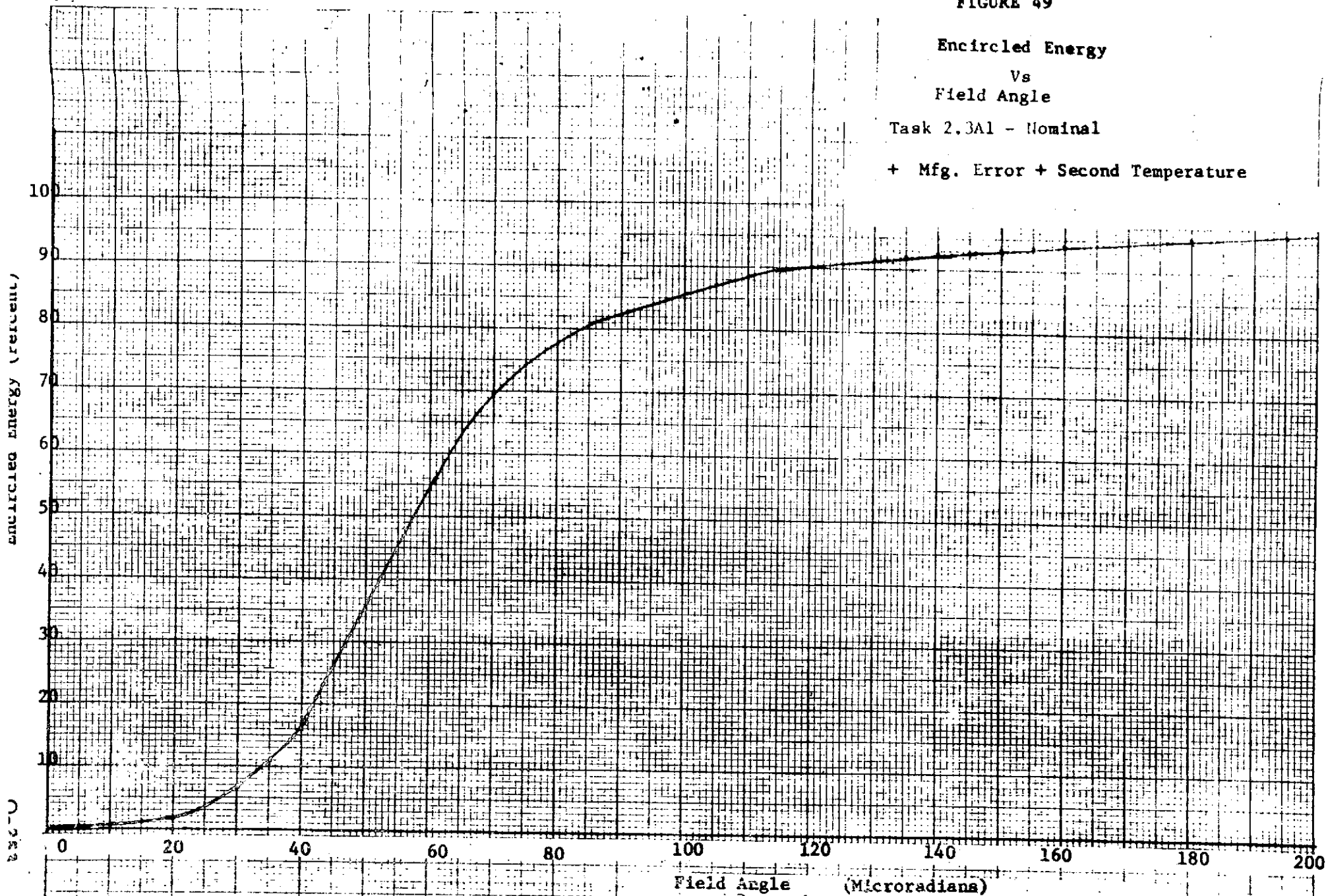


TABLE B16

ENCIRCLED ENERGY

\*\*\*\*\* Task 2.3A2 - Nominal + Mfg. Error + Third Temperature \*\*\*\*\*

CIRCLE \*  
 ----- \*  
 RADIUS \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 CPYNS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1
6.00	*	0.1	0.1	0.1	0.3	0.2	0.2	0.1	0.1	0.1
8.00	*	0.4	0.3	0.2	0.4	0.2	0.3	0.2	0.3	0.4
10.00	*	0.6	0.4	0.3	0.6	0.4	0.5	0.4	0.4	0.5
12.00	*	1.2	1.0	0.6	0.8	0.5	0.7	0.7	0.9	1.0
14.00	*	1.2	1.0	1.0	1.1	0.8	1.1	1.1	0.9	1.0
16.00	*	1.9	1.8	1.4	1.4	1.0	1.3	1.5	1.7	1.6
18.00	*	2.2	2.0	2.0	1.7	1.9	1.7	1.9	2.0	2.0
20.00	*	2.9	2.9	2.8	2.3	1.9	2.3	2.8	2.9	2.7
22.00	*	3.3	3.2	3.5	2.9	3.0	2.9	3.4	3.3	3.2
24.00	*	4.4	4.5	4.3	3.5	3.6	3.6	4.2	4.6	4.4
26.00	*	5.0	5.1	5.3	4.4	4.8	4.5	5.1	5.4	5.2
28.00	*	6.9	7.2	7.0	5.8	5.1	5.9	7.1	7.4	7.1
30.00	*	8.0	8.4	8.0	7.1	6.9	7.1	8.2	8.8	8.5
32.00	*	10.6	11.2	9.8	8.5	7.7	8.5	10.2	11.7	11.1
34.00	*	11.2	11.8	11.5	10.7	9.8	10.6	12.2	12.4	11.7
36.00	*	14.0	14.9	13.6	12.4	11.6	12.3	14.7	15.7	14.7
38.00	*	15.5	16.4	15.7	14.9	15.1	14.8	16.9	17.4	16.4
40.00	*	18.3	19.4	18.3	17.1	16.7	16.9	19.7	20.6	19.4
42.00	*	19.7	20.7	21.2	20.6	21.5	20.5	22.7	22.0	20.8
44.00	*	23.1	24.1	23.7	22.8	23.7	22.5	25.4	25.8	24.5
46.00	*	25.6	26.5	26.9	27.2	28.8	26.9	28.6	28.3	27.1
48.00	*	29.3	30.1	30.9	30.8	30.1	30.5	32.6	32.1	30.9
50.00	*	32.4	33.0	33.3	34.1	35.2	33.8	35.1	35.1	34.0
52.00	*	36.6	37.0	37.3	37.7	37.9	37.4	38.8	39.1	38.1
54.00	*	38.9	39.3	40.2	41.6	42.6	41.4	42.0	41.3	40.3
56.00	*	43.1	43.5	44.8	45.5	45.6	45.3	46.4	45.3	44.4
58.00	*	46.3	46.6	47.4	48.4	50.5	48.2	49.2	48.3	47.5
60.00	*	49.7	50.1	51.4	52.0	53.8	52.0	52.8	51.6	50.9
62.00	*	52.2	52.5	54.6	55.9	57.8	55.8	56.0	53.8	53.2
64.00	*	56.4	56.6	57.5	58.4	60.8	58.4	58.8	57.5	57.4
66.00	*	58.8	59.0	60.9	62.4	64.5	62.3	61.8	59.8	59.8
68.00	*	62.4	62.4	63.8	64.7	66.2	64.7	64.3	63.1	63.2
70.00	*	64.5	64.5	66.3	67.6	69.1	67.6	66.7	65.0	65.2
72.00	*	67.7	67.5	68.7	69.6	71.4	69.6	68.9	67.9	68.3
74.00	*	69.4	69.0	71.1	72.0	73.5	72.0	71.2	69.3	69.3
76.00	*	72.2	71.6	73.4	73.7	75.0	73.6	73.0	71.8	72.4
78.00	*	73.9	73.2	74.6	75.2	76.7	75.2	74.7	73.4	74.0
80.00	*	75.8	75.0	76.5	76.7	77.8	76.7	76.6	75.1	75.9

\*\*\*\*\*

TABLE B17

ENCIRCLED ENERGY

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

\*\*\*\*\*  
 CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 (MI- \*  
 CRNS) \*  
 \* CENTER (MICRONS):  
 \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*  
 \*\*\*\*\*

5.00	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1
10.00	0.6	0.4	0.3	0.6	0.4	0.5	0.4	0.4	0.5
15.00	1.6	1.5	1.2	1.3	1.0	1.3	1.3	1.4	1.4
20.00	2.9	2.9	2.8	2.3	1.9	2.3	2.8	2.9	2.7
25.00	4.8	4.9	5.1	4.3	4.1	4.3	4.9	5.1	4.7
30.00	8.0	8.4	8.0	7.1	6.9	7.1	8.2	8.8	8.7
35.00	12.8	13.6	12.5	11.2	11.1	11.1	13.2	14.3	13.5
40.00	18.3	19.4	18.3	17.1	16.7	16.9	19.7	20.6	19.4
45.00	24.5	25.5	25.5	25.7	26.7	25.4	27.2	27.2	25.7
50.00	32.4	33.0	33.3	34.1	35.2	33.8	35.1	35.1	34.0
55.00	41.6	42.0	42.8	43.5	44.9	43.3	44.5	43.8	43.0
60.00	49.7	50.1	51.4	52.0	53.8	52.0	52.9	51.6	50.7
65.00	57.5	57.7	59.6	60.8	63.0	60.8	60.6	58.6	58.4
70.00	64.5	64.5	66.3	67.6	69.1	67.6	66.7	65.0	65.2
75.00	71.0	70.5	72.3	72.9	74.3	72.9	72.4	70.8	71.3
80.00	75.8	75.0	76.5	76.7	77.8	76.7	76.6	75.1	75.9
85.00	79.2	78.2	79.7	79.9	80.6	79.9	79.9	78.4	79.3
90.00	81.8	80.9	81.9	82.3	82.6	82.3	82.1	81.2	82.0
95.00	83.9	83.4	83.8	84.1	84.3	84.1	83.9	83.4	84.0
100.00	85.4	85.2	85.4	85.6	85.8	85.7	85.5	85.2	85.4
105.00	86.5	86.6	86.8	86.9	87.1	87.0	86.8	86.6	86.6
110.00	87.7	87.8	88.0	88.0	88.3	88.1	88.0	87.9	87.8
115.00	88.7	89.0	89.0	88.9	89.2	89.0	89.0	89.0	88.8
120.00	89.6	89.9	89.9	89.8	90.0	89.8	89.9	89.9	89.6
125.00	90.3	90.6	90.6	90.5	90.7	90.6	90.7	90.6	90.4
130.00	91.0	91.2	91.2	91.2	91.3	91.2	91.3	91.2	91.1
135.00	91.8	91.7	91.8	91.8	91.9	91.8	91.8	91.7	91.7
140.00	92.3	92.2	92.3	92.4	92.3	92.4	92.3	92.3	92.3
145.00	92.7	92.8	92.8	92.8	92.8	92.8	92.8	92.8	92.7
150.00	93.1	93.2	93.2	93.2	93.3	93.3	93.2	93.2	93.1
155.00	93.5	93.6	93.6	93.6	93.7	93.6	93.6	93.6	93.5
160.00	93.9	93.9	93.9	93.9	94.0	93.9	94.0	94.0	93.9
165.00	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.2
170.00	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
175.00	94.9	94.9	94.9	94.9	94.9	94.9	94.9	94.9	94.9
180.00	95.2	95.2	95.2	95.2	95.3	95.2	95.2	95.2	95.2
184.99	95.4	95.5	95.4	95.5	95.5	95.5	95.5	95.5	95.5
189.99	95.7	95.7	95.7	95.8	95.8	95.8	95.8	95.8	95.7
194.99	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0
199.99	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2

\*\*\*\*\*





CC	C-CLASS	AV. THICK	W. THICK	W. THICK
NON	9	0.46	PK-PK	2.15

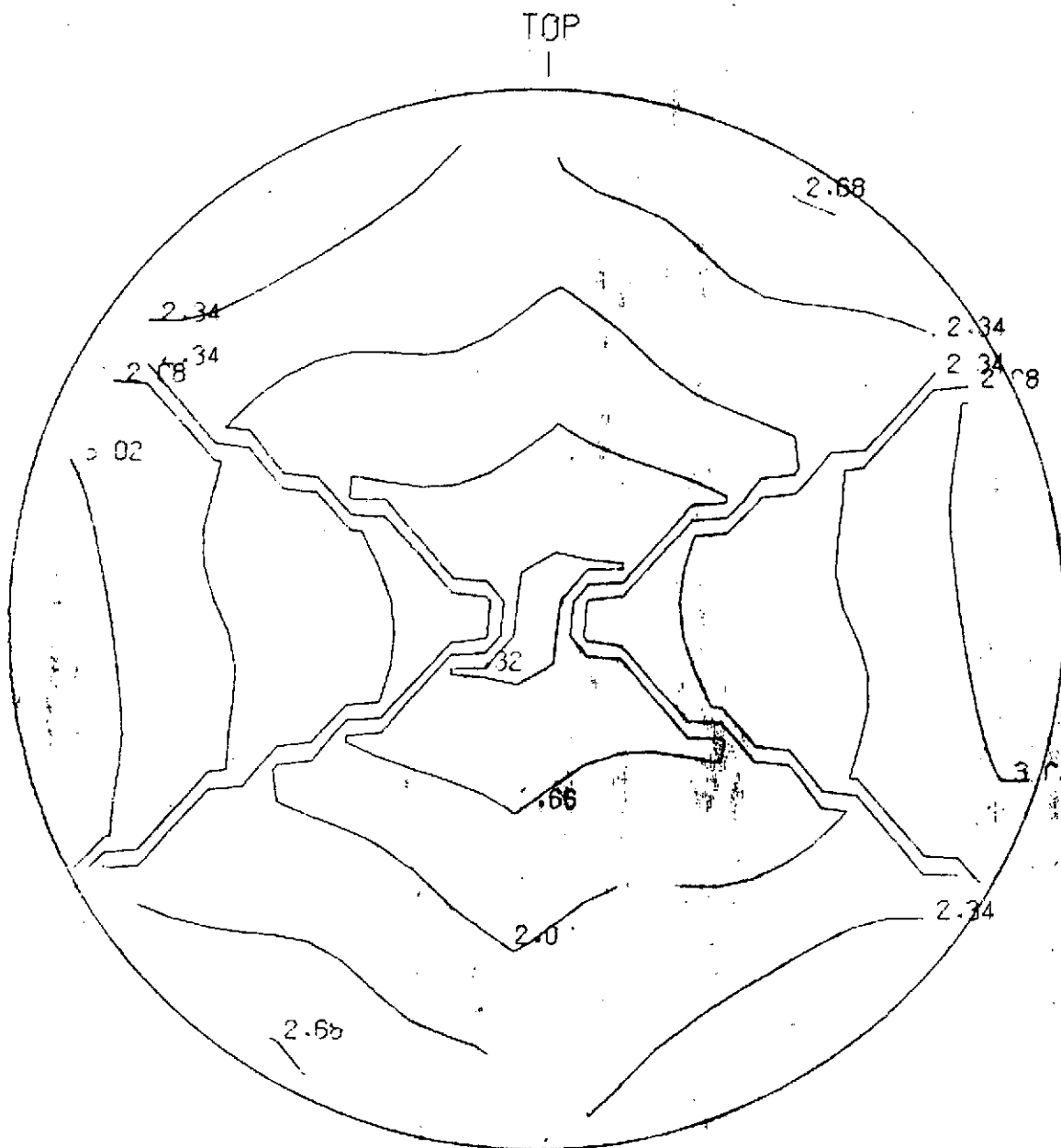
ED	WAV	CONT
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FIGURE B51

B69

Wavefront Plot-Q Polarization

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Wavefront Map - Polarisation  
Task 2.3A2 - Nominal + Mfg. Error + Third Temperature  
MAP IN UNITS OF 0.01 WAVES

362	353	346	340	335	198	201	204	206	212																				
380	372	363	354	347	340	334	328	194	199	201	203	208	217	227	236														
378	370	362	354	347	340	334	329	322	187	192	194	197	203	211	220	228	233												
373	367	360	352	345	338	334	330	325	320	177	183	187	190	196	203	211	216	220	221										
364	361	356	349	341	335	331	329	326	322	317	167	174	178	183	189	195	200	204	206	207	209								
352	352	350	343	336	330	326	324	322	320	317	311	156	162	169	176	182	188	192	193	194	195	198	200						
340	341	341	338	332	325	319	316	315	314	313	310	304	145	152	160	168	175	182	185	185	185	186	189	192	196				
356	332	332	331	327	321	314	308	305	306	306	306	302	297	137	144	151	159	167	173	177	176	179	179	181	185	189	226		
358	352	348	322	318	310	303	297	295	297	300	299	295	289	129	136	143	150	156	162	166	170	172	172	173	210	219	226		
361	359	349	343	310	302	292	286	286	289	292	291	287	280	122	127	132	138	143	148	154	159	164	166	199	210	220	228		
374	368	358	349	342	335	327	284	278	278	280	282	281	277	270	114	118	121	125	129	135	141	148	178	190	200	211	222	231	237
379	370	359	349	341	333	325	317	308	268	269	270	269	266	259	105	108	110	112	116	122	160	168	179	190	201	211	223	234	241
375	376	361	349	339	331	324	317	310	301	295	258	257	255	250	94	98	99	100	149	156	164	172	180	191	200	210	222	235	245
371	378	364	351	340	331	325	319	312	305	298	293	247	245	241	86	88	89	142	152	160	167	174	181	190	199	208	221	235	247
375	382	367	353	343	334	327	322	315	308	301	294	286	275	233	74	120	133	143	153	160	168	174	180	187	196	206	219	234	247
377	384	369	356	346	337	330	324	318	310	303	293	283	270	86	245	125	136	144	151	158	165	172	177	184	193	203	217	232	245
377	385	371	358	349	340	331	324	317	310	302	292	100	99	97	253	256	259	143	148	155	162	169	175	181	190	201	214	228	241
375	385	372	360	350	341	330	322	314	306	299	112	110	109	107	262	266	269	270	145	151	160	167	174	181	189	199	211	224	235
371	384	373	361	351	340	329	318	310	303	127	123	121	119	117	271	277	281	282	281	280	158	167	175	183	191	199	209	220	229
367	381	372	361	350	340	328	160	153	146	141	136	133	130	126	281	288	293	294	292	289	290	265	177	185	192	199	208	216	224
378	370	360	349	337	175	170	165	160	155	149	144	139	134	291	298	303	304	301	298	298	304	314	322	153	159	205	211		
378	369	360	349	338	184	183	181	178	173	168	161	154	147	141	300	307	311	312	309	307	309	314	322	329	333	198	202	208	
376	380	366	352	340	190	190	189	185	178	171	163	155	148	308	314	317	318	318	317	320	325	332	338	342	344	344	206		
207	204	200	198	197	197	197	193	187	179	171	164	156	316	321	325	326	326	328	331	337	343	349	353	353	352				
212	209	207	206	205	203	200	194	187	181	174	167	323	329	332	334	336	337	342	348	355	361	364	364						
220	219	217	215	212	207	200	195	190	185	178	329	334	338	340	343	347	353	360	368	373	376								
233	231	228	222	215	207	202	198	195	189	331	337	342	346	350	354	364	372	379	384										
249	239	232	223	215	209	204	203	198	334	340	346	352	358	366	374	382	389												
267	258	250	220	215	212	210	206	340	346	352	359	366	375	383	392														
323	218	215	213	209	347	352	358	365	373																				

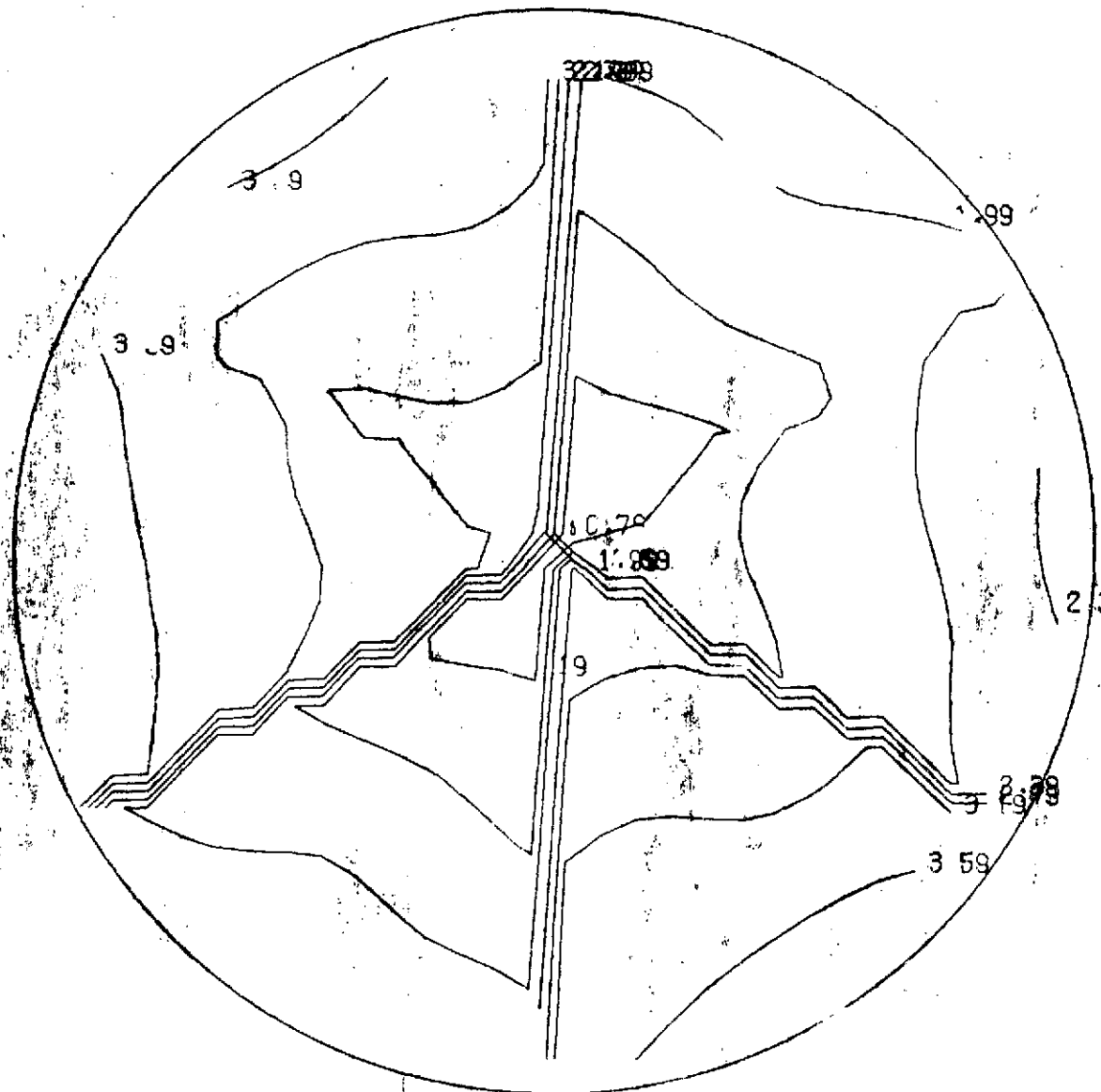
Q-253

FIGURE B53

Wavefront Plot-P Polarization

Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

TOP



REPRODUCIBILITY OF THIS ORIGINAL PAGE IS POOR



FIGURE B55

B73

Intensity Distribution - Central 129 Microradians  
Task 2.3A2 - Nominal + Mfg. Error + Third Temperature

