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**DOGS—A Collection of Graphics
for Support of Discrete
Ordinates Codes**

D. T. Ingersoll
C. O. Slater

MASTER

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OF DISCRETE ORDINATES CODES

D. T. Ingersoll

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TABLE OF CONTENTS

ABSTRACT	v
1. INTRODUCTION	1
2. EGAD - A CODE FOR DISPLAYING DOT GEOMETRIES.	5
2.1 Code Description.	5
2.2 Input Requirements.	6
2.3 Input Data Notes.	8
2.4 IØ File Requirements.	10
2.5 Region Requirements	10
2.6 JCL Requirements.	10
2.7 Sample Problems	11
3. ISØPLOT4 - A CODE FOR PLOTTING DOT-IV GEOMETRIES AND ISOFLUX CONTOURS	23
3.1 Code Description.	23
3.2 Input Requirements.	25
3.3 Input Data Notes.	28
3.4 IØ File Requirements.	29
3.5 Region Requirements	30
3.6 JCL Requirements.	30
3.7 Sample Problems	31
4. FORM - SURFACE PLOTTING CODE FOR DOT FLUXES.	43
4.1 Code Description.	43
4.2 Input Requirements.	43
4.3 Input Data Notes.	46
4.4 IØ File Requirements.	49
4.5 Region Requirements	50
4.6 JCL Requirements.	50
4.7 Sample Problems	50
5. ACTUAL - CODE FOR CALCULATING DOT ACTIVITIES	59
5.1 Code Description.	59
5.2 Input Requirements.	59
5.3 IØ Requirements	61
5.4 Region Requirements	61
5.5 JCL Requirements.	62
5.6 Sample Problems	62

6.	TOOTH - SURFACE PLOTTING CODE FOR SPACE-ENERGY CONTRIBUTON FLUXES	63
6.1	Code Description.	63
6.2	Input Requirements.	64
6.3	Input Data Notes.	67
6.4	IØ File Requirements.	70
6.5	Region Requirements	71
6.6	JCL Requirements.	71
6.7	Sample Problems	72
7.	ASPECT - A MULTIPURPOSE SPECTRUM PLOTTING CODE	85
7.1	Code Description.	85
7.2	Input Requirements.	86
7.3	Input Data Notes.	90
7.4	IØ File Requirements.	93
7.5	Region Requirements	93
7.6	JCL Requirements.	94
7.7	Sample Problems	94
	ACKNOWLEDGEMENTS	109
	REFERENCES	111
	APPENDIX A - DISSPLA POST PROCESSORS	A-1
	APPENDIX B - FIDO INPUT.	B-1

ABSTRACT

A collection of computer codes called DOGS (Discrete Ordinates Graphics Support) has been developed to assist in the display and presentation of data generated by commonly used discrete ordinates transport codes. The DOGS codes include: EGAD for plotting two-dimensional geometries, ISOPLOT4 for plotting 2-D fluxes in a contour line fashion, FORM for plotting 2-D fluxes in a 3-D surface fashion, ACTUAL for calculating 2-D activities, TOOTH for calculating and plotting space-energy contribution fluxes, and ASPECT for plotting energy spectra. All of the codes use FIDO input formats and DISSPLA graphics software including the DISSPOP post processors. The codes are generally tailored for minimum input requirements when used with the ANISN and DOT discrete ordinates codes, but include many special options for alternate uses and flexible plot enhancements. All of the DOGS codes function independently, and are operational on the ORNL and CTC IBM 360/370 computer systems.

1. INTRODUCTION

The evolution of fast and powerful computers and equally sophisticated computer codes has made it possible for a single individual to generate highly accurate and profoundly significant information faster than he can possibly interpret the data. Such is the case with present-day discrete ordinates codes such as ANISN¹ and DOT IV² which calculate radiation transport in a variety of one and two dimensional geometries. To help the discrete ordinates user cope with the deluge of data, several auxiliary codes have been developed to graphically display the large volume of calculated numbers in a convenient and interpretable manner. The codes have been shown to be valuable in several respects: (a) the diagnosis of computational mistakes, (b) the interpretation of calculated data, and (c) the communication of results to others. This report represents a collection of graphics codes which have been recently developed for the support of users of the ANISN and DOT computer codes. The codes include:

- EGAD - Plots two dimensional geometries and calculates geometry-related data useful for constructing and debugging complicated geometries. Standard X-Y, R-Z, and R- θ geometries are permitted.
- ISOPL0T4 - Plots iso-flux and iso-activity contours from DOT-IV fluxes overlaid on an EGAD-type geometry plot. Standard and variable mesh X-Y and R-Z geometries are permitted.

- FORM - Plots DOT fluxes or activities as a three-dimensional surface projected above an EGAD-type geometry plot. Standard X-Y, R-Z, and R- θ geometries are permitted.
- ACTUAL - Calculates activities from DOT fluxes on a zone-wise basis. Reads one-or two-dimensional response functions from cards or a library tape.
- TOOTH - Calculates $\phi*\phi$ matrix from ANISN angular fluxes and plots the space- and energy-dependent results as a three-dimensional surface. Slab, cylindrical, and spherical geometries are permitted.
- ASPECT - Plots flux spectra in almost any manner and from almost anywhere. Options permit automatic axis scaling and overlaying of spectra from different input sources.

Each of the codes documented in this report have several special features which are described in the individual sections. In addition, there are a few features common to all of the codes. They are:

1. The DISSPLA graphics software package³ is used for convenient and flexible plot manipulation.
2. The DISSPOP post-processing method⁴ is used for added flexibility in plot manipulation and device selection.
3. The subroutine ALOCAT provides maximum-allowed region allocation at the time of execution.
4. The FIDO input system is used.
5. Input arrays are consistent, when possible, to the arrays in ANISN and DOT.

In any computer code there is the inevitable conflict between maximum flexibility and minimum input requirements. For this collection of codes, the general approach has been to provide numerous input options, but whenever possible, default values are supplied which will yield adequate results with a minimum of effort. The success of this approach can only be judged by the user.

As listed above, the DOGS codes (excluding ACTUAL) use DISSPLA which is a proprietary graphics software package distributed by Integrated Software Systems Corporation. The package is an extensive collection of basic routines for constructing plots at all levels of sophistication. To take advantage of flexibilities offered by DISSPLA, some of the DOGS codes allow the user to optionally interact with DISSPLA directly for the purpose of special plot embellishments. This, of course, requires that the user be familiar with DISSPLA. Rather than reproduce for this report a large portion of the DISSPLA User's Manual (Ref.3), the relevant sections of the DISSPLA manual will be only referenced here with little further explanation.

A further advantage of the DISSPLA package is that it allows for post-processing of the plot commands. In this mode of operation, the graphics code produces a special output file containing all plot information which can be read by a number of different post-processors and converted to the actual pen or beam commands. The obvious advantages are that: (a) the graphics code is independent of plotting device, (b) the plot information file can be saved for later use, and (c) the same plot file can be used to generate plots on several different devices,

e.g., a CRT, then a CALCOMP pen plotter. Additionally, some simple plot manipulations can be performed in the post-processor such as scaling. For a detailed description of post-processing features, the user is directed to the DISSPOP User's Manual (Ref.4). However, for convenience, several of the more commonly used post-processors are described in Appendix A of this report. Also given in Appendix A are listings of the job control language (JCL) needed to run the post-processors on the ORNL and CTC computers.

Finally, all of the DOGS codes use the FIDO input system which is familiar to all discrete-ordinates users. For completeness, a description of FIDO formats and operators is given in Appendix B.

2. EGAD - A Code for Displaying DOT Geometries

2.1 Code Description

The program EGAD (Excellent Geometry Array Displayer) was written for constructing, debugging, and displaying two-dimensional geometries for the DOT transport code. A minimum amount of input is required to provide a full edit of spatial mesh boundaries, interval widths and areas, and zone volumes. Also, a high quality plot of zone and/or material boundaries can be produced with almost no effort. Many plotting options are available for flexible plot manipulation. Special features in addition to those listed in Section 1 include:

- A. Beyond the control parameter arrays, only the 2*, 4*, and 8\$ from DOT are required. If a material map/plot is desired, the 9\$ array must also be supplied.
- B. Output edit gives mesh boundaries, midpoints, widths, areas, and zone volumes. A 2-D print of individual cell volumes is optional.
- C. Standard X-Y, R-Z, and R- θ geometries are permitted; variable mesh is not treated properly.
- D. A 2-D printer map of zones by interval is provided with an option to also print a material map.
- E. Boundary plots can be produced with arbitrary I- and J-axis limits.
- F. Special plotting options are available to invert, reflect, and rotate geometries.
- G. Two geometries can be overlayed for comparison.

EGAD requires very few computer resources, so that virtually all problems of practical size can be executed in the minimum job class. Since EGAD uses DISSPLA post processors, any output device can be used for plots. The Gould plotter connected to the Remote 7 line in Bldg. 6025, especially, provides a means of fast job turnaround.

2.2 Input Requirements

The following input arrays and title cards are required in order to execute an EGAD case. Default values are given in []'s.

PRØBLEM TITLE CARD (20A4 format)

Control Parameters

61\$ array (7 entries)

IM	Number of I (X-R-R) intervals.
JM	Number of J (Y-Z-Ø) intervals.
IZM	Number of spatial zones.
IGEØM	0/1/2 - X-Y/R-Z/R=Ø geometry. [1]
MAT	0/1 - Print zone and material map/zone map only. [0]
IVØL	0/1 - No effect/calculate IM*JM cell volumes. [0]
NBUF	Number of k-bytes needed for IØ buffers. [10]

62\$ array (7 entries)

IPLØT	0/1 - No effect/plot zone and material (if MAT = 0) boundary map(s). [0]
IREFL	0/1 - No effect/reflect plot at left boundary for X-Y and R-Z or top boundary for R-Ø. [0]
INVS	0/1/2/3 - No effect/invert geometry with respect to I-direction/J-direction/both I and J. [0]

ITIP 0/1 - No effect/rotate entire plot 90° in clockwise direction. [0]

IFRM 0/1 - No effect/delete frame which surrounds plot. [0]

IBDR 0/1 - No effect/delete border which outlines plot page. [0]

IØVR 0/1/2 - No effect/plot is 1st of overlay pair/plot is 2nd of overlay pair. [0]

63* array (11 entries)

SIZE Maximum dimension of plot area in inches. [7.5]

XPAGE Horizontal length of page in inches. [8.5]

YPAGE Vertical length of page in inches. [10.4]

XSCL Relative scale factor for I-axis. [1]

YSCL Relative scale factor for J-axis. [1]

XSTP I-axis label increment. A zero means label only at axis ends. [0]

YSTP J-axis label increment. A zero means label only at axis ends. [0]

XMIN Minimum I-boundary to be plotted. [0]

XMAX Maximum I-boundary to be plotted. If XMIN = XMAX = 0, then actual min and max values are used. [0]

YMIN Minimum J-boundary to be plotted. [0]

YMAX Maximum J-boundary to be plotted. If YMIN = YMAX = 0, then actual min and max values are used. [0]

T Data Block 1 Terminator

Geometry arrays

- 2* (JM + 1) J-interval boundaries.
- 4* (IM + 1) I-interval boundaries.
- 8\$ (IM*JM) Zone numbers by interval.
- 9\$ (IZM) Material number by zone. Not required if MAT = 1.
- 12\$ (IZM) Shading style by zone. See Data Note I.

T Data Block 2 Terminator

PLØT TITLE CARD (14A1 format)

I-AXIS LABEL; J-AXIS LABEL (2(10A4) format)

Note: The PLØT TITLE and AXIS LABELS should be ended with a \$.

2.3 Input Data Notes

A. IVØL Setting IVØL = 1 provides individual cell volumes which can be useful in constructing complicated geometries. It does, however, destroy the 8\$ array which might effect multiple cases.

B. IREFL The reflection option generally yields an enhanced plot. It does require more space (nothing comes free), and shifts all arrays in Data Block 2. Caution must be used if multiple cases are run using IREFL = 1.

C. INVS The INVS parameter causes the 2*, 4*, and 8\$ arrays to be reordered and can be used independent of other plotting options. Inversions in the I (radial) direction are ignored for R-Ø problems.

D. ITIP For plots which are long in the J-direction, ITIP can be used to rotate the plot to run "along" the paper instead of "across" the paper. XPAGE and YPAGE should be considered independent of ITIP.

- E. IØVR Two geometries can be overlayed using this parameter. The two plots should be input as successive cases with all plotting options and dimensions identical. Also, the plot title and axis labels should be identical or blank in one of the cases. The second geometry is drawn with dotted lines.
- F. SIZE, XSCL, YSCL The boundary plot is scaled so as to just fit within the plot area defined by SIZE. Usually SIZE should be less than the smaller page dimension to insure no page runoff. The plot is normally scaled with equal step sizes in I- and J-directions (except R-Ø plots) unless XSCL or YSCL are used to alter proportions of the two axes. Setting XSCL $\neq$ YSCL for R-Ø plots would produce rather strange results and should be avoided.
- G. Multiple Cases Multiple cases are permitted, with the cautions noted above regarding IVØL, IREFL, and INVS. Also, MAT = 0 replaces zone numbers in 8\$ array with corresponding material numbers from 9\$ array.
- H. Plot and Axis Labels Flexible manipulation of the character strings for the title cards is possible if the user has knowledge of DISSPLA mixed alphabets. No further explanation will be presented here; users are directed to section 19 of the Intermediate Manual of DISSPLA. The required information needed to use the mixed alphabets of DISSPLA is as follows:

Character Font: SIMPLX

MX1ALF: "STANDARD"	ESCAPE CHAR: ")"
MX2ALF: "L/CSTD"	ESCAPE CHAR: "("
MX3ALF: "INSTRUCTION"	ESCAPE CHAR: "!"
MX4ALF: "L/CGREEK"	ESCAPE CHAR: "?"

I. Shading Style (12\$ array) Individual zones can be shaded using a variety of shading styles. The allowed styles are given in Fig. 2.0 which offer basically 7 different line patterns oriented at 4 different angles. In addition, a 0 can be used to specify no shading. Styles 7 and 27 are identical, as are 17 and 37. Also, styles 6, 16, 26, and 36 are identical, and should be used for only small zones since these styles give the plotter pen a real headache. There are a few limitations to the shading option due to the simplified (although clever) approach used to search and define zone boundaries. First, any one zone is searched for only once and the search is completed when the zone is fully enclosed. Therefore, if a zone appears as multiple mutually exclusive regions, then only the first region will be shaded. This can be overcome by identifying the separate regions as unique zones. Another limitation is that annular-type zones will be shaded as a solid zone, that is, the inside boundary will be ignored. This difficulty can not be overcome - tough luck.

Fig. 2.0. Shading styles permitted by EGAD.

2.4 IØ File Requirements

<u>File</u>	<u>Description</u>	<u>Required</u>
CØMPØUT	Compressed plot data	Always

2.5 Region Requirements

The number of words in blank COMMON needed to execute EGAD can be determined from:

$$NWØRDS = 3*(IZM+1) + 3*(IM+JM) + IM*JM + IM*(JM**IREFL)$$

The number of words available for execution is:

$$NSPACE = (REGIØN-NBUF-154)*256$$

where REGIØN is the value (in k-bytes) specified on the EXEC card.

For any single problem of practical size, EGAD will require less than 270K region, 20 seconds of IBM 360/91 time, and 1000 IØ-units.

2.6 JCL Requirements

The job control language (JCL) needed to run EGAD at either X-10 or K-25 is:

(Job card and CLASS cards)

```
//EGAD EXEC PGM=EGAD,REGIØN=270K
```

```
//GØ.STEPLIB DD DSN=X.DTI46103.PRØG,DISP=SHR
```

```
//GØ.FT05F001 DD DDNAME=SYSIN
```

```
//GØ.FT06F001 DD SYSØUT=A
```

```
//CØMPØUT DD UNIT=SYSDA,DISP=(NEW,PASS),
```

```
// DSN=&&PLTØUT,DCB=BUFNO=1,SPACE=(4000,(200,20),RLSE)
```

(Input cards)

(Post processor - see Appendix A)

2.7 Sample Problems

Several sample EGAD cases are presented in this section in order to demonstrate the simplicity of input and the flexibilities of plotting geometries with EGAD. Since the JCL does not vary from problem to problem, only the input data are listed. Problems 1-3 and problems 5-7 were run as multiple cases, while problem 4 was run separately.

Sample Problem 1: The first EGAD sample problem demonstrates a no-option R-Z case. The input which is given in Fig. 2.1 used all default values except for IPLØT to turn on the plotting feature. The lengthy 8\$ array was abbreviated for simplicity. The resulting zone and material plots are shown in Fig. 2.2. Both plots use the same plot title card, which uses parentheses to shift to lower case letters. Double parentheses were required to also draw the ()'s.

Sample Problem 2: A closeup of the "wraparound shield" portion of the R-Z geometry in Problem 1 is shown in Fig. 2.3. Also, axis label increments were specified, and no material plot was selected. The input listing which is given in Fig. 2.1 shows how only new input data are required.

Sample Problem 3: The input listing for the third sample problem is also given in Fig. 2.1, and shows that for IREFL = 1, the second data block must be reentered. Figure 2.4 shows the resulting plot which has also been inverted in the axial (J) direction to yield the true geometric orientation. When reflecting and inverting, a bit more care must be given to the axis label increments in order to produce the best label values. It should be noted that sample problems 1-3 combined took 22 seconds and 0.3 k-IØ units to execute on the ORNL IBM 360/91.

Sample Problem 4: The fourth EGAD sample uses the same R-Z mesh as the previous samples, except that the overlay option is used. Figure 2.5 lists the pair of input cases which produces the plot shown in Fig. 2.6. Since EGAD is simply avoiding the advance of the paper between cases, it is important that plot dimensions and labels are not changed in the second case. This particular example compares the zone boundaries to the coarse mesh boundaries which were used in the DOT IV problem to improve the rebalance and convergence of the flux calculation. It should be noted that other plotting options such as closeup, inversion, or reflection could have been specified in addition to the overlay.

Sample Problem 5: The fifth problem represents a no-option R- θ case. The input is listed in Fig. 2.7 while the plot is shown in Fig. 2.8. The axis labels become less obvious for R- θ problems and could probably be left blank for most cases. Considerable string manipulation was used for the plot title, which requires a knowledge of DISSPLA mixed alphabets and the appropriate escape characters (see Input Date Note H).

Sample Problem 6: The input for sample 6 is given in Fig. 2.7 which produces the closeup R- θ view in Fig. 2.9. Also, the plot frame was deleted. Here, the axis increments and labels have very little usefulness.

Sample Problem 7: The next EGAD sample problem is shown in Fig. 2.10. The 180° R- θ case is greatly enhanced by the full reflection.

Sample Problem 8: The last sample problem (Fig. 2.11) shows how shading can be used to enhance a zone plot.

```

EGAD SAMPLE 1:  GCPR R-Z 1 * CSC.1
O
61$$  99 107 50 1 0 0 10
62$$  1 E
T
4**   9I 0.0 2I 70.983 4I 88.243 3I 107.863 3I 124.427 3I 140.994
3I 157.56 179.50 5I 180.45 193.23 194.5 4I 199.6 214.6 1I 219.7
2I 224.8 228.7 1I 229.9 1I 234.9 1I 239.9 1I 242.7 244.9 246.2
3I 247.7 3I 252.7 1I 257.7 1I 262.7 1I 269.1 2I 282.1 4I 292.1
2I 302.1 1I 311.0 1I 312.9 1I 316.9 2I 324.9 342.9
2**   5I 0.0 28.25 5I 30.75 6I 56.5 89.5 92.0 1I 95.5 1I 101.5
3I 108.0 1I 133.0 150.0 2I 152.5 193.6 205.9 211.0 213.5
1I 224.1 253.0 258.1 272.0 2I 274.5 333.0 2I 335.5 394.0
2I 396.5 455.0 457.5 470.0 475.0 1I 480.0 516.0 2I 518.5 577.0
2I 582.1 1I 605.0 640.0 660.0 5I 670.0 7I 751.6 1I 797.3
4I 807.5 2I 845.6 1I 854.5 1I 856.4 1I 860.4 2I 868.4 886.40
8$$
10R 1 3R 2 5R 3 4R 4 4R 5 4R 16 4R 22 23 6R 25 24 22 5R 28
22 2R 29 4R 40 14R 42 4R 41 2R 30 15R 22 2R 49 7R 50 5Q 99
10R 1 3R 2 5R 3 4R 6 4R 7 4R 17 4R 22 23 6R 25 24 22 5R 28
. . . ETC . . .
9$$  11I 1 49 2R 57 4R 53 3R 57 2R 61 73 14R 61 2R 73 65
73 2R 65 81 77 85 89 93
T
EGAD S (AMPLE) P (ROBLEM) 1$
RADIUS ((CM))$
EGAD SAMPLE 2:  GCPR R-Z 1 * CSC.1
61$$  99 107 50 1 1 0 10
62$$  1 E
63**  5S 2R50.0 150. 320. 450. 700.
T
T
EGAD S (AMPLE) P (ROBLEM) 2$
RADIUS ((CM))$
EGAD SAMPLE 3:  GCPR R-Z 1 * CSC.1
61$$  99 107 50 1 1 0 10
62$$  1 1 2 E
63**  5S 171.45 100. 4Z
T
4**   9I 0.0 2I 70.983 4I 88.243 3I 107.863 3I 124.427 3I 140.994
3I 157.56 179.50 5I 180.45 193.23 194.5 4I 199.6 214.6 1I 219.7
2I 224.8 228.7 1I 229.9 1I 234.9 1I 239.9 1I 242.7 244.9 246.2
3I 247.7 3I 252.7 1I 257.7 1I 262.7 1I 269.1 2I 282.1 4I 292.1
2I 302.1 1I 311.0 1I 312.9 1I 316.9 2I 324.9 342.9
2**   5I 0.0 28.25 5I 30.75 6I 56.5 89.5 92.0 1I 95.5 1I 101.5
3I 108.0 1I 133.0 150.0 2I 152.5 193.6 205.9 211.0 213.5
1I 224.1 253.0 258.1 272.0 2I 274.5 333.0 2I 335.5 394.0
2I 396.5 455.0 457.5 470.0 475.0 1I 480.0 516.0 2I 518.5 577.0
2I 582.1 1I 605.0 640.0 660.0 5I 670.0 7I 751.6 1I 797.3
4I 807.5 2I 845.6 1I 854.5 1I 856.4 1I 860.4 2I 868.4 886.40
8$$
10R 1 3R 2 5R 3 4R 4 4R 5 4R 16 4R 22 23 6R 25 24 22 5R 28
22 2R 29 4R 40 14R 42 4R 41 2R 30 15R 22 2R 49 7R 50 5Q 99
10R 1 3R 2 5R 3 4R 6 4R 7 4R 17 4R 22 23 6R 25 24 22 5R 28
. . . ETC . . .
T
EGAD S (AMPLE) P (ROBLEM) 3$
RADIUS ((CM))$
HEIGHT ((CM))$

```

Fig. 2.1. Input Listing for EGAD Sample Problems 1-3. The lengthy 8\$ array was abbreviated for this report.