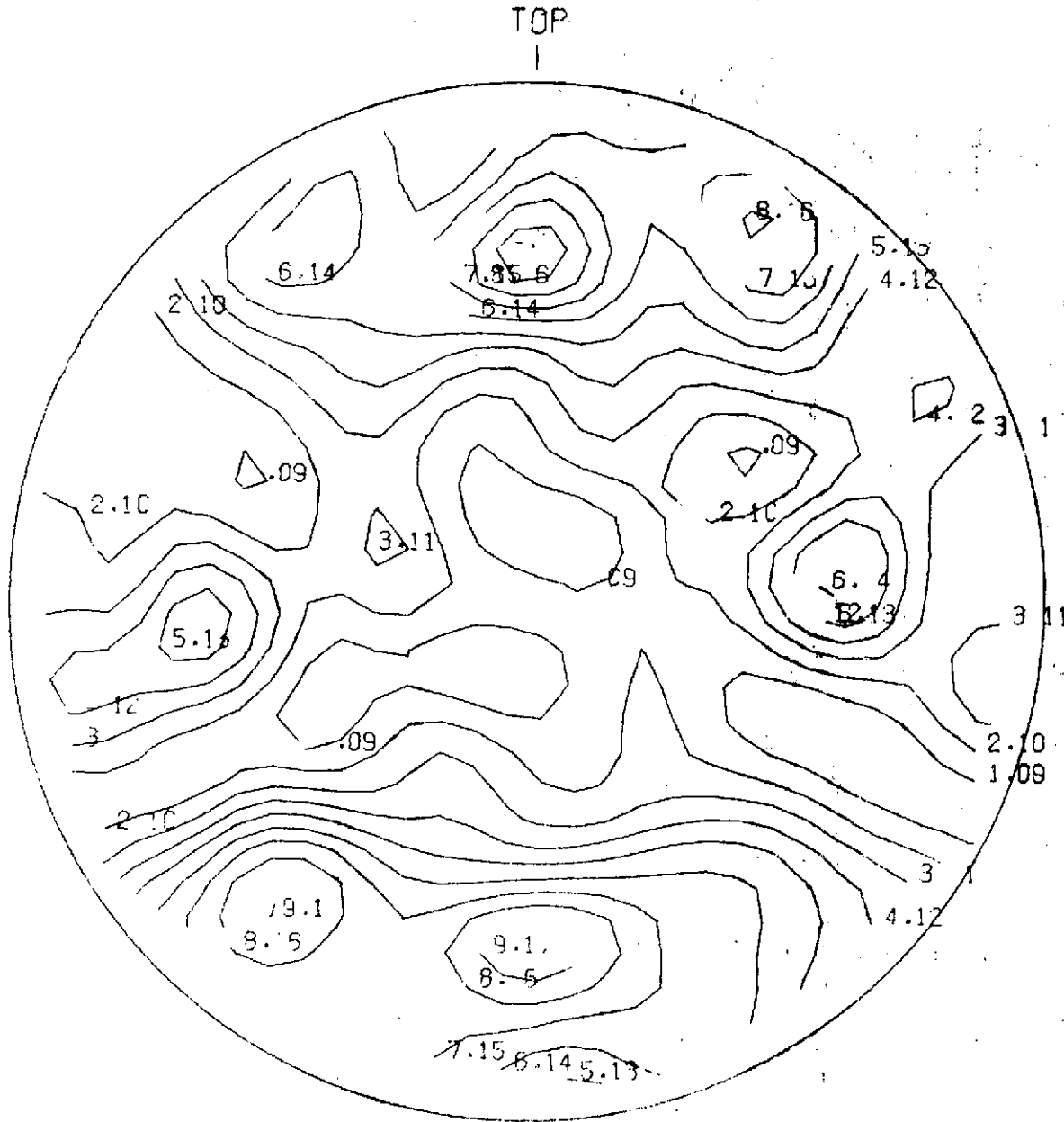
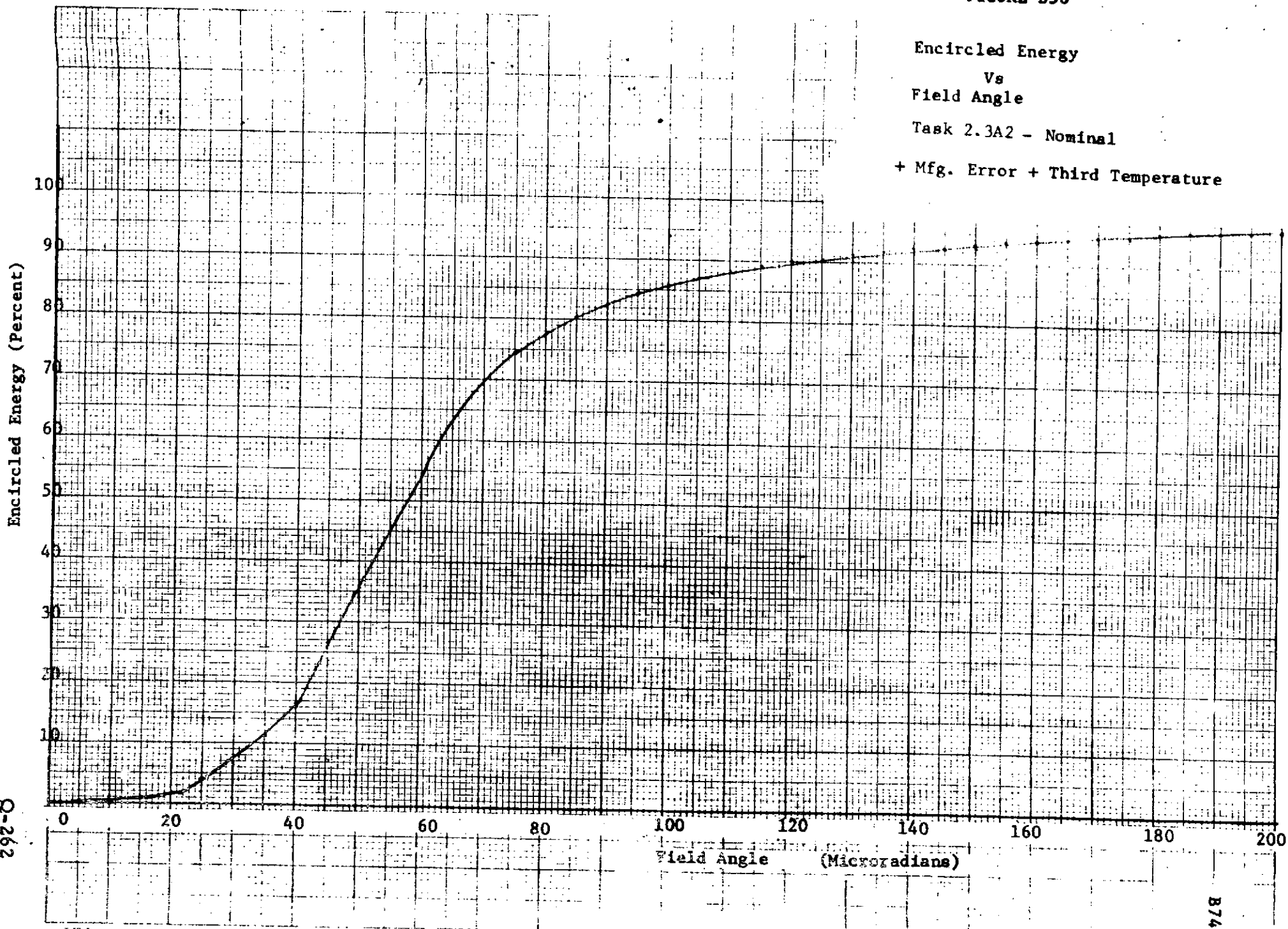


FIGURE B56



Q-262

TABLE B18

ENCIRCLED ENERGY

Task 2.5A - Nominal + Mfg. Error + Axial Gradient

CIRCLE	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
RADIUS	CENTER (MICRONS):									
(MI-CP7NS)	X=	-10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13
	Y=	-10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13
2.00	*	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0
4.00	*	0.2	0.2	0.1	0.1	0.0	0.0	0.1	0.3	0.3
6.00	*	0.2	0.2	0.5	0.4	0.2	0.2	0.6	0.3	0.3
8.00	*	0.9	0.9	0.9	0.6	0.2	0.3	1.0	1.1	0.9
10.00	*	1.2	1.3	1.4	0.9	0.6	0.6	1.6	1.6	1.3
12.00	*	2.8	2.9	2.3	1.4	0.7	1.0	2.6	3.3	2.8
14.00	*	2.8	2.9	3.3	2.4	1.5	2.0	3.8	3.3	2.8
16.00	*	4.7	5.0	4.5	3.0	2.1	2.7	5.1	5.5	4.6
18.00	*	5.6	5.8	5.7	4.4	5.0	4.1	6.4	6.4	5.6
20.00	*	7.4	7.8	7.7	5.7	5.0	5.6	8.5	8.5	7.5
22.00	*	8.2	8.6	9.4	7.9	9.0	7.9	10.1	9.4	8.5
24.00	*	10.6	11.2	11.1	9.2	10.5	9.3	11.8	12.1	11.1
26.00	*	11.8	12.4	13.2	12.1	14.5	12.3	13.8	13.5	12.7
28.00	*	15.0	16.0	16.5	15.3	15.5	15.5	17.6	17.1	16.1
30.00	*	17.1	18.1	18.6	18.3	19.6	18.5	19.4	19.7	18.7
32.00	*	21.6	22.9	22.0	20.9	21.4	21.1	23.2	24.5	23.2
34.00	*	22.5	24.0	24.6	25.0	24.8	25.1	26.2	25.6	24.2
36.00	*	27.4	29.0	28.4	27.8	27.9	27.8	30.5	30.6	29.0
38.00	*	29.5	31.2	31.3	31.5	32.8	31.5	33.3	33.1	31.4
40.00	*	33.7	35.2	34.9	34.6	35.1	34.5	37.4	37.1	35.6
42.00	*	35.6	37.2	38.5	39.2	41.2	39.1	40.9	39.1	37.5
44.00	*	40.0	41.1	41.6	41.6	43.9	41.2	44.1	43.1	42.0
46.00	*	42.9	43.6	45.0	46.7	49.9	46.4	47.3	45.7	44.9
48.00	*	47.0	47.3	49.2	50.4	51.2	50.0	51.2	49.4	48.8
50.00	*	50.1	50.2	51.6	53.6	56.2	53.3	53.2	52.2	51.9
52.00	*	54.2	53.7	55.5	57.0	58.4	56.7	56.8	55.5	55.7
54.00	*	56.4	55.9	58.1	60.2	61.9	60.1	59.2	57.6	57.6
56.00	*	60.3	59.6	62.2	63.3	64.1	63.3	62.8	60.9	61.2
58.00	*	63.0	62.3	64.0	65.4	67.3	65.2	64.8	63.3	63.5
60.00	*	65.7	65.0	67.2	67.9	69.4	67.9	67.6	65.8	66.2
62.00	*	67.6	66.9	69.0	70.2	71.8	70.2	69.6	67.5	67.9
64.00	*	70.3	69.7	71.1	71.6	73.4	71.7	71.6	70.0	70.6
66.00	*	71.9	71.4	73.0	73.8	75.5	73.8	73.4	71.6	72.2
68.00	*	74.0	73.4	74.7	75.1	76.3	75.1	75.0	73.6	74.3
70.00	*	75.1	74.6	76.1	76.7	77.8	76.6	76.3	74.8	75.5
72.00	*	77.0	76.4	77.4	77.7	78.7	77.7	77.5	76.5	77.3
74.00	*	77.9	77.2	78.6	79.0	79.7	79.0	78.6	77.3	78.1
76.00	*	79.4	78.7	79.8	79.9	80.3	79.9	79.7	78.8	79.5
78.00	*	80.3	79.6	80.4	80.7	81.1	80.6	80.4	79.7	80.3
80.00	*	81.4	80.6	81.4	81.4	81.7	81.4	81.4	80.7	81.4

TABLE B19

E N C I R C L E D      E N E R G Y

Task 2.5A - Nominal + Mfg. Error + Axial Gradient

\*\*\*\*\*

CIRCLE	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
RADIUS	-----									
(MI- CENTS)	CENTER (MICRONS):									
	X= -10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13	
	Y= -10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13	
5.00	0.2	0.2	0.4	0.3	0.1	0.1	0.4	0.3	0.3	
10.00	1.2	1.3	1.4	0.9	0.6	0.6	1.6	1.6	1.3	
15.00	3.9	4.2	4.1	2.6	2.1	2.3	4.7	4.6	3.8	
20.00	7.4	7.8	7.7	5.7	5.0	5.6	8.5	8.5	7.5	
25.00	11.3	12.0	12.6	11.8	12.4	12.0	13.2	13.0	12.1	
30.00	17.1	18.1	18.6	18.3	19.6	18.5	19.4	19.7	19.7	
35.00	25.6	27.0	26.6	25.8	27.1	25.8	28.2	28.4	27.1	
40.00	33.7	35.2	34.9	34.6	35.1	34.5	37.4	37.1	35.6	
45.00	41.6	42.6	43.4	45.0	47.5	44.7	45.9	44.7	43.5	
50.00	50.1	50.2	51.6	53.6	56.2	53.3	53.2	52.2	51.9	
55.00	59.0	58.2	60.6	61.8	63.7	61.7	61.4	59.6	59.9	
60.00	65.7	65.0	67.2	67.9	69.4	67.9	67.6	65.8	66.2	
65.00	71.0	70.4	72.3	73.0	74.7	73.0	72.7	70.8	71.3	
70.00	75.1	74.6	76.1	76.7	77.8	76.6	76.3	74.8	75.5	
75.00	78.7	78.1	79.2	79.5	80.0	79.5	79.3	78.2	78.9	
80.00	81.4	80.6	81.4	81.4	81.7	81.4	81.4	80.7	81.4	
85.00	83.1	82.5	83.1	83.2	83.3	83.2	83.3	82.6	83.2	
90.00	84.5	84.2	84.6	84.8	84.8	84.8	84.8	84.4	84.7	
95.00	85.9	85.9	85.9	86.1	86.4	86.2	86.1	86.0	86.1	
100.00	87.0	87.3	87.3	87.4	87.8	87.5	87.4	87.2	87.1	
105.00	88.0	88.3	88.5	88.5	88.8	88.6	88.5	88.3	88.1	
110.00	89.1	89.3	89.4	89.4	89.6	89.4	89.4	89.3	89.1	
115.00	90.0	90.1	90.1	90.1	90.2	90.1	90.1	90.1	90.0	
120.00	90.6	90.7	90.7	90.8	90.8	90.7	90.8	90.8	90.7	
125.00	91.2	91.2	91.3	91.3	91.4	91.3	91.4	91.3	91.3	
130.00	91.8	91.7	91.8	91.9	92.0	91.9	91.9	91.8	91.9	
135.00	92.3	92.3	92.3	92.3	92.5	92.3	92.3	92.3	92.2	
140.00	92.7	92.7	92.8	92.8	92.8	92.8	92.8	92.8	92.7	
145.00	93.1	93.1	93.1	93.2	93.2	93.2	93.2	93.1	93.1	
150.00	93.4	93.4	93.5	93.5	93.5	93.5	93.5	93.5	93.4	
155.00	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	
160.00	94.2	94.1	94.1	94.1	94.1	94.1	94.0	94.1	94.1	
165.00	94.4	94.4	94.5	94.4	94.4	94.4	94.4	94.4	94.4	
170.00	94.7	94.7	94.8	94.7	94.8	94.7	94.8	94.7	94.7	
175.00	95.0	95.0	95.0	95.0	95.0	95.0	95.1	95.0	95.0	
180.00	95.2	95.2	95.3	95.3	95.4	95.3	95.3	95.3	95.3	
184.99	95.5	95.5	95.5	95.6	95.6	95.6	95.5	95.6	95.6	
189.99	95.7	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	
194.99	96.0	96.0	96.0	96.0	96.1	96.0	96.0	96.0	96.0	
199.99	96.2	96.3	96.2	96.2	96.2	96.2	96.2	96.2	96.3	

\*\*\*\*\*





FIGURE B58

B78

Wavefront Plot-Q Polarization

Task 2.5A - Nominal + Mfg. Error + Axial Gradient

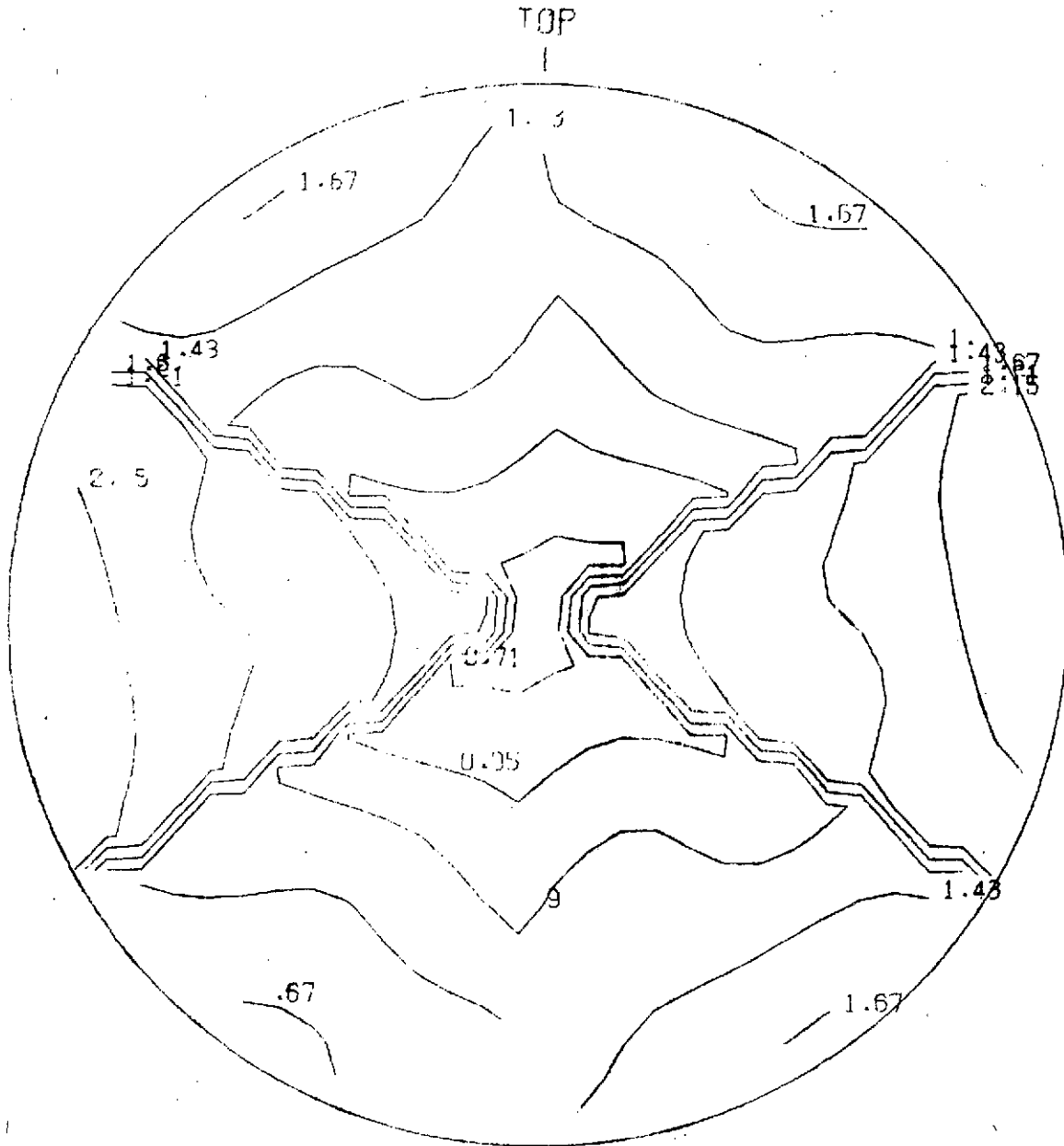






FIGURE B61

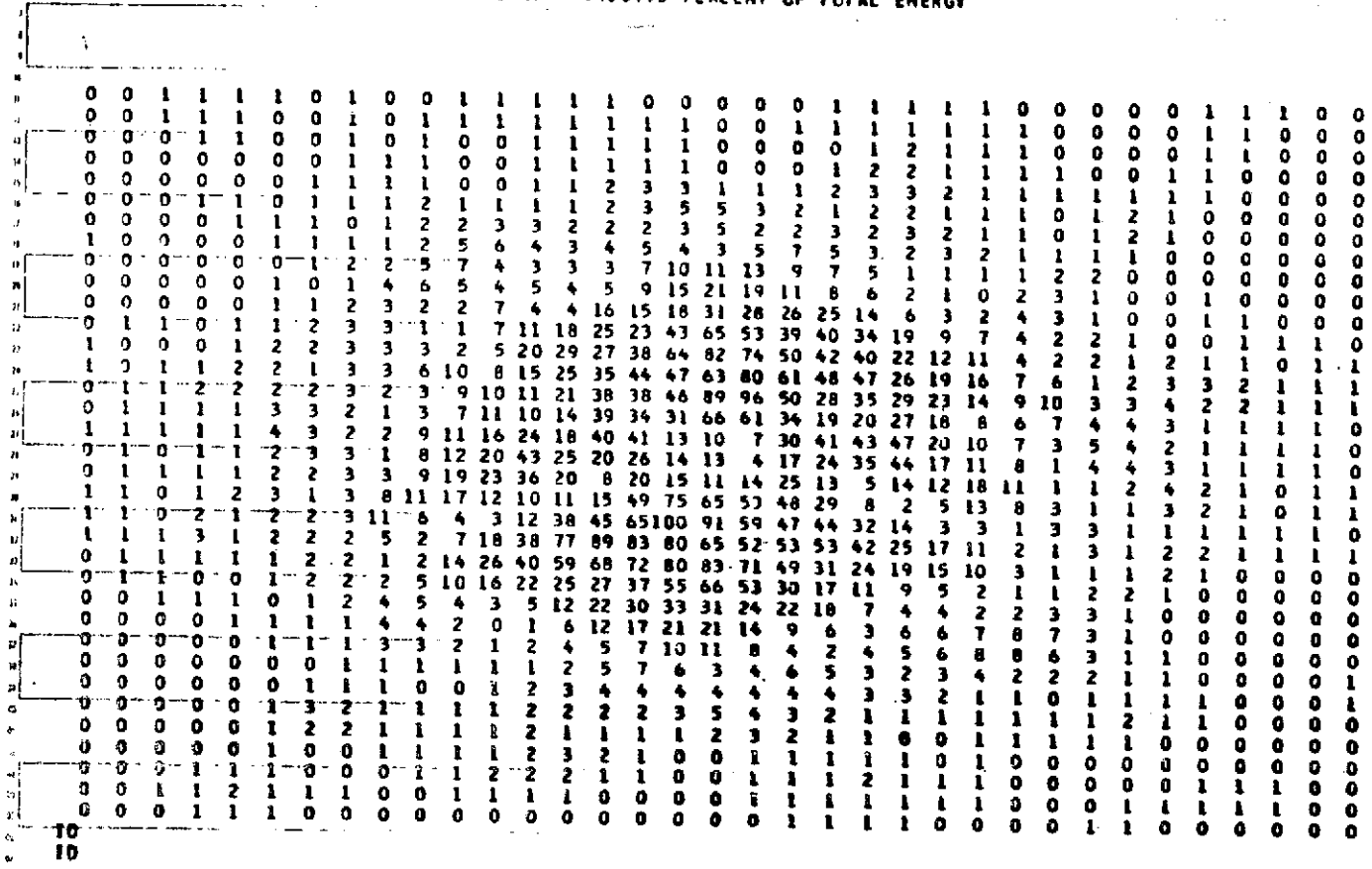
Task 2.5A - Nominal + Mfg. Error + Axial Gradient

PRINTER MAP OF POINT SPREAD FUNCTION

(ONE SPACE REPRESENTS 8.04 MICRONS)  
 NORMALIZED SD LARGEST VALUE = 0.0285 = 100  
 TOTAL ENERGY = 0.24610000+01

MAP REPRESENTS 0.23145650+01 OR 94.0498 PERCENT OF TOTAL ENERGY

B81



Q-269



FIGURE B62

B82

Intensity Distribution - Central 129 Microradians

Task 2.5A - Nominal + Mfg. Error + Axial Gradient

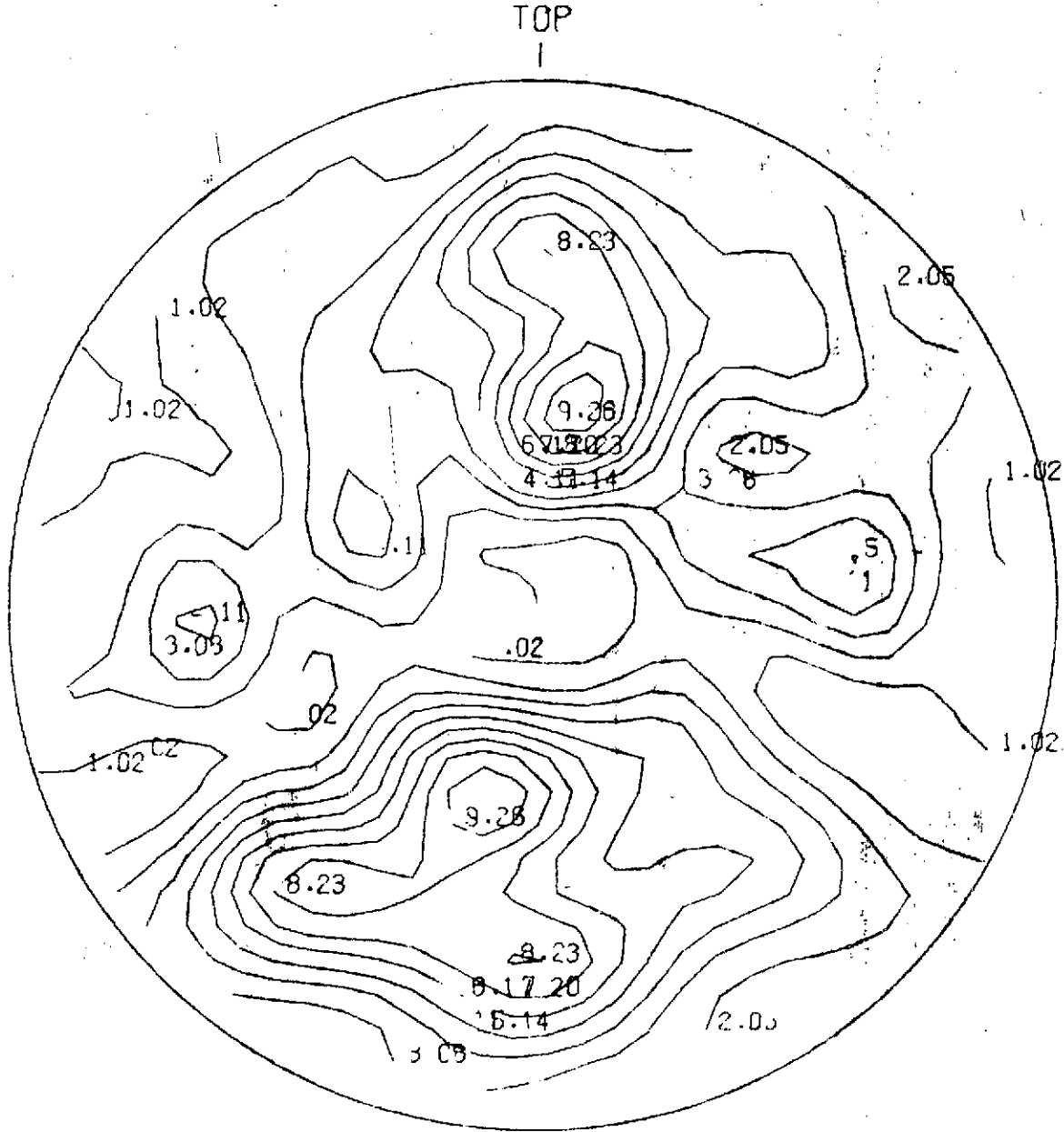
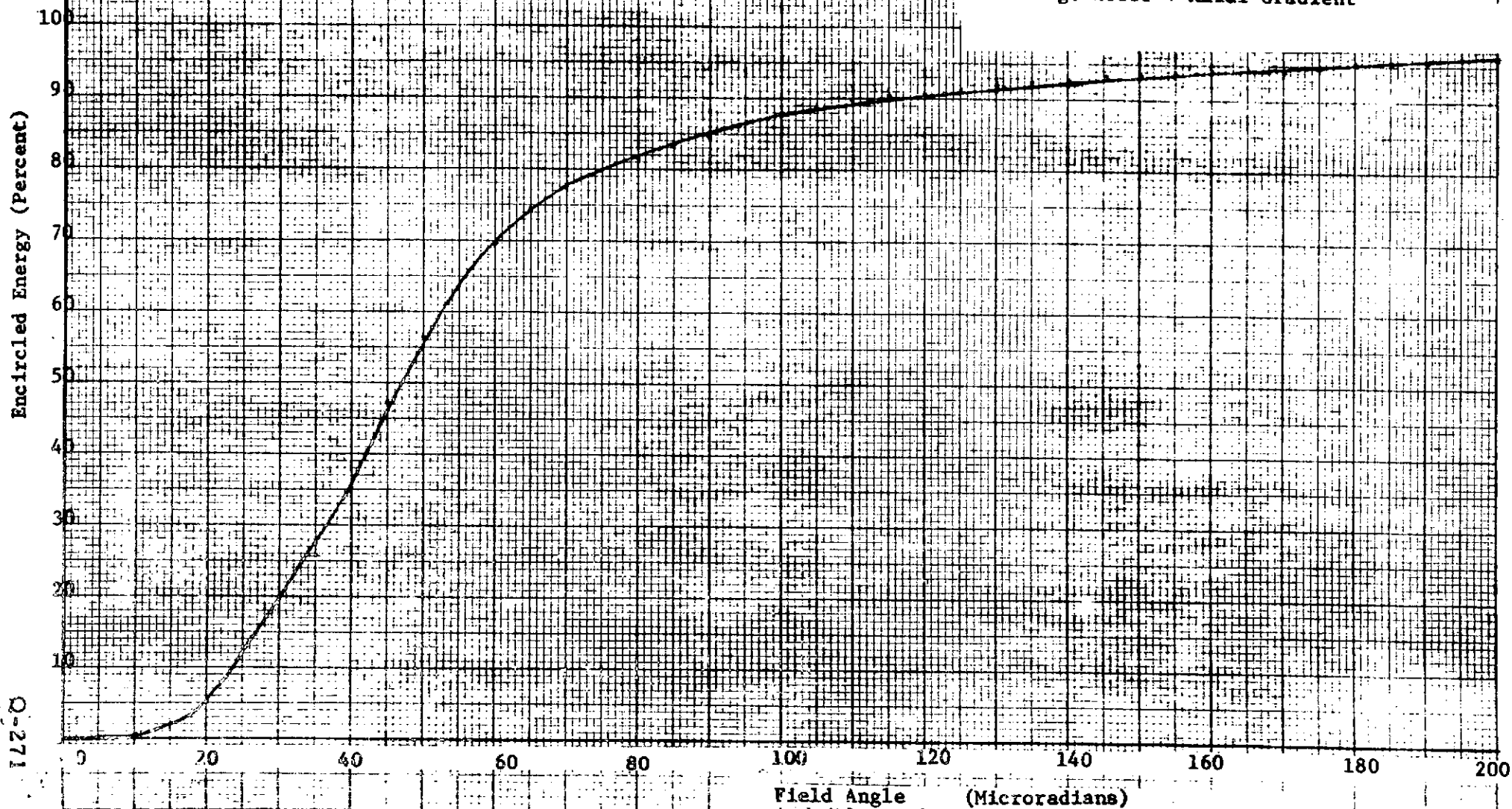


FIGURE B63

Encircled Energy  
Vs  
Field Angle

Task 2.5A - Nominal

+ Mfg. Error + Axial Gradient



Q-271



TABLE B20

ENCIRCLED ENERGY

Task 2.5B - Nominal + Mfg. Error + Radial Gradient

\*\*\*\*\*

CIRCLE \*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \*

(MI- CENTER (MICRONS):

\* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
6.00	*	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0
8.00	*	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.2	0.1
10.00	*	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2
12.00	*	0.3	0.3	0.3	0.2	0.1	0.1	0.3	0.4	0.3
14.00	*	0.3	0.3	0.4	0.3	0.3	0.3	0.5	0.4	0.3
16.00	*	0.5	0.4	0.4	0.4	0.3	0.4	0.5	0.6	0.5
18.00	*	0.6	0.5	0.5	0.6	0.6	0.5	0.7	0.6	0.6
20.00	*	0.8	0.7	0.7	0.7	0.6	0.7	0.8	0.7	0.8
22.00	*	0.9	0.7	0.8	0.9	1.0	0.9	0.9	0.8	0.9
24.00	*	1.1	0.9	1.0	1.1	1.1	1.0	1.0	1.0	1.1
26.00	*	1.2	1.0	1.2	1.3	1.4	1.2	1.2	1.1	1.2
28.00	*	1.5	1.2	1.5	1.5	1.5	1.5	1.4	1.3	1.5
30.00	*	1.7	1.4	1.6	1.7	1.8	1.7	1.6	1.4	1.7
32.00	*	2.1	1.8	1.9	1.9	1.9	1.8	1.8	1.8	2.0
34.00	*	2.2	1.9	2.1	2.1	2.1	2.1	2.1	1.9	2.1
36.00	*	2.7	2.4	2.4	2.3	2.3	2.3	2.4	2.5	2.6
38.00	*	2.9	2.7	2.7	2.6	2.5	2.6	2.7	2.7	2.9
40.00	*	3.5	3.4	3.2	2.9	2.7	2.9	3.2	3.4	3.5
42.00	*	3.7	3.7	3.7	3.3	3.1	3.4	3.8	3.8	3.8
44.00	*	4.6	4.6	4.2	3.8	3.4	3.8	4.3	4.7	4.7
46.00	*	5.2	5.3	4.8	4.4	4.0	4.4	5.1	5.5	5.4
48.00	*	6.1	6.3	5.7	5.2	4.4	5.1	6.0	6.6	6.3
50.00	*	7.0	7.2	6.5	6.0	5.6	5.9	7.0	7.6	7.3
52.00	*	8.3	8.5	7.5	7.0	6.3	6.9	8.0	9.1	8.6
54.00	*	9.0	9.4	8.8	8.2	8.0	8.1	9.3	10.0	9.4
56.00	*	10.7	11.0	10.5	9.8	9.0	9.7	11.1	11.8	11.1
58.00	*	12.1	12.5	12.0	11.3	11.1	11.1	12.6	13.4	12.6
60.00	*	14.2	14.8	14.0	13.3	12.8	13.1	14.7	15.8	14.8
62.00	*	15.5	16.0	16.3	15.6	15.0	15.4	17.1	17.1	16.1
64.00	*	18.7	19.3	18.1	17.8	17.1	17.5	19.0	20.4	19.3
66.00	*	20.5	21.2	20.8	20.9	20.0	20.6	21.8	22.4	21.2
68.00	*	23.7	24.4	23.2	23.0	21.9	22.8	24.3	25.6	24.4
70.00	*	26.0	26.6	26.2	26.4	25.5	26.1	27.4	28.0	26.8
72.00	*	29.3	30.0	28.5	29.1	29.1	28.9	29.7	31.3	30.1
74.00	*	31.3	32.0	32.4	32.5	33.1	32.3	33.6	33.3	32.1
76.00	*	34.6	35.4	35.6	35.6	36.2	35.4	36.8	36.6	35.6
78.00	*	37.4	38.0	38.5	38.5	40.1	38.3	39.6	39.2	38.4
80.00	*	40.5	41.3	41.9	42.2	43.2	42.1	43.0	42.4	41.5

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.5B - Nominal + Mfg. Error + Radial Gradient

\*\*\*\*\*

CIRCLE \*  
 ----- \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*

(MIL- \* CENTER (MICRONS):  
 CRVS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	*	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0
10.00	*	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2
15.00	*	0.4	0.4	0.4	0.3	0.3	0.3	0.5	0.5	0.5
20.00	*	0.8	0.7	0.7	0.7	0.6	0.7	0.8	0.7	0.8
25.00	*	1.2	1.0	1.1	1.3	1.2	1.2	1.2	1.0	1.2
30.00	*	1.7	1.4	1.6	1.7	1.8	1.7	1.6	1.4	1.7
35.00	*	2.5	2.2	2.3	2.2	2.3	2.2	2.2	2.2	2.4
40.00	*	3.5	3.4	3.2	2.9	2.7	2.9	3.2	3.4	3.5
45.00	*	4.9	4.9	4.5	4.1	3.8	4.1	4.7	5.1	5.0
50.00	*	7.0	7.2	6.5	6.0	5.6	5.9	7.0	7.6	7.3
55.00	*	10.1	10.5	9.6	9.1	8.7	8.9	10.2	11.2	10.5
60.00	*	14.2	14.8	14.0	13.3	12.8	13.1	14.7	15.8	14.8
65.00	*	19.5	20.2	19.7	19.4	18.9	19.2	20.6	21.3	20.2
70.00	*	26.0	26.6	26.2	26.4	25.5	26.1	27.4	28.0	26.8
75.00	*	33.1	34.0	33.7	34.3	34.5	34.1	35.0	35.2	34.0
80.00	*	40.5	41.3	41.9	42.2	43.2	42.1	43.0	42.4	41.5
85.00	*	48.2	48.7	50.2	50.9	51.8	50.9	50.9	49.4	49.0
90.00	*	55.9	56.0	57.1	58.1	59.4	58.2	57.6	56.6	56.4
95.00	*	62.8	62.4	63.5	64.3	65.7	64.4	63.7	62.6	63.1
100.00	*	68.3	67.5	69.0	69.4	70.6	69.5	69.2	67.6	68.6
105.00	*	72.8	71.8	73.3	73.6	74.7	73.7	73.4	71.6	73.0
110.00	*	76.7	75.7	76.7	77.0	77.8	77.0	76.7	75.8	76.8
115.00	*	79.8	79.0	79.5	80.0	80.2	80.0	79.7	79.1	79.8
120.00	*	82.1	81.7	82.1	82.5	82.5	82.5	82.3	81.8	82.3
125.00	*	84.8	83.8	84.3	84.4	84.9	84.5	84.5	83.9	84.2
130.00	*	85.7	85.8	86.2	86.2	86.8	86.3	86.3	85.9	85.9
135.00	*	87.6	87.4	87.6	87.7	88.1	87.7	87.6	87.4	87.6
140.00	*	88.8	88.7	89.2	89.2	89.4	89.3	89.3	88.8	88.9
145.00	*	90.0	89.6	90.0	90.1	90.1	90.1	90.1	89.7	90.0
150.00	*	90.9	90.6	91.0	90.9	91.1	90.9	91.0	90.7	90.9
155.00	*	91.6	91.5	91.7	91.6	91.8	91.6	91.6	91.5	91.6
160.00	*	92.4	92.3	92.3	92.3	92.2	92.3	92.2	92.2	92.3
165.00	*	92.9	92.9	93.0	92.9	92.9	92.9	93.0	92.8	92.8
170.00	*	93.3	93.3	93.5	93.4	93.6	93.4	93.5	93.3	93.3
175.00	*	93.9	93.9	94.0	93.9	94.0	93.9	94.0	93.9	93.9
180.00	*	94.3	94.3	94.4	94.4	94.5	94.4	94.4	94.4	94.3
184.99	*	94.8	94.8	94.7	94.8	94.8	94.8	94.7	94.8	94.7
189.99	*	95.1	95.1	95.1	95.2	95.2	95.2	95.1	95.1	95.1
194.99	*	95.5	95.5	95.5	95.5	95.5	95.5	95.4	95.4	95.5
199.99	*	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8

\*\*\*\*\*

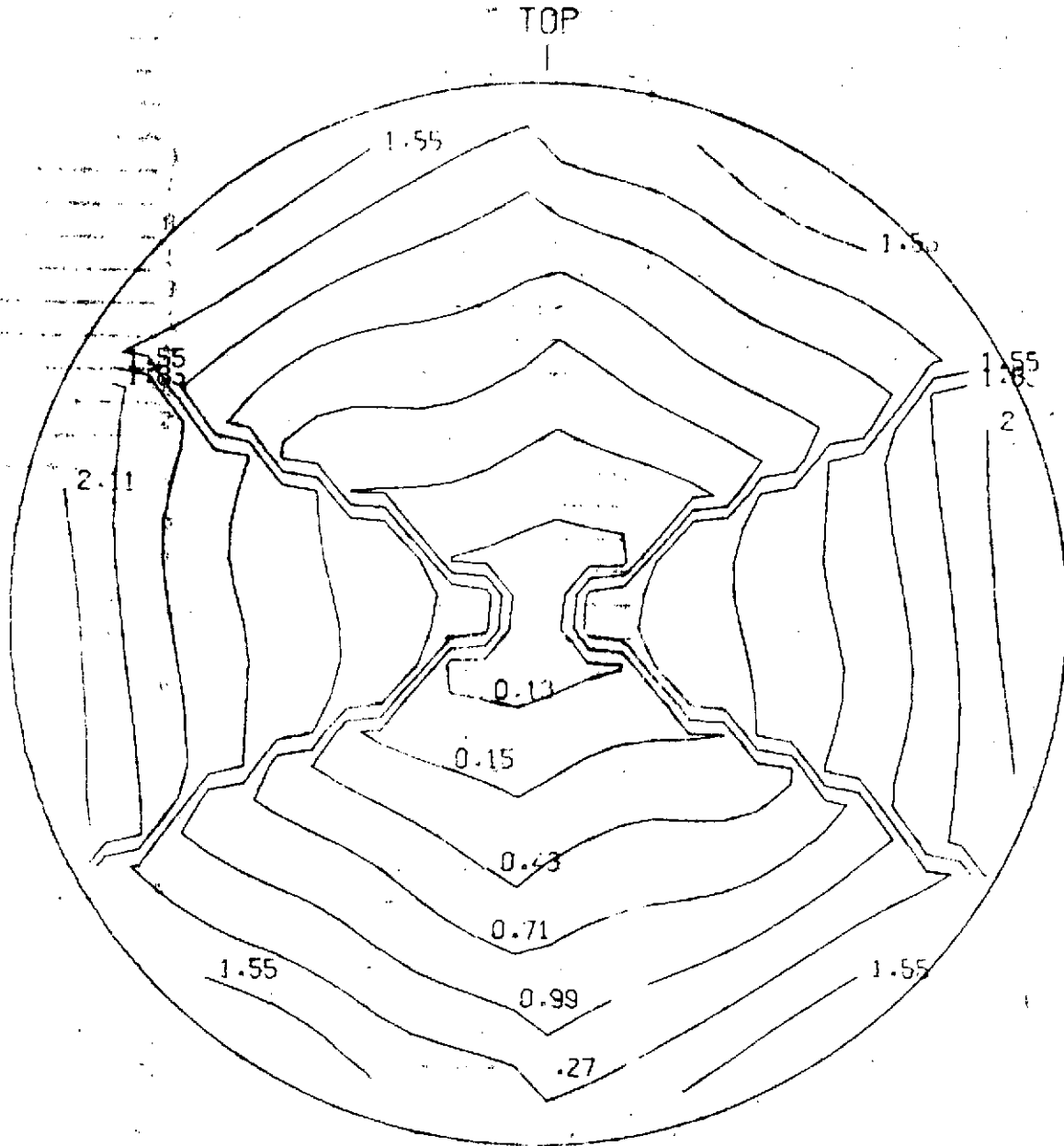


FIGURE B65

B87

Wavefront Plot-Q Polarization

Task 2.5B - Nominal + Mfg. Error + Radial Gradient





ADC P POLARI AV AG. VERRAGE VERRAGE VERRAGE  
MICR RMS 0.91 PK-PK 3 5. FREQ WAVEFRONT

FIGURE B67

B89

Wavefront Plot-P Polarization  
Task 2.5B - Nominal + Mfg. Error + Radial Gradient