ORNL-DWG-79-14969 ORNL-DWG-79-14968

EGAD Sample Problem 1 EGAD Sample Problem 1

Fig. 2.2. Geometry plots produced by Sample 1 input (Fig. 2.1). The zone boundary map (left) is plotted first followed by the material map (right).

EGAD Sample Problem 2

Fig. 2.3. Closeup view of a portion of the R-Z geometry given in Fig. 2.2

EGAD Sample Problem 3

Fig. 2.4. Example of reflection and inversion options for an R-Z problem

```

EGAD SAMPLE PROBLEM 4:  GCPR R-Z 1 * CSC.1
0
61$$ 99 107 50 1 1 0 10
62$$ 1 0 0 0 0 0 1
63** 5S 2R100. E T
4** 9I 0.0 2I 70.983 4I 88.243 3I 107.863 3I 124.427 3I 140.994
3I 157.56 179.50 5I 180.45 193.23 194.5 4I 199.6 214.6 1I 219.7
2I 224.8 228.7 1I 229.9 1I 234.9 1I 239.9 1I 242.7 244.9 246.2
3I 247.7 3I 252.7 1I 257.7 1I 262.7 1I 269.1 2I 282.1 4I 292.1
2I 302.1 1I 311.0 1I 312.9 1I 316.9 2I 324.9 342.9
2** 5I 0.0 28.25 5I 30.75 6I 56.5 89.5 92.0 1I 95.5 1I 101.5
3I 108.0 1I 133.0 150.0 2I 152.5 193.6 205.9 211.0 213.5
1I 224.1 253.0 258.1 272.0 2I 274.5 333.0 2I 335.5 394.0
2I 396.5 455.0 457.5 470.0 475.0 1I 480.0 516.0 2I 518.5 577.0
2I 582.1 1I 605.0 640.0 660.0 5I 670.0 7I 751.6 1I 797.3
4I 807.5 2I 845.6 1I 854.5 1I 856.4 1I 860.4 2I 868.4 886.40
8$$
10R 1 3R 2 5R 3 4R 4 4R 5 4R 16 4R 22 23 6R 25 24 22 5R 28
22 2R 29 4R 40 14R 42 4R 41 2R 30 15R 22 2R 49 7R 50 5Q 99
10R 1 3R 2 5R 3 4R 6 4R 7 4R 17 4R 22 23 6R 25 24 22 5R 28
. . . ETC . . .
T
EGAD S (AMPLE) P (ROBLEM) 4$
RADIUS ((CM))$ HEIGHT ((CM))$
EGAD: OVERLAY COARSE MESH
61$$ 13 42 26 1 1 0 10
62$$ 1 0 0 0 0 0 2
T
4**
0.0 35.49 70.983 107.863 140.994 179.50 199.60 219.70 239.90
262.70 292.10 311.00 324.90 342.90
2**
0.0 28.25 56.50 89.50 108.0 133.0 150.0 166.2 179.9 193.6
211.0 224.1 238.55 253.0 272.0 294.0 313.5 333.0 355.0
374.5 394.0 416.0 435.5 455.0 480.0 498.0 516.0 538.0
557.5 582.1 605.0 622.5 640.0 660.0 683.6 710.8 738.0 763.0
791.0 815.0 838.0 860.0 886.0
8$$ 24I 1 26 20Q 26
T
$
$
$

```

Fig. 2.5. Input Listing for EGAD Sample Problem 4

EGAD Sample Problem 4

Fig. 2.6. Example of overlay plot produced by input given in Fig. 2.5. The second plot is drawn with dotted lines.

```

EGAD SAMPLE PROBLEM 5: BEK R-THETA PROBLEM 1
O
61$$ 53 98 21 2 1 0 10
62$$ 1 E
T
2** 87I0.0 .4888889 1I.4890944 .4910417 .4944444 4I.4968842 .5
4**
38I0.0 5I117.8814 7I126.9492 139.0396
8$$
6R1 4R2 4R3 8R5 4R14 4R20 4R21 11R9 8R10
6R1 4R2 4R3 8R5 4R14 4R20 3R21 14R9 6R10
6R1 4R2 4R3 7R5 3R6 4R20 4R21 16R9 5R10
6R1 4R2 3R3 1R4 6R5 4R6 5R20 4R21 14R9 6R10
. . . ETC . . .
T
EGAD !M4)S!M5)AMPLE !M4)P!M5)ROBLEM 5 : !M4)R-?Q) S!M5)TANDARD$
RADIUS ((CM))$
EGAD SAMPLE PROBLEM 6: BEK R-THETA PROBLEM 1
O
62$$ A5 1 E
63** 5S 2Z 40. 90. 0.30 0.40
T
T
EGAD !M4)S!M5)AMPLE !M4)P!M5)ROBLEM 6 : !M4)R-?Q) C!M5)LOSEUP$
EGAD SAMPLE PROBLEM 7: BEK R-THETA PROBLEM 1
O
62$$ 1 1 P0
63** 5S 2R34.76 4Z
T
2** 87I0.0 .4888889 1I.4890944 .4910417 .4944444 4I.4968842 .5
4**
38I0.0 5I117.8814 7I126.9492 139.0396
8$$
6R1 4R2 4R3 8R5 4R14 4R20 4R21 11R9 8R10
6R1 4R2 4R3 8R5 4R14 4R20 3R21 14R9 6R10
6R1 4R2 4R3 7R5 3R6 4R20 4R21 16R9 5R10
6R1 4R2 3R3 1R4 6R5 4R6 5R20 4R21 14R9 6R10
. . . ETC . . .
T
EGAD !M4)S!M5)AMPLE !M4)P!M5)ROBLEM 7 : !M4)R-?Q) R!M5)EFLECTED$

```

Fig. 2.7. Input Listing for EGAD Sample Problems 5-7. Again, the 8\$ array was abbreviated to avoid a lengthy listing.

Fig. 2.8. Example of standard R- θ geometry plot spanning 180° . The plot title was truncated since only 60 characters (including special instructions) are permitted.

ORNL-DWG-79-14974

EGAD Sample Problem 6 : $R-\theta$ Closeu

Fig. 2.9. Example of closeup $R-\theta$ view from the geometry given in Fig. 2.8. Also, the plot frame has been deleted.

ORNL-DWG-79-14975

EGAD Sample Problem 7 : $R-\theta$ Reflec

Fig. 2.10. Example of reflected $R-\theta$ geometry. The radial line at $\theta=0$ is unavoidable, but only appears out of place for reflected 180° problems.

Fig. 2.11. Example of how shading can be used with EGAD.

3. ISØPLØT4 - A Code for Plotting DOT-IV Geometries and Isoflux Contours

3.1 Code Description

ISØPLØT4 combines the plotting principles of EGAD (Sec. 2.0) with those of ISØPLØT⁵ to form a code for plotting isoflux contours for variable mesh geometries. Since the fixed mesh case is a subset of the variable mesh case, the code will likewise perform plots for fixed mesh geometries. Flux input is accepted only in the VARFLM format.

The geometry plots are limited to X-Y or R-Z. A given plot may either be reflected or periodic about its left or bottom boundary. This allows one to extend the plot to one containing either two or four units of the basic geometry. Either a zone or material geometry may be plotted in one pass through the code, but the second plot may be obtained with minimum input respecification. A DOT-IV region edit plot may be obtained by substituting the data from the DØT-IV 84\$ array for that in the ISØPLØT4 9\$ array. The code also allows the user to specify the zone map with the "combinatorial-geometry" option* (described in Section 3.2).

Four alphabet types are allowed with each being triggered by a special character. The base alphabet is the upper case Roman ("STANDARD"). All characters will be printed with this alphabet until a special character signaling the start of a new alphabet is encountered. The return to the base alphabet is achieved by coding a right parenthesis (")"). The other alphabets are (1) the lower case Roman ("L/CSTD" signaled with a left

*W. A. Rhoades and R. L. Childs, "An Updated Version of the DOT-IV One- and Two-Dimensional Neutron/Photon Transport Code," ORNL/TM-7816 (draft report).

parenthesis - "("), (2) "INSTRUCTION" (signaled with a "#"), and (3) ITALIC (signaled with an ampersand "&"). The "INSTRUCTION" is really not an alphabet but a set of instructions to allow one to change the size, position, and orientation of a character or sets of characters. It was included here mainly for the capability of including subscripts and superscripts in titles.

The program hierarchy is shown in Fig. 3.1 and a suitable overlay structure is shown in Table 3.1. With this particular overlay structure, DISSPLA Version 8.2, and 20K bytes allowed for buffer space, 41984 data locations were available within a 380K region.

Table 3.1. Suitable Overlay Structure for Use in ISØPLØT4

ØVERLAY ØNE
INSERT CUMR,RPRT,MAP,MAPR,MAPX
ØVERLAY ØNE
INSERT PLTGM
ØVERLAY TWØ
INSERT FIDØS,FIDAS1,FFREED,FIDEL,CØPYIT,DØPYIT
ØVERLAY TWØ
INSERT REGPLT,ACTCMP,RDDAT,BNDACT,FLMT,SSØRT
ØVERLAY TWØ
INSERT WØT,FLXPLT,PNTSEP,FLTFX

Without overlay, as recommended with the IBM MVS system, the number of data locations available with a 380K region and a 20K buffer allocation becomes 33792. This represents a decrease of 12288 locations from that available with DISSPLA version 7.5 and the overlay structure shown in Table 3.1. While there is a substantial decrease in the data space

available, the impact is not expected to be serious at ORNL because of the generous region sizes under MVS.

Note that "inches" are used in the input description simply because the plotting routines are programmed with this unit. The violation of the SI convention is thus unavoidable.

3.2 Zone Specification by the Combinatorial-Geometry Option

An alternate method for specifying the zone numbers (8\$ array), the "combinatorial-geometry" option, is available. Rather than the usual 8\$ description, supply input in the following format:

```

-z1   i1   j1   I1   J1
-z2   i2   j2   I2   J2
etc
F 0

```

Each set of five integers contains:

```

-z:   The zone number, tagged with a negative
      i   Indices of lower, lefthand corner of zone in
      j   zone map
      I   Indices of upper, righthand corner of zone in
      J   zone map

```

(Note: The zone descriptions need not appear on separate cards.) As many descriptors as required to a limit of IMSJM* are used, and the remainder of the array is filled with 0. Zones can be overlaid as desired (i.e., specifying one zone and selectively replacing it by zone specifications which follow.) This type of 8\$ array must not be intermingled with the traditional type within a given problem. When used with variable mesh, the zones are understood to be cylindrical in space, not in the zone map.

*The total number of mesh cells in the problem.

Fig. 3.1. Hierarchy for ISØPLØT4 program.

Fig. 3.1a. Subroutine calls from subroutine FIDAS1.

24b

Fig. 3.1b. Subroutine calls from subroutine PLTGM.

3.3 Input Requirements (Data Notes in Brackets)

A. Problem Title Card (18A4 Format)

B. Block 1 Input

0\$ array (3 entries)

NFLSV Fortran unit number for flux or activity file
(default is 1).

IRFLX 0/1/2 = no effect/plot reflected about left
boundary/plot periodic about left boundary.

IRFLY 0/1/2 = no effect/plot reflected about bottom
boundary/plot periodic about bottom boundary.

1\$ array (9 entries)

IMX Maximum number of I intervals.

JM Number of J intervals.

NSET Number of I sets.

IZM Number of Zones.

IMAP 0/1/2/3 = Plot zone/mat'l/zone with minimum input
supplied/mat'l with minimum input supplied.

ITIP 0/1 = Do not/Do tip geometry 90 degrees.

IGM Maximum number of groups or activities to be used
from input flux tape.

NLVMX Maximum number of isoflux levels to be plotted
for any activity [DN1].

NBUF Number of K-bytes (1024 bytes) for buffer space.

2* array (12 entries)

SIZE Maximum plot size in inches [DN2]. If SIZE=0, a
suitable value is calculated internally.

XPAGE	X page length in inches [DN3].
YPAGE	Y page length in inches [DN3].
XSCL	Scale factor for X-axis.
YSCL	Scale factor for Y-axis.
XSTP	Units per division on X-axis (default is XMAX-XMIN).
YSTP	Units per division on Y-axis (default is YMAX-YMIN).
XMIN	Minimum X to be plotted [DN4].
XMAX	Maximum X to be plotted [DN4].
YMIN	Minimum Y to be plotted [DN4].
YMAX	Maximum Y to be plotted [DN4].
EPS	Minimum distance (inches) between plotted points for a given level.

T Block 1 Terminator

C. Block 2 Input [omit if IMAP>1]

3\$ array [NSET entries] Number of intervals per I-Set

4\$ array [JM entries] I-Set assigned to each J interval. Note that I-Sets must be consecutively and increasingly numbered and J-levels with the same I-Set must be contiguous.

T Block 2 Terminator

D. Block 3 Input [omit if IMAP>1]

5* array [JM+1 entries] J interval boundaries (2* array of DOT-IV).

6* array [IMSISM+NSET entries] I interval boundaries (4* array of DOT-IV). IMSISM defined by DOT-IV (Ref. 2).

7\$ array [IZM entries] Zone plot option: 0/1 = Do not/Do plot within zone.

8\$ array [IMSISM entries] Zone numbers by interval.

9\$ array [IZM entries] Material numbers by zone.

T Block 3 Terminator

E. Axis labels (separate cards)

1. X-axis label (10A4 format) — followed by '\$' if <40 characters.

2. Y-axis label (10A4 format) — followed by '\$' if <40 characters.

F. Plot title (15A4 format) — followed by '\$' if <60 characters.

G. Block 4 Input

3.2 Input Requirements (Data: Notes in Brackets)

A. Problem Title Card (18A4 Format)

B. Block 1 Input

1\$ array (8 entries)

IMX	Maximum number of I intervals.
JM	Number of J intervals.
NSET	Number of I sets.
IZM	Number of Zones.
IMAP	0/1/2/3 = Plot zone/mat'l/zone with minimum input supplied/mat'l with minimum input supplied.
ITIP	0/1 = Do not/Do tip geometry 90 degrees.
IGM	Maximum number of groups or activities to be used from input flux tape.
NLVMX	Maximum number of isoflux levels to be plotted for any activity [DN1].

2* array (12 entries)

SIZE	Maximum plot size in inches [DN2]. If SIZE=0, a suitable value is calculated internally.
XPAGE	X page length in inches [DN3].
YPAGE	Y page length in inches [DN3].
XSCL	Scale factor for X-axis.
YSCL	Scale factor for Y-axis.
XSTP	Units per division on X-axis (default is XMAX-XMIN).
YSTP	Units per division on Y-axis (default is YMAX-YMIN).

XMIN Minimum X to be plotted [DN4].
 XMAX Maximum X to be plotted [DN4].
 YMIN Minimum Y to be plotted [DN4].
 YMAX Maximum Y to be plotted [DN4].
 EPS Minimum distance (inches) between plotted points
 for a given level.

T Block 1 Terminator

C. Block 2 Input [omit if IMAP>1]

3\$ array [NSET entries] Number of intervals per I-Set
 4\$ array [JM entries] I-Set assigned to each J interval

T Block 2 Terminator

D. Block 3 Input [omit if IMAP>1]

5* array [JM+1 entries] J interval boundaries (2* array of DOT-IV).
 6* array [IMSISM+NSET entries] I interval boundaries (4* array
 of DOT-IV). IMSISM defined by DOT-IV (Ref. 2).
 7\$ array [IZM entries] Zone plot option: 0/1 = Do not/Do plot
 within zone.
 8\$ array [IMSISM entries] Zone numbers by interval.
 9\$ array [IZM entries] Material numbers by zone.

T Block 3 Terminator

E. Axis labels (separate cards)

1. X-axis label (10A4 format) — followed by '\$' if <40 characters.
2. Y-axis label (10A4 format) — followed by '\$' if <40 characters.

F. Plot title (15A4 format) — followed by '\$' if <60 characters.

G. Block 4 Input

10\$ array [4 entries]

IGA First group in activity sum [DN5].
 IGB Last group in activity sum [DN5].
 NLVL No. of flux* levels to plot (levels may be input if NLVL < 0) [DN6].
 IPLT 0/1/2 = Plot geometry/0 & plot isoflux/1 & print activity [DN7].

11* [3 entries]

FAC Scale factor for activity.
 FMIN Minimum flux value to plot (calculate minimum if ≤ 0.0).
 FMAX Maximum flux value to plot (calculate maximum if ≤ 0.0).

T Block 4 Terminator

H. Block 5 Input [omit if IPLT = 0]

12* array [IGM entries] Response function for activity

13* array (if NLVL < 0) [NLVMX entries] Flux levels to be plotted

T Block 5 Terminator

I. Return to input Section F. If this is the last plot for this particular geometry place 'LAST' in columns 1-4 of the plot title card. After the 'LAST' card, input begins again at Section A and the problem is terminated by an end of file at this point.

Otherwise, one may respecify all blocks and obtain a different plot or use the minimum input respecification feature to change either (1) from material to zone geometry, (2) plot size, (3) plot limits, (4) plot labels, or (5) plot orientation.

Flux and activity are used interchangeably here. Each refers to the quantity obtained by folding the group fluxes with the response function entered in the 12 array.

3.4 Input Data Notes

- DN1. NLVMX is used to allocate space for an array containing the flux levels to be plotted and an array containing data for the legend. If one desires a plot of the geometry only, much space may be saved by setting NLVMX to zero, since no space is allocated for the activity array and other smaller arrays. NLVMX may be changed by the code when the number of calculated levels (minimum of one level per decade) exceeds NLVMX if space is available.
- DN2. When an isoplot is made, SIZE should be chosen such that there are about 1.75 inches between the right side of the plot (in X-direction) and the XPAGE right boundary. For a plot that is tipped, SIZE should be chosen such that the length of the X-axis is about 4 inches shorter than XPAGE. This should provide left and right margins of 2.25 and 1.75 inches respectively. For a plot that is not tipped, again allow about a 4-inch difference between XPAGE and the length of the X-axis. From the X-axis length (in inches), the X-axis and Y-axis lengths in actual units, and any applicable scale factors (XSCL,YSCL), determine SIZE (the length of the longest scaled axis in inches). If the Y-dimension of the plot is bigger than the X-dimension, one should then check to be sure that the length of the Y-axis is about 2.5 inches shorter than YPAGE to allow a 1.5 inch margin at the top and a 1.0 inch margin at the bottom.
- DN3. If ITIP=0 and YPAGE>11.0 inches (or ITIP=1 and XPAGE>11.0 inches), a subroutine (INCH30) is called to allow for a maximum

plot height (or width if tipped) of 29.5 inches. If one dimension is less than 11.0 inches, the plot can be arranged such that the narrower width paper would suffice.

- DN4. XMIN, XMAX, YMIN, and YMAX may be used to limit the portion of the geometry which is plotted. One can get a blow-up of a particular area by appropriate specification of these parameters. Generally these parameters should be within the extrema of the input X and Y values.
- DN5. Note IGA and IGB may refer to activities if an activity tape in VARFLM format were supplied. Normally IGA=IGB=position of activity on tape in this case. However, two or more activities may be combined in specified proportion as group fluxes are to form activities.
- DN6. If NLVL is negative, the code will expect NLVMX flux levels to be input although it will plot only |NLVL| of them. Thus one need only specify |NLVL| actual values and fill the remainder of the array (13*) with zeroes. Note that |NLVL| should be less than or equal to NLVMX.
- DN7. The activity printout will contain 2*NSET extra J-intervals in the array. These represent fluxes at the J-boundaries of a given variable mesh region.

3.5 IØ File Requirements

<u>File</u>	<u>Description</u>	<u>Required</u>
CØMPØUT	Compressed plot data	Always
FTnnFOØ1	DOT-IV VARFLM tape	IPLT>0

where nn = NFLSV. (NFLSV may have several values if stacked cases are run and the appropriate entry is made in the 0\$ array.)

3.6 Region Requirements

The region requirements consists of (a) program storage, (b) buffer space, and (c) data storage. Without overlay about 224K bytes are required for the program storage. The user inputs the buffer space requirement (NBUF) in k-bytes and the code calculates the maximum data space from the allocated REGION size and the space allocated to the program and buffers.

The number of words for data storage may be determined from the formulae below.

$$NWORD1 = 5*NSET + 3*JM + IZM + 3 + IJMB + IJM + IZM*IFCT$$

$$NWORD2 = [IMX*(1 + JM + 2*NSET) + 4*KCNT*(IMX + JM) + IGM + 10]*IFCT$$

$$NWORDS = NWORD1 + \text{MAX}(NWORD2 + 7*NLVMX, IJM)$$

where IJMB is the number of I-boundaries in all I-sets, IJM is the number of mesh points ($\leq IMX*JM$), KCNT=1, 2, or 4 according to whether IRFLX+IRFLY=0, 1, or 2, respectively, and IFCT is 0 or 1 if NLVMX is equal to zero or greater than zero, respectively. The data storage requirement may be reduced by setting NLVMX and thus IFCT to zero.

The required REGION is then given by:

$$R(\text{k-bytes}) = 224 + NBUF + NWORDS/256.$$

The approximate resource requirements for a problem with DISSPLA version 7.5, IMX=42, JM=75, NSET=3, NBUF=30K, NLVL=-13, and IGM=51 were about a 240K region, 7 seconds of IBM 360/195 cpu time, and 800 IØ-units for both the ISØPLØT4 and post-processor steps. As indicated earlier, the region requirement is about 50K bytes higher with DISSPLA version 8.2 and without the overlay structure of Table 3.1.

3.7 JCL Requirements

(Job card and other HASP or ASP cards)

```
//A EXEC PGM=ISØPLØT4,REGIØN=270K
//STEPLIB DD UNIT=3330-1,DSN=X.SCØDE647.SCØPRØGM,DISP=SHR,
// VØL=SER=ZX8888
//DUMP DD SYSØUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1064)
//FT06F001 DD SYSØUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT53F001 DD UNIT=3330-1,DSN=X.SCØDE647.SCØPRØGM(ISØPLØT4),DISP=SHR,
//VØL=SER=ZX8888
//CØMPØUT DD UNIT=SYSDA,DSN=&&PLTØUT,DISP=(NEW,PASS),
// DCB=BUFNØ=1,SPACE=(4000,(150,50),RLSE)
//FT01F001 (DOT-IV VARFLM tape DD card)
//FT05F001 DD *
```

(Post processor - see Appendix A)

3.8 Sample Problems

A few sample problems are presented to demonstrate some of the features of the code. The available options are few; hence the number of sample problems is also limited.

Sample Problem 1: This sample problem is just a test case for geometry plotting. It contains three I-sets with a variable number of I per set. The stacked cases illustrate changing from zone to material geometry and changing plot limits and orientation with minimum input respecification. The input is shown in Fig. 3.2 and the output plots are shown in Figs. 3.3 (part of zone map), 3.4 (full zone map), and 3.5 (full material map).

Sample Problem 2: This problem is also a variable mesh case with three I-sets. The I-sets, however, contain the same number of I intervals. The problem uses a DOT-IV VARFLM tape to calculate the total neutron fluence within the lower portion of a fuel subassembly of the GCFR. Flux levels to be plotted were input. The resources used are given in Section 3.5. The input is given in Fig. 3.6 and the output in Fig. 3.7.

Sample Problem 3: This problem is like Sample Problem 2, except that it uses an activity tape in VARFLM format for the plot. The number of IØ operations is greatly reduced if an activity tape is used for stacked cases. The problem uses the "zone-plot" option to prevent plotting within specified zones. The input is given in Fig. 3.8 and the second plot from the case is given in Fig. 3.9. With IMX=94, JM=127, 30K-bytes of buffer space, NSET=1, six activities, and a total of 55 plotted levels, this case required 38 seconds of IBM 360/195 cpu time, a region of 310K, and about 500 IØ operations.

Sample Problems 4: These problems illustrate the reflective and periodic plotting conditions at the left and bottom boundaries. Two I-Sets are included in the problem and the combinatorial geometry option (Section 3.2) is used to describe the zones. The input for the case is shown in Fig. 3.10. This figure shows the small fortran program which generates the flux file for the case. The fluxes are not physical. The flux plots are shown in Figs. 3.11 - 3.14. Figure 3.11 is the plot for the basic geometry (IRFLX=IRFLY=0). In Fig. 3.12 the plot has been reflected about the bottom boundary (IRFLX=0,IRFLY=1). The plot is periodic about the left boundary (IRFLX=2) and reflected about the bottom boundary (IRFLY=1) in Fig. 3.13. Finally, in Fig. 3.14 the plot has been made periodic about both the left and bottom boundaries (IRFLX=IRFLY=2).

```

//SCOR JOB (14647), '6025 C. G. SLATER'
//*CLASS CPU91=10S,R=270K,L=2,IC=2
//A EXEC PGM=ISOPLOT4,REGION=270K
//STEPLIB DD UNIT=3330,DSN=X.SCODE647.SCOPROGM,DISP=SHR,
// VOL=SER=ZX8988
//DUMP DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1064)
//FT06F001 DD SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT53F001 DD UNIT=3330,DSN=X.SCODE647.SCOPROGM(ISOPLOT4),DISP=SHR,
// VOL=SER=ZX8988
//COMPQUT DD UNIT=SYSDA,DSN=66ISOPLT,DISP=(NEW,PASS),DCB=BUFNO=1,
// SPACE=(4000,(150,50),RLSE)
//FT05F001 DD *
SAMPLE PLOT - ZONE UPRIGHT
0
1$ 125 30 3 15 0 0 1 0 14
2** 7.5 8.5 10.5 1 1 20 50 10 90 25 90 0
T
3$ 125 60 125 4$ 10R1 10R2 10R3 T
5** 91 0 71 50 11 90 91 100 150
6**
391 0 141 30 41 40 51 42 31 50 341 51 91 80 91 85 100
91 0 41 20 341 25 291 60 100 541 0 691 44 100
8$
40P1 15R2 5R3 6R4 4R5 35R6 10R7 10R8 20125
40R1 10R2 10R3 6R4 9R5 25R6 15R7 10R8 30125
40R1 15R2 5R3 6R4 4R5 35R6 10R7 10R8 20125
10R9 5R10 35P11 30R12 7090 10R9 40R13 30R12 Q80 55R14 70R15 90125
9$ 1 2 2 2 3 4 3 5 1 6 3 5 1 1 5
T
RADIUS ((CM))$
HEIGHT ((CM))$
2-D ZONE GEOMETRY PLOTS
10$ 1 1 22 T
LAST
SAMPLE PLOT - FULL ZONE GEOMETRY - UPRIGHT
1$ A5 2 E
2** 7.5 8.5 10.5 1 1 20 50 0 100 0 150 0
T
RADIUS ((CM))$
HEIGHT ((CM))$
2-D ZONE GEOMETRY PLOTS
10$ 1 1 22 T
LAST
SAMPLE PLOT - MATERIAL - TIPPED
1$ A5 3 1 E
2** 11.5 10 14 1 1 20 50 0 100 0 150 0
T
RADIUS ((CM))$
HEIGHT ((CM))$
2-D MATERIAL GEOMETRY PLOTS
10$ 1 1 22 T
LAST
//GPLY EXEC GLOPLY,REGION=110K
//CUMPIN DD DSN=66ISOPLT,DISP=(OLD,PASS)
//FT05F001 DD *
DRAW=1-END
//

```

Fig. 3.2 Input Listing for Sample Problem 1

ORNL-DWG-79-20236

2-D ZONE GEOMETRY PLOT

Fig. 3.3. Plot Output from Sample Problem 1 which illustrates the selective plotting of a portion of the zone geometry.

ORNL-DWG-79-20237

2-D ZONE GEOMETRY PLOT

Fig. 3.4. Plot Output from Sample Problem 1; shown is a plot of the full zone geometry.

2-D MATERIAL GEOMETRY PLOT

Fig. 3.5. Plot Output from Sample Problem 1; shown is a plot of the full material geometry. (The plot appears upright though it was plotted on its side.)

```

//SCDISPL2 JOB (14647),'X-10 6025 C. SLATER'
//**MAIN SYSTEM=SY1
//**MAIN ORG=RM090
//**CLASS CPL95=10M,R=270K,L=10,I0=12
//**CLASS CPU95=60S,I0=5
//A EXEC PGM=ISOPLOT4,REGION=270K
//STEPLIB DD UNIT=3330,DSN=X.SCODE647.SCOPROGM,DISP=SHR,
// VOL=SER=ZX3330
//DUMP DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1064)
//FTC6F001 DD SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT53F001 DD UNIT=3330,DSN=X.SCODE647.SCOPROGM(ISOPLOT4),DISP=SHR,
// VOL=SER=ZX3330
//COMPOUT DD UNIT=SYS0A,DSN=66ISOPLT,DISP=(NEW,PASS),DCB=BUFNO=1,
// SPACE=(4000,(150,50),RLSE)
//FT01F001 DD UNIT=TAPE62,DSN=X.SCODE647.GCRUPFLW.HETRVFLM,DISP=OLD,
// DCB=BUFNO=1,VOL=SER=A14716
//FTC5F001 DD *
ISOPLOT FOR HETEROGENEOUS LOWER CELL OF UPFLOW GCFR
0
1$$$ 42 75 3 38 1 1 76 25 30
2** 24 10 29 4 1 4.8067 22.802 0 9.6134 0 228.02 0.3 T
3$$$ 3R42 4$$$ 30R1 14R2 31R3 T
5**
141 0 71 60 21 93 11 105 11 108 11 111 21 114.29 21 125.91 11 137.53
11 140.06 11 145 11 151.97 31 155 11 170.47 173.61 21 175.69 11 186.0
191.66 193.74 195.88 11 198.56 201.41 11 203.85 11 209.96 214.37 216.00
218.83 11 219.85 224.88 226.64 228.02
6**
0 373-3 466889-6 702056-6 937777-6 12022-4 140667-5 164846-5 187555-5
210278-5 234444-5 260083-5 281333-5 30244-4 328222-5 354723-5 375111-5
395639-5 422-2 448773-5 468531-5 488408-5 515062-5 541933-5 561593-5
581364-5 608124-5 634603-5 654655-5 674687-5 701186-5 726888-5 747717-5
76821-4 794248-5 818875-5 840779-5 85933-4 88731-4 907265-5 92722-4
94428-4 96134-4
151 0 21 4.026 4.614 21 4.868 5.566 11 5.82 61 6.171 7.655 51 7.872
11 9.2722 9.6134
11 0 11 .4445 31 .935 11 1.869 21 2.22 2.98 21 3.213 3.973 11 4.189
4.51 11 4.697 11 5.08 41 5.588 6.729 6.856 21 6.983 11 7.872 41 9.372
9.6134
7$$$ F1
8$$$
1 2 18Q2 3 3 4 4 14Q42 5 6 18Q2 7 7 8 8 7Q42 9 10 18Q2 2R11 2R12 2Q42
3R13 2R14 2R15 Q42 16 17 18Q2 2R18 2R19 Q42 26R20 14R21 2R22 Q42 23R20
21 9R23 7R21 2R22 2Q42 19R20 21 13R23 7R21 2R22 2Q42 16R24 24R25 2R24
3Q42 16R24 18R25 8R26 Q42 18R27 5R28 9R29 3R28 7R30 5Q42 18R31 17R32
7R32 Q42 18R31 3R32 9R34 5R32 7R33 18R31 3R32 9R35 5R32 7R33 2Q42 20R31
3R32 7R35 5R32 7R33 Q42 23R31 2R32 5R34 5R32 7R33 25R36 10R37 7R38
31R36 4R37 7R38 2R36 11R37 18R36 4R37 7R38 Q42 10R36 3R37 18R36 4R37
7R38 8R36 5R37 18R36 4R37 7R38 Q42 8R36 5R37 18R36 6R37 5R38 Q42 8R36
9R37 14R36 6R37 5R38 8R36 9R37 14R36 6R37 5R36 8R36 9R37 25R36 14R37
28R36 Q42 10R36 4R37 28R36 4R36 10R37 28R36
9$$$
66 14 30 14 70 14 34 14 74 14 30 2R14 26 14 78 14 26 14 N2 14 19 14 26
22 14 26 18 22 14 26 22 86 82 14 26 22
T
RADIUS ((CM))$
HEIGHT ((CM))$
TOTAL NEUTRON FLUENCE (( )24 FPY)$
10$$$ 1 51 -24 1 11** 7.5737+8 5+19 1+25 T
13**
375+22 31 3+24 1+24 31 5+23 1+23 5+22 2+22 1+22 5+21 2+21 1+21 7+20
31 5+20 1+20 6+19 F0
12** F1 T
LAST
//PLT EXEC PGM=POPD92,REGION=110K
//STEPLIB DD DSN=SYS2.DISSPOP,DISP=SHR
//FT06F001 DD SYSOUT=A
//COMPIN DD DSN=66ISOPLT,DISP=(OLD,PASS)
//FT49F001 DD UNIT=IN20U2,DISP=(NEW,KEEP),DCB=SYS2.DISKDCB,
// SPACE=(3208,99,RLSE),DSN=C925600.SCOPLT2
//PLOTSUBS DD DSN=SYS2.JGSPLOTH,DISP=(SHR,PASS)
//FTC5F001 DD *
DRAW=1-END
//

```

Fig. 3.6. Input Listing for Sample Problem 2

ORNL-DWG-79-20239

TOTAL NEUTRON FLUENCE (24 FPY)

Fig. 3.7. Plot Output from Sample Problem 2; shown are levels of equal total neutron fluence within a heterogeneous cell mockup of the lower half of a GCFR fuel subassembly. The curves are superimposed on a plot of the material geometry.


```

/*RELAY      REMOTES
95
//SCOTSP LI JOB (14647), 'X-10 6025 C. SLATER'
//**MAIN SYSTEM=SY1
//**MAIN ORG=RM090
//**CLASS CPU95=90S,R=400K,L=5,I0=5
//A FXEC PGM=ISNPL0T4,REGION=400K
//STFPL18 DD UNIT=3330,DSN=X.SCODE647.SCOPR0GM,DISP=SHR,
// VOL=SER=ZX3330
//DUMP DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1064)
//FTC6F001 DD SYSOUT=A,DCB=(RECFM=VRA,LRECL=137,BLKSIZE=1100)
//FT53F001 DD UNIT=3330,DSN=X.SCODE647.SCOPROGM(ISOPL0T4),DISP=SHR,
// VOL=SER=ZX3330
//COMPOUT DD UNIT=SYSDA,DSN=88ISOPLT,DISP=(NEW,FASS),DCB=BUFNO=1,
// SPACE=(4000,(400,50),RLSE)
//FTC1F001 DD UNIT=TAPE62,DSN=X.SCODE647.GCRUPFLW.MIDACT02,
// VOL=SER=031844,LABEL=(3,SL),DCB=BUFNO=1,DISP=OLD
//FTC5F001 DD *
ISOPL0TS FOR THE UPFLOW GCFR MID-REGIONS - MODIFIED SOURCE
0
1$$ 54 127 1 70 1 0 36 25 30
2** 7.5 10 10 1 1 73.4 94.924 0 367 -228.02 246.6 0.3 T
3$$ 54 4$$ F1 T
5**
          31 -228.02 31 -216.0 11 -203.6 -198.5 -196.0 -193.74 -192.
11 -190.73 -186.0 -184.33 11 -183.2 11 -176.8 -171.7 11 -170.47
-164.0 11 -162.73 11 -157.10 11 -151.97 -145.0 -142.0 -137.53
11 -133.0 -123.87 11 -122.6 -116.2 -114.0 -111. -108. 21 -105.0
71 -93.0 -60.57 -60.0 -59.3 41 -56.8 -34.4 31 -30.0 31 -15.2
51 0.0 51 30.0 31 60.0 21 80.0 21 93.0 21 105. 11 118. 11 125.0
71 130.5 31 167.52 41 184.0 209.5 41 214.0 21 237.0 246.6
6**
          91 0.0 21 70.983 41 88.243 31 108.338 31 124.427 31 140.994
31 158.257 31 174.901 71 191.546 11 224.16 228.60 11 232.41
21 237.51 51 242.61 21 265.21 11 270.31 275.41 11 278.61 283.41
286.61 287.88 11 290.58 299.45 21 300.72 310.14 311.41 313.34
214.61 11 316.23 322.58 327.48 329.38 335.28 11 337.18
11 341.18 21 346.18 367.18
8**
30R 45 19R 54 2R 58 3R 64 6R 67 3R 65 2R 60 19R 54 69 9R 70
30 94
30R 45 2R 48 10R 49 54 2R 53 3R 64 6R 67 3R 65 2R 60 19R 54
69 9R 70 30 94
30R 45 2R 48 10R 49 54 16R 59 19R 54 69 9R 70 094
30R 45 8R 48 10R 49 36R 54 69 9R 70
30R 45 2R 48 10R 49 20R 50 16R 54 69 9R 70
30R 44 2R 48 10R 49 20R 50 16R 54 69 9R 70
30P 44 2R 48 10R 49 20R 50 54 5R 61 10R 54 69 9R 70
30R 44 2R 48 10R 49 20R 50 54 61 3R 68 61 10R 54 69 9R 70
20 94
30R 44 8R 47 10R 49 20R 50 54 61 3R 68 61 10R 54 69 9R 70
30R 44 8R 47 10R 49 18R 53 2R 50 54 61 3R 68 61 10R 54 69
9R 70 094
30R 44 2R 47 10R 49 53 16R 56 53 2R 50 54 61 3R 68 61
10R 54 69 9R 70 094
30R 44 8R 47 10R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 53
2R 50 54 61 3R 68 61 10R 54 69 9R 70
30R 43 8R 47 10R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 53
2R 50 54 61 3R 68 61 10R 54 69 9R 70 094
30R 43 8R 47 10R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 53
2R 50 54 61 3R 68 61 10R 54 69 9R 70 094
30R 41 2R 46 10R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 53
2R 50 54 61 9R 68 61 4R 54 69 9R 70 094
30R 41 2R 46 10R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 53
2R 50 54 61 9R 68 61 4R 54 69 9R 70 094
30R 41 8R 46 8R 51 2R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 53
2R 50 54 61 9R 68 61 4R 54 69 9R 70
30R 41 2R 42 8R 51 2R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 53
2R 50 54 61 9R 68 61 4R 54 69 9R 70
18R 39 12R 40 8R 42 8R 51 2R 49 53 2R 55 3R 62 6R 66 3R 63
2R 57 53 2R 50 54 61 9R 68 61 4R 54 69 9R 70
18P 39 12R 40 4R 25 4R 26 8R 51 2R 49 53 2R 55 3R 62 6R 66
3R 63 2R 57 53 2R 50 54 61 9R 68 61 4R 54 69 9R 70 094
18R 39 12R 40 4R 25 4R 26 8R 51 2R 49 53 2R 55 3R 62 6R 66
3R 63 2R 57 53 2R 50 54 61 7R 68 61 4R 54 69 9R 70
18P 39 12R 40 4R 25 4R 26 8R 51 2R 49 53 2R 55 3R 62 6R 66
3R 63 2R 57 53 2R 50 54 61 7R 68 61 3R 54 6R 69 7R 70
18R 39 12R 38 4R 25 4R 26 8R 51 2R 49 53 2R 55 3R 62 6R 66
3R 63 2R 57 53 2R 50 54 61 7R 68 61 3R 54 6R 69 7R 70
18R 37 12R 38 4R 25 4R 26 8R 51 2R 49 53 2R 55 3R 62 6R 66
3R 63 2R 57 53 2R 50 54 61 7R 68 61 3F 54 6R 69 7R 70
18R 36 12R 38 4R 25 4R 26 8R 51 2R 49 53 2R 55 3R 62 6R 66
3R 63 2R 57 53 2R 50 54 61 7R 68 61 3R 54 6R 69 7R 70
18P 22 4R 16 4R 18 4R 24 4R 25 4R 26 8R 51 2R 49 53 2R 55
3R 62 6R 66 3R 63 2R 57 53 2R 50 54 61 7R 68 61 3R 54 2R 69
3R 53 69 7R 70 20 94
18R 20 4R 12 4R 14 4R 24 4R 25 4R 26 8R 51 2R 49 53 2R 55

```

Fig. 3.8. Input Listing for Sample Problem 3

```

3R 62 6R 66 3P 63 2R 57 53 2R 50 54 61 7R 68 61 3R 54 2R 69 94
3R 53 6R 7R 70 70 94 95
18P 20 4R 12 4R 14 4R 24 4R 25 4R 26 8R 51 2R 49 53 2R 55 96
3R 62 6R 66 3R 63 2R 57 53 2R 50 54 9R 61 3R 54 2R 69 97
3R 53 6R 7R 70 98
10R 1 3R 2 5R 3 4R 8 4R 10 4R 24 4R 25 4R 26 8R 51 2R 49 53 99
2R 55 3R 62 6R 66 3P 63 2R 57 53 2R 50 54 9R 61 3R 54 2R 69 100
3R 53 6R 7R 70 101
10R 1 3R 2 5R 3 4R 8 4R 10 4R 24 4R 25 4R 26 8R 51 2R 49 53 102
2R 55 3R 62 6R 66 3R 63 2R 57 53 2R 50 13R 54 2R 69 103
3R 53 6R 7R 70 104
10R 1 3R 2 5R 3 4R 8 4R 10 4R 24 4R 25 4R 26 8R 51 2R 49 53 105
2R 55 3R 62 6R 66 3P 63 2P 57 53 2R 50 3R 54 12R 69 106
3R 53 6R 7R 70 40 94 107
10R 1 3R 2 5R 3 4R 8 4R 10 4R 24 4R 25 4R 26 8R 51 2R 49 53 108
2P 55 3P 62 6R 66 3R 63 2R 57 53 15R 50 2R 53 109
3R 53 6R 7R 70 110
10R 1 3R 2 5R 3 4R 4 4R 6 4R 24 4R 25 4R 26 8R 51 2R 49 53 111
2R 55 3R 62 6R 66 3R 63 2R 57 53 15R 50 2R 53 112
3R 53 6R 7R 70 30 94 113
10R 1 3R 2 5R 3 4R 4 4R 6 4R 24 4R 25 4R 26 8R 51 2R 49 53 114
2R 55 3R 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 30 94 115
10R 1 3R 2 5R 3 4R 5 4R 7 4R 24 4R 25 4R 26 8R 51 2R 49 53 116
2R 55 3P 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 50 94 117
10R 1 3R 2 5R 3 4R 4 4R 11 4R 24 4R 25 4R 26 8R 51 2R 49 53 118
2R 55 3R 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 50 94 119
18P 21 4R 13 4R 15 4R 24 4R 25 4R 26 10R 49 53 120
2R 55 3R 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 30 94 121
18P 21 4R 13 4R 15 4R 24 4R 25 4R 26 8R 52 2R 49 53 122
2R 55 3R 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 20 94 123
18P 23 4R 17 4R 19 4R 24 4R 25 4R 26 8R 52 2R 49 53 124
2R 55 3R 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 20 94 125
18P 27 12R 28 4R 25 4R 26 8R 52 2R 49 53 126
2R 55 3R 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 20 94 127
18P 27 12R 29 4R 25 4R 26 8R 52 2R 49 53 128
2R 55 3P 62 6R 66 3R 63 2R 57 21R 53 6R 7R 70 094 129
30R 29 4R 25 4R 26 8R 52 2R 49 53 2R 55 3R 62 6R 66 3R 63 130
2R 57 21R 53 6R 7R 70 094 131
30P 30 4R 25 4R 26 8R 52 2R 49 53 2R 55 3R 62 6R 66 3R 63 132
2R 57 21R 53 6R 7R 70 70 94 133
30R 31 4P 25 4R 26 8P 52 2P 49 53 2R 55 3R 62 6R 66 3R 63 134
2R 57 21P 53 6R 7R 70 80 94 135
30R 31 8R 32 8P 52 2R 49 53 2R 55 3R 62 6R 66 3R 63 136
2R 57 21P 53 6R 7R 70 137
30P 33 8P 34 10R 49 53 2R 55 3R 62 6R 66 3R 63 2R 57 21R 53 138
6R 7R 70 40 94 139
46P 35 2R 49 53 2R 55 3P 62 6R 66 3R 63 2R 57 21R 53 140
6R 7R 70 20 94 141
933 1 5 9 2P 13 2R 17 2R 21 2R 25 2P 29 2R 33 2R 37 2R 41 151
2R 45 2R 49 53 85 89 93 113 165 97 101 165 105 109 57 152
165 121 117 125 129 133 161 137 141 145 149 153 157 2R 61 153
4R 57 7R 65 4R 73 3R 69 77 81 154
7** 0 F1
T
RADIUS ((CM))$
HEIGHT ((CM))$
TOTAL NEUTRON FLUX$
1033 1 1 11 1 11** 1 1+5 1+15 T
12** F1 T
TOTAL NEUTRON FLUENCE (( )24 F0Y)$
1033 2 2 11 1 11** 1 1+14 1+24 T
12** F1 T
E .GT. 1.0 M(F) V N FLUX$
1033 3 3 10 1 11** 1 1+3 1+12 T
12** F1 T
E .GT. 0.1 M(E) V N FLUX$
1033 4 4 10 1 11** 1 1+4 1+13 T
12** F1 T
0.1 M(E) V .GT. E .GT. 2.38 (E) V N FLUX$
1033 5 5 12 1 11** 1 1+3 1+14 T
12** F1 T
E .LT. 2.38 (E) V N FLUX$
1033 6 6 13 1 11** 1 1 1+12 T
12** F1 T
LAST
//PLT EXEC PGM=POPD92,REGION=110K
//STEPLIR DD DSN=SYS2.DISSPOP,DISP=SHR
//FT06F001 DD SYSOUT=A
//COMPIIN DD DSN=CEISOPLT,DISP=(CLD,PASS)
//FT49F001 DD UNIT=IN20U2,DISP=(NEW,KEEP),DCB=SYS2.DISKDCB,
// SPACE=(3200,99,RLSE),DSN=C925600.SCOPLT1
//PLQTSUBS DD DSN=SYS2.JGSPLOTH,DISP=(SHR,PASS)
//FT65F001 DD *
DRAW=1-END
//