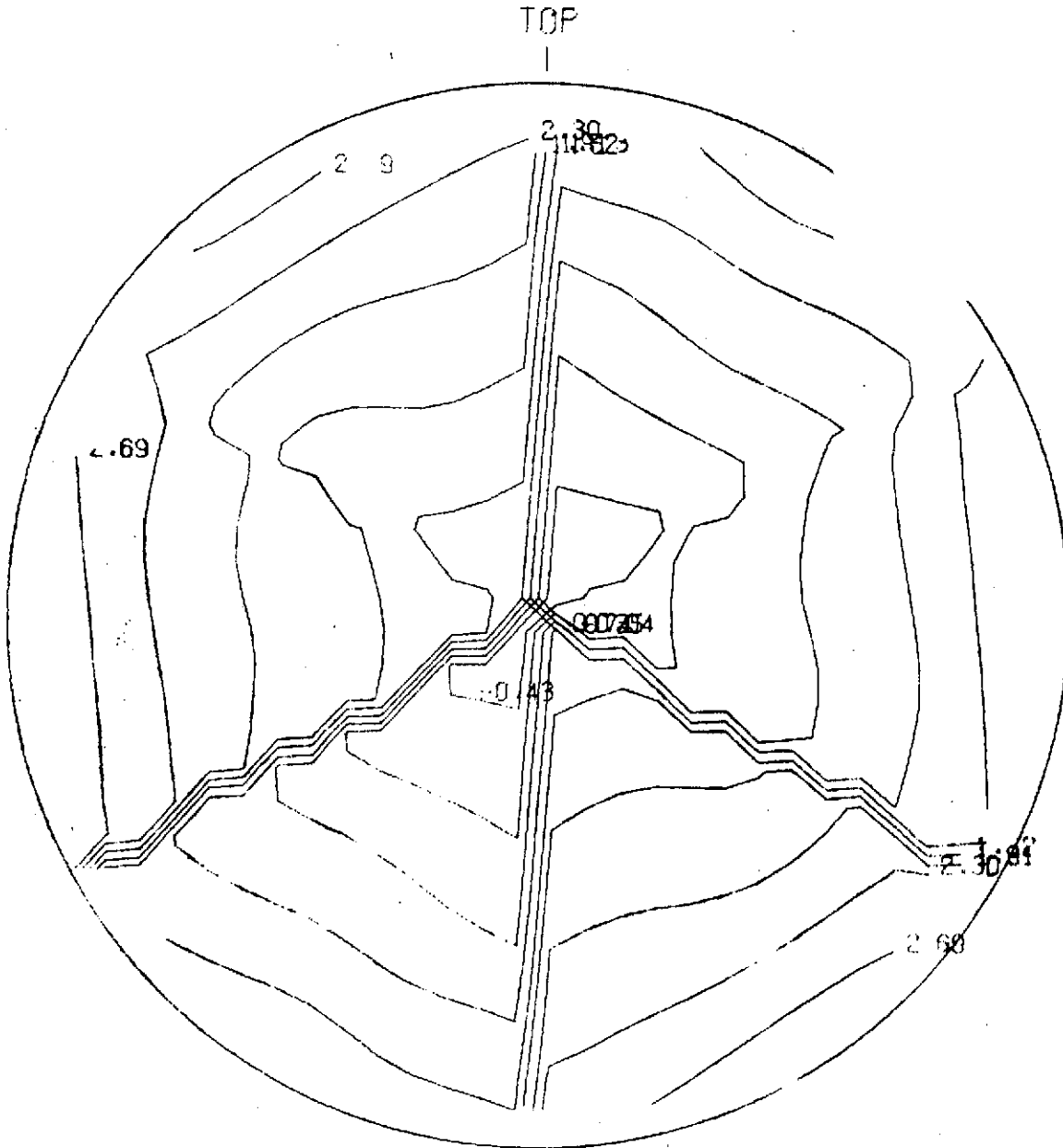


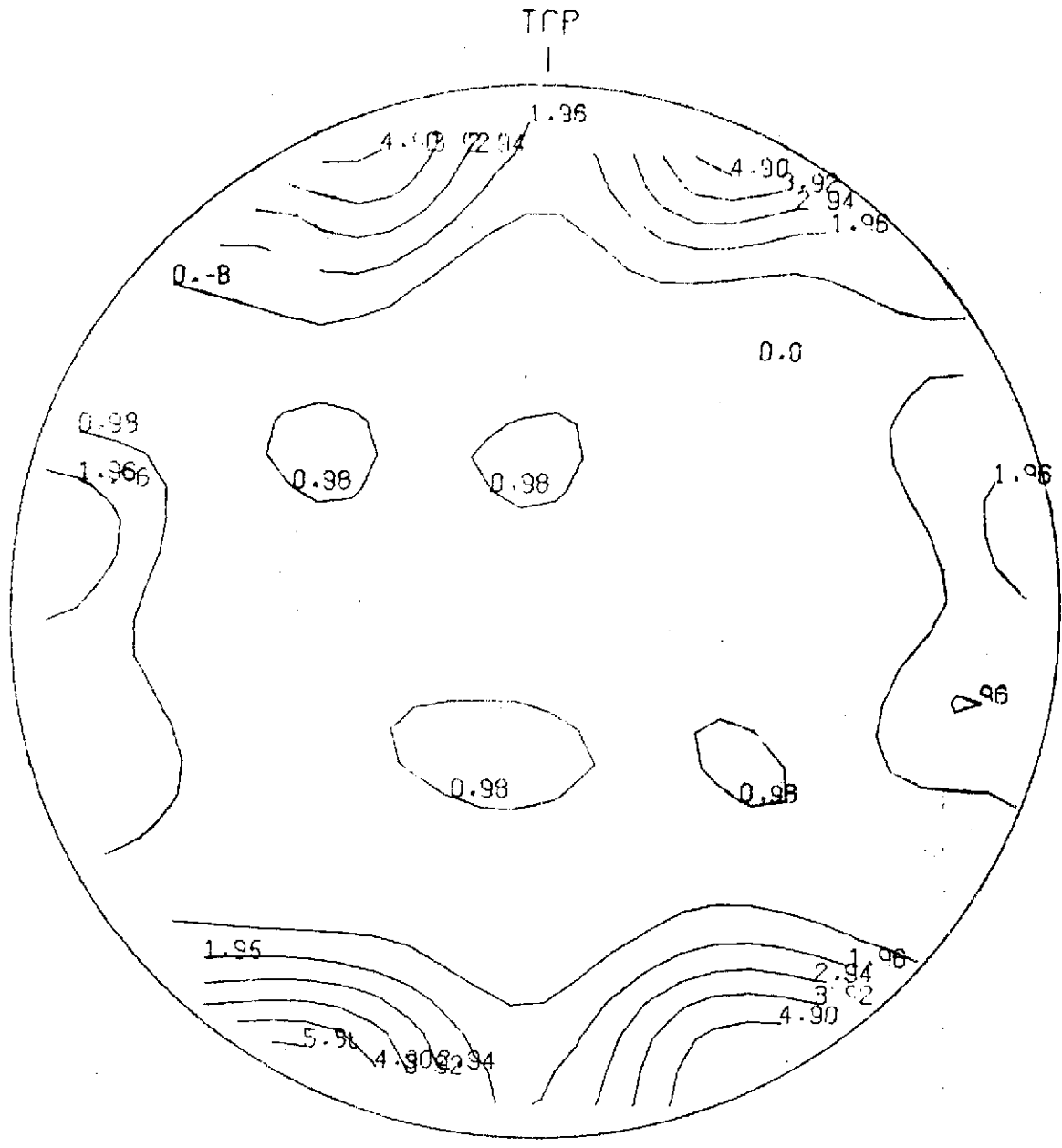


FIGURE B69

B91

Intensity Distribution - Central 129 Microradians

Task 2.5B - Nominal + Mfg. Error + Radial Gradient



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Q-279

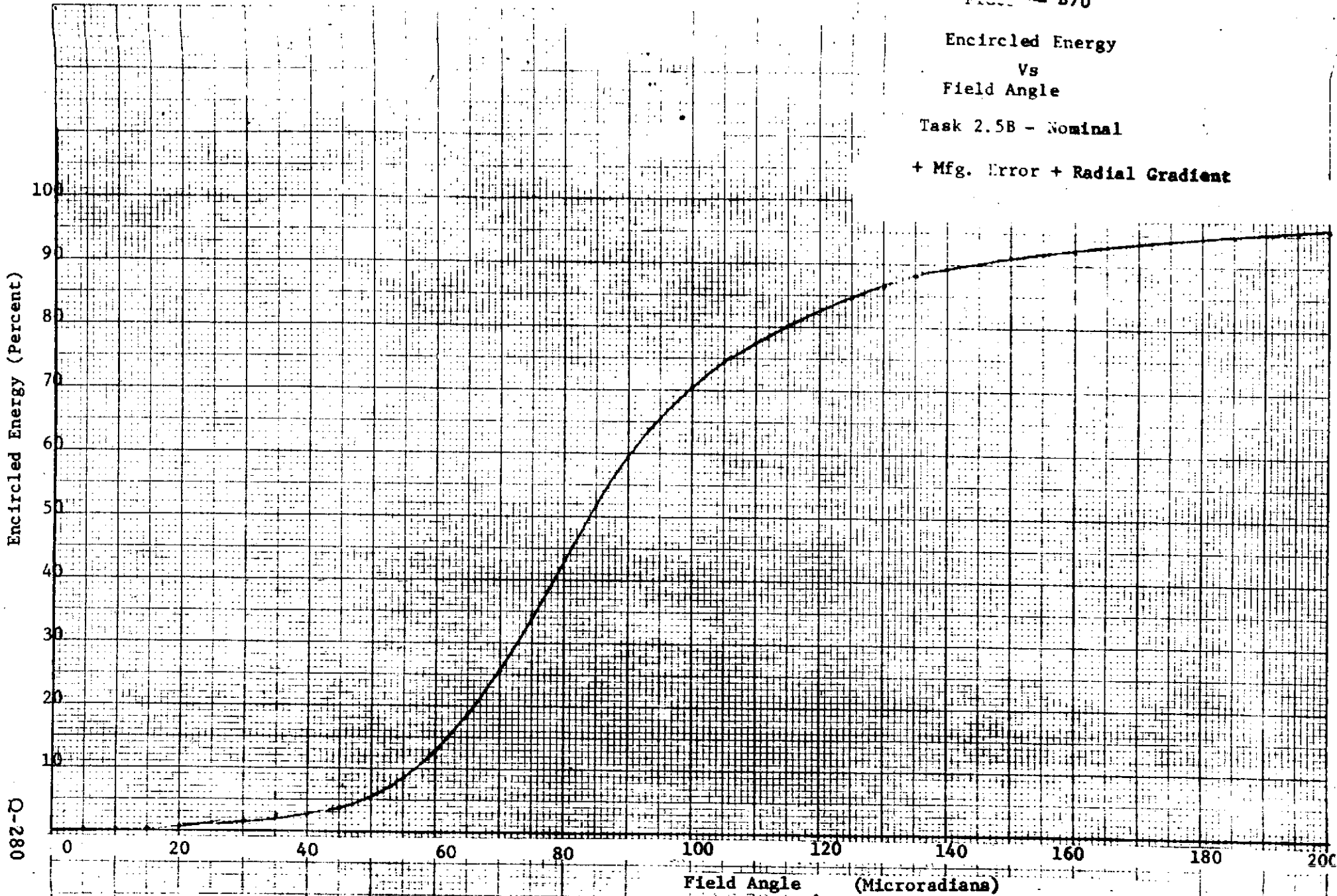


FIGURE B70

Encircled Energy  
Vs  
Field Angle

Task 2.5B - Nominal

+ Mfg. Error + Radial Gradient



0-280

TABLE B22

ENCIRCLED ENERGY

B93

\*\*\*\*\* Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis \*\*\*\*\*

CIRCLE \*  
 ----- \*  
 PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 RADIUS \*  
 ----- \*  
 (MI- \* CENTER (MICRONS):  
 OPTNS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1
6.00	*	0.1	0.1	0.0	0.2	0.2	0.2	0.1	0.1	0.1
8.00	*	0.2	0.2	0.1	0.3	0.2	0.3	0.1	0.2	0.3
10.00	*	0.3	0.3	0.2	0.4	0.3	0.4	0.2	0.3	0.3
12.00	*	0.4	0.4	0.3	0.5	0.4	0.5	0.3	0.4	0.4
14.00	*	0.5	0.5	0.4	0.6	0.5	0.6	0.4	0.5	0.5
16.00	*	0.8	0.7	0.6	0.8	0.6	0.8	0.7	0.7	0.7
18.00	*	1.3	1.2	0.9	1.0	0.7	1.0	1.0	1.2	1.2
20.00	*	1.6	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.4
22.00	*	2.3	2.1	2.0	1.7	1.3	1.7	2.0	2.2	2.1
24.00	*	2.6	2.4	2.6	2.1	2.0	2.0	2.5	2.5	2.5
26.00	*	3.7	3.5	3.4	2.6	2.4	2.6	3.3	3.7	3.6
28.00	*	4.3	4.1	4.2	3.3	3.3	3.2	4.1	4.4	4.3
30.00	*	6.0	6.0	5.8	4.5	3.5	4.3	5.9	6.3	6.2
32.00	*	7.1	7.0	6.8	5.6	5.1	5.5	7.0	7.5	7.3
34.00	*	9.4	9.4	8.4	6.8	5.9	6.6	8.9	10.1	9.8
36.00	*	10.0	10.0	9.9	9.0	8.0	8.7	10.7	10.7	10.3
38.00	*	12.6	12.7	11.9	10.5	9.8	10.2	13.0	13.7	13.2
40.00	*	14.0	14.0	13.8	13.0	13.3	12.8	15.0	15.2	14.8
42.00	*	16.8	16.8	16.3	15.2	15.0	14.8	17.7	18.2	17.8
44.00	*	18.1	18.1	19.2	18.7	19.5	18.4	20.5	19.6	19.1
46.00	*	21.7	21.5	21.7	20.8	21.6	20.4	23.1	23.2	22.9
48.00	*	24.1	23.9	24.8	25.2	26.4	24.8	26.2	25.8	25.5
50.00	*	27.9	27.6	28.8	28.7	27.8	28.3	30.2	29.5	29.2
52.00	*	30.9	30.6	31.2	31.9	32.6	31.6	32.8	32.6	32.3
54.00	*	35.1	34.7	35.1	35.5	35.3	35.2	36.5	36.6	36.4
56.00	*	37.3	37.0	38.0	39.3	40.1	39.1	39.8	38.8	38.5
58.00	*	41.4	41.2	42.5	43.2	43.2	43.0	44.2	42.8	42.6
59.00	*	44.4	44.3	45.4	46.1	48.3	46.0	47.1	45.8	45.6
60.00	*	47.8	47.7	49.2	49.8	51.8	49.8	50.7	49.1	49.0
62.00	*	50.2	50.1	52.5	53.7	55.9	53.7	53.9	51.3	51.3
64.00	*	54.3	54.3	55.4	56.4	59.0	56.4	56.6	55.3	55.4
66.00	*	56.8	56.8	58.9	60.4	62.6	60.4	59.8	57.6	57.8
68.00	*	60.4	60.4	61.8	62.8	64.3	62.9	62.3	61.1	61.3
70.00	*	62.5	62.6	64.5	65.7	67.2	65.8	64.8	63.0	63.3
72.00	*	65.8	65.8	66.8	67.8	69.5	68.0	67.0	66.1	66.3
74.00	*	67.4	67.4	69.3	70.1	71.6	70.2	69.3	67.6	67.8
76.00	*	70.1	70.1	71.5	71.8	73.1	72.0	71.5	70.2	70.4
78.00	*	71.8	71.8	72.9	73.2	74.9	73.4	72.9	71.8	71.9
80.00	*	73.7	73.6	74.7	74.8	76.0	75.0	74.7	73.6	73.8

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

CIRCLE	PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES									
RADIUS										
(MI- CRONS)	CENTER (MICRONS):									
	X= -10.13	10.13	0.0	-10.13	0.0	10.13	0.0	-10.13	10.13	
	Y= -10.13	-10.13	-10.13	0.0	0.0	0.0	10.13	10.13	10.13	
5.00	0.1	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.1
10.00	0.3	0.3	0.2	0.4	0.3	0.4	0.2	0.3	0.3	0.3
15.00	1.1	1.0	0.8	1.0	0.7	1.0	0.8	1.0	0.9	0.9
20.00	2.3	2.1	2.0	1.7	1.3	1.7	2.0	2.2	2.1	2.1
25.00	4.1	3.9	4.0	3.2	2.8	3.1	3.9	4.1	4.1	4.1
30.00	7.1	7.0	6.8	5.6	5.1	5.5	7.0	7.5	7.3	7.3
35.00	11.5	11.6	10.8	9.4	9.3	9.1	11.7	12.4	12.0	12.0
40.00	16.8	16.8	16.3	15.2	15.0	14.8	17.7	18.2	17.8	17.8
45.00	23.0	22.8	23.3	23.7	24.5	23.2	24.8	24.8	24.2	24.2
50.00	30.9	30.6	31.2	31.9	32.6	31.6	32.8	32.6	32.3	32.3
55.00	40.0	39.7	40.6	41.2	42.4	41.0	42.2	41.4	41.2	41.2
60.00	47.8	47.7	49.2	49.8	51.8	49.8	50.7	49.1	49.0	49.0
65.00	55.4	55.5	57.5	58.8	61.1	58.8	58.6	56.4	56.5	56.5
70.00	62.5	62.6	64.5	65.7	67.2	65.8	64.8	63.0	63.3	63.3
75.00	69.0	69.0	70.5	71.0	72.4	71.2	70.5	69.1	69.2	69.2
80.00	73.7	73.6	74.7	74.8	76.0	75.0	74.7	73.6	73.8	73.8
85.00	77.1	76.8	78.0	78.2	78.9	78.2	78.2	76.9	77.3	77.3
90.00	80.0	79.5	80.3	80.7	80.9	80.6	80.5	79.7	80.2	80.2
95.00	82.4	81.9	82.3	82.6	82.7	82.6	82.4	82.1	82.6	82.6
100.00	84.1	83.8	84.1	84.3	84.4	84.3	84.2	83.9	84.2	84.2
105.00	85.5	85.4	85.7	85.9	86.1	85.9	85.8	85.5	85.6	85.6
110.00	86.8	87.0	87.1	87.2	87.5	87.3	87.2	87.1	87.0	87.0
115.00	88.0	88.4	88.4	88.4	88.7	88.4	88.5	88.4	88.1	88.1
120.00	89.1	89.5	89.5	89.4	89.7	89.5	89.5	89.5	89.1	89.1
125.00	90.0	90.4	90.4	90.3	90.5	90.3	90.4	90.3	90.0	90.0
130.00	90.8	91.0	91.1	91.1	91.2	91.1	91.1	91.1	90.8	90.8
135.00	91.7	91.6	91.7	91.7	91.8	91.6	91.6	91.6	91.6	91.6
140.00	92.2	92.2	92.2	92.3	92.3	92.3	92.2	92.2	92.1	92.1
145.00	92.6	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.6	92.6
150.00	93.0	93.1	93.1	93.1	93.2	93.2	93.1	93.1	93.0	93.0
155.00	93.4	93.4	93.5	93.5	93.6	93.5	93.5	93.5	93.4	93.4
160.00	93.8	93.8	93.9	93.8	93.9	93.8	93.9	93.8	93.8	93.8
165.00	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.1	94.1
170.00	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.4	94.4	94.4
175.00	94.8	94.8	94.8	94.8	94.7	94.8	94.8	94.8	94.8	94.8
180.00	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
184.99	95.3	95.3	95.3	95.3	95.4	95.4	95.3	95.4	95.4	95.4
189.99	95.6	95.6	95.6	95.7	95.7	95.7	95.6	95.6	95.6	95.6
194.99	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9
199.99	96.1	96.1	96.1	96.2	96.1	96.2	96.1	96.2	96.2	96.2

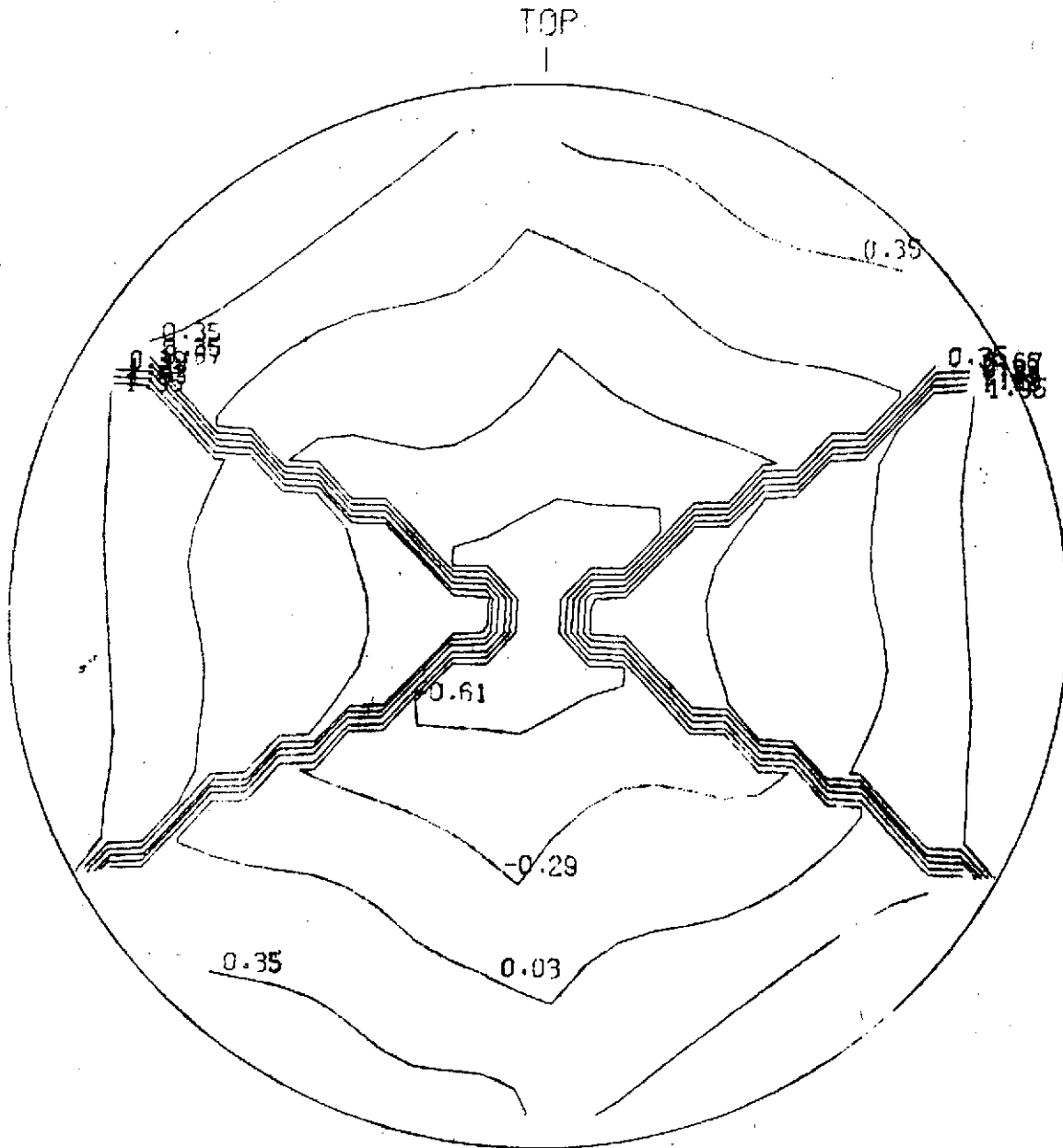


FIGURE B72

B96

Wavefront Plot-Q Polarization

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis





400

ON AXIS

AVERAGE

AVERAGE

AVERAGE

1

NONE

RMS

0.94

PK-PK

3.23

FREQ

WAVEFRONT

FIGURE B74

B98

Wavefront Plot-P Polarization

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

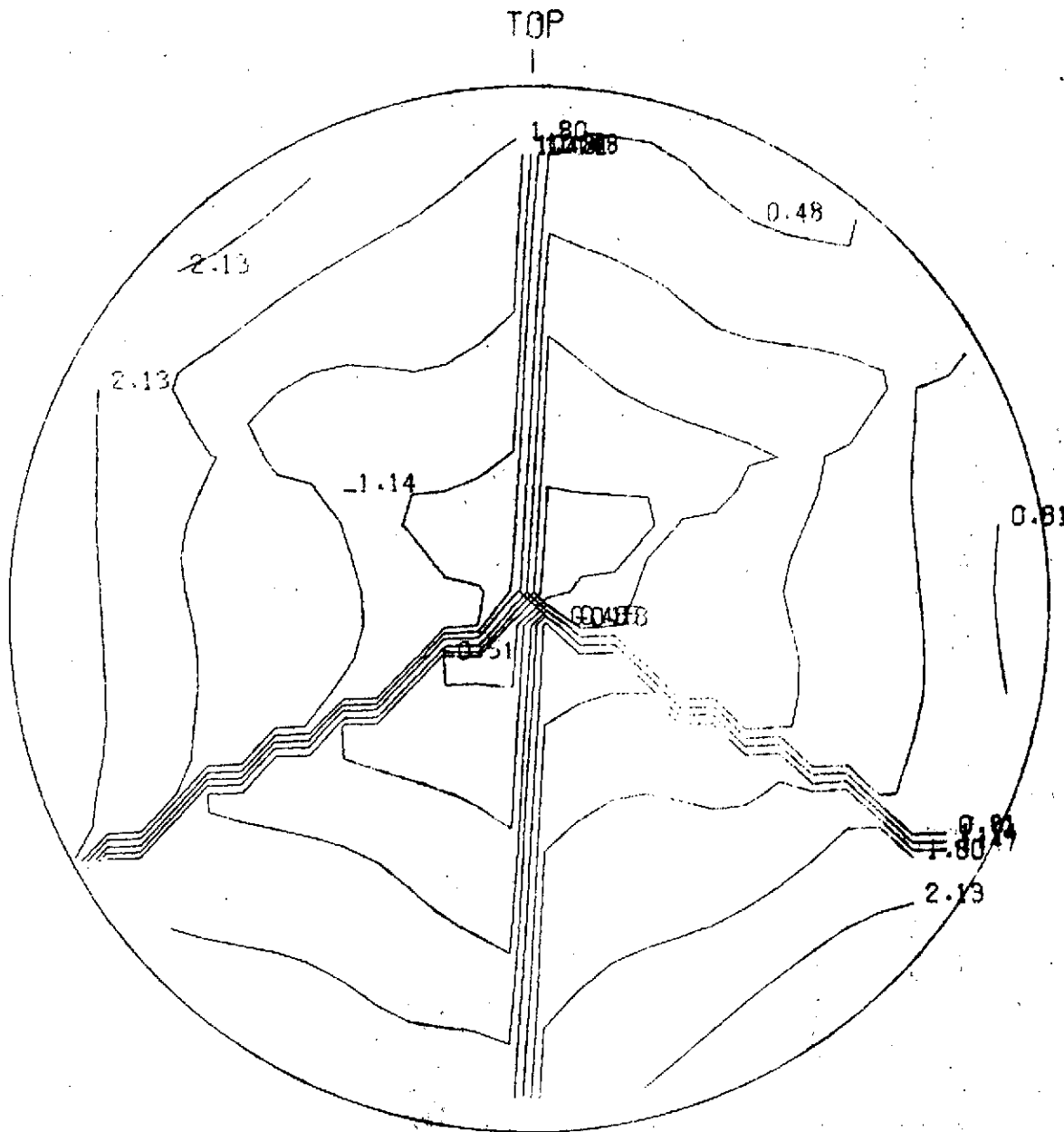


FIGURE B75

Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis

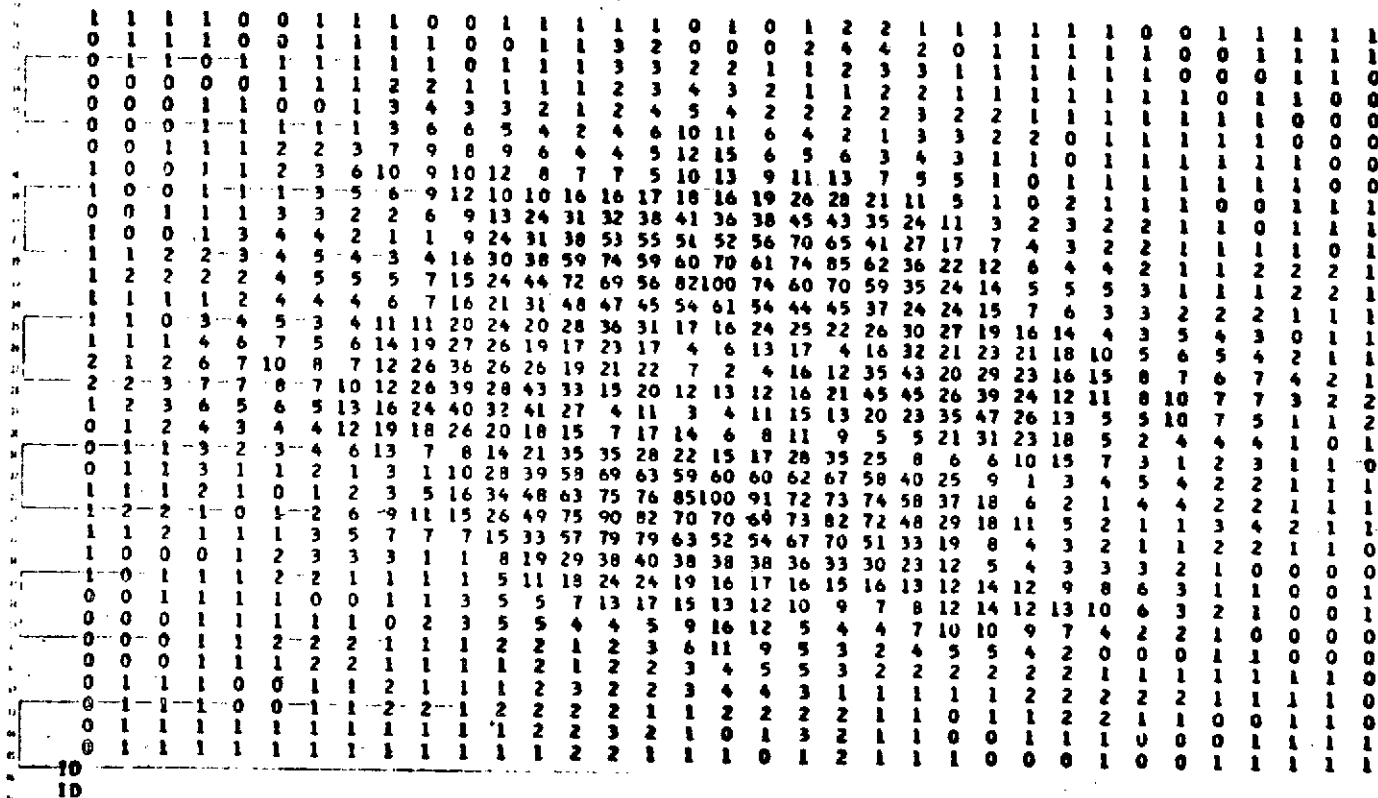
PRINTER MAP OF POINT SPREAD FUNCTION

(ONE SPACE REPRESENTS 8.04 MICRONS)  
 NORMALIZED SO LARGEST VALUE = 0.0192 = 100

TOTAL ENERGY = 0.2461000D+01

MAP REPRESENTS 0.23057200D+01 OR 93.6904 PERCENT CF TOTAL ENERGY

899



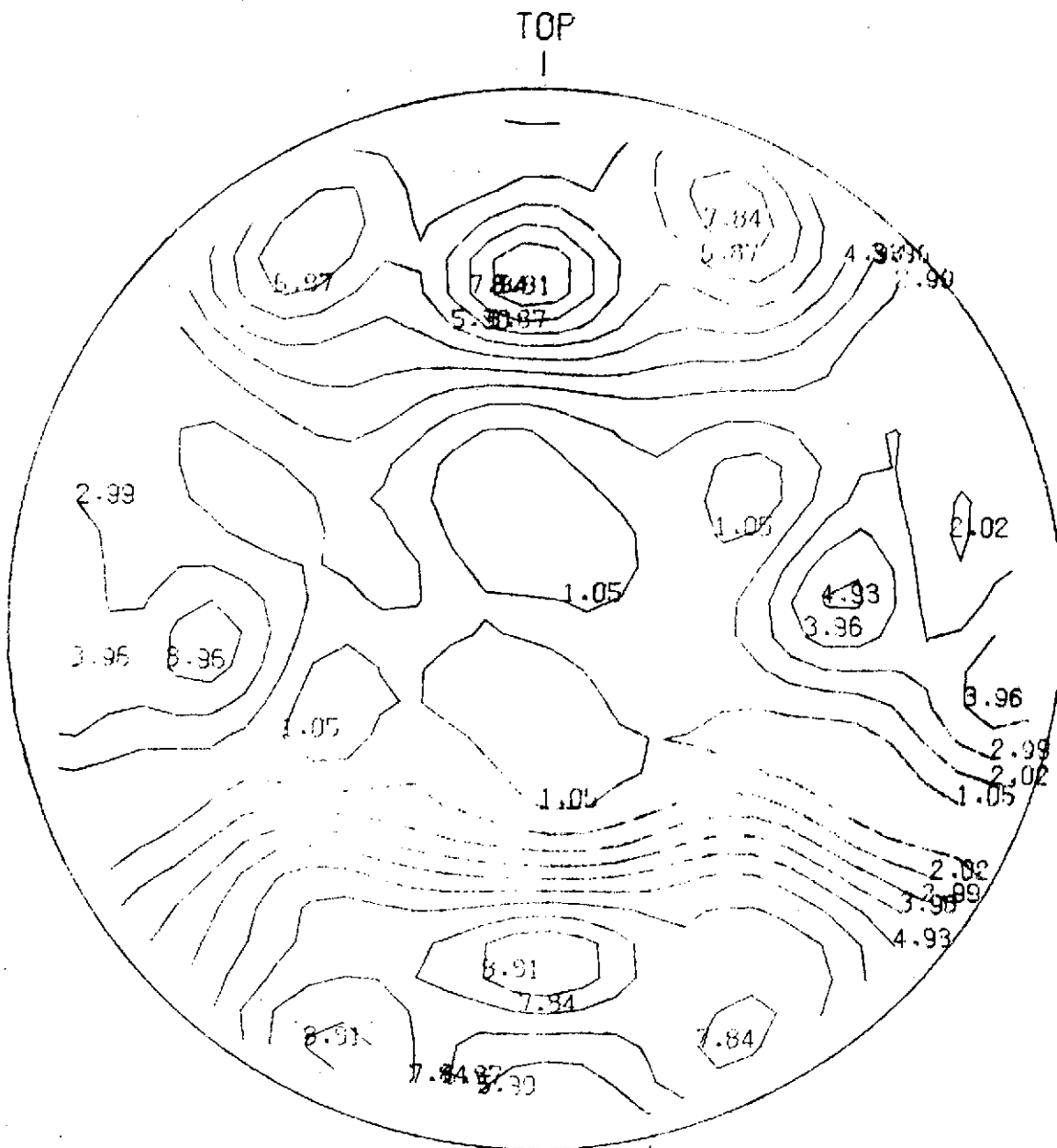
Q-287



B100

FIGURE B76

Intensity Distribution - Central 129 Microradians  
Task 2.4A - Off Nominal Cube + Mfg. Error-On Axis