```

Fig. 3.8. (Continued)

ORNL-DWG-79-20240

TOTAL NEUTRON FLUENCE (24 FPY)

Fig. 3.9. Plot Output from Sample Problem 3; shown are curves of equal total neutron fluence in a homogeneous mockup of the upflow GCFR.

```

//SCOPLOT1 JOB (20106), 'RMT42 6025 L.SLATER'
//ROUTE PRINT RMT01
//ROUTE PUNCH RMT01
//*CLASS CPU91=30S,R=380K,L=5,I0=2
//A EXEC FORTHCLG,LIR=PORT,GO SIZE=380K
//PORT.SYSIN DD *
COMMON L1,L2,X(15,12)
DATA IM,JM,Y/15,12,1.0/
L1=3
L2=L1+IM*JM
CALL FIDUS(1,J3,5.5,L1,L1,L1)
DO 10 I=1,5
WRITE(1)Y
10 CONTINUE
DO 20 J=1,JM
20 CALL WRTFLX(X(1,J),IM,1)
WRITE(1)Y
RE*IND 1
STOP
END
SUBROUTINE WRTFLX(X,N,IU)
DIMENSION X(N)
WRITE(IU)X
RETURN
END
//LKED.SYSLIB DD
// DD
// DD
// DD DSN=E.JVP45285,WARLIB,DISP=SHR
//GO.FT01F001 DD UNIT=SYSDA,DSN=EEFLUX,DISP=(NEW,PASS),
// DCB=(RECFM=VBS,LRECL=100,RLKSIZE=3156),SPACE=(TPK,(5,5),RLSE)
//GO.FT03F001 DD *
C
1**
1 2 3 7 10 15 17 19 20 17 15 12 5 3 5 2 3 5 12 17 26 30 33 35 30 26 21
10 5 9 3 6 9 21 30 46 52 58 61 52 46 36 19 9 15 5 11 16 37 53 79 90
191 106 90 79 64 32 16 26 9 18 28 55 92 138 157 175 184 157 138 111
55 28 46 16 32 43 112 161 241 273 305 321 273 241 193 96 48 80 32 24
48 64 73 95 195 280 420 476 532 560 448 252 112 56 42 84 112 127 166
342 488 732 830 927 976 780 479 194 97 73 146 104 222 200 590 850 1276
1446 1616 1731 1360 765 739 169 127 254 339 380 503 1037 1482 2223
2519 2816 2964 2370 1333 590 295 221 443 590 673 876 1908 2582 3873
4390 4906 5165 4130 2322 1328 514 386 771 1328 1173 1527 3150 4500
6750 7650 8550 9000 7197 4046 1792
T
//G2 EXEC PGM=ISOPLOT4,REGION=380K
//STEPLIB DD DSN=T.SC054647,SCNPRGM,DISP=SHR
//FT53F001 DD DSN=T.SC054647,SCNPRGM(ISOPLOT4),DISP=SHR,
// LABEL=(,,IN)
//FT05F001 DD SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,RLKSIZE=1100)
//DUMP DD SYSOUT=A,DCB=(RECFM=FA,RLKSIZE=133)
//COMPUT DD UNIT=SYSDA,DSN=EEISOPLOT,DISP=(NEW,PASS),
// DCB=BUFNO=1,SPACE=(4000,(150,50),RLSE)
//FT02F001 DD DSN=EEFLUX,DCB=BUFNO=1,DISP=(OLD,DELETE)
//FT05F001 DD *
ISOPLOT FOR REGULAR CELL GEOMETRY
1** 2 27
1** 15 12 2 5 1 0 1 25 20
2** 0 2R8.5 1 1 10 10 -10 60 Q2 0.2

```

Fig. 3.10. Input for Sample Problem 4.

```

T
3$$ 15 15 4$$ 6R1 6R2 T
5** 111 0 60 6** 81 0 51 45 60 51 0 81 15 60 7$$ F1
9$$
-1 1 1 5 6 -1 5 1 7 3 -1 4 7 6 12 -1 7 7 8 7 -2 6 4 7 6 -2 8 1 9 5
-2 7 8 9 12 -2 9 7 10 9 -3 8 6 9 6 -3 10 1 12 6 -3 9 10 10 12
-3 11 7 15 12 -4 13 1 14 6 -4 2 7 3 12 -5 15 1 15 6 -5 1 7 1 12 F0
9$$ 1 2 3 4 5
T
RADIUS ((CM))$
HEIGHT ((CM))$
FLUX PLOT 03$
10$$ 1 1 -10 2 11** 1 1 9000 T
12** 1 13** 100 50 500 1 5 1000 10 7000 8500 5000 F0 T
LAST
ISOPLOT FOR CELL REFLECTED ABOUT BOTTOM BOUNDARY
3$$ 2 0 1
1$$ 15 12 2 5 1 0 1 25 20
2** 0 2R8.5 1 1 10 10 -10 60 02 0.2
T
3$$ 15 15 4$$ 6R1 6R2 T
5** 111 0 60 6** 81 0 51 45 60 51 0 81 15 60 7$$ F1
9$$
-1 1 1 5 6 -1 5 1 7 3 -1 4 7 6 12 -1 7 7 8 7 -2 6 4 7 6 -2 8 1 9 5
-2 7 8 9 12 -2 9 7 10 9 -3 8 6 9 6 -3 10 1 12 6 -3 9 10 10 12
-3 11 7 15 12 -4 13 1 14 6 -4 2 7 3 12 -5 15 1 15 6 -5 1 7 1 12 F0
9$$ 1 2 3 4 5
T
RADIUS ((CM))$
HEIGHT ((CM))$
FLUX PLOT 01$
10$$ 1 1 -10 1 11** 1 1 9000 T
12** 1 13** 100 50 500 1 5 1000 10 7000 8500 5000 F0 T
LAST
ISOPLOT FOR CELL WITH PERIODIC LFT BDRY AND REFLECTED BOT BDRY
3$$ 2 2 1
1$$ 15 12 2 5 1 0 1 25 20
2** 0 2R8.5 1 1 10 10 -10 60 02 0.2
T
3$$ 15 15 4$$ 6R1 6R2 T
5** 111 0 60 6** 81 0 51 45 60 51 0 81 15 60 7$$ F1
9$$
-1 1 1 5 6 -1 5 1 7 3 -1 4 7 6 12 -1 7 7 8 7 -2 6 4 7 6 -2 8 1 9 5
-2 7 8 9 12 -2 9 7 10 9 -3 8 6 9 6 -3 10 1 12 6 -3 9 10 10 12
-3 11 7 15 12 -4 13 1 14 6 -4 2 7 3 12 -5 15 1 15 6 -5 1 7 1 12 F0
9$$ 1 2 3 4 5
T
RADIUS ((CM))$
HEIGHT ((CM))$
FLUX PLOT 21$
10$$ 1 1 -10 1 11** 1 1 9000 T
12** 1 13** 100 50 500 1 5 1000 10 7000 8500 5000 F0 T
LAST
ISOPLOT FOR CELL PERIODIC ABOUT LFT AND BOT BOUNDARIES
3$$ 2 2 2
1$$ 15 12 2 5 1 0 1 25 20
2** 0 2R8.5 1 1 10 10 -10 60 02 0.2
T
3$$ 15 15 4$$ 6R1 6R2 T
5** 111 0 60 6** 81 0 51 45 60 51 0 81 15 60 7$$ F1
9$$
-1 1 1 5 6 -1 5 1 7 3 -1 4 7 6 12 -1 7 7 8 7 -2 6 4 7 6 -2 8 1 9 5
-2 7 8 9 12 -2 9 7 10 9 -3 8 6 9 6 -3 10 1 12 6 -3 9 10 10 12
-3 11 7 15 12 -4 13 1 14 6 -4 2 7 3 12 -5 15 1 15 6 -5 1 7 1 12 F0
9$$ 1 2 3 4 5
T
RADIUS ((CM))$
HEIGHT ((CM))$
FLUX PLOT 22$
10$$ 1 1 -10 1 11** 1 1 9000 T
12** 1 13** 100 50 500 1 5 1000 10 7000 8500 5000 F0 T
LAST
//GPLT EXEC GLOPLT,REGION=110K
//COMPIN 00 DSN=66ISOP,DISP=(OLD,DELETE)
//FT05F001 00 *
DRAW=1-END
//

```

Fig. 3.10. Continued.

Fig. 3.11. ISOPLLOT for basic geometry (IRFLX=IRFLY=0).

Fig. 3.12. ISOPLLOT for geometry reflected about the bottom boundary at height=0.0 cm (IRFLX=0,IRFLY=1).

ORNL DWG 81-9691

Fig. 3.13. ISOPLLOT for geometry periodic about left boundary at radius=0.0 cm (IRFLX=2) and reflected about bottom boundary at height=0.0 cm (IRFLY=1).

Fig. 3.14. ISOPLLOT for geometry periodic about left boundary at radius=0.0 cm (IRFLX=2) and about the bottom boundary at height=0.0 cm (IRFLY=2).

4. FORM - Surface Plotting Code for DOT Fluxes

4.1 Code Description

The program FORM (Fluxes Over Region Map) is a simulated three-dimensional plotting code for the representation of 2-D discrete-ordinates fluxes and the corresponding geometry. Minimum knowledge of plotting is necessary to generate perspective views of the two-dimensional fluxes or activities with an EGAD-type zone boundary plot projected directly below the 3-D surface. Special features of FORM include:

- A. DOT 3.5 or DOT IV fluxes can be read directly.
- B. Activities can be plotted either by inputting the 1-D response functions into FORM, or by passing to FORM the activities calculated by the ACTUAL auxiliary code (discussed in Section 5).
- C. An EGAD-type geometry plot can be projected directly under the surface plot in addition to a separate nonprojected zone/material plot. If plotted on the CALCOMP 925/1036 plotters, the projected region map can be drawn in a second pen color.
- D. Multiple views from arbitrary viewpoints can be specified.
- E. Arbitrary minimum and maximum flux/activity limits can be specified.
- F. Linear or log flux/activity can be plotted.
- G. FORM can plot X-Y, R-Z, or R- θ geometries.
- H. Default axis labels of "RADIUS (cm)" and "HEIGHT (cm)" are available, or labels can be input explicitly.

4.2 Input Requirements

The following input arrays and title cards are required in order to execute a FORM case. Default values are given in []'s.

PROBLEM TITLE CARD (20A4 format)

Control Parameters

61\$ array (9 entries)

IM	Number of I (X-R-R) intervals. [1]
JM	Number of J (Y-Z- θ) intervals. [1]
IGM	Number of energy groups. [1]
I7M	Number of spatial zones. [1]
IGEOM	0/1/2 - X-Y/R-Z/R- θ geometry. [1]
ITYPE	3/4 - DOT 3.5/DOT IV input flux tape. [4]
NIN	Input flux logical unit number. [1]
NSCR	Scratch logical unit number. [2]
NBUF	Number of k-bytes of buffer space needed. [20]

62\$ array (8 entries)

NACT	Number of different flux/activity plots. [1]
IPRT	0/1 - No effect/Print 2-D activities. [1]
NVU	Number of viewpoints for each activity. [1]
ILL	0/1 - Plot linear/log flux. [0]
MNMX	0/1 - No effect/Read min and max flux values to be plotted. [0]
IREG	0/ ± 1 / ± 2 -Plot flux only/flux with projected zone map/flux with material map. Negative value uses second pen color. [1]
IFRM	0/1/2/3 - No effect/delete page border/delete plot skirt/both 1 and 2. [0]
LABL	0/1/2/3 - No effect/read I-, J-, and flux-axis labels/read flux-axis label only/read I- and J-axis labels only. A

negative entry uses default labels. [-1]

63* array (10 entries)

HPAGE	Horizontal length of page in inches. [8.5]
VPAGE	Vertical length of page in inches. [11]
HLGTH	Horizontal length of plot area in inches. [6]
VLGTH	Vertical length of plot area in inches. [8.5]
XREL	Relative I-axis length. [1]
YREL	Relative J-axis length. [1]
ZREL	Relative flux-axis length. [1]
XDIV	I-axis label increment. A zero means label only at axis ends. [0]
YDIV	J-axis label increment. A zero means label only at axis ends. [0]
RREL	Relative location of zone/material map below the surface plot. [1]

T Data Block 1 Terminator

Remaining input arrays

2* (JM + 1)	J-interval boundaries.
4* (IM + 1)	I-interval boundaries.
6* (IGM*NACT)	Response functions for activities.
8\$ (IM*JM)	Zone number by interval.
9\$ (IZM)	Material number by zone (IREG = ±2).
11* (3*NVU)	Viewing coordinates in relative units.
12* (2*NACT)	Min and max flux/activity limits (MNMX = 1).

T Data Block 2 Terminator

PLØT TITLE CARD for first activity (14A4 format)

I- AND J-AXIS LABELS (2(10A4) format) (if LABL = 1 or 3)

FLUX (ACTIVITY) AXIS LABEL (20A4 format) (if LABL = 1 or 2)

PLØT TITLE CARD for remaining activities - one per card (if NACT > 1)

NOTE: The PLØT TITLE and AXIS LABELS should be ended with a \$.

4.3 Input Data Notes

A. IGEØM The IGEØM parameter has a hidden feature which is useful to the serious R-Ø plotter. For X-Y and R-Z geometries, there is a one-to-one correspondence between the rectangular grid of the flux surface and the mesh defined by the 2* and 4* arrays. However, for R-Ø problems, the surface grid is independent of the R and Ø mesh. The default grid contains 60 equally spaced lines in each of the x- and y-directions. It is generally more presentable to scale the number of x and y lines according to their relative axis lengths which are determined by $|\cos \theta_{\max}|$. For example, a 45° (or 135°) $\theta_{\max}$ problem would appear best if a ratio of $2/\sqrt{2}$ were used for the number of x and y lines. This could be accomplished by setting IGEØM = 6043 to produce a 60 by 43 line grid. Therefore, to use this feature, input $\text{IGEØM} = 100 * (\# \text{ of x-lines}) + (\# \text{ of y-lines})$.

Note: This option markedly affects the required number of storage locations. If the IGEØM > 2 option is used, then the 7200 value of the WØRK term in the storage relation (Section 4.5) is replaced by $2 * (\# \text{ of x-lines}) * (\# \text{ of y-lines})$.

- B. NSCR For DOT 3.5 or DOT IV input fluxes, the scalar flux is first copied to a scratch data set in "FORM" format, i.e., JM*IGM records of IM length. This saves storage space and avoids numerous rewinds of the input data set when many activities are plotted. This is especially important when the input flux is stored on a magnetic tape. If NSCR = 0, it is assumed that the input is already in FORM format, either as output from the ACTUAL code (Section 5) or saved from a previous FORM case.
- C. NACT Multiple activities in a single case can be plotted using the 6* array. This array can contain a string of 1-D response functions, or simply an assortment of 1's and 0's to select particular energy groups. Activities can also be calculated using ACTUAL and then plotted by FORM using the 6* array to select one "group" at a time.
- D. XREL, YREL, ZREL, and RREL The imaginary 3-D box which defines the plot area for the flux surface is described by the relative axis lengths XREL, YREL, and ZREL. These lengths are given in absolute units as defined by DISSPLA, although their absolute values are relatively unimportant. Their relative values, however, determine the proportions of the 3-D plot area. On the other hand, the units used in the 2* and 4* arrays have no relative value, but are defined by DISSPLA as relative units. The relative lengths XREL, YREL, and ZREL once defined do determine the absolute value of RREL, the distance from the minimum surface value to the region plot. Also, the viewpoint coordinates are given in terms of the same units, which are relatively absolute, but not absolutely relative.
- E. IFRM The IFRM option allows the user to delete the line which is

drawn around the page as well as the plot identification information which is written along the edge of the page. Also, IFRM allows the user to delete the border, or "skirt", which is plotted around the 3-D surface. The purpose of the skirt is to obscure the underside of the surface which would otherwise be visible. However, there are occasions when it is desirable to see the underside. Setting IFRM=2 (or 3) will accomplish this. In general, including the skirt produces the best plot.

F. LABL This parameter controls a number of options relating to the x-, y-, and z-axis labels. Only axes which are selected by LABL to be read as input or defaulted (specified by negative entry) will be plotted. For example, LABL = -3 would plot "RADIUS (cm)" on the x-axis and "HEIGHT (cm)" on the y-axis with no z-axis. The defaults are:

RADIUS (cm)	x-axis
HEIGHT (cm)	y-axis
FLUX	z-axis if ILL=0
LOG FLUX	z-axis if ILL=1

When the z-axis is plotted, it is drawn from the region map (if plotted) to the maximum limit of the flux surface. Although the portion of the axis between the region map and the minimum flux value is meaningless, its presence is unavoidable. Finally, it is important to note that when LABL>0, the AXIS LABEL CARDS are entered only once. For multiple activities, only the PLOT TITLE CARD is input.

G. Viewpoint (11* array) The viewpoint for the perspective plots are

specified by viewing coordinates which are defined in relative x, y, and z units (see Data Note D). The viewpoint is only restricted not to lie within the workbox defined by the coordinate points (0, 0, 0) and (XREL, YREL, ZREL). For most problems, an adequate viewpoint is (50*XREL, -50*YREL, 50*ZREL). Moving closer to the workbox increases the perspective effect while moving away tends to "square-off" the workbox so that in the limit of a very distant viewpoint, the 3-D plot will be isometric; i.e., parallel lines are plotted parallel.

H. Plot and Axes Labels Flexible manipulation of the character strings for the title cards is possible if the user has knowledge of DISSPLA mixed alphabets. No further explanation will be presented here; users are directed to section 19 of the Intermediate Manual of DISSPLA. The required information needed to use the mixed alphabets of DISSPLA is as follows:

Character Font: SIMPLX

MX1ALF: "STANDARD" ESCAPE CHAR: ")"

MX2ALF: "L/CSTD" ESCAPE CHAR: "("

MX3ALF: "INSTRUCTION" ESCAPE CHAR: "!"

MX4ALF: "L/CGREEK" ESCAPE CHAR: "?"

4.4 I/O File Requirements

<u>File</u>	<u>Description</u>	<u>Required</u>
COMPØUT	Compressed plot data	Always
NIN	Input flux/activity data	Always
NSCR	Scalar flux scratch	If NSCR > 0

4.5 Region Requirements

The number of words in blank COMMON needed to execute FORM can be determined from:

$$NWØRDS = NACT*(IGM+2) + 3*(IM+JM+NVU+2) + IM + IZM + 2*IM*JM + WØRK$$

$$\text{where } WØRK = \begin{cases} 2*(JM+IM)+12 & \text{IGEØM}<2 \\ 7200 & \text{IGEØM}=2 \end{cases}$$

The number of words available for execution is

$$NSPACE = (REGION-NBUF-210)*256$$

where REGION is the value (in k-bytes) specified on the EXEC card.

4.6 JCL Requirements

The job control language (JCL) needed to run FORM at either X-10 or K-25 is:

(Job card and CLASS cards)

//FØRM EXEC PGM=FØRM,REGION=270K

//GØ.STEPLIB DD DSN=X.DTI46103.PRØG,DISP=SHR

//GØ.FT05F001 DD DDNAME=SYSIN

//GØ.FT06F001 DD SYSØUT=A

(DD cards as required - see Section 4.4)

(Input cards)

(Post processor - see Appendix A)

//

4.7 Sample Problems

Sample Problem 1: The first FORM sample problem demonstrates a garden-

variety R-Z case producing a surface plot of total flux and the corresponding geometry for the core and blanket model. Figure 4.1 lists the data input used to produce the two plots in Fig. 4.2. The plots were generated on the Bldg. 6025 Gould plotter, which does not give the high quality characteristic of CALCOMP pen plotters, but does give reasonably good resolution, even for the 3-D surface. It should be noted that the flux surface is transparent to the projected geometry, so that one need not worry if the two plots overlap. The stand-alone geometry plot is always scaled with equal units/inch factors in both spatial directions; however, the scale factors for the projected map (and surface) are determined independently by XREL and YREL. In this example, XREL and YREL were set with the same ratio as the maximum R and Z values, so that the projected geometry retained the same proportions as the stand-alone geometry.

Sample Problem 2: The second FORM sample demonstrates how the ACTUAL code can be used to prepare activities for plotting with FORM. The input listing for both the ACTUAL case and the FORM case is given in Fig. 4.3. Three activities were calculated using a response table which was input from an ANISN-binary-formatted library on unit NCRX. The three activities, which were (1) flux greater than 100 keV, (2) flux less than 2.38 eV, and (3) carbon atom displacement, were passed to FORM as a temporary data set resembling a 3-group, 2-D flux. Since the output of ACTUAL is in the proper record format, the copy step in FORM was avoided by inputting NSCR = 0. The resulting plots are given in Fig. 4.4. The third activity plot contains apparent "holes" in the surface, which is a result of ACTUAL calculating the third activity (carbon atom

displacement) only for zones containing carbon. The non-carbon zones are filled with zeros which FORM plots at the level of the minimum positive value when ILL = 1, i.e., for log plots.

Sample Problem 3: The final FORM sample problem demonstrates an R- θ case. The input listing is shown in Fig. 4.5, and the resulting plots are given in Fig. 4.6. The surface lines are always plotted on rectangular grid, but only points within the inscribed R- θ geometry are raised above the base level. In this example, the IGEOM>2 feature was used to produce a grid with equal X- and Y-spacings. Generally, the finer the grid spacing, the better; however, if the R- θ mesh is fairly coarse, then the surface will appear "stepped" regardless of the number of grid lines. The plot in Fig. 4.6 is titled as a "doughnut" because the minimum radial boundary is greater than zero. Based on the resulting plot, it would have been more appropriately titled: "BEK WEDDING CAKE PROBLEM."

```

FORM SAMPLE 1:  BOL FLUX FOR PUJGC01
0
61$$  56  31  9  0  1  3  1  2  30
62$$  1  0  1  0  0  1  0  0
63**  8.5  10.4  7.  8.5  2.7  1.5  1.5  2R50.0  1.0  T
2**  14I0.0  11I72.83  3I132.83  152.83
4**  23I0.0  7I117.78  3I155.53  3I174.28  3I194.78  3I213.32  3I231.86
3I250.40  270.40
6**  P1.0
8$$  24R1  8R2  4R3  4R4  4R5  4R6  4R7  4R8  14Q56
    24R9  8R10  4R11  4R12  4R5  4R6  4R7  4R8  11Q56
    56R8  3Q56
11**  80.0  -80.0  80.0
T
FORM S(AMPLE), P(ROBLEM) 1$

```

Fig. 4.1. Input Listing for FORM Sample 1.