C-4

FIGURE B77

Encircled Energy  
Vs  
Field Angle

Task 2.4A - Off Nominal Cube

+ Mfg. Error-On Axis

Encircled Energy (Percent)

Q-289

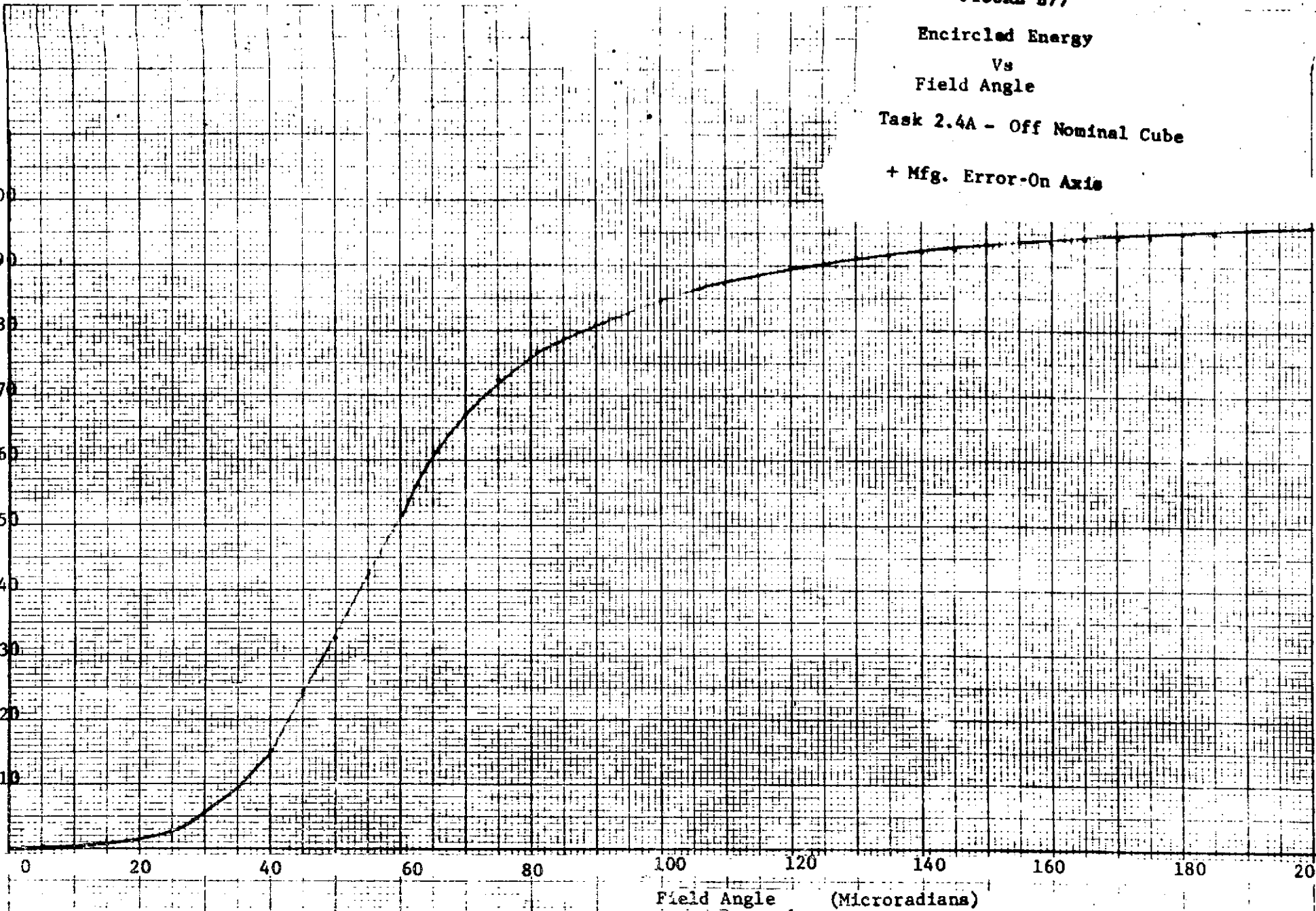


TABLE B24

B102

ENCIRCLED ENERGY

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis

\*\*\*\*\*

CIRCLE \*  
 ----- \*  
 RADIUS \*  
 ----- \*  
 \*  
 \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 ----- \*

(MI- \* CENTER (MICRONS):  
 (SENS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

5.00	*	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
10.00	*	0.5	0.6	0.2	0.5	0.5	0.5	0.3	0.7	0.7
15.00	*	1.7	1.9	0.9	1.8	1.0	1.9	1.2	2.2	2.1
20.00	*	3.4	3.6	2.4	3.5	1.9	3.5	2.9	4.2	4.0
25.00	*	5.4	5.5	5.5	5.9	5.1	5.9	6.3	6.6	6.3
30.00	*	8.6	8.7	8.8	9.1	9.4	8.9	9.8	10.0	9.7
35.00	*	13.7	13.7	12.6	13.6	13.9	13.4	13.7	14.8	14.6
40.00	*	19.5	19.4	18.2	19.9	18.5	19.7	19.6	20.7	20.4
45.00	*	25.3	25.2	25.5	26.4	25.7	26.3	26.9	26.8	26.6
50.00	*	32.2	32.1	32.6	33.2	34.0	33.0	34.4	34.5	34.2
55.00	*	39.5	39.4	40.1	41.0	43.3	40.8	42.6	42.0	41.8
60.00	*	46.8	46.7	48.0	49.5	50.8	49.3	50.8	49.2	49.3
65.00	*	54.4	54.2	56.0	57.3	58.1	57.3	58.5	56.2	56.7
70.00	*	61.7	61.4	63.0	63.5	64.8	63.9	64.7	62.8	63.5
75.00	*	67.9	67.8	69.1	69.2	71.5	69.7	70.2	68.5	69.1
80.00	*	72.8	72.8	74.5	74.4	76.3	74.6	74.8	73.1	73.6
85.00	*	76.8	76.9	78.7	78.6	79.8	78.6	78.8	77.1	77.3
90.00	*	80.3	80.3	81.3	81.3	82.3	81.3	81.4	80.4	80.5
95.00	*	82.9	82.9	83.3	83.3	83.9	83.3	83.4	82.9	82.8
100.00	*	84.5	84.6	84.9	84.9	85.1	84.9	84.8	84.6	84.5
105.00	*	85.8	85.9	86.1	86.1	86.2	86.1	86.0	85.9	85.7
110.00	*	86.9	87.0	87.1	87.1	87.2	87.1	87.1	87.0	86.9
115.00	*	87.5	88.0	88.0	88.0	88.2	88.1	88.1	88.0	88.0
120.00	*	88.8	88.9	88.9	88.9	89.1	89.0	89.0	88.9	88.9
125.00	*	89.6	89.6	89.7	89.7	90.0	89.8	89.8	89.6	89.6
130.00	*	90.3	90.3	90.4	90.5	90.6	90.5	90.4	90.3	90.3
135.00	*	90.9	90.9	90.9	91.0	91.1	91.0	91.1	91.0	91.0
140.00	*	91.4	91.4	91.4	91.5	91.5	91.5	91.6	91.5	91.5
145.00	*	91.8	91.8	91.8	91.9	91.9	91.9	92.0	91.9	91.9
150.00	*	92.3	92.2	92.3	92.4	92.3	92.3	92.4	92.3	92.3
155.00	*	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
160.00	*	93.1	93.1	93.1	93.1	93.1	93.1	93.0	93.1	93.1
165.00	*	93.5	93.5	93.6	93.5	93.5	93.5	93.5	93.4	93.4
170.00	*	93.9	93.8	93.9	93.9	93.9	93.9	93.8	93.8	93.8
175.00	*	94.2	94.2	94.2	94.2	94.3	94.2	94.2	94.1	94.2
180.00	*	94.5	94.5	94.5	94.6	94.6	94.6	94.6	94.5	94.5
184.99	*	94.8	94.8	94.7	94.8	94.8	94.8	94.8	94.9	94.9
189.99	*	95.1	95.1	95.1	95.1	95.2	95.1	95.2	95.1	95.2
194.99	*	95.3	95.3	95.4	95.4	95.4	95.4	95.4	95.4	95.4
199.99	*	95.6	95.7	95.7	95.6	95.7	95.7	95.7	95.7	95.6

\*\*\*\*\*

TABLE B25

ENCIRCLED ENERGY

B103

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis

\*\*\*\*\*

CIRCLE

\*

PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS

\*

(MI-  
CROSS)

= CENTER (MICRONS):

= X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 = Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1
6.00	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.1	0.1
8.00	0.3	0.4	0.2	0.4	0.3	0.3	0.2	0.5	0.5
10.00	0.5	0.6	0.2	0.5	0.5	0.5	0.3	0.7	0.7
12.00	1.2	1.3	0.4	1.0	0.5	1.0	0.5	1.5	1.5
14.00	1.2	1.3	0.8	1.5	0.7	1.5	1.1	1.5	1.5
16.00	2.1	2.3	1.1	2.1	1.0	2.1	1.4	2.7	2.5
18.00	2.6	2.7	1.7	2.7	1.9	2.7	2.2	3.2	3.0
20.00	3.4	3.6	2.4	3.5	1.9	3.5	2.9	4.2	4.0
22.00	3.8	4.0	3.6	4.4	3.5	4.4	4.2	4.8	4.5
24.00	5.0	5.1	4.1	5.0	4.5	4.9	4.8	6.1	5.8
26.00	5.7	5.8	5.7	6.2	6.5	6.1	6.5	6.9	6.6
28.00	7.3	7.3	7.3	7.7	7.2	7.6	8.2	8.6	8.3
30.00	8.6	8.7	8.8	9.1	9.4	8.9	9.8	10.0	9.7
32.00	11.2	11.2	10.0	10.7	10.8	10.5	11.1	12.5	12.3
34.00	11.8	11.8	12.1	12.9	12.2	12.6	13.4	13.1	12.9
36.00	14.9	14.8	13.8	15.1	14.6	14.9	15.1	16.0	15.9
38.00	16.7	16.6	15.9	17.2	16.9	17.0	17.2	17.9	17.7
40.00	19.5	19.4	18.2	19.9	18.5	19.7	19.6	20.7	20.4
42.00	21.0	20.9	21.3	22.5	21.4	22.7	22.7	22.3	22.0
44.00	24.1	24.1	22.9	24.4	24.2	24.3	24.5	25.5	25.2
46.00	26.6	26.5	26.8	27.7	28.1	27.6	28.4	28.4	28.1
48.00	29.2	29.2	29.8	30.8	29.7	30.7	31.9	31.2	30.8
50.00	32.2	32.1	32.6	33.2	34.0	33.0	34.4	34.5	34.2
52.00	35.2	35.2	35.3	36.1	37.3	35.9	37.7	37.8	37.4
54.00	37.2	37.1	38.4	39.4	40.6	39.1	41.1	39.8	39.6
56.00	40.7	40.6	42.2	43.3	44.1	43.0	44.9	43.3	43.1
58.00	43.9	43.7	44.6	45.8	47.6	45.5	47.1	46.5	46.4
60.00	46.9	46.7	48.0	49.5	50.8	49.3	50.8	49.2	49.3
62.00	49.3	49.1	51.3	52.7	53.6	52.6	53.8	51.6	51.8
64.00	53.4	53.1	53.5	55.1	56.7	55.1	56.4	55.1	55.6
66.00	56.1	55.9	57.3	58.4	60.0	58.6	59.7	57.8	58.3
68.00	59.0	58.7	60.0	61.0	61.5	61.3	62.1	60.4	61.0
70.00	61.7	61.4	63.0	63.5	64.8	63.9	64.7	62.8	63.5
72.00	64.5	64.3	65.2	65.6	67.8	66.0	66.8	65.3	66.0
74.00	66.1	65.9	68.2	68.3	70.2	68.7	69.3	67.0	67.7
76.00	68.9	68.6	70.7	70.5	72.4	71.0	71.3	69.5	70.0
78.00	71.0	71.0	72.2	72.1	74.5	72.5	72.9	71.4	71.9
80.00	72.8	72.5	74.5	74.4	76.3	74.6	74.8	73.1	73.6

\*\*\*\*\*



FIGURE B79

B105

Wavefront Plot-Q Polarization

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis

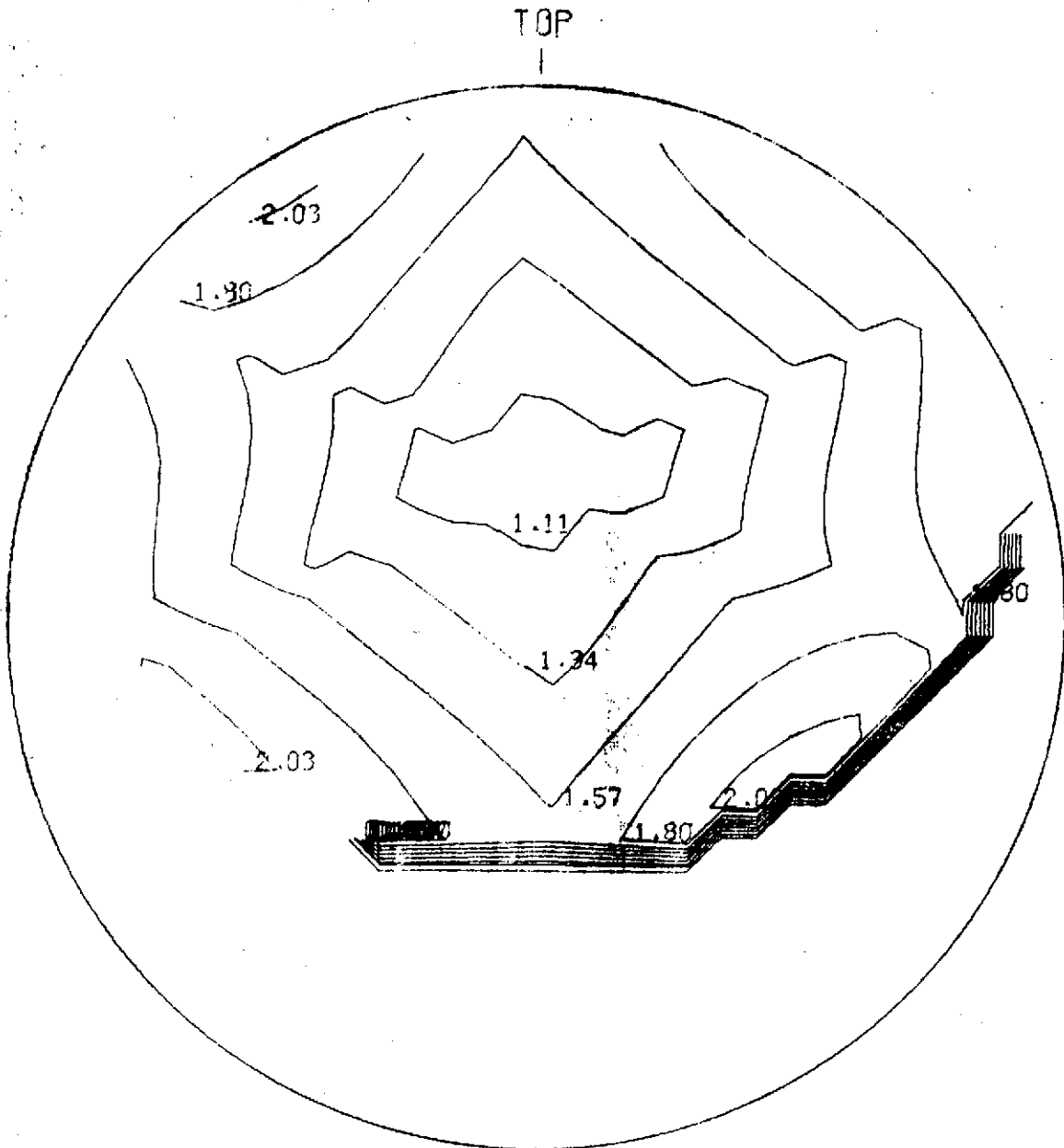




FIGURE B81

B107

Wavefront Plot-P Polarization

Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis

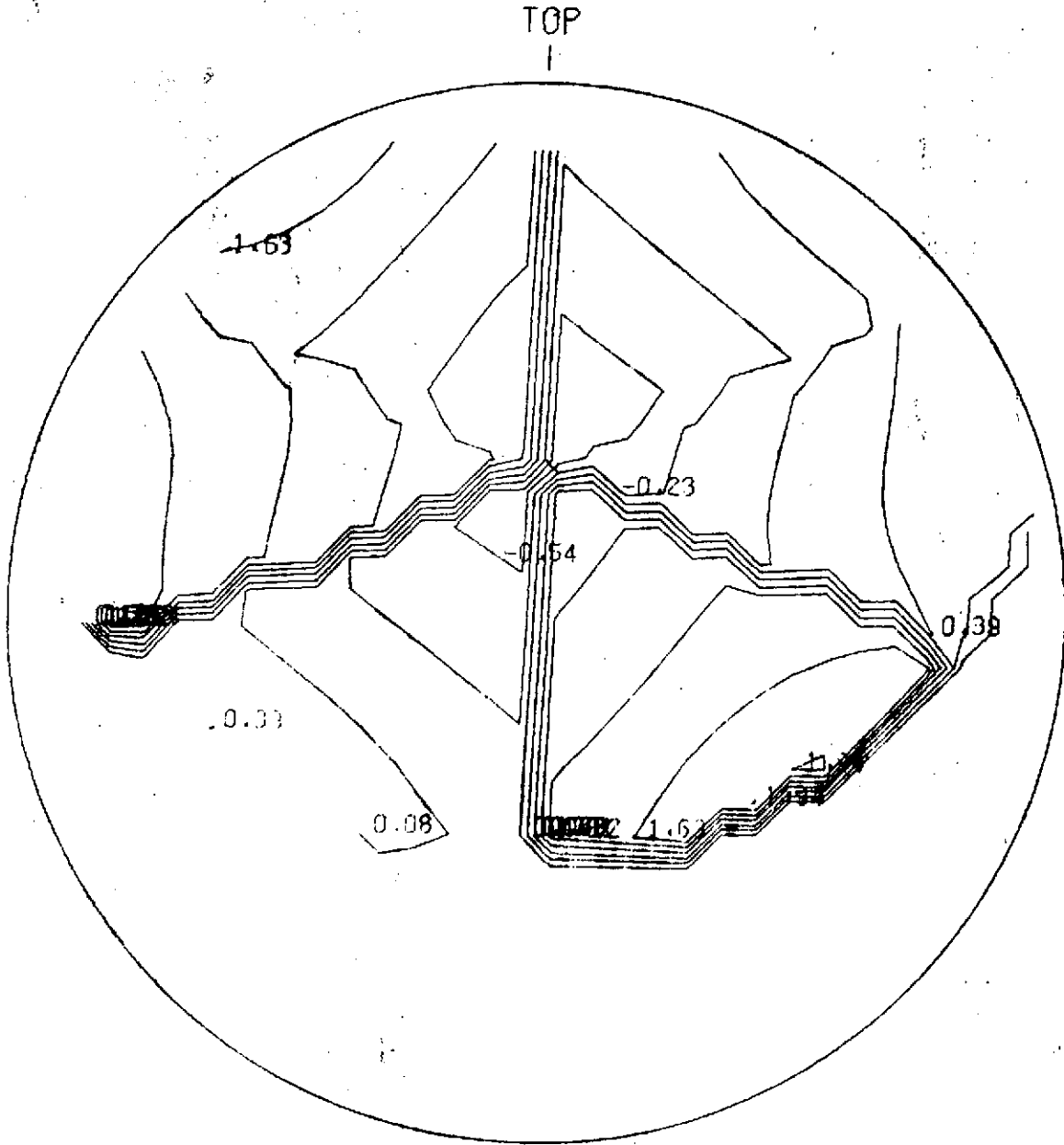
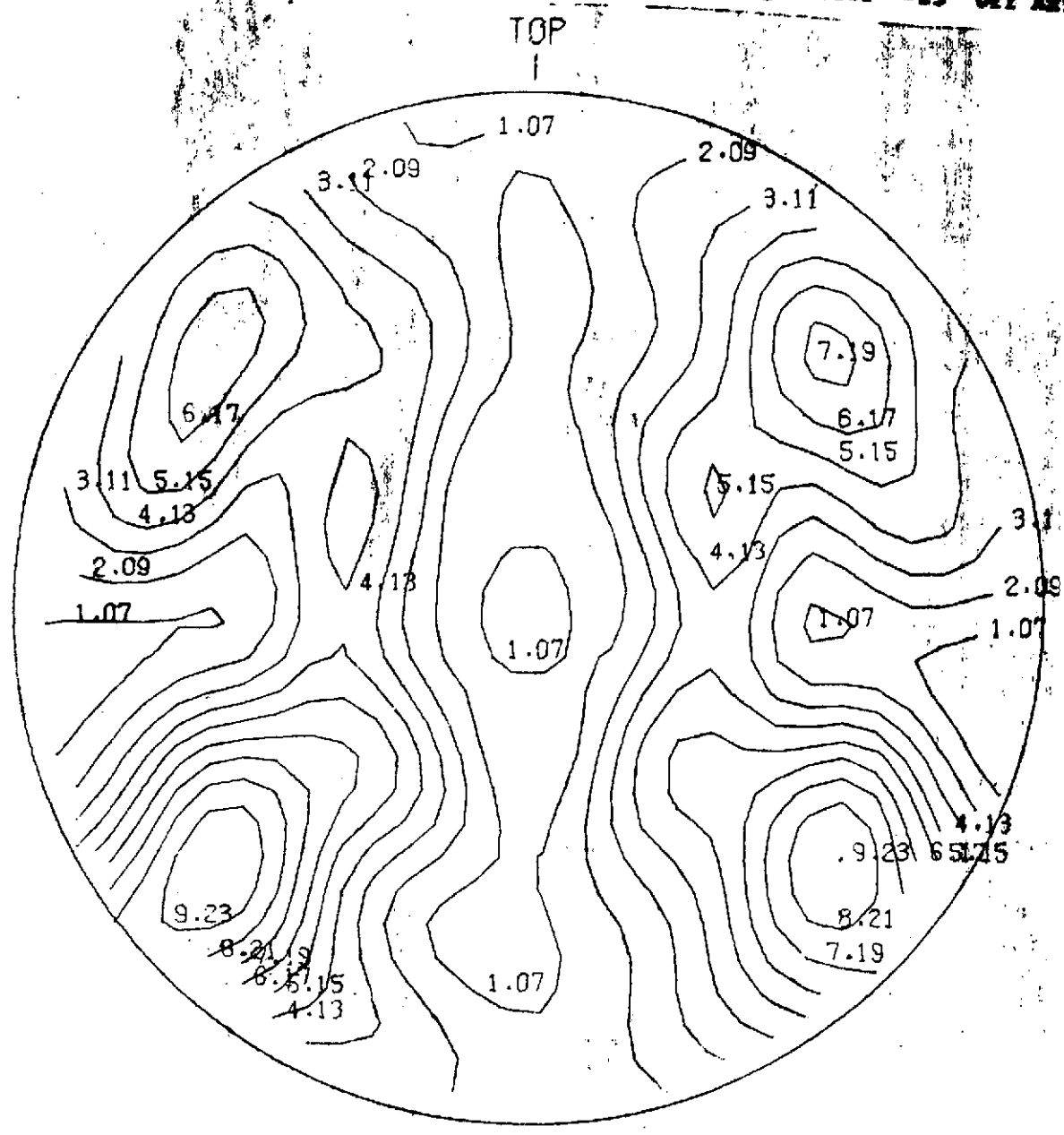