FORM Sample Problem 1

Fig. 4.2. Example of simple R-Z problem plotted with FORM. The two plots were produced on the Gould electrostatic plotter.

ACTUAL: NEUTRON FLUX DISTRIBUTION FOR FILSS REFERENCE CASE

O

1\$\$ 28 50 51 8 3 0 4 2 81 1 2 3 4 30

T

2** 4I0.0 1I15.0 19.0 5I19.5 25.5 26.5 27.0 27.5 5I28.5 34.5 3I35.0
 4I39.0 3I49.0 1I56.0 2I60.0 1I65.0 4I69.0 84.0

4** 4I0.0 2I3.75 6.875 6.9473 2I7.0 4I10.0 4I15.0 2I22.5 1I28.5 30.0

8\$\$ 5R1 23R2 4Q28
 5R1 13R3 10R2 1Q28
 5R1 8R4 5R3 10R2 6Q28
 5R1 3R4 5 4R4 5R3 10R2 3Q28
 5R1 8R4 5R3 10R2 1Q28
 5R6 8R4 5R3 10R2 4Q28
 5R6 13R3 10R2 2Q28
 18R3 10R2
 28R2 8Q28
 26R7 2R2 1Q28
 23R8 3R7 2R2 2Q28
 26R7 2R2 1Q28
 28R2 4Q28

T

FLUX > 100 KEV

6\$\$ 185 3 T

FLUX < 2.38 EV

6\$\$ 185 5 T

CARBON ATOM DISPLACEMENT

7** 0. 2R0.0385 3Z 0.0385 0.

6\$\$ 185 20 T

FORM SAMPLE 2: NEUTRON ACTIVITIES FOR NDA FILSS DESIGN

O

61\$\$ 28 50 3 8 1 4 1 0 20

62\$\$ 3 0 1 1 0 1 0 0

63** 4S 1.0 3.0 2.0 10.0 20.0 1.0

T

2** 4I0.0 1I15.0 19.0 5I19.5 25.5 26.5 27.0 27.5 5I28.5 34.5 3I35.0
 4I39.0 3I49.0 1I56.0 2I60.0 1I65.0 4I69.0 84.0

4** 4I0.0 2I3.75 6.875 6.9473 2I7.0 4I10.0 4I15.0 2I22.5 1I28.5 30.0

6** 1. 2Z 0. 1. 0. 3Z 1.

8\$\$ 5R1 23R2 4Q28
 5R1 13R3 10R2 1Q28
 5R1 8R4 5R3 10R2 6Q28
 5R1 3R4 5 4R4 5R3 10R2 3Q28
 5R1 8R4 5R3 10R2 1Q28
 5R6 8R4 5R3 10R2 4Q28
 5R6 13R3 10R2 2Q28
 18R3 10R2
 28R2 8Q28
 26R7 2R2 1Q28
 23R8 3R7 2R2 2Q28
 26R7 2R2 1Q28
 28R2 4Q28

11** 150.0 -100.0 100.0

T

FORM S (AMPLE) 2 - (M4)A(M5)CTIVITY 1\$

FORM S (AMPLE) 2 - (M4)A(M5)CTIVITY 2\$

FORM S (AMPLE) 2 - (M4)A(M5)CTIVITY 3\$

Fig. 4.3. Input Listing for FORM Sample Problem 2. The two-step case used ACTUAL to calculate the 3 activities.

ORNL-DWG-79-14978
FORM Sample 2 - Activity 2

ORNL-DWG-79-14977
FORM Sample 2 - Activity 1

ORNL-DWG-79-14979
FORM Sample 2 - Activity 3

Fig. 4.4. Example of multiple activities plotted using FORM.

```

FORM SAMPLE 3: BEK DOUGHNUT PROBLEM
O
61$$ 118 98 45 0 8040 4 1 2 30
62$$ 1 0 1 0 0 1 0 0
63** 8.5 11.0 7. 8.5 2.0 1.0 2.0 2R50.0 1.5 1
2** 8710.0 .4888889 11.4890944 .4910417 .4944444 41.4968842 .5
4**
81137.5283
11151.13 11152.4 31182.88 11187.96 11189.865 192.405 193.04 11197.485
11207.0608 11218.1352 31228.6 61254.0 11289.56 11308.61 314.643
11329.8952 21335.28 11337.82 141342.9 378.46 21386.08
51393.7 91414.02 81430.276 11455.516 21455.676 11609.6
11612.14 21617.22 640.08
6** F1.0
8$$ 1R1 7R2
12R2 9R3 2R4 2R5 19R6 2R7 3R8 3R9 2R10 15R11 34R12 7R13
2R1 6R2
12R2 9R3 2R4 2R5 19R6 2R7 3R8 3R9 2R10 15R11 34R12 7R13
1 7R2
. . . ECT . . .
11$$ 100. 130. 80.
T
BEK DOUGHNUT PROBLEM$
RADIUS ((CM))$ RADIUS ((CM))$

```

Fig. 4.5. Input Listing for FORM Sample 3

ORNL-DWG-79-14981

BEK DOUGHNUT PROBLEM

ORNL-DWG-79-14980

Fig. 4.6. Example of R- θ problem plotted using FORM

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5. ACTUAL - Code for Calculating DOT Activities

5.1 Code Description

The program ACTUAL (ACTivities with Useful ALlowances) provides a capability to calculate "after the fact" activities using fluxes from the DOT 3.5 or DOT IV transport codes. Several options for inputting activity response functions are available, and the calculated activities can be output in a format suited for plotting with FORM. Special features of ACTUAL include:

- A. Activity response functions can be input in 1-D or 2-D formats from cards, or in 2-D format from an ANISN-type binary cross section library.
- B. Zone multipliers can be specified to accommodate different material compositions or densities.
- C. DOT 3.5 or DOT IV fluxes can be read directly.
- D. Activities can be output in a format which is appropriate for plotting with the FORM code.

5.2 Input Requirements

The following input arrays and title cards are required in order to execute an ACTUAL case. Default values are given in []'s.

PRØBLEM TITLE CARD (20A4 format)

Control Parameters

1\$ array (14 entries)

IM Number of I intervals.

JM Number of J intervals.

IGM Number of energy groups.
 IZM Number of spatial zones.
 NACT Number of activities to calculate. [1] (NACT=-NN will print
 scalar flux through group NN. No activities are calculated.)
 IPRT 0/1 - Print/Do not print activities. [0]
 ITYP 3/4 - DOT 3.5/DOT IV input flux tape. [4]
 IRD 0/1/2 - Read response functions as 1-D from cards/2-D
 from cards/2-D from tape. [0]
 IHT Table length of 2-D response functions. [0]
 NIN Input flux logical unit number. [1]
 NCRX Input 2-D response function logical unit number. [2]
 NSCR Scratch logical unit number. [3]
 NOUT Output activity logical unit number. [0] (NOUT=7 will punch
 activities in free-form FIDO.)
 NBUF Number of k-bytes of buffer space needed. [20]

T Data Block 1 Terminator

Geometry arrays

2* (JM + 1) J-interval boundaries (not required).
 4* (IM + 1) I-interval boundaries (not required).
 8\$ (IM*JM) Zone number by interval.

T Data Block 2 Terminator

The following Data Block is entered only if IRD = 1.

9* (IHT*IGM) 2-D activity response functions.

T Data Block 3 Terminator (if IRD = 1)

The remaining Data Block is entered NACT times.

ACTIVITY TITLE CARD (20A4 format)

- 6* (IGM) 1-D response function. IRD = 0
-or-
6\$ (1) Table position of response function from 2-D card input.
IRD = 1
-or-
6\$ (2) Material number; table position of response function from
2-D tape input. IRD = 2.
7* (IZM) Activity multiplier by zone. Not required if all 1.0's.

T Data Block 4 Terminator

5.3 IØ File Requirements

<u>File</u>	<u>Description</u>	<u>Required</u>
NIN	Input DOT flux tape	Always
NCRX	Input response library tape	If IRD = 2
NSCR	Scalar flux scratch	Always
NØUT	Output activities	If NØUT > 0

5.4 Region Requirements

The number of words of blank COMMON needed to execute ACTUAL can be determined from:

$$NWØRDS = JM + IZM + 2*(IM+IM*JM+1) + NRSP$$

$$\text{where } NRSP = \begin{cases} IGM & \text{IRD} = 0 \\ IRD+IHT*IGM & \text{IRD} > 0 \end{cases}$$

The number of words available for execution is:

$$\text{NSPACE} = (\text{REGION} - \text{NBUF} - 48) * 256$$

where REGION is the value (in k-bytes) specified on the EXEC card.

5.5 JCL Requirements

The job control language (JCL) needed to run ACTUAL at either X-10 or K-25 is:

```
(Job card and CLASS cards)
//ACT EXEC PGM=ACTUAL,REGION=270K
//GØ.STEPLIB DD DSN=X.DTI46103.PRØØ,DISP=SHR
//GØ.FT05F001 DD DDNAME=SYSIN
//GØ.FT06F001 DD SYSØUT=A
(DD cards as required - see Section 5.3)
(Input cards)
//
```

5.6 Sample Problems

Refer to Sample Problem 2, Section 4.7, for an example of ACTUAL.

6. TOOTH - Surface Plotting Code for Space-Energy Contribution Fluxes

6.1 Code Description

The program TOOTH (This Obviously Ought To be Helpful) is a companion to the widely distributed FANG code which calculates and plots contribution fluxes, i.e., the product of a forward flux and a corresponding adjoint flux. Whereas FANG requires DOT 2-D fluxes and plots $\phi^*\phi$ matrix as a function of the two spatial dimensions, TOOTH requires ANISN angular fluxes and plots $\phi^*\phi$ as a function of the spatial dimension and the energy dimension. Numerous options are available in TOOTH which permit the plotting of the forward and the adjoint fluxes as well as their product, and permit the specification of arbitrary space and energy limits. Also, coupled n- γ problems are treated properly by producing plots which span the neutron groups and gamma-ray groups separately. Special features of TOOTH include:

- A. Either the contribution flux or the contribution leakage can be calculated. The results will appear quite differently for cylindrical and spherical geometries since a surface area factor is included in the leakage calculation.
- B. Slab, cylindrical, and spherical geometries are permitted.
- C. The forward, adjoint, and/or contribution fluxes can be plotted.
- D. Although the $\phi^*\phi$ calculation requires ANISN angular flux data, the ANISN output file containing the scalar fluxes and moments can be used to plot only the forward and/or adjoint fluxes.

- E. TOOTH automatically plots neutron and gamma-ray groups separately for coupled problems.
- F. Multiple views from arbitrary viewpoints can be specified.
- G. The fluxes can be plotted in linear or logarithmic fashion.
- H. Arbitrary space, energy, and flux limits can be specified.
- J. For those who are familiar with DISSPLA, the plots can be enhanced via the user-supplied subroutine INSERT.

6.2 Input Requirements

The following input arrays and title cards are required in order to execute a TOOTH case. Default values are given in []'s.

PRØBLEM TITLE CARD (20A4 format)

Control Parameters

61\$ array (12 entries)

ISN	Order of angular quadrature.
IM	Number of spatial intervals.
IGM	Number of energy groups.
LNG	Last neutron group.
IGE	1/2/3 - Slab/Cylinder/Sphere geometry. [1]
ICR	-1/0/1 - Calculate contributon leakage/Calculate contributon flux/Read $\phi^*\phi$ from unit NMTX. [0]
IPRT	0/1 - No effect/Print contributon matrix. [1]
NFRD	Input unit number of ANISN forward angular flux. [1] (NFRD < 0 reads a scalar flux tape which is allowed if ICR = 1.)

NADJ Input unit number of ANISN adjoint angular flux. [2]
 (NADJ < 0 reads a scalar flux tape which is allowed if
 ICR = 1.)

NSCR Unit number for scratch device. (BLKSIZE=6444) [3]

NMTX Unit number for contribution matrix. Used for output
 if ICR < 1, or for input if ICR = 1. [4]

NBUF Number of k-bytes of buffer space needed. [20]

62\$ array (10 entries)

IPF 0/1 - No effect/Plot forward flux. [0]

IPA 0/1 - No effect/Plot adjoint flux. [0]

IPM 0/1 - No effect/Plot contribution matrix. [1]

NVU Number of viewpoints. [1]

ILL 0/1 - Plot linear/log flux. [0]

LIMX 0/1 - No effect/Enter limits (12* array) for space
 dimension. [0]

LIMY 0/1 - No effect/Enter limits (13* array) for energy
 dimension. [0]

LIMZ 0/1 - No effect/Enter limits (14* array) for flux. [0]

NØRM -1/0/1 - Delete flux axis/No effect/Normalize plotted
 flux such that maximum flux = 1.0. [0]

IFRM 0/1 - No effect/Delete page border. [0]

63* array (8 entries)

HPAGE Horizontal length of page (inches). [8.5]

VPAGE Vertical length of page (inches). [11]

HLGTH Horizontal length of plot area (inches). [6]

VLGTH Vertical length of plot area (inches). [8.5]
 XREL Relative length of space axis. [1]
 YREL Relative length of energy axis. [1]
 ZREL Relative length of flux axis. [1]
 XDIV Label increment for space axis. XDIV = 0 writes
 label only at axis ends. [0]

T Data Block 1 Terminator

Remaining Input Arrays

2* (LNG + 1) Upper boundaries plus lower boundary of last
 group for neutron energy groups.
 3* (IGM-LNG + 1) Upper boundaries plus lower boundary of last
 group for gamma-ray energy groups.
 4* (IM + 1) Interval boundaries for spatial mesh.
 6* (MM^a) Weights for angular quadrature.
 7* (MM^a) Direction cosines for angular quadrature.
 11* (3*NVU) Viewpoint coordinates (in units of XREL, YREL,
 and ZREL).
 12* ($2*NGAM^b$) Minimum and maximum values for space axis.
 13* ($2*NGAM^b$) Minimum and maximum values for energy axis.
 14* ($2*NGAM^b$) Minimum and maximum values for flux (leakage)
 axis.

$a_{MM} = ISN + 1$ for IGE = 1 & 3; = $ISN*(ISN+4)/4$ for IGE = 2.

$b_{NGAM} = 1$ if LNG = IGM and NGAM = 2 if LNG < IGM.

T Data Block 2 Terminator

PLØT TITLE CARD(S) (14A4 format)

Enter 1 card for each

plot excluding multiple views. Therefore, for a n-γ case with IPF=IPA=IPM=1, 6 title cards would be required.

6.3 Input Data Notes

A. ICR The contributon matrix $C(I,J)$ is calculated from the forward and adjoint angular fluxes using the following relation:

$$C(I,J) = \sum_{M=1}^{MM} \phi^*(I,J,M) \phi(I,J,M) WT(M) [MU(M)A(I)]^{-ICR}$$

where:

ϕ and ϕ^* are the cell-centered angular fluxes

WT are the angular quadrature weights

MU are the direction cosines

A are the cell-centered surface areas transverse to the spatial direction

I,J,M are the space, energy, and angle indices, respectively. When ICR = 0, the relation above yields the scalar contributon flux while for ICR = -1, $C(I,J)$ represents the contributon leakage. For most problems, the scalar flux will be similar to the leakage except for the surface area factor. Sample problems 3 and 4 show the effect of the area factor for a spherical geometry case.

In addition to the contributon matrix, the space-dependent response R is calculated at each mesh point:

$$R(I) = \sum_{J=1}^{IGM} C(I,J)$$

where:

ICR = -1 in the relation above for $C(I,J)$. This response is written as the last record on unit NMTX and is listed as group (IGM + 1) when IPRT = 1.

- B. NFRD and NADJ Calculation of the contribution matrix requires the use of ANISN angular fluxes which are output from ANSIN on unit #3. However, it is sometimes desirable to plot only the space-energy scalar flux (forward or adjoint) which is output from ANISN on the optional unit #15. This is permitted with TOOTH by specifying NFRD or NADJ as negative. This feature necessarily requires that $ICR = 1$, even if no contribution plot is desired (done by setting $IPM = 0$).
- C. NSCR A scratch device is required when $ICR < 1$ or when $NADJ > 0$ and $IPA = 1$. This scratch unit is used as random access storage to reorder the adjoint flux in both angle and energy. *To insure correct results, NSCR should be specified with $BLKSIZE = 6444$.*
- D. LIMX, LIMY, LIMZ TOOTH allows the user to specify arbitrary space, energy, and flux limits using LIMX, LIMY, LIMZ, and the corresponding 12*, 13*, and 14* arrays. The limits for the space and energy axes need not be exact boundaries since TOOTH simply searches for the nearest mesh or group boundary. Both upper and lower limits must be specified. Limits for the energy axis can be entered in either order; TOOTH will cleverly rearrange them if needed. Also, the limits are entered separately for neutron and gamma-ray plots (if $LNG < IGM$). Setting $min = max$ for any of the three axes will cause TOOTH to ignore the corresponding plot, which can be useful when desiring only a gamma-ray plot, for example, in an n- γ problem.
- E. NØRM DISSPLA has an automatic scaling feature which causes the axis labels to be selected within some convenient range, and causes a corresponding scale factor (an even power of 10) to be written at the end of the axis. However, more times than not, this scale factor is inconveniently written on top of the axis title. To avoid this problem, NØRM can be used to outwit DISSPLA. If $NØRM = 1$, the maximum plotted flux is set to unity which eliminates automatic scaling. This does not alter the actual contribution flux written on unit NMTX. Setting $NØRM = -1$ completely annihilates the flux axis - title and all.

F. XREL, YREL, ZREL The proportions of the 3-D surface plot are determined by the relative units XREL, YREL, and ZREL which specify the relative lengths of the space, energy, and flux axes, respectively. Only experience and several trial values will determine the best values. Since the energy axis usually spans several decades, it is recommended that YREL be set 1.3 - 1.7 times XREL and ZREL.

G. Viewpoint (11* array) The viewpoint for the perspective plots are specified by viewing coordinates which are defined in relative x, y, z units (see Data Note F). The viewpoint is only restricted not to lie within the workbox defined by the coordinate points (0, 0, 0) and (XREL, YREL, ZREL). For most problems, an adequate viewpoint is (50*XREL, -50*YREL, 50*ZREL). Moving closer to the workbox increases the perspective effect while moving away tends to "square-off" the workbox so that in the limit of a very distant viewpoint, the 3-D plot will be isometric; i.e., parallel lines are plotted parallel.

H. Plot and Axes Labels Flexible manipulation of the character strings for the title cards is possible if the user has knowledge of DISSPLA mixed alphabets. No further explanation will be presented here; users are directed to section 19 of the Intermediate Manual of DISSPLA. The required information needed to use the mixed alphabets of DISSPLA is as follows:

Character Font: SIMPLX

MX1ALF: "STANDARD" ESCAPE CHAR: ")"

MX2ALF: "L/CSTD" ESCAPE CHAR: "("

MX3ALF: "INSTRUCTION" ESCAPE CHAR: "!"

MX4ALF: "L/CGREEK" ESCAPE CHAR: "?"

I. Subroutine INSERT It is recommended that the user who is not familiar with the particulars of DISSPLA skip this mess and go directly to Section 6.4. In order to add special whistles and bells to a plot, the user has access to the plot via the subroutine INSERT. Immediately following a call to GRFITI with parameters to describe the

plane defined by the space and energy axes, the following call is made:

```
CALL INSERT (X0, X1, XRLL, YRLL, ZRLL, HEIGHT)
```

where: X0 = min value on space axis

X1 = max value on space axis

XRLL = relative length of space axis

YRLL = relative length of energy axis

ZRLL = relative length of flux axis

HEIGHT = relative height of axis labels.

The subroutine INSERT which was compiled with T00TH simply returns to the calling routine, then the plot is terminated. The possibilities and pitfalls from the clever use of INSERT are unlimited. For example, mesh or zone boundaries can be drawn and labeled, or arrows can be pointed at key energies, etc. Sample problem 2 gives an example of how INSERT can be used to denote zone boundaries. One caution is that if the user-supplied INSERT calls for DISSPLA or system routines which are not otherwise used by T00TH, the appropriate SYSLIB cards must be included in the JCL to resolve the external references.

6.4. I/O File Requirements

<u>File</u>	<u>Description</u>	<u>Required</u>
C0MP0UT	Compressed plot data	Always
NFRD	Input forward flux	ICR < 1 or IPF = 1
NADJ	Input adjoint flux	ICR < 1 or IPA = 1
NSCR	Random Access Scratch NOTE: Use BLKSIZE = 6444	ICR < 1 or IPA = 1
NMTX	Contribution matrix	ICR < 1 or IPM = 1

6.5 Region Requirements

The number of words in blank COMMON needed to execute T00TH can be determined from:

$$NW\emptyset RDS = 7 + IGX + 2*IGM + 3*(IM + MM + NVU + IG24) + M_1 + M_2$$

where $M_1 = \max[(IM + 2)*(IGX + 2), (IGM + 1)*IM*IPRT]$

$$M_2 = \max[2*(IM + IGX) + 12, 2*(IM + 1)*MM]$$

$$IGX = \max(LNG, IGM - LNG)$$

$$IG24 = 2 \text{ for } IGM = LNG; = 4 \text{ for } IGM > LNG$$

The number of words available for execution is:

$$NSPACE = (REGI\emptyset N - NBUF - 225)*256$$

where REGI\emptyset N is the value (in k-bytes) specified on the EXEC card.

6.6 JCL Requirements

The job control language (JCL) needed to run T00TH at either X-10 or K-25 is:

(Job card and CLASS cards)

```
//TUTH EXEC PGM=T00TH,REGI\emptyset N=270K
```

```
//G\emptyset .STEPLIB DD DSN=X.DTI46103.PR\emptyset G,DISP=SHR
```

```
//G\emptyset .FT05F001 DD DDNAME=SYSIN
```

```
//G\emptyset .FT06F001 DD SYS\emptyset UT=A
```

(DD cards as required - see Section 6.4)

(Input cards)

(Post processor - see Appendix A)

```
//
```

6.7 Sample Problems

Sample Problem 1: The first sample problem demonstrates several TOOTH options, including the use of subroutine INSERT. Because different JCL is required when compiling INSERT, the entire input listing including data cards and JCL is given in Fig. 6.1. The resulting plots were generated on the ORGDP CALCOMP 925/1036 plotter using the PLOTTAPE procedure, and are shown in Figs. 6.2-4. The problem which is described by the three surface plots is a slab-geometry shield configuration with a fast neutron boundary source at position $X=0.0$ cm, and an epithermal neutron detector (3" Bonner ball) located at $X=130.0$ cm. A shield consisting of stainless steel, graphite, and boronated graphite separates the source and detector, while 10 cm of concrete is positioned behind the detector.