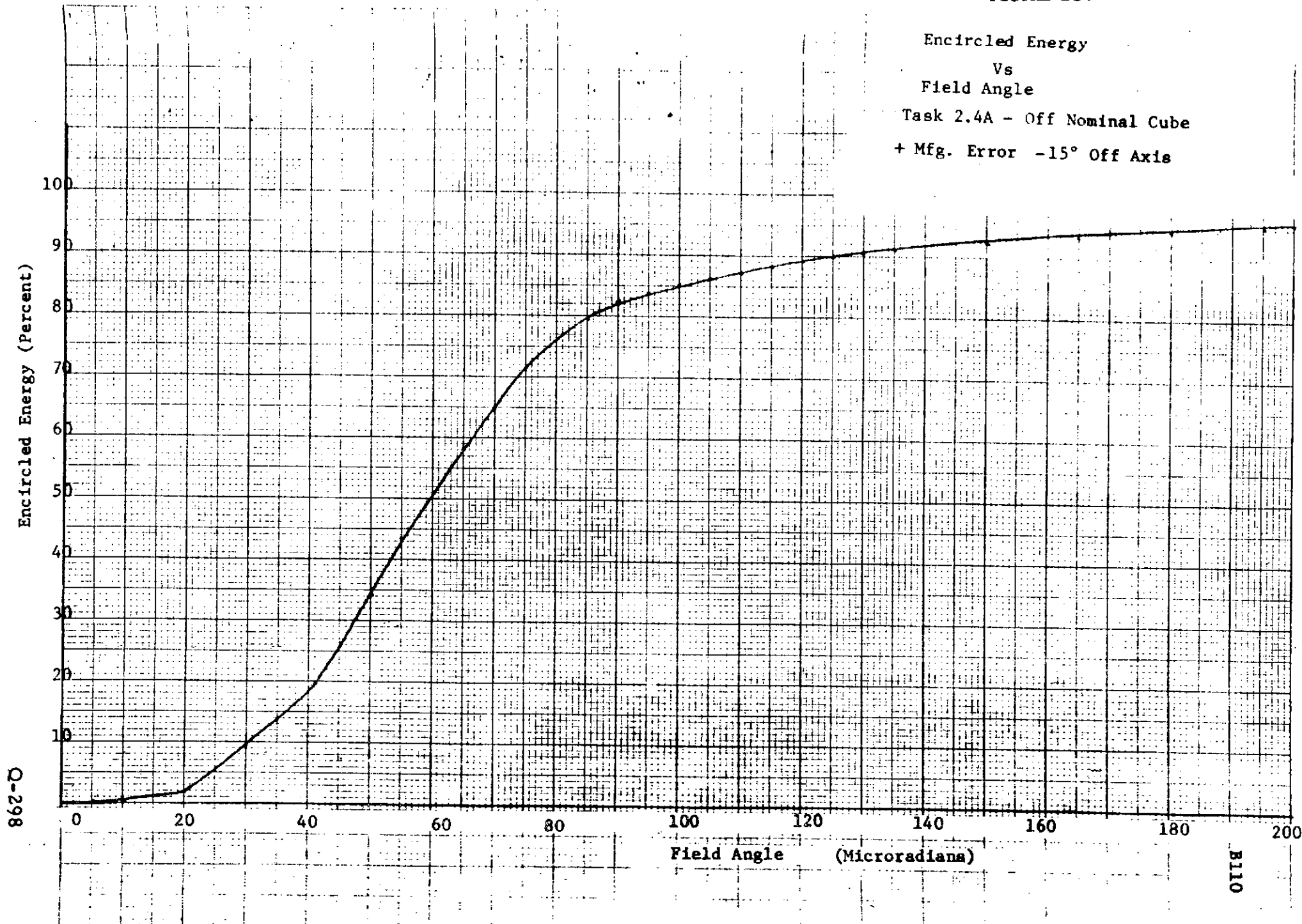
FIGURE B83

Intensity Distribution - Central 129 Microradians  
Task 2.4A - Off Nominal Cube + Mfg. Error -15° Off Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIGURE B84



ENCIRCLED ENERGY

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

\*\*\*\*\*

CIRCLE \*  
----- \*  
RADIUS \*  
----- \*  
(MI- \*  
CRONS) \* CENTER (MICRONS):  
\* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1
5.00	*	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
8.00	*	0.3	0.2	0.1	0.4	0.2	0.3	0.2	0.2	0.3
10.00	*	0.4	0.3	0.2	0.5	0.4	0.5	0.3	0.3	0.4
12.00	*	0.8	0.7	0.4	0.7	0.5	0.7	0.5	0.7	0.8
14.00	*	0.8	0.7	0.7	0.9	0.7	0.9	0.8	0.7	0.8
16.00	*	1.4	1.2	0.9	1.2	0.9	1.2	1.0	1.2	1.2
18.00	*	1.7	1.4	1.3	1.4	1.5	1.4	1.3	1.4	1.5
20.00	*	2.3	2.1	2.0	1.9	1.5	1.9	1.9	2.1	2.1
22.00	*	2.6	2.4	2.6	2.2	2.2	2.2	2.4	2.4	2.5
24.00	*	3.6	3.4	3.2	2.8	2.5	2.8	3.1	3.5	3.5
26.00	*	4.2	4.0	4.1	3.4	3.4	3.3	3.9	4.1	4.2
28.00	*	5.8	5.7	5.5	4.5	3.6	4.4	5.5	5.9	5.9
30.00	*	6.8	6.7	6.4	5.5	5.0	5.4	6.5	7.0	7.0
32.00	*	9.0	9.0	7.9	6.6	5.7	6.5	8.2	9.5	9.3
34.00	*	9.6	9.6	9.4	8.5	7.6	8.3	10.0	10.1	9.9
36.00	*	12.1	12.2	11.2	10.0	9.2	9.8	12.1	12.9	12.5
38.00	*	13.5	13.4	13.1	12.3	12.4	12.0	14.1	14.4	14.0
40.00	*	16.2	16.0	15.4	14.3	13.9	14.0	16.6	17.2	16.9
42.00	*	17.4	17.2	18.2	17.5	18.2	17.2	19.4	18.5	18.2
44.00	*	20.8	20.4	20.6	19.6	20.2	19.2	21.9	22.0	21.8
46.00	*	23.2	22.8	23.6	23.7	24.8	23.3	25.0	24.5	24.3
48.00	*	26.7	26.3	27.5	27.2	26.2	26.8	28.8	28.2	27.9
50.00	*	29.7	29.3	29.9	30.3	30.9	30.0	31.4	31.3	31.0
52.00	*	33.8	33.3	33.7	33.9	33.6	33.6	35.1	35.3	35.1
54.00	*	36.0	35.6	36.6	37.7	38.4	37.4	38.4	37.5	37.2
56.00	*	40.1	39.8	41.1	41.5	41.4	41.4	42.8	41.6	41.3
58.00	*	43.1	43.0	43.9	44.6	46.6	44.4	45.8	44.6	44.3
60.00	*	46.6	46.6	47.9	48.3	50.2	48.3	49.5	48.1	47.8
62.00	*	49.0	49.0	51.3	52.4	54.4	52.4	52.8	50.3	50.1
64.00	*	53.2	53.3	54.3	55.2	57.7	55.2	55.7	54.4	54.4
66.00	*	55.7	55.8	57.9	59.4	61.6	59.4	59.0	56.8	56.9
68.00	*	59.5	59.7	61.0	61.9	63.5	62.0	61.6	60.4	60.5
70.00	*	61.9	61.9	63.8	65.1	66.7	65.2	64.3	62.5	62.7
72.00	*	65.2	65.3	66.3	67.4	69.2	67.5	66.6	65.7	65.9
74.00	*	67.0	67.1	69.1	69.9	71.5	70.1	69.1	67.3	67.5
76.00	*	69.9	70.0	71.5	71.8	73.2	72.0	71.5	70.2	70.2
78.00	*	71.7	71.8	72.9	73.4	75.2	73.6	73.0	71.8	71.9
80.00	*	73.7	73.8	74.9	75.1	76.5	75.3	75.1	73.8	73.9

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

\*\*\*\*\*

CIRCLE \*  
----- \*  
RADIUS \*  
----- \*  
(MI- \*  
CENTERS) \*  
----- \*

CENTER (MICRONS):  
\* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
\*-----\*

5.00	*	0.1	0.1	0.0	0.2	0.1	0.2	0.1	0.1	0.1
10.00	*	0.4	0.3	0.2	0.5	0.4	0.5	0.3	0.3	0.4
15.00	*	1.2	1.0	0.8	1.1	0.9	1.1	0.9	1.0	1.0
20.00	*	2.3	2.1	2.0	1.9	1.5	1.9	1.9	2.1	2.1
25.00	*	4.0	3.8	3.9	3.3	2.9	3.2	3.7	3.9	4.0
30.00	*	6.8	6.7	6.4	5.5	5.0	5.4	6.5	7.0	7.0
35.00	*	11.0	11.0	10.2	9.0	8.7	8.8	10.9	11.7	11.4
40.00	*	16.2	16.0	15.4	14.3	13.9	14.0	16.6	17.2	16.9
45.00	*	22.0	21.7	22.2	22.3	23.0	21.8	23.6	23.4	23.1
50.00	*	29.7	29.3	29.9	30.3	30.9	30.0	31.4	31.3	31.0
55.00	*	38.7	38.3	39.2	39.6	40.7	39.4	40.8	40.1	39.9
60.00	*	46.6	46.6	47.9	48.3	50.2	48.3	49.5	48.1	47.8
65.00	*	54.4	54.5	56.5	57.7	60.0	57.7	57.7	55.5	55.5
70.00	*	61.8	61.9	63.8	65.1	66.7	65.2	64.3	62.5	62.7
75.00	*	68.6	68.8	70.3	70.9	72.4	71.1	70.4	69.0	69.0
80.00	*	73.7	73.8	74.9	75.1	76.5	75.3	75.1	73.8	73.9
85.00	*	77.4	77.3	78.5	78.8	79.7	78.8	78.8	77.4	77.7
90.00	*	80.4	80.1	80.9	81.4	81.8	81.3	81.1	80.3	80.7
95.00	*	83.0	82.6	83.0	83.3	83.5	83.3	83.1	82.7	83.1
100.00	*	84.7	84.4	84.7	84.9	85.0	84.9	84.7	84.4	84.8
105.00	*	86.0	85.8	86.2	86.3	86.5	86.4	86.2	85.9	86.1
110.00	*	87.2	87.3	87.4	87.5	87.8	87.6	87.5	87.4	87.3
115.00	*	88.3	88.6	88.6	88.6	88.9	88.6	88.7	88.7	88.4
120.00	*	89.3	89.7	89.6	89.6	89.8	89.6	89.7	89.6	89.3
125.00	*	90.1	90.5	90.5	90.4	90.6	90.5	90.5	90.5	90.1
130.00	*	90.9	91.2	91.2	91.2	91.3	91.2	91.2	91.2	90.9
135.00	*	91.8	91.7	91.8	91.8	91.9	91.7	91.8	91.7	91.7
140.00	*	92.3	92.2	92.3	92.4	92.4	92.4	92.3	92.2	92.2
145.00	*	92.7	92.7	92.8	92.8	92.8	92.8	92.8	92.7	92.7
150.00	*	93.1	93.1	93.2	93.2	93.3	93.2	93.2	93.2	93.1
155.00	*	93.5	93.5	93.6	93.5	93.7	93.5	93.6	93.5	93.5
160.00	*	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9
165.00	*	94.2	94.2	94.2	94.3	94.2	94.2	94.2	94.2	94.2
170.00	*	94.5	94.5	94.6	94.5	94.5	94.5	94.5	94.5	94.5
175.00	*	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8
180.00	*	95.1	95.1	95.1	95.1	95.2	95.1	95.1	95.1	95.1
184.99	*	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
189.99	*	95.6	95.6	95.6	95.7	95.7	95.7	95.7	95.6	95.7
194.99	*	95.9	95.9	95.9	95.9	96.0	95.9	95.9	95.9	95.9
199.99	*	96.1	96.2	96.1	96.2	96.2	96.2	96.1	96.2	96.2

\*\*\*\*\*



FIGURE B86

B114

Wavefront Plot-Q Polarization

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

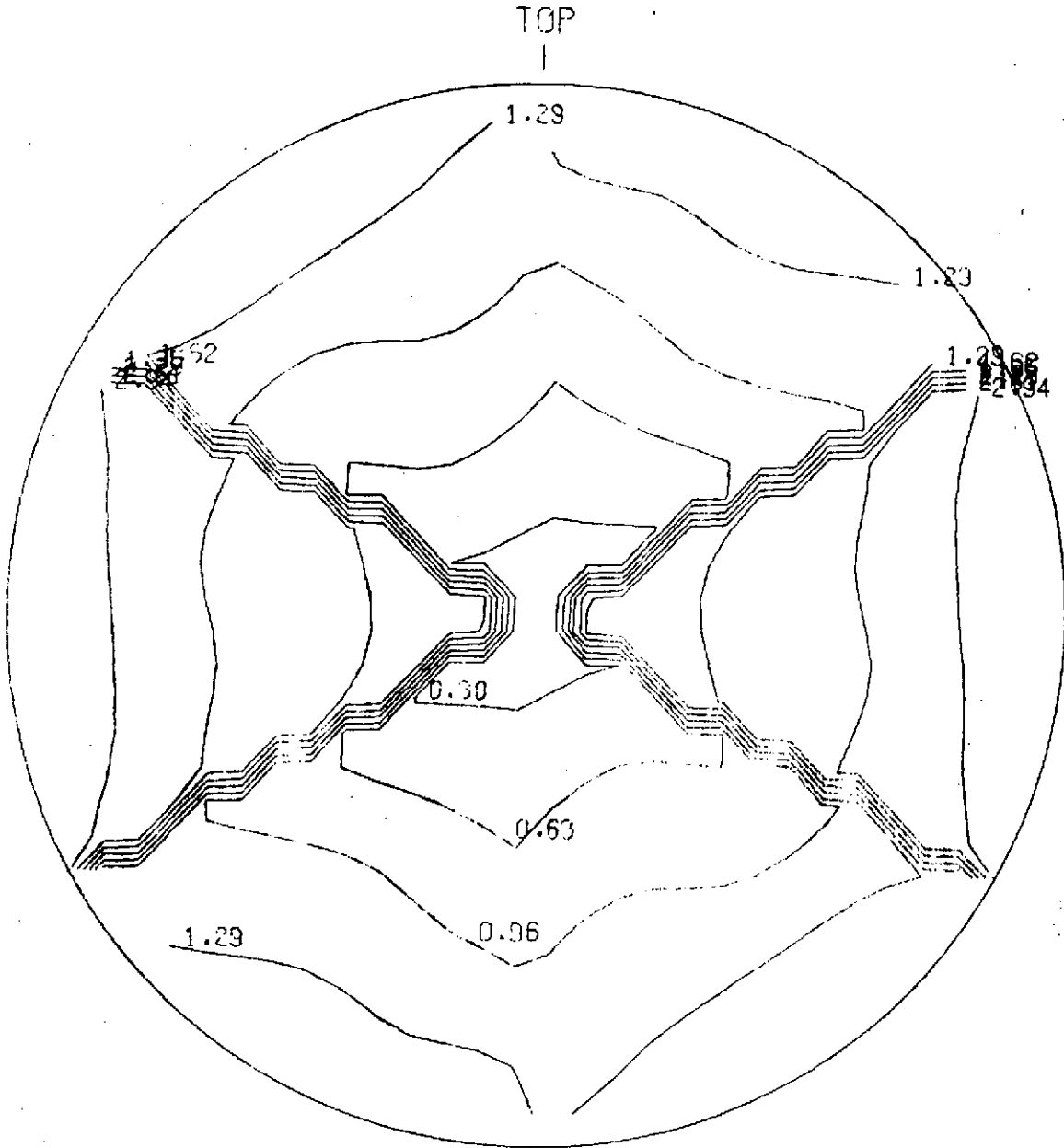






FIGURE B88

B116

Wavefront Plot-P Polarization

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

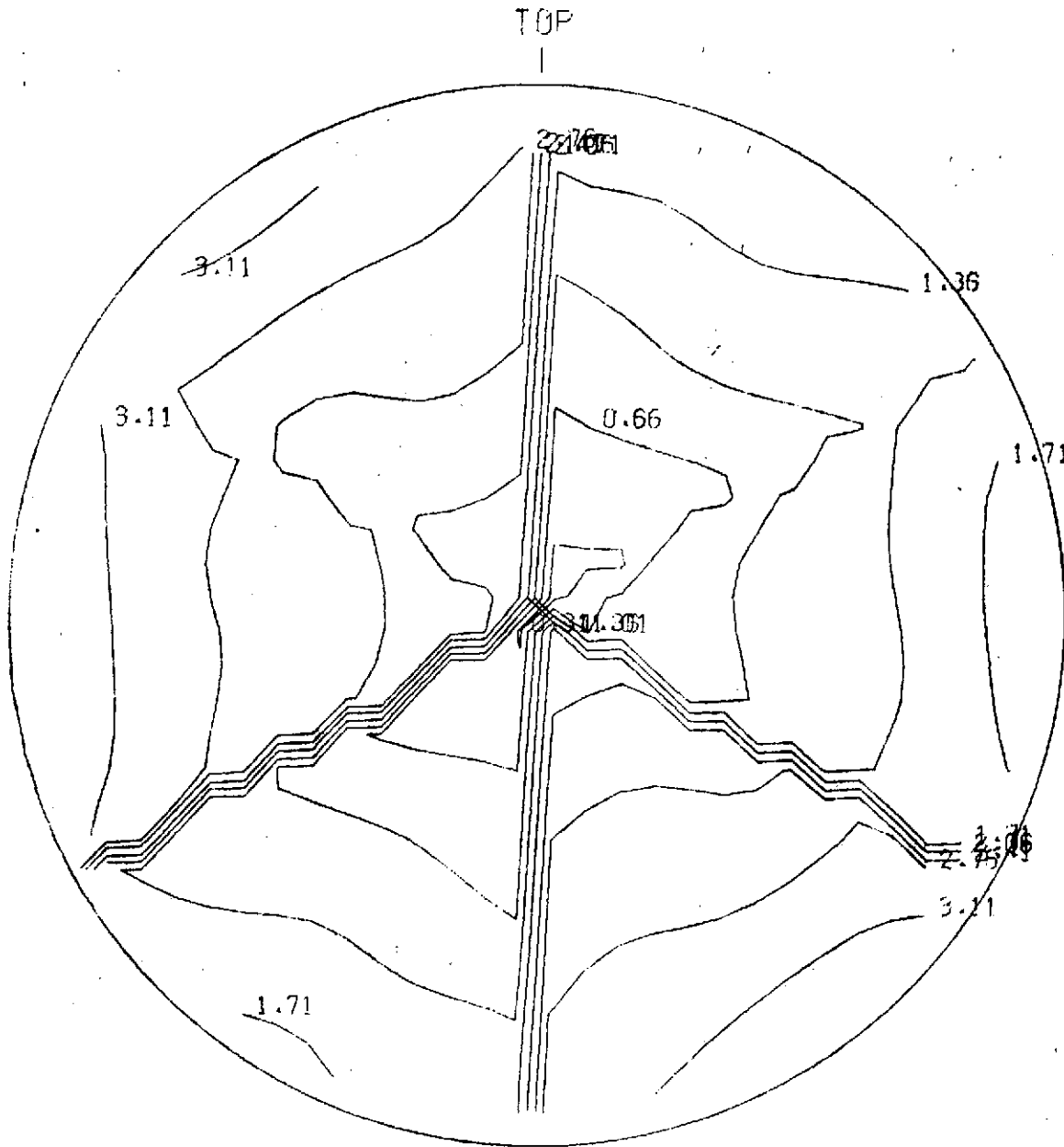




FIGURE B90

B118

Intensity Distribution - Central 129 Microradians  
Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature-On Axis

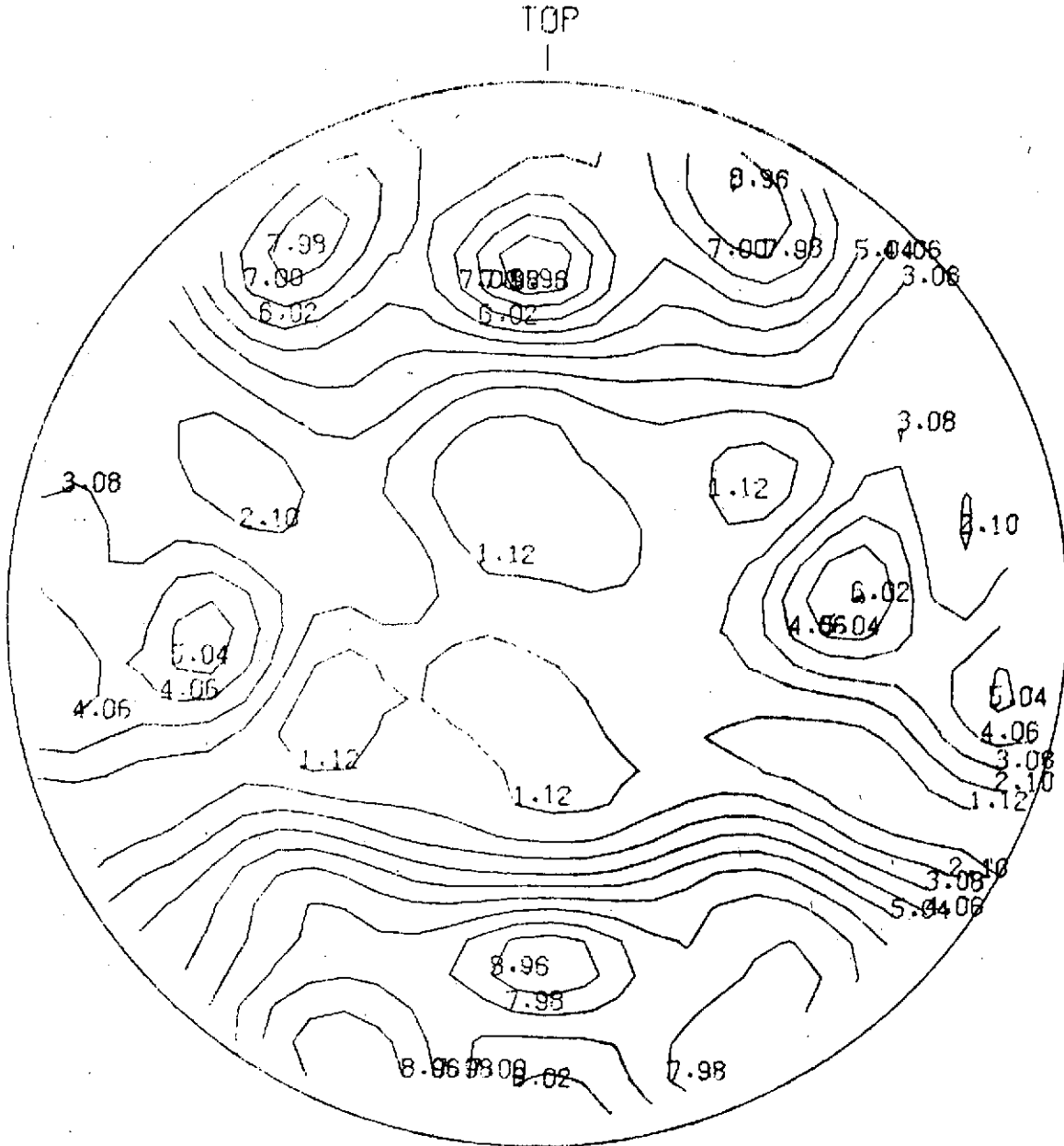




TABLE B28

B120

ENCIRCLED ENERGY

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

CIRCLE \*  
 ----- \*  
 RADIUS \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES  
 ----- \*  
 (41- \* CENTER (MICRONS):  
 COORDS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13  
 \* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13  
 \*

\*\*\*\*\*

2.00	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00	*	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1
6.00	*	0.1	0.1	0.1	0.2	0.3	0.1	0.1	0.1	0.1
8.00	*	0.3	0.4	0.2	0.4	0.3	0.3	0.2	0.4	0.3
10.00	*	0.4	0.5	0.2	0.5	0.4	0.4	0.3	0.6	0.5
12.00	*	1.0	1.2	0.4	0.9	0.5	0.9	0.5	1.4	1.1
14.00	*	1.0	1.2	0.7	1.4	0.7	1.3	0.9	1.4	1.1
16.00	*	1.9	2.1	1.0	1.9	0.9	1.8	1.2	2.5	2.0
18.00	*	2.1	2.5	1.6	2.4	1.7	2.4	1.8	2.9	2.4
20.00	*	2.9	3.3	2.2	3.2	1.7	3.1	2.5	3.9	3.2
22.00	*	3.2	3.7	3.2	3.9	3.1	3.8	3.6	4.3	3.7
24.00	*	4.3	4.6	3.6	4.4	4.0	4.3	4.1	5.5	4.9
26.00	*	4.9	5.2	5.0	5.4	5.7	5.3	5.5	6.1	5.6
28.00	*	6.4	6.5	6.2	6.9	6.2	6.6	6.9	7.6	7.2
30.00	*	7.7	7.6	7.5	8.0	8.1	7.8	8.4	8.8	8.6
32.00	*	10.1	9.7	8.6	9.5	9.3	9.2	9.5	11.0	10.9
34.00	*	10.6	10.2	10.4	11.4	10.5	11.1	11.6	11.5	11.5
36.00	*	13.5	12.9	11.9	13.5	12.5	13.2	13.1	14.2	14.2
38.00	*	15.2	14.5	13.7	15.4	14.5	15.1	15.0	15.8	15.8
40.00	*	17.8	17.1	15.8	17.8	16.0	17.6	17.1	18.4	18.4
42.00	*	19.1	18.5	18.8	20.5	18.8	20.2	20.0	19.9	19.8
44.00	*	22.0	21.4	20.3	22.0	21.4	21.8	21.6	22.9	22.7
46.00	*	24.4	23.8	24.1	25.0	25.1	24.7	25.4	25.5	25.3
48.00	*	26.8	26.3	27.0	28.0	26.7	27.7	28.6	28.2	28.0
50.00	*	29.7	29.1	29.7	30.2	30.9	29.8	31.2	31.3	31.2
52.00	*	32.8	32.1	32.4	33.0	34.0	32.6	34.3	34.4	34.5
54.00	*	34.6	34.0	35.9	36.2	37.3	35.7	37.7	36.4	36.6
56.00	*	38.2	37.4	39.1	40.1	40.6	39.7	41.5	39.7	40.2
58.00	*	41.3	40.4	41.4	42.6	44.1	42.2	43.7	42.9	43.5
60.00	*	44.3	43.3	44.8	46.3	47.3	46.0	47.4	45.6	46.6
62.00	*	46.7	45.7	48.1	49.5	50.1	49.4	50.6	48.1	49.1
64.00	*	50.8	49.8	50.3	52.0	53.3	52.1	53.2	51.8	53.0
66.00	*	53.4	52.6	54.2	55.3	56.8	55.6	56.8	54.7	55.7
68.00	*	56.3	55.6	57.0	58.0	58.4	58.5	59.3	57.4	58.5
70.00	*	58.9	58.5	60.1	60.6	61.9	61.2	62.1	60.1	61.0
72.00	*	61.9	61.5	62.4	62.8	65.2	63.5	64.3	62.9	63.7
74.00	*	63.4	63.4	65.7	65.7	67.8	66.3	67.1	64.7	65.4
76.00	*	66.4	66.5	68.3	68.3	70.2	68.8	69.3	67.4	67.9
78.00	*	68.6	68.9	70.0	70.0	72.6	70.4	71.0	69.6	70.0
80.00	*	70.7	71.0	72.5	72.5	74.6	72.8	73.2	71.5	71.8

\*\*\*\*\*

ENCIRCLED ENERGY

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

\*\*\*\*\*

CIRCLE \* PERCENT ENERGY WITHIN CIRCLE CENTERED AT INDICATED COORDINATES

RADIUS \* -----

(MI- \* CENTER (MICRONS):

COORDS) \* X= -10.13 10.13 0.0 -10.13 0.0 10.13 0.0 -10.13 10.13

\* Y= -10.13 -10.13 -10.13 0.0 0.0 0.0 10.13 10.13 10.13

\*\*\*\*\*

5.00	*	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
10.00	*	0.4	0.5	0.2	0.5	0.4	0.4	0.3	0.6	0.5
15.00	*	1.4	1.8	0.9	1.7	0.9	1.7	1.0	2.0	1.6
20.00	*	2.9	3.3	2.2	3.2	1.7	3.1	2.5	3.9	3.2
25.00	*	4.7	5.0	4.8	5.2	4.6	5.1	5.4	5.9	5.3
30.00	*	7.7	7.6	7.5	8.0	8.1	7.8	8.4	8.8	8.6
35.00	*	12.4	11.9	10.7	12.2	11.9	11.9	11.9	13.0	13.0
40.00	*	17.8	17.1	15.8	17.8	16.0	17.6	17.1	18.4	18.4
45.00	*	23.1	22.5	22.9	23.8	22.9	23.5	24.0	24.2	23.9
50.00	*	29.7	29.1	29.7	30.2	30.9	29.8	31.2	31.3	31.2
55.00	*	37.0	36.2	37.1	37.9	39.9	37.5	39.2	38.5	38.9
60.00	*	44.3	43.3	44.8	46.3	47.3	46.0	47.4	45.6	46.6
65.00	*	51.8	50.9	52.8	54.1	54.8	54.3	55.4	52.9	54.1
70.00	*	58.9	58.5	60.1	60.6	61.9	61.2	62.1	60.1	61.0
75.00	*	65.4	65.3	66.6	66.8	69.2	67.3	68.1	66.4	66.9
80.00	*	70.7	71.0	72.5	72.5	74.6	72.8	73.2	71.5	71.8
85.00	*	75.1	75.6	77.3	77.2	78.6	77.4	77.6	75.9	75.9
90.00	*	79.0	79.5	80.4	80.4	81.5	80.5	80.6	79.6	79.5
95.00	*	82.0	82.4	82.8	82.8	83.6	82.9	82.9	82.4	82.1
100.00	*	84.0	84.4	84.7	84.6	85.1	84.7	84.6	84.4	84.0
105.00	*	85.5	85.9	86.1	86.0	86.3	86.0	85.9	85.8	85.4
110.00	*	86.8	87.1	87.2	87.1	87.3	87.1	87.0	87.0	86.8
115.00	*	88.0	88.1	88.1	88.1	88.2	88.1	88.1	88.0	88.0
120.00	*	88.8	88.9	88.9	88.9	89.1	89.0	89.0	88.8	88.9
125.00	*	89.6	89.6	89.7	89.7	89.9	89.8	89.8	89.5	89.6
130.00	*	90.2	90.3	90.4	90.4	90.6	90.5	90.4	90.2	90.3
135.00	*	90.9	90.9	90.9	91.0	91.1	91.0	91.0	91.0	91.0
140.00	*	91.4	91.4	91.4	91.5	91.5	91.5	91.6	91.5	91.5
145.00	*	91.9	91.8	91.9	92.0	91.9	91.9	92.0	91.9	92.0
150.00	*	92.4	92.2	92.3	92.4	92.4	92.3	92.4	92.3	92.4
155.00	*	92.8	92.7	92.7	92.8	92.8	92.7	92.8	92.7	92.7
160.00	*	93.2	93.1	93.2	93.1	93.1	93.1	93.1	93.1	93.1
165.00	*	93.5	93.5	93.6	93.5	93.5	93.5	93.5	93.5	93.4
170.00	*	93.8	93.9	93.9	93.9	93.9	93.9	93.8	93.8	93.8
175.00	*	94.2	94.2	94.2	94.2	94.3	94.2	94.2	94.2	94.2
180.00	*	94.5	94.5	94.5	94.6	94.6	94.6	94.6	94.5	94.6
184.99	*	94.8	94.8	94.8	94.8	94.8	94.9	94.9	94.8	94.9
189.99	*	95.1	95.1	95.1	95.1	95.2	95.2	95.2	95.1	95.2
194.99	*	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
199.99	*	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7

\*\*\*\*\*



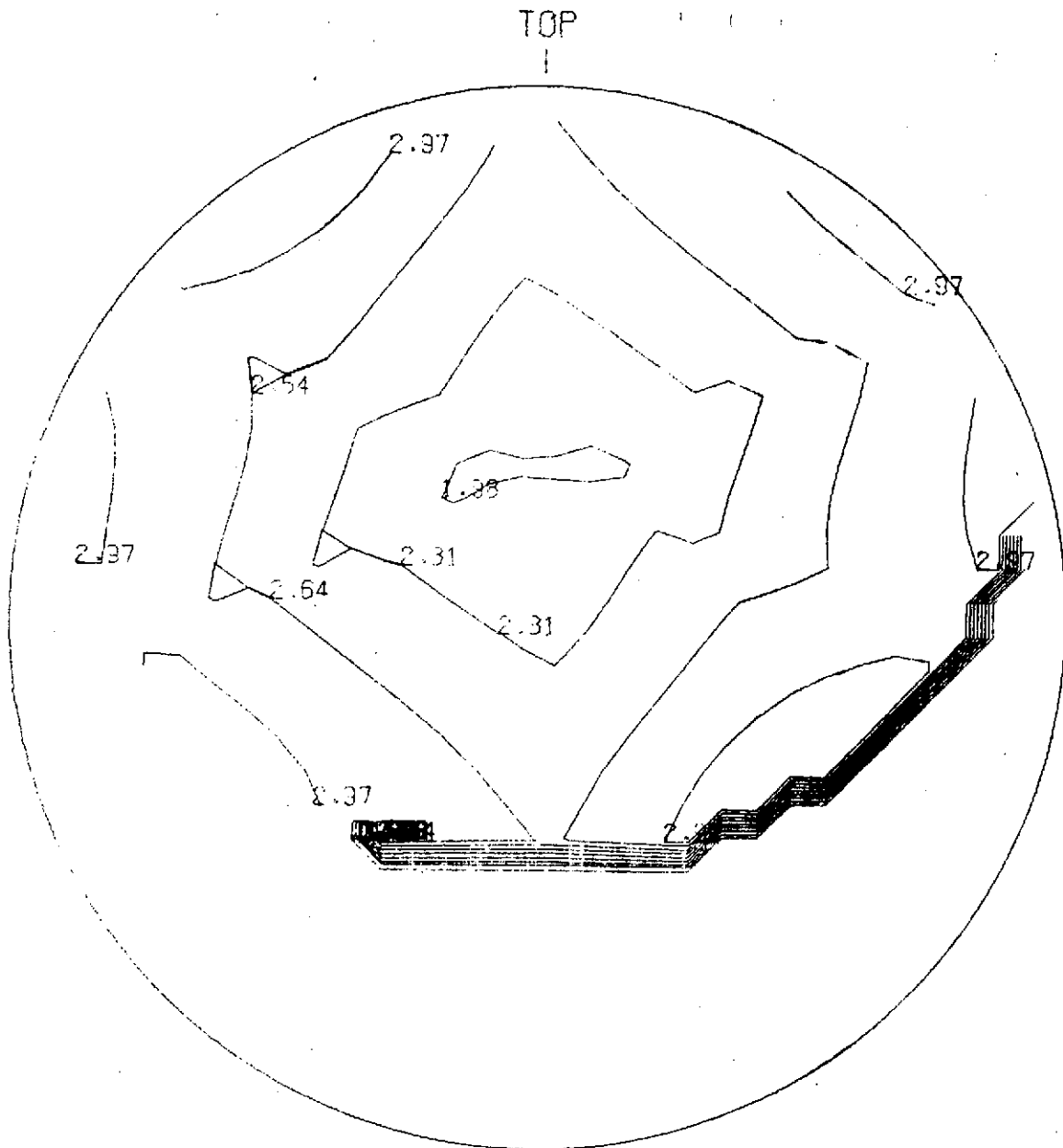
ADD	FULL	AVERAGE	AVERAGE	QUARTER	TEMPERAT
NONE		RMS 0.30	PK-PK	1.42	FRED WAVEFRONT

FIGURE B93

B123

Wavefront Plot-Q Polarization

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR





ADD  
1  
NONE

FULL

AVERAGE

AVERAGE

QUARTER

TEMPERAT

PLOT NUMBER 4

RMS

0.85

PK-PK

3.12

FREQ

WAVEFRONT

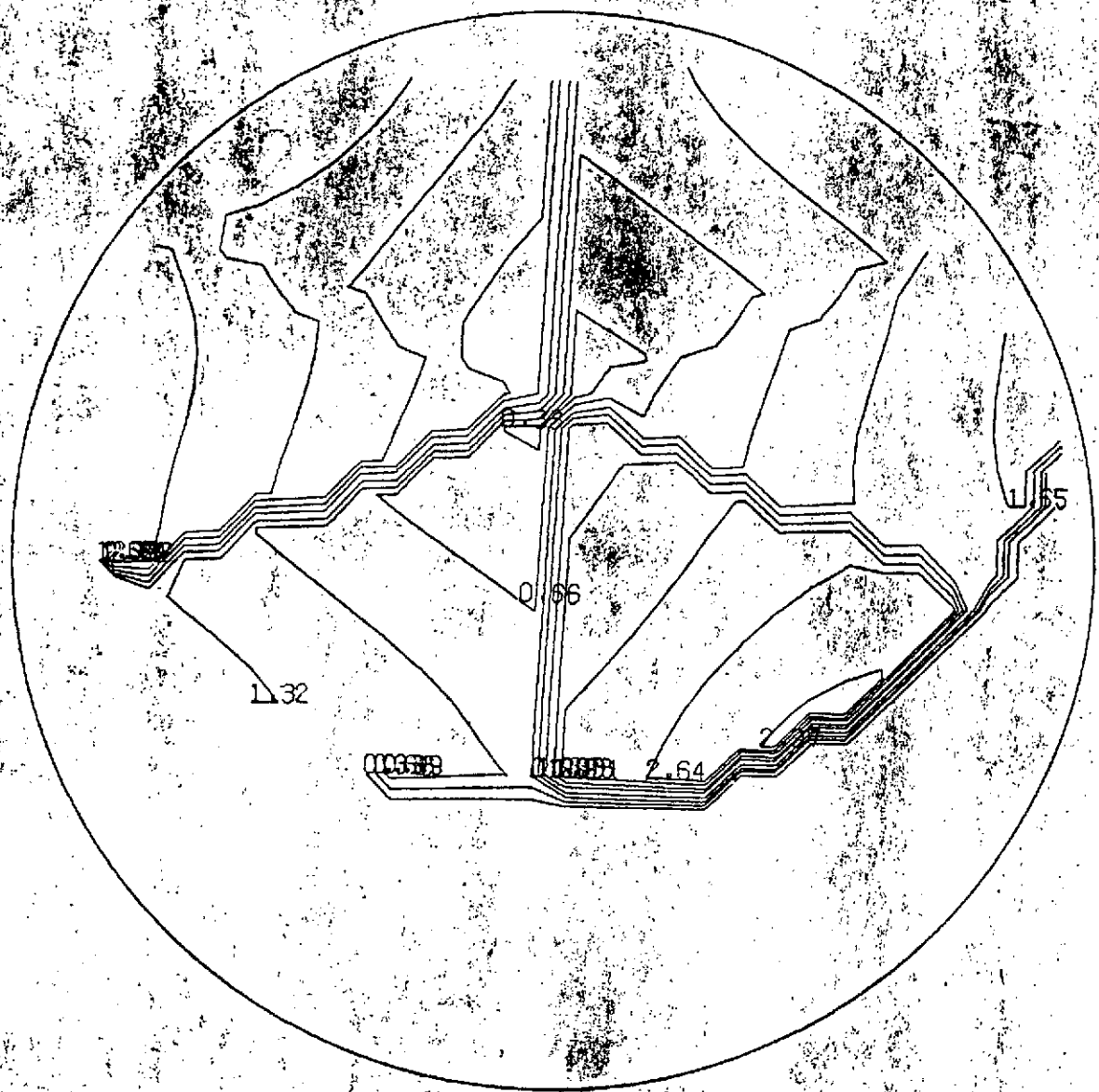
FIGURE B95

B125

Wavefront Plot-P Polarization

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

TOP  
1



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Q-313

FIGURE B96

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis

PRINTER MAP OF POINT SPREAD FUNCTION

(ONE SPACE REPRESENTS 8.04 MICRONS)  
 NORMALIZED SO LARGEST VALUE = 0.0146 = 100  
 TOTAL ENERGY = 0.18704000+01  
 MAP REPRESENTS 0.17381950+01 OR 92.9318 PERCENT OF TOTAL ENERGY

B126

0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	2	2	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1			
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10  
10

ID  
ID  
NONE

RMS 2.28

PK-PK

10.25

FREQ

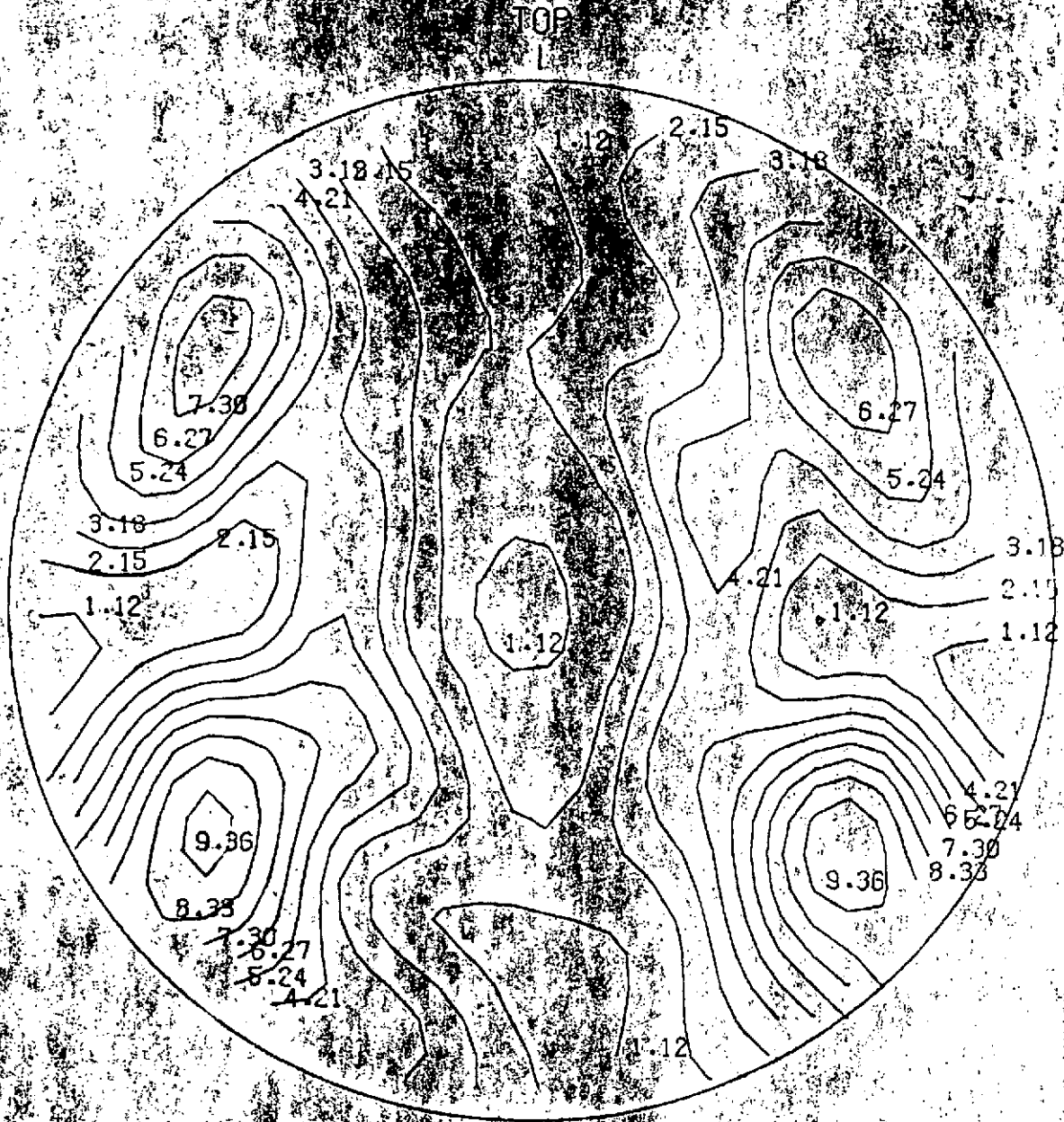
WAVEFRONT

FIGURE B97

B127

Intensity Distribution - Central 129 Microradians

Task 2.4B2 - Off Nominal Cube + Mfg. Error + First Temperature -15° Off Axis



REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIGURE B98

Encircled Energy

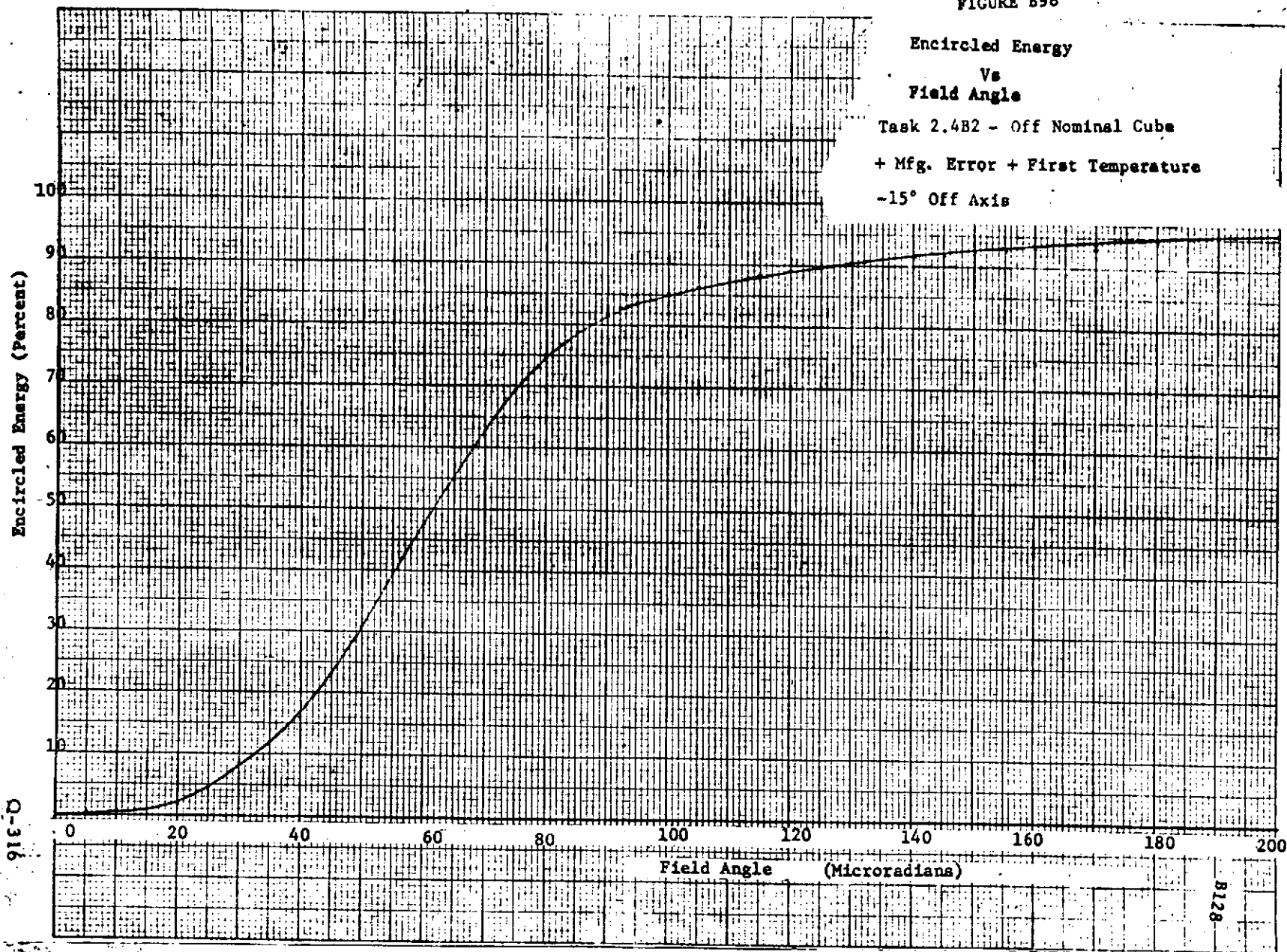
Vs

Field Angle

Task 2.4B2 - Off Nominal Cube

+ Mfg. Error + First Temperature

-15° Off Axis



91C-D

8128

TABLE B30  
ENCIRCLED ENERGY IN THE  
32-42 MICRORADIAN RING  
FOR 2.1 SEC DIHEDRAL ANGLE VARIATION

Task	Case	Percent Energy 32-42 Microradians	
		On Axis	Full
2.1	Nominal Cube	14.9	7.3
2.2	Nominal Cube + $\lambda/4$	13.3	6.9
2.3B	Nominal Cube + $\lambda/4$ + Temp 1	12.3	6.2
2.3A1	Nominal Cube + $\lambda/4$ + Temp 2	14.4	
2.3A2	Nominal Cube + $\lambda/4$ + Temp 3	13.8	
2.4A	Off Nominal Cube + $\lambda/4$	13.6	6.9
2.4B2	Off Nominal Cube + $\lambda/4$ + Temp 1	12.5	6.2
2.5A	Nominal Cube + $\lambda/4$ + Axial Grad.	19.8	
2.5B	Nominal Cube + $\lambda/4$ + Radial Grad.	1.2	

APPENDIX CViewgraph Presentation

The following pages C2-C20 are copies of the viewgraphs presented at a briefing at George C. Marshall Space Flight Center, Huntsville, Alabama on 4 September, 1974.