The forward flux plot in Fig. 6.2 shows the nature of the neutron source on the left spatial boundary. The $NORM=1$ option was used to normalize the flux, and INSERT was used to show the major regions of the problem geometry. It should be apparent from the input listing of INSERT in Fig. 6.1 that effective use of this routine requires close familiarity with DISSPLA. The adjoint flux is given in Fig. 6.3 and shows the general nature of the detector response which is located in the "GAP" region. It should be noted that while the forward flux and contribution matrix are plotted on a "per unit lethargy" basis, the adjoint flux is always plotted as calculated, i.e., on a "per group" basis. Finally, the contribution flux plot is given in Fig. 6.4. The interpretation of the surface is not exactly obvious, but fortunately, the role of TOOTH is to plot the matrix, not explain it.

Sample Problem 2: The second example shows how TOOTH can be used to plot

a space-energy flux from a scalar + moments input tape. The specific problem is an adjoint flux for k_{eff} in a reactor model. The input listing which is given in Fig. 6.5 shows how string manipulation can be used to plot the lower case letters and subscripts in the plot title shown in Fig. 6.6. An unavoidable shortcoming of the method that TOOTH uses to plot the energy axis is shown in Fig. 6.6: for viewpoints with a negative y-coordinate, the axis label and values will appear backwards. Oh well, can't win them all.

Sample Problem 3: The third example demonstrates a coupled neutron and gamma-ray problem which consists of a spherical shell of niobium with a ^{252}Cf neutron and gamma-ray source at the center of the sphere. The adjoint source was the total neutron and gamma-ray leakage at the outside surface of the sphere. A listing of the TOOTH input is given in Fig. 6.7 while the corresponding neutron and gamma-ray contribution plots are given in Fig. 6.8. The LIMY parameter was used to reduce the energy range according to the entries in the 13* array. Note that the limits for both the neutron and the gamma-ray matrices must be entered. Also, two plot title cards are required.

Sample Problem 4: The last sample problem is identical to Sample Problem 3, except that the contribution leakage is plotted instead of the flux. The effect is dramatic as shown in Fig. 6.9, and is due to the $1/r^2$ geometric attenuation characteristic of spherical problems. Plotting the contribution leakage removes the $1/r^2$ factor since it includes a $4\pi r^2$ surface area factor which is not present in the flux calculation. Whereas the flux plots in Fig. 6.8 are dominated by the source at the sphere's center, the leakage plots in Fig. 6.9 show the behavior of the contribution

population through the spherical shell. The rather prominent ridge in the gamma-ray contribution leakage plot corresponds to the production of 511 keV annihilation radiation in the niobium.

```

/95
//*SEQCARD
//DTTOTH1 JOB (14646),'EPD 6025 INGEFSOLL'
//*CLASS CFI95=Q1M,REGION=400K,IO=2
//*MAIN CEG=FM090
//THE EXEC FORTHCLG,REGION=400K
    SUERCUTINE INSERT(X0,X1,XRLI,YRLI,ZRLI,HGHT)
    DIMENSION XP(4)
    DATA XP/22.0, 57.22, 107.4, 143.0/
C
    XL(NI,NL) = ((XP(NI)+XP(NI+1))/2.0) - 0.5*FLOAT(NL)*(HGHT/1.5)*
    1 (X1-X0)/XRLI
C
    CALL TITLE(0,0,0,0,0,0,XRLI,YRLI)
    Y1 = X1 * YRLI/XRLI
    CALL GRAP(X0,X1-X0,X1,X0,Y1-X0,Y1)
    DO 10 I=1,4
10 CALL RLVEC(XP(I),-70.,XP(I),-40.,0)
    CALL HEIGHT(HGHT/1.5)
    CALL RLMESS('IN. SHLDS',9,XL(1,9),-55.)
    CALL RLMESS('CUTER SHIELD',12,XI(2,12),-55.)
    CALL RLMESS('GAP',3,XL(3,3),-55.)
    CALL RLMESS('PCRV',4,145.,-55.)
    RETURN
    END
//LKED.SYSLIB DD
//          DD
//          DD DSN=SYS2.DISSPLA,DISP=SHR
//LKED.LMCD DD DSN=X.DTI46103.PROG,DISP=SHR
//LKED.SYSIN DD *
    INCLUDE LMCD(TOOTH)
    ENTEY MAIN
//GO.FT05P001 DD DDNAME=SYSIN
//GO.FT06F001 DD SYSOUT=A
//COMPCUT DD UNIT=SYSDA,DSN=8&PLICUT,DISP=(NEW,PASS),DCB=BUFNC=1,
//          SPAC=(4000,(150,50))
//GO.FT03P001 DD UNIT=SYSDA,SPACE=(TRK,(200,20)),
//          DCF=(RCPM=VBS,BKSIZE=6444,BUFNO=1,BUPL=8176)
//GO.FT01F001 DD UNIT=3330,VOL=SER=ZX3330,DISP=SHR,
//          DCF=(BUFNO=1,BUPL=14320),DSN=X.DTI46103.RBS48A
//GO.FT02F001 DD UNIT=3330,VOL=SER=ZX3330,DISP=SHR,
//          DCF=(BUFNO=1,BUPL=14320),DSN=X.DTI46103.RBS56A
//GO.FT04F001 DD UNIT=SYSDA,SPACE=(TRK,(200,20)),
//          DCF=(RCPM=VBS,BKSIZE=6447,BUFNO=1,BUPL=8176)
    TOOTH: 51 GRP SHIELD MOCKUP WITH 3" RR RESPONSE
0
618$ 16 74 51 51 1 0 0 1 2 3 4 40
628$ 1 1 1 1 0 0 0 0 1 0
63** 12.5 8.5 10.5 6.8 3.0 4.5 1.3 30.
1
2**
14918+3 12214+3 1+7 818729+1 670319+1 548809+1 449329+1 36788+2
30119+2 2466+3 202+4 1653+3 13534+2 1108+3 907179 742719 603099 49787+1
40762+1 33373+1 27324+1 22371+1 18316+1 14996+1 12277+1 865169-1
524749-1 40868 318279-1 24788 19305 15034 710169-2 430739-2 33546-1
26126-1 20347-1 15846-1 12341-1 96112-2 454 21445-2 1013-1 47851-3
22603-3 10677-3 50435-4 23824-4 11254-4 41399-5 1-1 1-5
6**
0 1.35765-2 3.1127-2 4.75785-2 6.23145-2 7.4798-2 8.45785-2 9.13015-2
9.47255-2 N8

```

Fig. 6.1. Input Listing for TOOTH Sample Problem 1; the resulting plots are shown in Figs. 6.2-4.

```

7**
-1 -0.989401 -0.944574 -0.865631 -0.755404 -0.617876 -0.458017
-0.281603 -9.50124-2 MB
4** 0.0 0.001 1122.0 9122.95 1135.65 36.92 6142.02 57.22 3162.32
3167.52 1172.62 15173.41 1196.31 3197.1 31102.2 21107.4 11143.0
71144.9 154.9
11** 80.0 -80.0 70.0
\1
TOOTH S(AMPLE) 1: F(ORWARD) F(LUX)$
TOOTH S(AMELE) 1: A(DJOINT) F(LUX)$
TOOTH S(AMELE) 1: C(ONT RIBUTON) F(LUX)$
//DSKPL1 EXEC PGM=POPC92,REGION=110K,COND=EVEN
//STEPL1 DD DSN=SYS2.DISSPOP,DISP=SHR
//PTC6F001 DD SYSOUT=A
//COMPIN DD DSN=66PLTOUT,DISP=OLD
//GO.FT54F001 DD UNIT=TAPE9,DCB=(RECFM=VS,LRECL=364,BLKSIZE=368)
//PTC5F001 DD *
DRAW=1-END
//

```

Fig. 6.1. (Continued)

TOOTH Sample 1: Forward Flux

Fig. 6.2. Example of a forward flux plot produced by TOOTH. The geometry description at the left was generated by subroutine INSERT given in Fig. 6.1.

TOOTH Sample 1: Adjoint Flux

Fig. 6.3. Example of an adjoint flux plot produced by TOOTH. The input listing is given in Fig. 6.1.

TOOTH Sample 1: Contribution Flux

Fig. 6.4. Example of a contribution flux plot produced by TOOTH. The corresponding forward and adjoint fluxes are given in Figs. 6.2 and 6.3.

```

PLOTING TEST2 KEFF FIXED SOURCE ADJCINT FLUX
61$ 0 68 9 9 3 1 0 0 -1 3 0 16
62$ 0 1 0 1 F0
63** 8.5 10.4 6.0 8.0 1.00 1.20 1.20 35.0
T
2** 1.4918+7 6.0653+6 1.1080+6 4.9787+5 4.0868+4 3.3546+3 2.6126+3
    1.0130+3 0.10 0.010
4**
0 10403-3 11107-3 15003-3 16513 3 17788-3 18903-3 199-1 20805-3 21639-3
22412-3 23136-3 23816-3 2446 2 25072-3 25655-3 26213-3 29584-3 32324-3
34664-3 36725-3 39578-3 40268-3 41827-3 43277-3 44637-3 45918-3 47131-3
48285-3 49387-3 50441-3 51453-3 52427-3 54902-3 57172-3 59275-3 61239 3
63004-3 64827-3 66481-3 68056-3 69562-3 71005-3 72392-3 73728-3 75017-3
76263-3 7747-2 7864-2 8145-2 84078-3 86552-3 88891-3 91114-3 93233-3
9526-2 97204-3 99074-3 10087-2 10355-2 1061-1 10853-2 11085-2 11309-2
11523-2 1173-1 1193-1 12124-2 12311-2
11** -100.0 -80.0 60.0
T
TOOTH S (AMPIE) 2: K!LH0.5 (EFF!LXHX) ADJOINTS

```

Fig. 6.5. Input Listing for TOOTH Sample Problem 2; the resulting plot is given in Fig. 6.6.

ORNL-DWG-79-20035

TOOTH Sample 2: K_{eff} ADJOINT

Fig. 6.6. Example of TOOTH plot from an adjoint scalar flux tape. The input listing is given in Fig. 6.5.

TOOTH SAMPLE 3: 171-36 NB SPHERE WITH CF252 AND N+G LEAKAGE

O

61\$	32	35	207	171	3	0	0	1	2	3	4	40
62\$	0	0	1	1	0	0	1	0	0	0		
63**	8.5	11.0	7.0	3.5	1.	1.5	1.	4.0				

I

2**

17313+3 16487+3 15683+3 14918+3 1455+4 14191+3 1384+4 13499+3 1284+4
 12214+3 11618+3 11052+3 10513+3 1+7 951229+1 90484+2 86071+2 818729+1
 7788+3 74082+2 70469+2 67032+2 65924+2 63763+2 60653+2 57695+2 548809+1
 52205+2 49659+2 47237+2 449329+1 40657+2 36788+2 33287+2 31664+2 30119+2
 2865+3 27253+2 25924+2 2466+3 23852+2 23653+2 23457+2 23069+2 22313+2
 21225+2 2019+3 19205+2 18268+2 17377+2 1653+3 15724+2 14957+2 14227+2
 13534+2 12873+2 12246+2 11648+2 1108+3 10026+2 961639 90718+1 86294+1
 82085+1 78082+1 74274+1 70651+1 672059 639279 6081+2 57844+1 550229
 5234+2 49787+1 45049+1 40762+1 38774+1 36883+1 33373+1 30197+1 2985+2
 2972+2 29452+1 28725+1 27324+1 24724+1 23518+1 22371+1 2128+2 20242+1
 19255+1 18316+1 17422+1 16573+1 15764+1 14996+1 14264+1 13569+1 12907+1
 12277+1 11679+1 11109+1 98037 86517 825+2 795+2 72+3 67379 56562 52475
 46309 40868 34307 31828 285+2 27+3 26058 24788 24176 23579 21875 19305
 15034 11709 91188-1 71017-1 55308-1 43074-1 37074-1 33546-1 30354-1
 27465-1 26126-1 24852-1 22487-1 20347-1 15846-1 12341-1 96112-2 74852-2
 58295-2 454 35358-2 27536-2 21445-2 16702-2 13007-2 1013-1 78893-3
 61442-3 47851-3 37267-3 29203-3 22603-3 17603-3 1371-2 10677-3 83153-4
 6476-3 50435-4 39279-4 3059-3 23724-4 18554-4 1445-3 11254-4 87642-5
 68256-5 53158-5 41399-5 1-1 1-5

3**

14+6 12+6 1+7 8+6 75+5 7+6 65+5 6+6 55+5 5+6 45+5 4+6 35+5 3+6 25+5 2+6
 166+4 15+5 133+4 1+6 8+5 7+5 6+5 512+3 51+4 45+4 4+5 3+5 2+5 15+4 1+5
 75+3 6+4 45+3 3+4 2+4 1+4

4**

C.	0.24	0.25	0.265	0.28	0.3	0.35	0.42	0.5	0.6	0.7
0.84	1.	1.2	1.4	1.68	2.	2.4	2.8	3.09	3.5	4.
4.8	5.6									

6*

0.0	.00350931	.00813720	.01269603	.01713693
.02141795	.02549903	.02934205	.03291111	.03617290
.04165596	.04387605	.04558694	.04692220	.04781936

16N

7*

-1.0	-.9972639	-.9856115	-.9647623	-.9349061
-.8963212	-.8493676	-.7944838	-.7321821	-.6630443
-.5068999	-.4213513	-.3318686	-.2392874	-.1444720

16M

11**

80.0	-80.0	70.0
------	-------	------

13**

1.0+3	2.0+7	1.0+4	2.0+7
-------	-------	-------	-------

T

TOOTH S(AMILE) 3: N(EUTRON) C F(LUX) \$

TOOTH S(AMILE) 3: G(AMMA) C F(LUX) \$

TOOTH SAMPLE 4: 171-36 NB SPHERE WITH CF252 AND N+G LEAKAGE

61\$

A6	-1	E	T
----	----	---	---

T

TOOTH S(AMILE) 4: N(EUTRON) C L(KGE) \$

TOOTH S(AMILE) 4: G(AMMA) C L(KGE) \$

Fig. 6.7. Input Listing of TOOTH Sample Problem 3 and 4. The corresponding plots are given in Figs. 6.8 and 6.9.

ORNL-DWG-79-20036

TOOTH Sample 3: Neutron C Flux

ORNL-DWG-79-20037

TOOTH Sample 3: Gamma C Flux

83

Fig. 6.8. Example of contribution flux plots for a spherical neutron-gamma-ray problem. The input listing is given in Fig. 6.7.

ORNL-DWG-20039

TOOTH Sample 4: Neutron C Lkge

ORNL-DWG-79-20039

TOOTH Sample 4: Gamma C Lkge

Fig. 6.9. Example of contributon leakage plots corresponding to the problem shcwn in Fig. 6.8.

7. ASPECT - A Multipurpose Spectrum Plotting Code

7.1 Code Description

The program ASPECT (Any SPECTrum) is a flexible graphics code for plotting groupwise energy spectra and spatial traverses. Numerous options permit a variety of input data formats and a variety of axis scaling and labeling, such that almost any one-dimensional quantity can be plotted effectively. The code was initially developed for plotting multigroup flux spectra generated from the ANISN and DOT discrete-ordinates codes, so that the input requirements and internal default values are tailored to this application and designed to produce useful plots from minimum input specifications. Special features of ASPECT include:

- A. Spectra and traverses can be input from 1-D scalar or angular flux tapes, 2-D flux tapes, or input data cards.
- B. Spectra and traverses can be plotted individually or on the same plot with optional legend.
- C. Either axis can be linear or logarithmic.
- D. Spectra can be plotted on a per-unit-lethargy or a per-unit-energy basis and also normalized to the total flux, if desired.
- E. Groupwise activities can be calculated and plotted.
- F. Spectra and traverses can be punched.
- G. The range on either axes can be input explicitly or scaled automatically.
- H. The axis label increments on linear axes can be input explicitly or scaled automatically.
- I. The user can interact directly with the plot via the user-supplied subroutine INSERT.

- J. Plots from consecutive cases can be overlaid to compare spectra or traverses from different input sources and/or different energy-group structures.

7.2 Input Requirements

The following input arrays and title cards are required in order to execute an ASPECT case. Default values are given in []'s. Parameters preceded by a "*" apply to spectra and traverses.

PRØBLEM TITLE CARD (20A4 format)

Control Parameters

61\$ array (8 entries)

- * IM Number of I-mesh intervals for 1-D and 2-D geometries. [1]
- * JM Number of J-mesh intervals for 2-D geometries. [1]
- * MM Number of angles in 1-D angular flux input. [0]
- * IGM Number of energy groups.
- * LNG Last neutron group. [IGM]
- * ITYPE 0/1/2/3/4/7/8 - Flux input source:
 - 0 - XSDRNPM⁶ scalar flux output tape
 - 1 - ANISN scalar flux output tape
 - 2 - ANISN angular flux output tape
 - 3 - DOT 3.5 scalar output tape
 - 4 - DOT IV scalar output tape
 - 7 - Use spectra and traverses from previous case
 - 8 - Read on cards as 8* array

[Default = 8].
- * NIN Unit number for input flux tape (if ITYPE<7). [1]
- * NBUF Number of k-bytes of buffer space needed. [20]

62\$ array (13 entries)

- NSPECT Number of different spectra to be plotted. [1]
- NPLT 0/1 - Plot all spectra on one set of axes/Plot one spectrum
per set of axes. [0]
- NØG 0/1 - Plot neutron groups/gamma-ray groups. [0]
- LLXY 0/1/2/3 - Spectra axes to be log-x, log-y/linear-x,
log-y/log-x, linear-y/linear-x, linear-y. [0]
- IDV 0/1/2 - Plot spectra "as is"/per unit lethargy/per unit
energy (MeV). [1]
- NØRM 0/1 - No effect/Divide spectra by total flux (or
activity). [0]
- * IACT 0/1/2/3 - Input format for response function(s):
 0 - No input
 1 - A single constant
 2 - A single groupwise response
 3 - (NSPCT+NIP+NJP) groupwise responses
 [Default value = 0].
- * NPUN 0/1 - No effect/Punch input spectra and traverses in free-
form FIDO format/Punch spectra in fixed 6E12.5 format. [0]
- * NHLD 0/1/2/3 - Plot overlay option:
 0 - No effect
 1 - Plot from this case is first plot in overlay set
 2 - Plot from this case is an intermediate plot in overlay
 set
 3 - Plot from this case is final plot in overlay set
 [Default = 0].
- * LGND 0/1 - No effect/Plot legend. [0]

- * LABL 0/1 - No effect/Read x- and y-axis labels immediately preceding first plot title card. [0]
- * IFRM 0/1 - No effect/Delete heavy-line frame around plot, and non-labeled tick-marks. [0]
- * IBDR 0/1 - No effect/Delete line around page limits. [0]

63* array (12 entries)

- * XPAGE Horizontal length of page. [8.5 inches]
- * YPAGE Vertical length of page. [11 inches]
- * XAXS Length of horizontal axis (energy). [6.5 inches]
- * YAXS Length of vertical axis (flux). [8.5 inches]
- XMIN Minimum value on energy axis (for spectra). [0.0]
- XSTP Label increment on linear-type energy axis. If XSTP=0, an appropriate value will be automatically selected. [0]
- XMAX Maximum value on energy axis. If XMIN=XMAX, the full energy range given in the 2* or 3* arrays will be used. [0.0]
- YMIN Minimum value on spectrum axis. [0.0]
- YSTP Label increment on linear-type spectrum axis. If YSTP=0, an appropriate value will be automatically selected. [0.0]
- YMAX Maximum value on spectrum axis. If YMIN=YMAX, the spectrum(a) for each plot will be scanned and appropriate YMIN and YMAX values will be selected. [0.0]
- XLGND Horizontal position of upper left corner of legend for spectra plots (if LGND=1). [0.0]
- YLGND Vertical position of upper left corner of legend for spectra plots (if LGND=1). [YAXS inches]

64\$ array (6 entries)

NIP Number of I-direction space traverses. [0]
 NJP Number of J-direction space traverses. [0]
 IJPLT 0/1 - Plot similar type traverses together./Plot each
 traverse separately. [0]
 LLIJ 0/1/2/3 - Traverse axes to be: log-x, log-y/linear-x,
 log-y/log-x, linear-y/linear-x, linear-y. [1]
 IJNRM Reserved. [0]
 IJSYM -N/0/N- Plot symbol every n^{th} point./Plot line only./Plot
 line and symbol every n^{th} point. [0]

65*array (11 entries)

XIMIN Minimum value of space axis for I-direction traverses. [0]
 XISTP Label increment on linear-type I-traverse space axis. If
 XISTP=0, an appropriate value will be automatically
 selected. [0.0]
 XIMAX Maximum value of space axis for I-direction traverses. If
 XIMIN=XIMAX, the full range specified in the 14* array will
 be used. [0.0]
 XJMIN }
 XJSTP } Same as XIMIN,XISTP,XIMAX except for J-direction traverses.
 XJMAX }
 TMIN Minimum value of flux axis for I- or J-direction
 traverses. [0.0]
 TSTP Label increment on linear-type flux axis. If TSTP=0.0,
 an appropriate value will be automatically selected. [0.0]
 TMAX Maximum value of flux axis for I- or J-direction traverses.
 If TMIN=TMAX, appropriate values will be determined auto-
 matically. [0.0]

TXLGN Horizontal position of upper left corner of legend for
traverses (if LGND=1). [0.0]

TYLGN Vertical position of upper left corner of legend for
traverses (if LGND=1). [YAXS inches]

T Data Block 1 Terminator

Remaining Input Arrays

1\$ (NSPCT) Spatial locations of spectra. Given as interval number
for 1-D fluxes, and as $I+(J-1)*IM$ for (I,J) location in
2-D flux. Not required if ITYPE>4.

2* (LNG+1) Upper boundaries plus lower boundary of last group for
neutron energy groups.

3* (IGM-LNG+1) Upper boundaries plus lower boundary of last group for
gamma-ray energy groups.

5* (1) Constant spectrum scaling factor. (IACT=1)
— or —

5* (IGM) Single response function. (IACT=2)
— or —

5* (IGM*(NSPCT
+NIP+NJP)) Multiple response functions. (IACT=3) Entered by group
for spectra first, then I-traverses, then J-traverses.

6* (MM) Angular quadrature weights. Used only if ITYPE=2.

7* (MM) Angular quadrature cosines. Used only if ITYPE=2.

8* (IGM*NSPCT
+IM*NIP
+JM*NJP) Input spectra and traverses if ITYPE=8. Spectra are
entered first, then I-direction traverses, then
J-direction traverses.

11\$ (NJP) I-locations corresponding to J-direction traverses.
 12* (JM+1) J-mesh boundaries (2* array in DOT).
 13\$ (NIP) J-locations corresponding to I-direction traverses.
 14* (IM+1) I-mesh boundaries (4* array in DOT).

T Data Block 2 Terminator

X-AXIS TITLE CARD	(20A4 format)	} Only if LABL=1
Y-AXIS TITLE CARD	(20A4 format)	
PLOT TITLE CARD	(14A4 format)	
LEGEND TITLE CARD	(20A4 format) - Only if LGND=1; repeat NSPCT times if NPLT=0.	