THERMO-OPTICAL ANALYSIS

LAGEOS

PREPARED UNDER

CONTRACT TO

BENDIX AEROSPACE SYSTEMS DIVISION

4 SEPTEMBER 1974



TOPICS

- PURPOSE/OBJECTIVES
- SUMMARY OF RESULTS
- ASSUMPTIONS/INPUTS
- TECHNIQUES/MODEL
- OUTPUT
- CONCLUSIONS/FUTURE EFFORT

PURPOSE/OBJECTIVES

ANALYTICALLY PREDICT LAGEOS OPTICAL PERFORMANCE/SENSITIVITY

● MODEL INDIVIDUAL RETROREFLECTOR

● MATERIAL

● MANUFACTURING

● SURFACE QUALITY

● ANGULAR ANOMALIES

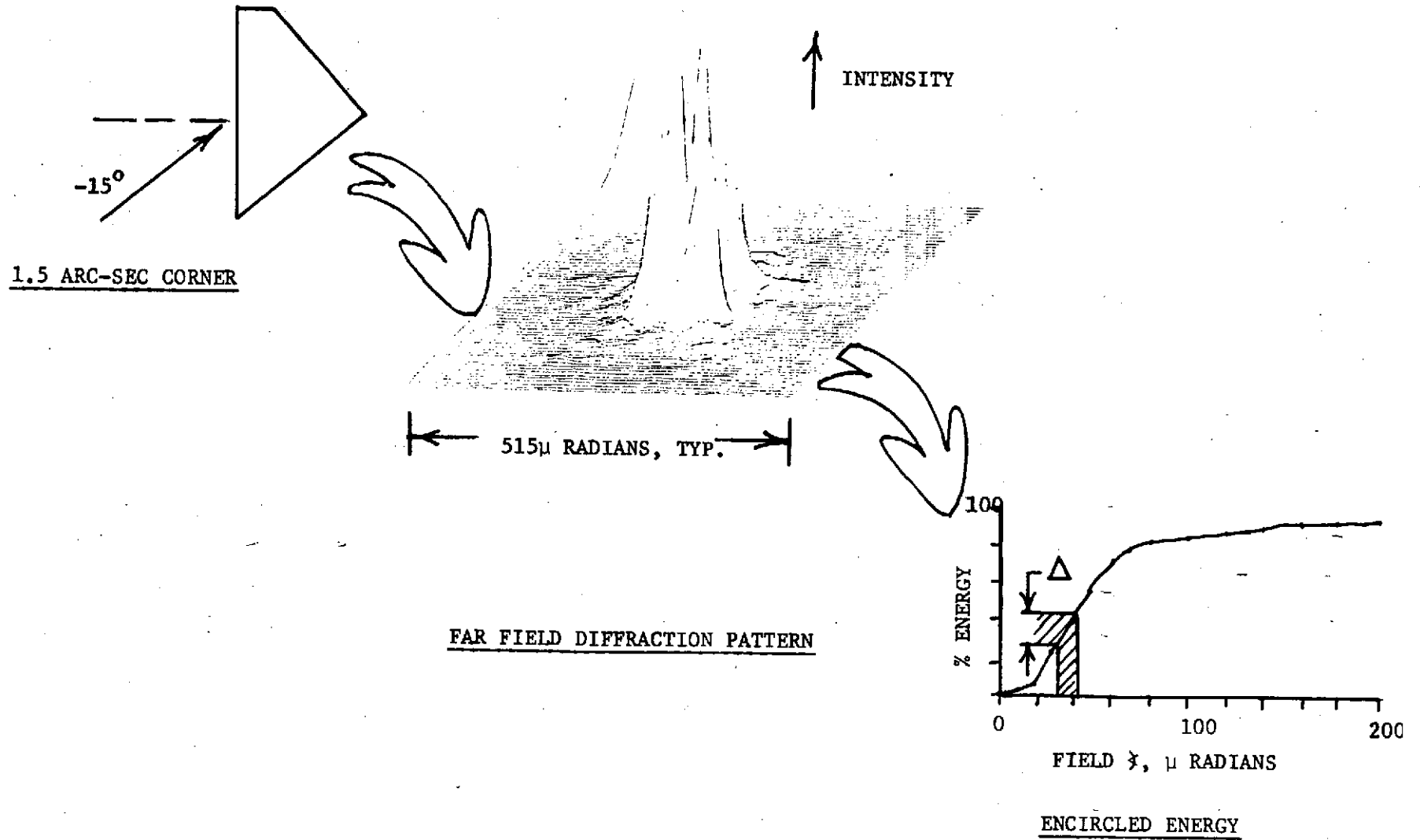
● ENVIRONMENTAL LOADING

PURPOSE/OBJECTIVES CONTINUED

● FAR FIELD CHARACTERISTICS

- FIELD ANGLE
- POLARIZATION EFFECTS
- ENCIRCLED ENERGY
- FAR FIELD PATTERN

FAR-FIELD CHARACTERISTICS



SUMMARY - NOMINAL CUBE CORNERS

% ENCIRCLED ENERGY, 32 TO 42 $\mu$  RADIANT REGION, TYP.

( ASSUMES 100% INPUT @ 0 $^{\circ}$  )

	<u>0<math>^{\circ}</math></u>	<u>-15<math>^{\circ}</math></u>
● 1.5 ARC-SEC	21.6	10.8
● 2.1 ARC-SEC	14.9	7.3

SUMMARY OF SENSITIVITY RESULTS - MANUFACTURING

(CHANGES IN ENCIRCLED ENERGY SHOWN ARE ACTUALS, NOT %'S OF %'S)

- SURFACE QUALITY
  - UP TO 1.6% CHANGES
  - $\sim \lambda/4$  PK-PK SMOOTH WFE/SECTOR
  
- ANGULAR DIFFERENTIALS
  - UP TO 0.4% CHANGES
  - CORNER WITH  $\pm 0.5$  ARC-SEC ANGLES
  
- CONSTANT  $\lambda$  ERROR
  - UP TO 8.1% CHANGES
  - 2.1 vs 1.5 ARC-SEC CORNERS

SUMMARY OF SENSITIVITY RESULTS - 3D TEMPERATURE MAPS

(FACE COOL, EDGE WARM)

● +30°C CAVITY, W/SUN, W/O IR

- UP TO 1.1% CHANGES
- 1.9°C  $\Delta T_A$ , 1.3°C  $\Delta T_R$

● -30°C CAVITY, W/SUN, W/O IR

- UP TO 1.1% CHANGES
- 1.0°C  $\Delta T_A$ , 0.4°C  $\Delta T_R$

● ESTIMATED MAXIMUM

- UP TO 1.0% CHANGES
- 3.5°C  $\Delta T_A$ , 2.0°C  $\Delta T_R$

SUMMARY OF SENSITIVITY RESULTS - UNIT LOADS

$$dw = \int dn(s) ds$$

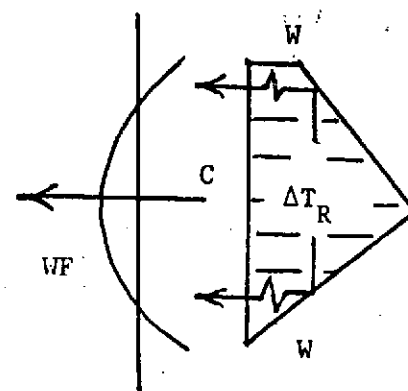
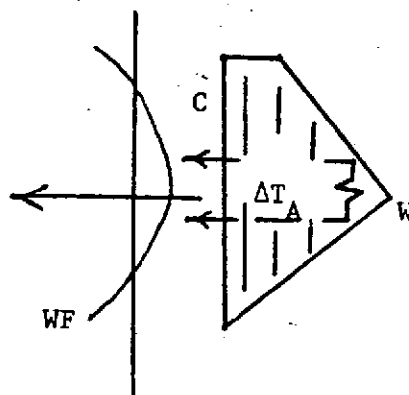
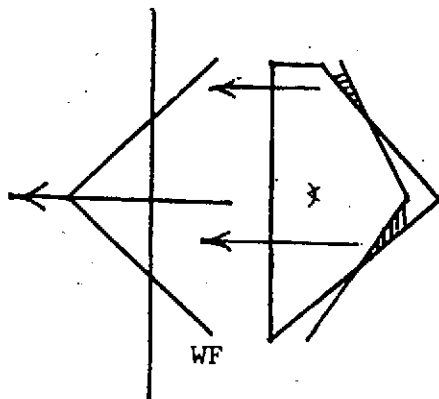
NOMINAL  
RAY PATH

● 1.5°C AXIAL GRADIENT

● 1ST REMOVES  $\lambda$  ERROR, THEN ADDS  
● 21.2  $\rightarrow$  10% (ENERGY TO CORE)  $\rightarrow$  18.0%

● 2.0°C RADIAL GRADIENT

● UP TO 16.1% LOSSES



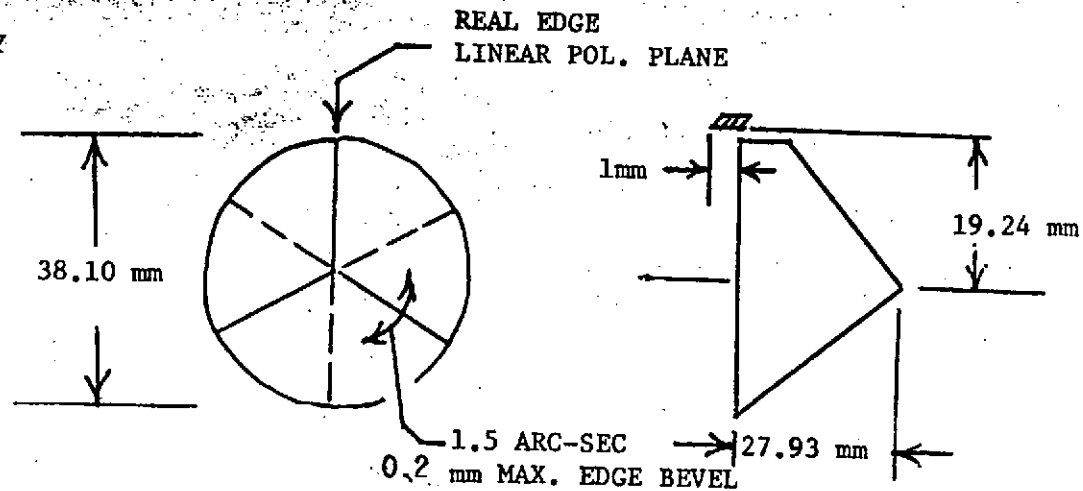


ASSUMPTIONS/INPUTS

● MATERIAL

- T-19 SUPRASIL 1 (SPECIAL)
- AMERSIL DATA -  $N(\lambda)$ ,  $\partial n/\partial T$  ( $\lambda, T, P$ ) → 7 to 8.5 x
- HOMOSIL, CONSERVATIVE

● GEOMETRY

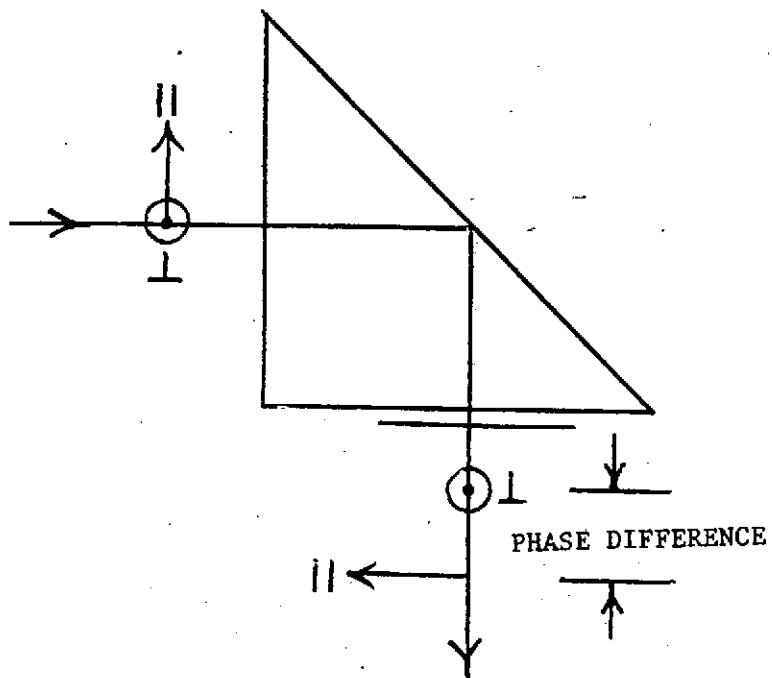


● LASER

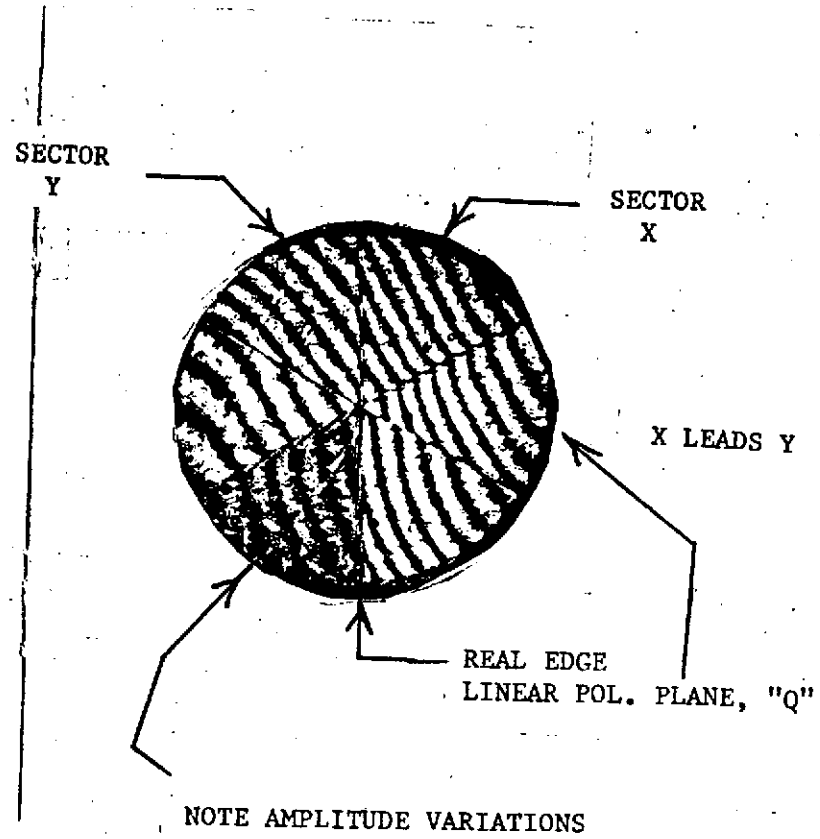
- 6328A, FLAT WF, CENTERED
- 20% GAUSSIAN VARIATION OVER 50 mm DIAMETER

TOTAL INTERNAL REFLECTION  
 LIGHT REFLECTS AND POLARIZATION STATE IS CHANGED

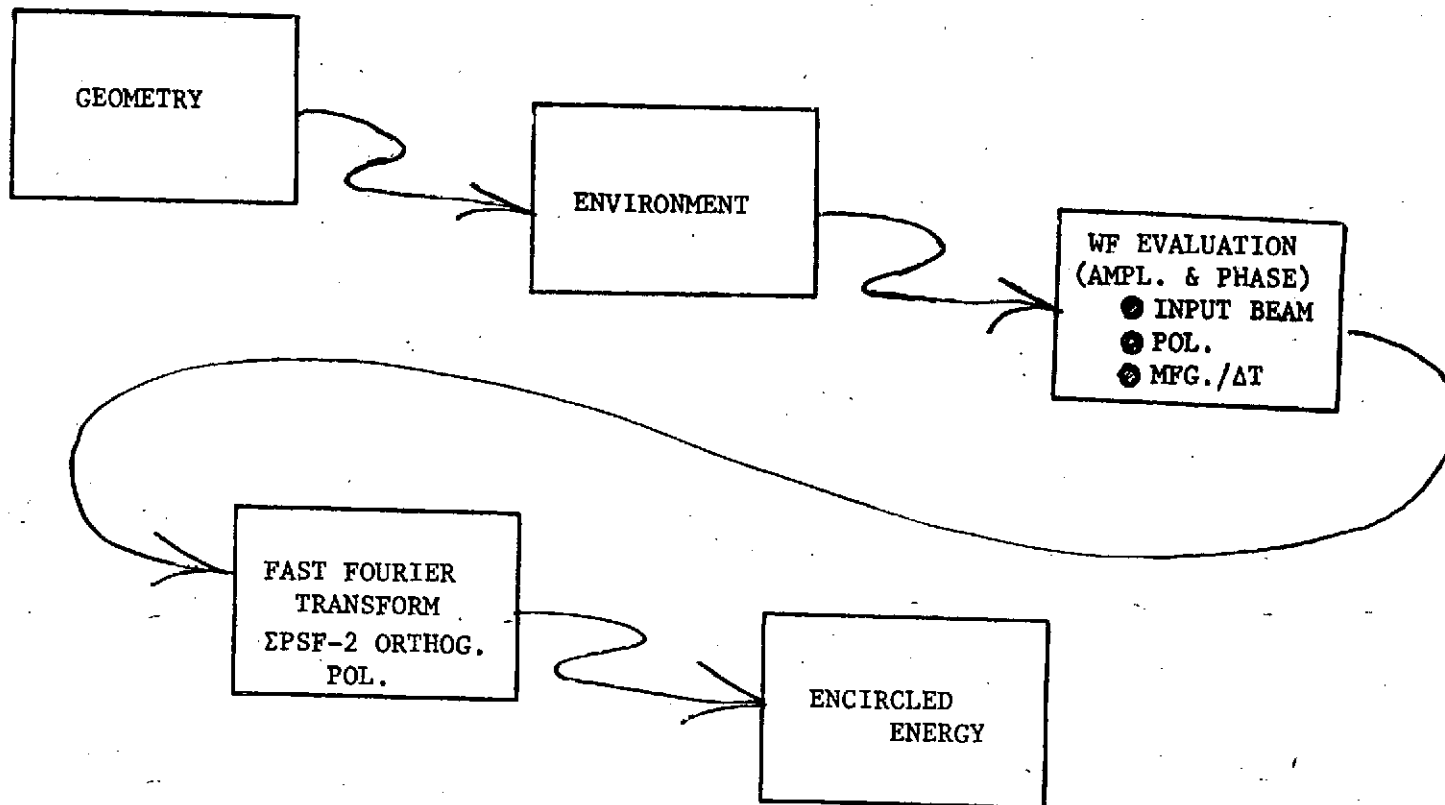
2-D, CARTOON



3-D, INTERFEROGRAM



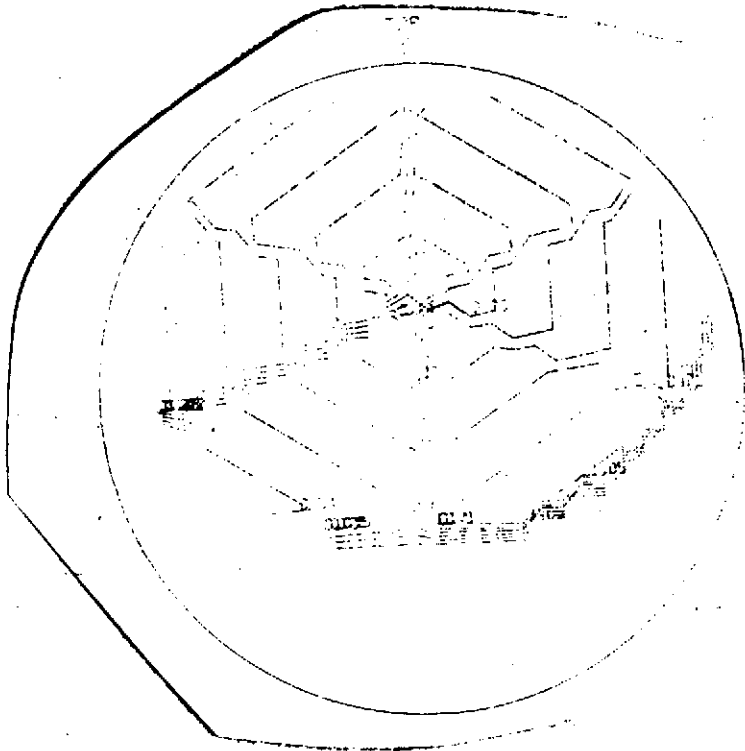
TECHNIQUES/MODEL



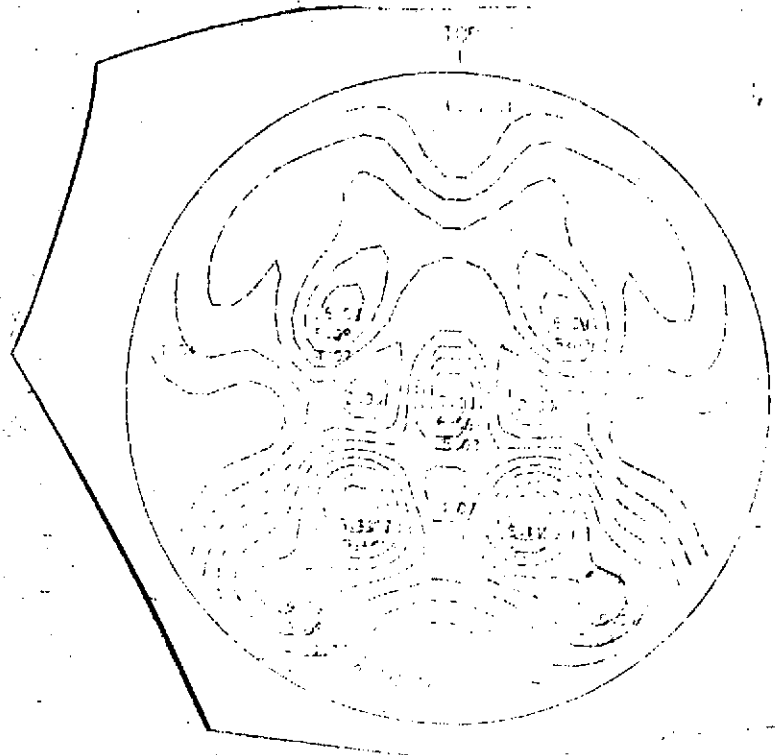
ACCURACY ~ 1% IN ENCIRCLED ENERGY

OTHER TYPES OF OUTPUT

"P/Q" AMPLITUDES & PHASES  
(NOMINAL CUBE,  $-15^\circ$ )



"P" WAVEFRONT



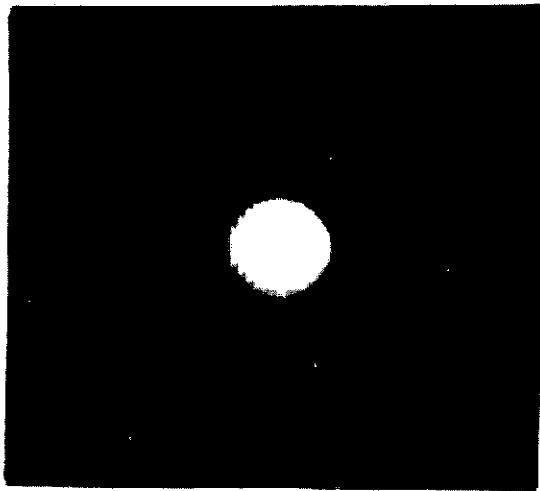
PSF-CENTRAL 129μ RADIANS

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

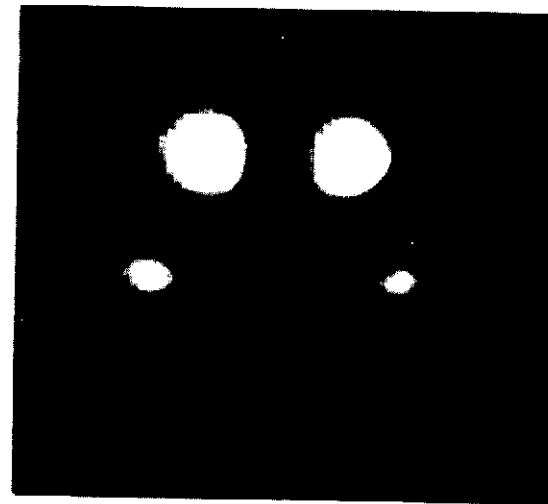


ITEK LASER SCANNER RECORDER PHOTOGRAPHS

(PERFECT BK7 CORNER)  
(NOTE-UNCALIB. EXAMPLE)



"Q" - 61 % OF TOTAL ENERGY



"P" 39 % OF TOTAL ENERGY

CONCLUSIONS

- ALL ENCIRCLED ENERGY DATA AVAILABLE FOR TEST CORRELATION.
- RETROREFLECTOR RELATIVELY INSENSITIVE -  $\lambda/4$ ,  $\pm 0.5$  ARC-SEC.
- SENSITIVITY TO CONSTANT  $\lambda$  ERROR -  $\leq 6.8\%$  CHANGES/0.5 ARC-SEC.
- 3-D TEMPERATURE PROFILES EFFECT  $32 - 42\mu\text{RAD}$ .  $\sim 1\%$ .
- AXIAL GRADIENTS COMPENSATE WEDGE/RADIAL GRADIENTS.
- INDEPENDENT GRADIENT TYPES HAVE FAIRLY HIGH SENSITIVITY.

RECOMMENDATIONS-ADDITIONAL EFFORT

(DEPENDENT UPON CUSTOMER/INVESTIGATOR NEEDS)

- TEST CORRELATION
  - SPECIFIC CORNER ANGLES/GEOMETRY
  - TEST EQUIPMENT EFFECTS
  - INTERFEROMETRIC/PHOTOMETRIC INPUT
  - FIELD ANGLE/APODIZATION REFINEMENT
  - INCIDENT WF QUALITY
  - FAR FIELD INTENSITY CROSS CHECKS
- ALTERNATE  $\lambda$ 's, TREATMENT OF ARRAYS/POL. VARIATIONS
- "TRANSFER FUNCTION" SUPPORT



1.5 ARC SEC CORNER  
ENCIRCLED ENERGY IN THE  
32-42 MICRORADIAN RANGE

CASE	% ENERGY 32-42 $\mu$ RAD ON AXIS	FULL
NOMINAL CUBE	21.6	10.8
NOMINAL CUBE + $\lambda/4$	21.2	9.8
NOMINAL CUBE + $\lambda/4$ +30°C CAVITY	20.4	9.4
NOMINAL CUBE + $\lambda/4$ +(-)30°C CAVITY	21.1	
NOMINAL CUBE + $\lambda/4$ + EST. MAX.	20.2	
OFF NOMINAL CUBE + $\lambda/4$	20.8	9.8
OFF NOMINAL CUBE + $\lambda/4$ + 30°C CAVITY	20.0	9.2
NOMINAL CUBE + $\lambda/4$ + AXIAL GRAD.	18.0	
NOMINAL CUBE + $\lambda/4$ + RADIAL GRAD.	5.1	

2.1 ARC-SEC CORNER  
ENCIRCLED ENERGY IN THE  
32-42 MICRORADIAN RANGE

CASE	% ENERGY 32-42 $\mu$ RAD ON AXIS	FULL
NOMINAL CUBE	14.9	7.3
NOMINAL CUBE + $\lambda/4$	13.3	6.9
NOMINAL CUBE + $\lambda/4$ + 30°C CAVITY	12.3	6.2
NOMINAL CUBE + $\lambda/4$ + (-)30°C CAVITY	14.4	
NOMINAL CUBE + $\lambda/4$ + EST. MAX.	13.8	
OFF NOMINAL CUBE + $\lambda/4$	13.6	6.9
OFF NOMINAL CUBE + $\lambda/4$ +30°C CAVITY	12.5	6.2
NOMINAL CUBE + $\lambda/4$ + AXIAL GRAD.	19.8	
NOMINAL CUBE + $\lambda/4$ + RADIAL GRAD.	1.2	