Repeat PLOT and LEGEND cards NSPCT times if NPLT=1. Repeat above sequence of titles for I-traverses, if any, then J-traverses, if any.

Note: All TITLES should be ended with a \$.

7.3 Input Data Notes

- A. ITYPE Input fluxes can be read from one of several different sources as determined by ITYPE. For ITYPE=0 through 4, a discrete-ordinates flux tape is read on unit NIN and the energy spectra at the locations indicated in the 1\$ array are saved. The entries in the 1\$ array give the spatial mesh point number at which a spectrum is desired. For 2-D geometries, a single entry is given for each spectrum as $I+(J-1)*IM$ for the mesh point (I,J). If ITYPE=7, the input spectra and/or traverses (not full fluxes) from the previous case are used, and if ITYPE=8, the input is read in the 8* array.
- B. IACT This parameter allows the user to plot groupwise activities or to renormalize the fluxes. If IACT>0, one or more entries are required in the 5* array. With IACT=1, ASPECT multiplies each group of each spectrum or traverse by the single entry in the 5* array, while IACT=2 folds the single response function (IGM entries) with each flux distribution. If IACT=3, each distribution is folded with a different response function.
- C. NHLD The user can compare flux distributions from different flux tapes and/or spectra with different group structures by using the NHLD option to overlay successive cases. When plots are to be overlaid, only one plot per case is permitted and the first case must specify NHLD=1. Thereafter, all cases should use NHLD=2 until the last case is reached which must specify NHLD=3. The plot and axis titles are taken from the first case, all other titles are ignored, but must be

entered. If automatic scaling is used (see Data Note F), the axes limits will be determined from the first spectrum only.

D. IFRM and IBDR Each plot of one or more distributions is drawn within a page border defined by XPAGE and YPAGE (63* array). At one edge of the page border, a line of text is written to identify the plot. Also, the graph is plotted with a heavy-line box circumscribing the spectra with tick-marks on all four sides but labeled only on the left and bottom axes. Setting IBDR=1 deletes the page border and identification information, while IFRM=1 deletes the plot frame which leaves only the two labeled axes.

E. LABL If LABL=0, i.e., no explicit axis titles are read, default titles are supplied. These defaults are simple, although they do reflect the selected values of NØG, IDV, and NØRM.

F. Automatic Scaling Automatic scaling of x-axis (energy-axis) can be accomplished by setting XMIN=XMAX. When this is done, the entire range specified in the 2* array (for neutrons) or the 3* array (for gamma-rays) will be used. Similarly, if YMIN=YMAX, all spectra on a given plot will be searched for the minimum and maximum values. Automatic scaling of the x- and y-axes is independent, except that the search for the y-axis limits is performed only for groups between XMIN and XMAX.

G. XSTP and YSTP Log-type axes are labeled with a power of 10 at each decade, while linear axes are labeled at each tick-mark as defined by XSTP and YSTP. These parameters give the number of units (eg., "eV" for x-axis and "n/(cm²·s)" for y-axis) between successive tick-marks. The values of XSTP and YSTP are chosen internally if

automatic scaling is used (see Data Note F), and can also be chosen internally if input as zero. If XSTP or YSTP are input as non-zero, the actual values will be used.

H. Subroutine INSERT The user who is familiar with the intricacies of DISSPLA can embellish his plot with special whistles and bells through the user-supplied subroutine INSERT. Immediately following the plotting of each spectrum, INSERT is called with the following arguments:

```
CALL INSERT(NF,NC)
```

where NF = current plot number
 NC = current spectrum number (starts at 1
 for each new plot)

The user can use this subroutine to add arrows and/or additional lines of text or legend. One can even use this routine to read and plot additional data. Sample Problems 3 and 4 show how INSERT was applied in two different ways. If INSERT is used, the following labeled COMMON from ASPECT may be helpful:

```
COMMON/AR60/L60(6),IM,JM,...,TYLGN
```

The variables beyond L60(4) are the input parameters from the 61\$ through 65* arrays, and are listed in the same order in which they appear in the arrays. If XMIN,XSTP,XMAX,YMIN,YSTP, and YMAX were set for automatic scaling and step size selection (see Data Notes F and G), then the final calculated values will appear in the COMMON when accessed by INSERT.

I. Plot and Axes Labels Flexible manipulation of the character strings

for the title cards is possible if the user has knowledge of DISSPLA mixed alphabets. No further explanation will be presented here; users are directed to section 19 of the Intermediate Manual of DISSPLA. The required information needed to use the mixed alphabets of DISSPLA is as follows:

Character Font: SIMPLX

MX1ALF: "STANDARD" ESCAPE CHAR: ")"

MX2ALF: "L/CSTD" ESCAPE CHAR: "("

MX3ALF: "INSTRUCTION" ESCAPE CHAR: "!"

MX4ALF: "L/CGREEK" ESCAPE CHAR: "?"

7.4 I/O File Requirements

<u>File</u>	<u>Description</u>	<u>Required</u>
CØMPØUT	Compressed plot data	Always
NIN	Input flux data	ITYPE<7

7.5 Region Requirements

The number of words in blank COMMON needed to execute ASPECT can be determined from:

$$N\text{WORDS} = IGM + 2*(1+MM+2*NGP) + NSPCT*(2+IGM+NGP) + IRSP + IREC$$

where:

$$NGP \text{ (No. of groups plotted)} = LNG*(1-NOG) + (IGM-LNG)*NOG$$

$$IRSP \text{ (Length of 5* array)} = \begin{cases} 1 & IACT=1 \\ IGM & IACT=2 \\ IGM*NSPCT & IACT=3 \end{cases}$$

$$\text{IREC (Flux tape record length)} = \begin{cases} \text{IM*IGM} & \text{ITYPE=0} \\ \text{IM} & \text{ITYPE=1 or 4} \\ (\text{IM}+1)*\text{MM} & \text{ITYPE=2} \\ \text{IM*JM} & \text{ITYPE=3} \end{cases}$$

The number of words available for execution is:

$$\text{NSPACE} = (\text{REGION}-\text{NBUF}-204)*256$$

where REGION is the value (in k-bytes) specified on the EXEC card.

7.6 JCL Requirements

The job control language (JCL) needed to run an ASPECT case at either X-10 or K-25 is:

(Job card and CLASS cards)

```
//ASP EXEC PGM=ASPECT,REGION=270K
```

```
//GØ.STEPLIB DD DSN=X.DTI46103.PRØG,DISP=SHR
```

```
//GØ.FT05F001 DD DDNAME=SYSIN
```

```
//GØ.FT06F001 DD SYSØUT=A
```

(DD cards as required - see Section 7.4)

(Input cards)

(Post processor - see Appendix A)

```
//
```

7.7 Sample Problems

Several sample problems using ASPECT are given in this section. They are intended to demonstrate some of the more flexible and less obvious features of ASPECT.

Sample Problem 1: A listing of the input cards for the first sample problem is given in Fig. 7.1 and the corresponding plots are shown in Fig. 7.2. The problem demonstrates how one can plot the neutron and the gamma-ray spectra from an ANISN angular flux tape. The first case reads the ANISN tape and constructs the scalar flux for both neutrons and gamma-rays in the last spatial interval, and then plots the neutron groups using automatic scaling for the flux axis. The second case uses the saved spectrum from the first case and plots the gamma-ray groups using automatic scaling for both axes. Since all IGM values of the input spectrum were punched in the first case, NPUN was set back to zero in the second case to avoid a duplicate set of cards.

Sample Problem 2: The second sample problem is a double case example which demonstrates the overlay feature of ASPECT. The input listing is given in Fig. 7.3 and the corresponding plot is given in Fig. 7.4. The first case plots the neutron spectrum from the first interval of an XSDRNPM calculation, while the second case plots the spectrum at the center of a more realistic DOT IV calculation of the same reactor model. The comparison of the two spectra, which were normalized by total flux, shows the effects of the different geometries and also the different group structures. Placement of the legend was estimated in this case by prior knowledge of the approximate shape of the spectra. However, trial and error is usually required for best results.

Sample Problem 3: A complete listing of JCL and input cards for the third sample problem is given in Fig. 7.5. The example shows how the subroutine INSERT can be used to include additional information on the spectrum plot.

In this case, INSERT was used to plot measured data corresponding to the 1-D spectrum calculation which was punched in Sample Problem 1. Also, the calculated and measured spectra were distinguished using special arrows and legends. Obviously, some familiarity with DISSPLA is helpful when using INSERT. The SYSLIB card which was included in the link edit step was necessary because the VECTOR subroutine called by INSERT is not ordinarily called by ASPECT. The plot generated from the cards listed in Fig. 7.5 is shown in Fig. 7.6. The placement of the words "MEASUREMENT" and "CALCULATION" and the arrows was determined by first plotting only the spectra and measuring the needed dimensions with a ruler. Considerable string manipulation was used to generate the flux axis title. The 5** array was used in this example to normalize the calculated spectrum to the measured spectrum based on a previously determined scale factor.

Sample Problem 4: The fourth sample problem demonstrates a non-spectrum application of ASPECT. The complete input listing is given in Fig. 7.7 and consists of two major job steps. The first step uses the cross section manipulation code AXMIX⁷ to read and reformat a single material array from an ANISN-formatted cross section library. The material array, which consists of several detector response functions, is passed by AXMIX to ASPECT in a "group-independent" format which ASPECT reads as an ANISN scalar flux. The individual response functions are referenced by their respective table positions which are disguised as interval numbers. If more than one material had been desired, the same procedure could be used except that the group-independent data set from AXMIX would be read as a DOT 3.5 tape by ASPECT with JM equal to the number of materials. As with Sample Problem 3, the subroutine INSERT was used to enhance the plot

which is given in Fig. 7.8. The IACT=3 option was used so that the first detector response could be multiplied by 10 for a more convenient comparison of the 3 responses. The plot frame was deleted for demonstration purposes; it is generally preferable to retain the frame.

Sample Problem 5: The fifth sample problem demonstrates the plotting of spectra and spatial traverses. The input listing is given in Fig. 7.9 and the resulting plots are shown in Fig. 7.10. The energy axis and I-traverse axis were specified explicitly, while all other axes ranges were determined by ASPECT. This example shows how the response functions in the 5* array must be ordered when IACT=3.

ASPECT SAMELE 1: NEUTRON FLUX FROM ANISN CASE OF TSP THO2 BLANKET

```

O
61$$$ 95 1 17 207 171 2 1 20
62$$$ A8 1 E
63** 11. 8.5 8. 6. 1.-1 0. 2.+7 E T
1$$$ 95
2**
17373+3 16487+3 15683+3 14918+3 1455+4 14191+3 1384+4 13499+3 1284+4
12214+3 11618+3 11052+3 10513+3 1+7 951229+1 90484+2 86071+2 818729+1
7788+3 74082+2 70469+2 67032+2 65924+2 63763+2 60653+2 57695+2 548809+1
52205+2 49659+2 47237+2 449329+1 40657+2 36788+2 33287+2 31664+2 30119+2
2865+3 27253+2 25924+2 2466+3 23852+2 23653+2 23457+2 23069+2 22313+2
21225+2 2019+3 19205+2 18268+2 17377+2 1653+3 15724+2 14957+2 14227+2
13534+2 12873+2 12246+2 11648+2 1108+3 10026+2 961639 90718+1 86294+1
82085+1 78082+1 74274+1 70651+1 672059 639279 6081+2 57844+1 550229
5234+2 49787+1 45049+1 40762+1 38774+1 36883+1 33373+1 30197+1 2985+2
2972+2 29452+1 28725+1 27324+1 24724+1 23518+1 22371+1 2128+2 20242+1
19255+1 18316+1 17422+1 16573+1 15764+1 14996+1 14264+1 13569+1 12907+1
12277+1 11679+1 11109+1 98037 86517 825+2 795+2 72+3 67379 56562 52475
46309 40868 34307 31828 285+2 27+3 26058 24788 24176 23579 21875 19305
15034 11709 91188-1 71017-1 55308-1 43074-1 37074-1 33546-1 30354-1
27465-1 26126-1 24852-1 22487-1 20347-1 15846-1 12341-1 96112-2 74852-2
58295-2 454 35358-2 27536-2 21445-2 16702-2 13007-2 1013-1 79893-3
61442-3 47851-3 37267-3 29203-3 22603-3 17603-3 1371-2 10677-3 83153-4
6476-3 50435-4 39279-4 3059-3 23724-4 18554-4 1445-3 11254-4 87642-5
68256-5 53158-5 41399-5 1-1 1-5
3**
14+6 12+6 1+7 8+6 75+5 7+6 65+5 6+6 55+5 5+6 45+5 4+6 35+5 3+6 25+5 2+6
166+4 15+5 133+4 1+6 9+5 7+5 6+5 512+3 51+4 45+4 4+5 3+5 2+5 15+4 1+5
75+3 6+4 45+3 3+4 2+4 1+4
6**
0 1.35765-2 3.1127-2 4.75785-2 6.23145-2 7.4798-2 8.45785-2 9.13015-2
9.47255-2 N8
7**
-1 -0.989401 -0.944574 -0.865631 -0.755404 -0.617876 -0.458017
-0.281603 -9.50124-2 M8
T
ASPECT SAMELE 1: ANISN N(NEUTRON) F(LUX) $
ASPECT SAMELE 1: GAMMA FLUX FROM ANISN CASE OF TSP THO2 BLANKET
61$$$ A6 7 0 20
62$$$ A3 1 A8 0 E
63** A5 6Z F T
T
ASPECT SAMELE 1: ANISN G(GAMMA) F(LUX) $

```

Fig. 7.1. Input listing for ASPECT Sample Problem 1

ORNL-DWG-79-20756

ASPECT SAMPLE 1: ANISN Neutron Flux

ORNL-DWG-79-20757

ASPECT SAMPLE 1: ANISN Gamma Flux

Fig. 7.2. Spectrum plots produced by Sample Problem 1 (Fig. 7.1.)

ASPECT SAMPLE 2: COMPARISON OF 1D AND 2D EIR FLUX AT CORE CENTER

```

O
61$$ 42 1 0 171 171 0 1 20
62$$ A6 1 0 1 1 1 E
63** 11. 8.5 8. 6. 1.-1 0. 2.+7 1.-11 0. 1.+0 3.5 2.5
T
1$$ 1
2**
17333+3 16487+3 15683+3 14918+3 1455+4 14191+3 1384+4 13499+3 1284+4
12214+3 11618+3 11052+3 10513+3 1+7 951229+1 90484+2 86071+2 818729+1
7788+3 74082+2 70469+2 67032+2 65924+2 63763+2 60653+2 57695+2 548809+1
52205+2 49659+2 47237+2 449329+1 40657+2 36788+2 33297+2 31664+2 30119+2
2865+3 27253+2 25924+2 2466+3 23852+2 23653+2 23457+2 23069+2 22313+2
21225+2 2019+3 19205+2 18268+2 17377+2 1653+3 15724+2 14957+2 14227+2
13534+2 12873+2 12246+2 11648+2 1108+3 10026+2 961639 90718+1 86294+1
82085+1 78082+1 74274+1 70651+1 672059 639279 6081+2 57844+1 550229
5234+2 49767+1 45049+1 40762+1 38774+1 36883+1 33373+1 30197+1 2985+2
2972+2 29452+1 28725+1 27324+1 24724+1 23518+1 22371+1 2128+2 20242+1
19255+1 18316+1 17422+1 16573+1 15764+1 14996+1 14264+1 13569+1 12907+1
12277+1 11679+1 11109+1 98037 86517 825+2 795+2 72+3 67379 56562 52475
46309 40668 34307 31828 285+2 27+3 26058 24788 24176 23579 21875 19305
15034 11709 91188-1 71017-1 55308-1 43074-1 37074-1 33546-1 30354-1
27465-1 26126-1 24952-1 22487-1 20347-1 15846-1 12341-1 96112-2 74852-2
58295-2 454 35358-2 27536-2 21445-2 16702-2 13007-2 1013-1 78893-3
61442-3 47651-3 37267-3 29203-3 22603-3 17603-3 1371-2 10677-3 83153-4
6476-3 50435-4 39279-4 3059-3 23724-4 18554-4 1445-3 11254-4 87642-5
68256-5 53158-5 41399-5 1-1 1-5
T
ASPECT SAMPLE 2: O(VERLAY) 1D (AND) 2D S(PECTRA)$
171 G(RP) XSDRNPM C(ALC)$
ASPECT SAMPLE 2: COMPARISON OF 1D AND 2D EIR FLUX AT CORE CENTER
61$$ 43 43 0 10 10 4 2 20
62$$ A9 3 E T
1$$ 1
2** 15.0+6 1.35335+6 0.30197+6 67.38+3 15.034+3 1.2341+3
61.44 5.044 1.125 0.1 0.01
T
$
10 G(RP) DCT IV C(ALC)$

```

Fig. 7.3. Input listing for ASPECT Sample Problem 2

ASPECT SAMPLE 2: Overlay 1D and 2D Spectra

Fig. 7.4. Spectra plot generated by Sample Problem 2 (Fig. 7.3.)

```

//DTIASPEC3 JOB (14646), 'EPD 6025 INGEFSOLL'
//*CLASS CPU91=10S,REGION=270K,IO=2
//*CLASS SPECIAL=TAPES
//*PICT TYPE=CALQ25,INK=BLACK/L,NUMBER=1,PAPER=600
//*ROUTE PRINT REMOTE1
//ASE EXEC FORTHCLG,REGION=270K
SUBROUTINE INSERT(NF,NC)
COMMON/AR60/L60(4),IM,JM,MM,IGM,LNG,ITYPE,NIN,NRUF,
1 NSPCT,NPLT,NOG,LLXY,IDV,NORM,IAC,NPUN,NHLD,LGND,LABL,IFRM,IBDR,
2 XPAGE,YPAGE,XAXS,YAXS,XMIN,XSTP,XMAX,YMIN,YSTP,YMAX,XLGND,YLGND
DIMENSION EM(120),P(120,2),ID(20)
READ(5,502) ID
WRITE(6,601) ID
READ(5,503) NW
READ(5,501) (EM(I),2(I,1),P(I,2),I=1,NW)
DO 10 I=1,NW
IF(P(I,1).LE.0.0) P(I,1) = YMIN * 1.0E-3
IF(P(I,2).LE.0.0) P(I,2) = YMIN * 1.0E-3
10 EM(I) = EM(I) * 1.0E+6
C
DO 50 K=1,2
CALL CURVE(EM,P(1,K),NW,0)
50 CONTINUE
C
CALL VECTOR(3.25,5.8,2.45,5.1,301)
CALL MESSAGE('MEASUREMENT',11,3.5,5.8)
CALL VECTOR(2.45,3.35,3.18,4.0,301)
CALL MESSAGE('CALCULATION',11,0.5,3.25)
501 FORMAT(6E12.5)
502 FORMAT(20A4)
503 FORMAT(I10)
601 FORMAT(1H0,20A4,////)
RETURN
END
//LKED.SYSLIB DD DSN=SYS2.DISSPLA,DISP=SHR
//LKED.LMOD DD DSN=X.DTI46103.PROG,DISP=SHR
//LKED.SYSIN DD *
INCLUDE LMOD(ASPECT)
ENTRY MAIN
//GO.FIGCF001 DD DENAME=SYSIN
//GO.FIGCF001 DD SYSOUT=A
//COMPUT ID UNIT=SYSDA,DSN=EEPLTOUT,DISP=(NEW,PASS),
// SPACE=(4000,(50,50),RLSE)
ASPECT SAMELE 3: USE INSERT TO PLOT NF-213 DATA
0
61$$ 1 1 0 207 171 8 0 10
62$$ A4 1 2 0 1 3Z 1 E
63** 8.5 11.0 6. 8. 0. 2.+6 1.8+7 5.-4 0. 2.+1 E T
2**

```

(continued on next page)

Fig. 7.5. Complete input listing for ASPECT Sample Problem 3

17373+3 16487+3 15683+3 14918+3 1455+4 14191+3 1394+4 13499+3 1284+4
 12214+3 11618+3 11052+3 10513+3 1+7 951229+1 90484+2 86071+2 818729+1
 7788+3 74062+2 70469+2 67032+2 65924+2 63763+2 60553+2 57695+2 548809+1
 52205+2 49659+2 47237+2 449329+1 40657+2 36788+2 33297+2 31664+2 30119+2
 2865+3 27253+2 25924+2 2466+3 23852+2 23653+2 23457+2 23069+2 22313+2
 21225+2 2019+3 19205+2 18268+2 17377+2 1653+3 15724+2 14957+2 14227+2
 13534+2 12873+2 12246+2 11648+2 1108+3 10026+2 961639 90718+1 86294+1
 82085+1 78082+1 74274+1 70651+1 672059 639279 6081+2 57844+1 550229
 5234+2 49787+1 45049+1 40762+1 38774+1 36983+1 33373+1 30197+1 2985+2
 2972+2 29452+1 28725+1 27324+1 24724+1 23518+1 22371+1 2128+2 20242+1
 19255+1 18316+1 17422+1 16573+1 15764+1 14996+1 14264+1 13569+1 12907+1
 12277+1 11679+1 11109+1 98037 86517 825+2 725+2 72+3 67379 56562 52475
 46309 40868 34307 31828 285+2 27+3 26058 24788 24176 23579 21875 19305
 15034 11709 91189-1 71017-1 55309-1 43074-1 37074-1 33546-1 30354-1
 27455-1 26126-1 24852-1 22487-1 20347-1 15846-1 12341-1 96112-2 74852-2
 58295-2 454 35359-2 27536-2 21445-2 16702-2 13007-2 1013-1 78893-3
 61442-3 47851-3 37267-3 29203 3 22603-3 17603-3 1371-2 10677-3 83153-4
 6476-3 50435-4 32279-4 3059-3 23724-4 18554-4 1445-3 11254-4 87642-5
 68256-5 53158-5 41399-5 1-1, 1-5

3**

14+6 12+6 1+7 8+6 75+5 7+6 65+5 6+6 55+5 5+6 45+5 4+6 35+5 3+6 25+5 2+6
 166+4 15+5 123+4 1+6 9+5 7+5 6+5 512+3 51+4 45+4 4+5 3+5 2+5 15+4 1+5
 75+3 6+4 45+3 3+4 2+4 1+4

5**

8***

282769-14 52471-13 434372-14 613417-14 764601-14 937916-14 115068-13 1 1
 338476-13 34081-12 449624-13 615907-12 119194-12 139987-12 18472-11 1 2
 254165-12 231738-12 330878-12 442894-12 496373-12 500207-12 728041-12 1 3
 288409-12 604039-12 112455-11 102406-11 107805-11 158512-11 12029-10 1 4
 154558-11 154551-11 26842-10 195734-11 163613-11 107185-11 209625-11 1 5
 262045-11 287566-11 324829-11 339995-11 345666-11 155924-11 198904-11 1 6
 302631-11 409212-11 392345-11 316333-11 290482-11 246583-11 394003-11 1 7
 370105-11 349981-11 374282-11 404603-11 421535-11 261762-11 405088-11 1 8
 52034-10 436884-11 504414-11 163047-11 371945-11 424316-11 661679-11 1 9
 306249-11 927332-11 129211-10 149515-10 17717-9 199107-10 223726-10 1 10
 233635-10 245191-10 224782-10 283753-10 171211-10 10996-9 134325-10 1 11
 332693-10 412639-10 491955-11 181024-11 265498-11 954991-11 202633 10 1 12
 477227-10 252458-10 247291-10 284226-10 244446-10 233754-10 31183-9 1 13
 355672-10 319087-10 313016-10 32422-9 234725-10 461791-10 440369-10 1 14
 453029-10 461471-10 409224-10 922292-10 111585-9 320844-10 597922-10 1 15
 920213-10 754679-10 182103-9 687804-10 123026-9 132159-9 162935-9 1 16
 598727-10 342167-10 930205-11 525805-10 126648-9 449978-10 341074-10 1 17
 927368-10 139143-9 201844-9 216738-9 203997-9 116704-9 140548-9 134111-9 1 18
 725428-10 517827-10 480235-10 415104-10 174949-10 138916-10 226687-10 1 19
 368935-10 823219-10 823544-10 664055-10 623825-10 574967-10 479447-10 1 20
 309654-10 27885-9 317277-10 24716-9 225977-10 171301-10 157883-10 1 21
 122498-10 100807-10 966256-11 9071-9 518309-11 28402-10 251357-11 1 22
 238878-11 226025-11 211899-11 195955-11 177944-11 158367-11 139954-11 1 23
 115515-11 971721-12 791207-12 600285-12 457435-12 231359-12 230314-12 1 24
 269667-12 405389-13 93025-18 618774-15 374553-11 380038-11 231023-11 1 25
 964283-12 126773-11 131436-11 111154-11 125216-11 939065-11 106457-10 1 26
 150705-10 30889-9 571555-10 535956-10 257529-10 283652-10 605739-10 1 27
 447717-10 215383-10 250264-10 232223-10 130645-10 174533-10 14636-9 1 28
 296467-10 281851-10 116925-10 730105-11 710583-12 555272-13 112611-13 1 29
 174285-12 371088-14 101204-14 1 30

T

(continued on next page)

Fig. 7.5. Continued


```

NEUTRON ENRGY ((E)V)$
PLUX ((N/(C4!EH0.5)2!EXHX(*S*)M(E)V*(K)W))$
ASPECT SAMPLE 3: U(SE) INSERT$
RUN 7796A,7787A SM+18THO2 5/3/79
55
0.23471E 02-0.19352E-03 0.25029E-02 0.22560E 02-0.19226E-03 0.20973E-03
0.21580E 02-0.21187E-03 0.18135E-03 0.20556E 02-0.31784E-03 0.89382E-04
0.19452E 02-0.35185E-03 0.57171E-04 0.18521E 02-0.33445E-03 0.93520E-04
0.17533E 02 0.23337E-04 0.43051E-03 0.16539E 02 0.10955E-02 0.15592E-02
0.15629E 02 0.31063E-02 0.37267E-02 0.14792E 02 0.55753E-02 0.64674E-02
0.14021E 02 0.83248E-02 0.94577E-02 0.13201E 02 0.13880E-01 0.15343E-01
0.12393E 02 0.23878E-01 0.26029E-01 0.11751E 02 0.34084E-01 0.36599E-01
0.11247E 02 0.44141E-01 0.47057E-01 0.10777E 02 0.57926E-01 0.61323E-01
0.10259E 02 0.80292E-01 0.84441E-01 0.97411E 01 0.11169E 00 0.11648E 00
0.92613E 01 0.15045E 00 0.15582E 00 0.87578E 01 0.19971E 00 0.20636E 00
0.82364E 01 0.25597E 00 0.26633E 00 0.73265E 01 0.32589E 00 0.33770E 00
0.72352E 01 0.42898E 00 0.43900E 00 0.68390E 01 0.53323E 00 0.54608E 00
0.65557E 01 0.61751E 00 0.63592E 00 0.62542E 01 0.71377E 00 0.73595E 00
0.59380E 01 0.81941E 00 0.83663E 00 0.56453E 01 0.90193E 00 0.92197E 00
0.52459E 01 0.97191E 00 0.98987E 00 0.50422E 01 0.10588E 01 0.10773E 01
0.47521E 01 0.11532E 01 0.11740E 01 0.44540E 01 0.11907E 01 0.12124E 01
0.41528E 01 0.11397E 01 0.11649E 01 0.39061E 01 0.10610E 01 0.10862E 01
0.37074E 01 0.10057E 01 0.10347E 01 0.35009E 01 0.10677E 01 0.11041E 01
0.32965E 01 0.14232E 01 0.14532E 01 0.30075E 01 0.21471E 01 0.21855E 01
0.28984E 01 0.32350E 01 0.32708E 01 0.27026E 01 0.46101E 01 0.46472E 01
0.24089E 01 0.63218E 01 0.63684E 01 0.22961E 01 0.76621E 01 0.77031E 01
0.21000E 01 0.74304E 01 0.74816E 01 0.19323E 01 0.64609E 01 0.65146E 01
0.18125E 01 0.61939E 01 0.62493E 01 0.17095E 01 0.64429E 01 0.65007E 01
0.16100E 01 0.68788E 01 0.69567E 01 0.15107E 01 0.72723E 01 0.73365E 01
0.14121E 01 0.74200E 01 0.74897E 01 0.13096E 01 0.73946E 01 0.74596E 01
0.12047E 01 0.71546E 01 0.72194E 01 0.11069E 01 0.69906E 01 0.70630E 01
0.10066E 01 0.79994E 01 0.80678E 01 0.90694E 00 0.11003E 02 0.11089E 02
0.81135E 00 0.13464E 02 0.13612E 02
//PLOT EXEC PGM=POPC02,REGION=110K
//STEPLIB DD DSN=SYS2.DISSPOP,DISP=SHR
//FTC6F001 DD SYSOUT=A
//COMPIN DD DSN=SSPLTOUT,DISP=OLD
//FT54F001 DD DNAME=PLOTTAPF
//PLCTAPE DD UNIT=TAPE9,DISP=(NEW,KFED),DSN=DTIRLOT,
// DCE=(RECTM=VS,LEWCL=264,BLKSIZE=268),LABEL=(,NL)
//FTC5F001 DD *
DRAW=1-END
//

```

Fig. 7.5. Continued

ASPECT SAMPLE 3: Use INSERT

Fig. 7.6. Spectra plot generated by Sample Problem 3 (Fig. 7.5.)

```

//DTIASPC4 JOB (14646), 'EPD 6025 INGEFSOLL'
//*CLASS CPU91=10S,REGION=500K,IO=2
//*ROUTE EFINT REMOTE1
//*ROUTE PUNCH REMOTE7
//AXMX EXEC FORTHLG,GOSSIZE=500K
//SYSLIB DD
//      DD
//      DD
//      DD DSN=E.JVP45285.JAMLIB,DISP=SHR
//      DD DSN=E.JVP45285.WARLIB,DISP=SHR
//PROG1 DD DSN=E.JVP45285.PROG,DISP=SHR
//SYSIN DD *
  INCLUDE PROG1(AXMIX2)
  ENTRY MAIN
//GO.FT05FC01 DD DDNAME=SYSIN
//BUF1 DD UNIT=SYSDA,SPACE=(30000,(200,50))
//BUF2 DD UNIT=SYSDA,SPACE=(30000,(200,50))
//GO.FT02F001 DD DSN=88GIPXSC,DISP=(NEW,PASS),UNIT=SYSDA,
// DCB=(RECFM=VS,BLKSIZE=13030,BUFNO=1),SPACE=(13030,(102,51))
//GO.FT04F001 DD DSN=88NCLXSC,DISP=(NEW,PASS),UNIT=SYSDA,
// DCB=(RECFM=VS,BLKSIZE=13030,BUFNO=1),SPACE=(13030,(102,51))
//GO.FT03F001 DD UNIT=3330,VOL=SER=ZY8888,DISP=SHR,DCB=BUFNO=1,
// DSN=X.DT46103.RBX20.DETR207
AXMIX: WRITE DETECTOR RESPONSE TABLE IN GIP FORMAT
  O
1$$$ 207 212 21 0 1 4Z 1 0 0 0 20
2$$$ 1 E T
13$$$ 5000 17$$$ 1 T
STOP
//ASP EXEC FORTHCLG,REGION=270K
  SUBROUTINE INSERT(NF,NC)
  IF (NC.GI.1) RETURN
  CALL VECTOR(4.8,1.45,4.35,1.0,301)
  CALL MESSAG(' ((*10)) ',7,4.9,1.4)
  RETURN
  END
//LKED.SYSLIB DD DSN=SYS2.DISSPLA,DISP=SHR
//LKED.LMOD DD DSN=X.DT46103.PROG,DISP=SHR
//LKED.SYSIN DD *
  INCLUDE LMOD(ASPECT)
  ENTRY MAIN
//GO.FT05FC01 DD DDNAME=SYSIN
//GO.FT06F001 DD SYSOUT=A
//COMPCUT DD UNIT=SYSDA,DSN=88PLTOUT,DISP=(NEW,PASS),
// SPACE=(4000,(50,50),RLSE)
//GO.FT01F001 DD DSN=88GIPXSC,DISP=OLD

```

(continued on next page)

Fig. 7.7. Input listing for ASPECT Sample Problem 4

ASPECT SAMELE 4: PLOT NON-SPECTRUM

```

0
61$$ 21 1 0 207 171 1 1 30
62$$ 3 37 0 0 3 0 0 1 1 0
63** 11. 8.5 8. 5. 1.+0 0. 2.+7 1.-2 0. 2.+0 0.25 1.5 T
1$$ 3 8 12
2**
17333+3 16487+3 15683+3 14918+3 1455+4 14191+3 1384+4 13499+3 1284+4
12214+3 11618+3 11052+3 10513+3 1+7 951229+1 90484+2 86071+2 818729+1
7788+3 74082+2 70469+2 67032+2 65924+2 63763+2 60653+2 57695+2 548809+1
52205+2 49659+2 47237+2 449329+1 40657+2 36788+2 33287+2 31664+2 30119+2
2865+3 27253+2 25924+2 2466+3 23852+2 23653+2 23457+2 23069+2 22313+2
21225+2 2019+3 19205+2 18268+2 17377+2 1653+3 15724+2 14957+2 14227+2
13534+2 12873+2 12246+2 11648+2 1108+3 10026+2 961639 90718+1 86294+1
92088+1 79082+1 74274+1 70651+1 672059 639279 6081+2 57844+1 550229
5234+2 49787+1 45049+1 40762+1 38774+1 36883+1 33373+1 30197+1 2985+2
2972+2 29452+1 28725+1 27324+1 24724+1 23518+1 22371+1 2128+2 20242+1
19255+1 18316+1 17422+1 16573+1 15764+1 14996+1 14264+1 13569+1 12907+1
12277+1 11679+1 11109+1 98037 86517 825+2 795+2 72+3 67379 56562 52475
46309 40668 34307 31828 285+2 27+3 26058 24788 24176 23579 21875 19305
15034 11709 91188-1 71017-1 55308-1 43074-1 37074-1 33546-1 30354-1
27465-1 26126-1 24352-1 22487-1 20347-1 15846-1 12341-1 96112-2 74852-2
58295-2 454 35358-2 27536-2 21445-2 16702-2 13007-2 1013-1 78893-3
61442-3 47851-3 37267-3 29203-3 22603-3 17603-3 1371-2 10677-3 82153-4
6476-3 50435-4 39279-4 3059-3 23724-4 18554-4 1445-3 11254-4 87642-5
68256-5 53158-5 41399-5 1-1 1-5
3**
14+6 12+6 1+7 8+6 75+5 7+6 65+5 6+6 55+5 5+6 45+5 4+6 35+5 3+6 25+5 2+6
166+4 15+5 133+4 1+6 8+5 7+5 6+5 512+3 51+4 45+4 4+5 3+5 2+5 15+4 1+5
75+3 6+4 45+3 3+4 2+4 1+4
5** 267810. 81.0
T
NEUTRON ENERGY ((E)V)$
RESPONSE ((COUNTS/(NEUTRONS*CM!EHO.7 (-2! EXHX)))$
ASPECT SAMELE 4: D(ETECTOR) R(ESPONSES)$
2" R(CNNER) B(ALL)$
5" R(CNNER) E(ALL)$
10" R(CNNER) B(ALL)$
//GPLT EXEC SLDPLT,REGION=110K
//COMPIV DE DSN=SSPLTOUT,DISP=OLD
//FTC5F0C1 DD *
DRAW=1-END
//

```

Fig. 7.7. Continued

ASPECT SAMPLE 4: Detector Responses

Fig. 7.8. Spectra plot generated by Sample Problem 4 (Fig. 7.7.)

ASPECT: SAMPLE PROBLEM 5 - SPECTRA AND TRAVERSES

```

0
61$$ 60 42 0 51 51 4 1 20
62$$ 2 0 0 0 1 0 3 0 0 1 0 0 0
63** 11. 8.5 8. 5. 1.+0 0 2.+7 0 0 0 0.5 4.5
64$$ 2 1 1 1 0 1
65** 0.0 5.0 40.0 3Z 3Z 5. 4.5
T
1$$ 1201 2461
2**
14918+3 12214+3 1+7 818729+1 670319+1 548809+1 449329+1 36788+2
30119+2 2466+3 202+4 1653+3 13534+2 1108+3 907179 742719 603099 49787+1
40762+1 33373+1 27324+1 22371+1 18316+1 14996+1 12277+1 865169-1
524749-1 40868 318279-1 24788 19305 15034 710169-2 430739-2 33546-1
26126-1 20347-1 15846-1 12341-1 96112-2 454 21445-2 1013-1 47851-3
22603-3 10677-3 50435-4 23824-4 11254-4 41399-5 1-1 1-5
5** 51R 1.0 Q51
' 2"-CD BONNER BALL (COUNTS//NEUTRON/CM**2)
60794-9 96432-9 11517-8 13894-8 18203-8 1887-7 16918-8 15339-8 16616-8
19474-8 24179-8 17095-8 13614-8 14541-8 1762-7 2372-7 32504-8 38433-8
39819-8 48169-8 60435-8 67559-8 73508-8 79767-8 89319-8 10816-7 12855-7
14553-7 16477-7 18647-7 2111-6 27154-7 36797-7 44266-7 5009-6 56217-7
64271-7 73046-7 82769-7 10645-6 15551-6 22248-6 31879-6 47318-6 70035-6
1015-4 1466-4 20767-5 22862-5 2Z
' 5" BONNER BALL (COUNTS//NEUTRON/CM**2)
12064-5 15544-5 19861-5 24783-5 30916-5 35081-5 4115-4 48039-5 55955-5
64411-5 72763-5 8079-4 88412-5 95492-5 10183-4 10732-4 112-2 11581-4
11873-4 12094-4 12243-4 12339-4 12397-4 12423-4 12426-4 12404-4 12388-4
12396-4 12405-4 12434-4 12457-4 12547-4 1267-3 12737-4 12797-4 12864-4
12922-4 12986-4 13009-4 12993-4 13025-4 12591-4 12288-4 12342-4 12101-4
1143-3 10508-4 91393-5 54765-5 2Z
51R 1.0
11$$ 1
13$$ 21 21
12** 9I 0.0 9I 10.0 30.0 19I 30.96 156.4 157.0
14**
0. 0.55 2.19 3.30 4.94 6.05 7.68 8.79 9.61 2I9.93 10.6 10.93 11.86
13.1 14.95 16.2 18.05 19.3 21.15 22.4 24.25 25.5 26.42 2I26.79
1I 28.0505 3I 29.18 1I 37.78 9I 38.1 1I 53.34 4I 54.29 6I 61.8 84.77
T
SAMPLE 5-1: SPECTRA$
S(PECTRUM AT 30.5 CM)$
S(PECTRUM AT 156.7 CM)$
SAMPLE 5-2: I-DIRECTION TRAVERSES$
2" B(ONNER) B(ALL)$
SAMPLE 5-3: I-DIRECTION TRAVERSES$
5" B(ONNER) B(ALL)$
SAMPLE 5-4: J-DIRECTION TRAVERSES$
T(OTAL) F(LUX)$

```

Fig. 7.9. Input listing for ASPECT sample problem 5

Fig. 7.10. Plots produced by Sample Problem 5

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APPENDIX A

DISSPLA POST PROCESSORS

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APPENDIX A

DISSPLA Post Processors

All of the plotting codes described in this report produce the plot information in the form of a compressed data set. The compressed file can be saved and plotted at a later time, or passed via a temporary storage device directly to a post processor for immediate plotting. The post processor is simply a translator which converts the information in the compressed file to the actual pen or beam commands. This procedure has several advantages:

- A. The plotting code and corresponding JCL is independent of the plotting device,
- B. The compressed file can be saved for future plotting and/or for plotting on several different devices,
- C. The program size of the plotting code is substantially reduced, and,
- D. The post processors permit some plot manipulations such as scaling.

In this section, the JCL for some of the most commonly used post processors will be presented. For a complete and current listing of available post processors, the user should consult the online IBM 360 HELP file with TITLE=DISSPLA.

Each post processor requires a compressed plot data file as input. Also, a string of post-processor directives can be input to manipulate the output plots. For the purpose of this section, it will be assumed that the compressed data set (output as COMPØUT from the plotting codes)

was written on SYSDA with DSN=&&PLTØUT and DISP=(NEW,PASS). Only one directive will be used, DRAW=1-END, which causes all plots in the compressed file to be plotted. A full description of other directives is given in the DISSPØP User Manual. Unless otherwise noted, the JCL given below applies to both X-10 and K-25 sites.

A.1 CALCØMP 925/1036 DISKPLØT

The following JCL may be used to post-process a compressed file on the CALCØMP 925/1036 plotter using the DISKPLØT feature.

```
//PLT EXEC PGM=PØPD92,REGION=110K
//STEPLIB DD DSN=SYS2.DISSPØP,DISP=SHR
//FT06F001 DD SYSØUT=A
//CØMPIN DD DSN=&&PLTØUT,DISP=ØLD
//FT49F001 DD UNIT=IN2ØU2,DISP=(NEW,KEEP),DCB=SYS2.DISKDCB,
// SPACE=(3208,99,RLSE),DSN=C925YYY.XXXXX
//PLØTSUBS DD DSN=SYS2.JGSPLØTH,DISP=(SHR,PASS)
//F105F001 DD *
DRAW=1-END
//
```

The YYY is 600 for 11" wide blank paper and 500 for 30" wide blank paper; the XXXXX should be the user ID plus additional character(s) for uniqueness.

A.2 CALCØMP 925/1036 PLØTTAPE

This post processor is similar to that described above, except that a tape instead of a disk file is produced. This is required if a

special option is desired such as liquid ink instead of the default of ball-point pen.

(a) requires user-supplied Job Submission Form and Plotter Work Request:

```

/*SEQCARD
ooo

/*CLASS SPECIAL=TAPE                                *X-10 ONLY*
ooo

//PLT EXEC PGM=P0PC92,REGION=110K
//STEPLIB DD DSN=SYS2.DISSP0P,DISP=SHR
//FT06F001 DD SYS0UT=A
//C0MPIN DD DSN=&&PLT0UT,DISP=0LD
//FT54F001 DD UNIT=TAPE9,DISP=(NEW KEEP),
// DSN=ANYNAME,LABEL=(,NL),V0L=SER=54,                *X-10 ONLY*
// DCB=(RECFM=VS,LRECL=364,BLKSIZE=368)
//FT05F001 DD *
DRAW=1-END
//

```

(b) machine-generated Job Submission Form and Plotter Work Request

(X-10 only):

```

/*CLASS SPECIAL=TAPES
/*PL0T TYPE=CAL925,INK=...,NUMBER=..., PAPER=...
ooo

//PLT EXEC PGM=P0PC92,REGION= 110K
//STEPLIB DD DSN=SYS2.DISSP0P, DISP=SHR
//FT06F001 DD SYS0UT=A
//C0MPIN DD DSN=&&PLT0UT,DISP=0LD

```



```
//FT54F001 DD DDNAME=PLØTTAPE
//PLØTTAPE DD UNIT=TAPE9,DISP=(NEW,KEEP),
// DSN=ANYNAME,LABEL=(,NL),
// DCB=(RECFM=VS, LRECL=364,BLKSIZE=368)
//FT05F001 DD *
DRAW=1-END
//
```

See Section 13.4 of the Programmer's Notebook for information on using the `//*PLØT` statement.

A.3 Gould Plotter

The Gould plotter which is connected to the Remote 7 line in Bldg. 6025 provides potential for fast turn-around of plotting jobs. The JCL needed to post process on the Gould is as follows:

```
//PLT EXEC GLDPLT,REGION=110K
//CØMPIN DD DSN=&&PLTØUT,DISP=ØLD
//FT05F001 DD *
DRAW=1-END
//
```

A.4 Line Printer

When debugging plot programs, the line printer can produce a poor resolution, but quick turn-around plot. The JCL needed to post process on the line printer is as follows:

```
//PLT EXEC PGM=PØPLPT,REGION=110K
//STEPLIB DD DSN=SYS2.DISSPØP,DISP=SHR
```

```
//FT06F001 DD SYSOUT=A
//FT05F001 DD *
DRAW=1-END
/*
//CØMPIN DD DSN=&&PLTØUT,DISP=ØLD
//
```

A.5 FR80 Film Plotter

Plots can be produced directly on film for slides, or on microfiche, using the FR80 plotter available only at K-25. As with the CALCØMP plotters, a DISKPLØT feature can be used if default options are sufficient. Otherwise, a tape must be used with the submission of an FR80 Work Request.

(a) DISKPLØT

A plot output on 35-mm unsprocketed film in the full reversal mode (white lines on black background) can be obtained using the same JCL as specified in Section A.1, except for a modification in the DSN of FT49F001. For plots that would use normal 11"-wide paper, use DSN=C925FR86.XXXXX, and for plots that would use 30" wide paper, use DSN=C925FR85.XXXXX. As before, XXXXX should be the user ID plus additional character(s) for uniqueness.

(b) FR80TAPE

If non-default camera options are needed, then an FR80TAPE must be used. The appropriate JCL is as follows:

```
//*SEQCARD
```

```
ooo
```

```
//PLT EXEC PGM=POPFR8,REGION=110K
//STEPLIB DD DSN=SYS2.DISSPOP, DISP=SHR
//FT06F001 DD SYSOUT=A
//COPPIN DD DSN=PPPLTOUT,DISP=OLD
//FR80TAPE DD UNIT=TAPE9,DSN=ANYNAME,DISP=(,KEEP)
//FT05F001 DD *
DRAW=1-END
//
```

An FR80 Work Request must accompany the job. A description of camera and format options and the corresponding directives is given in the IBM 360/370 online HELP file with TITLE=FR8INTR0.

B-1

APPENDIX B

FIDO INPUT

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APPENDIX B

FIDO INPUT

The FIDO input method is especially devised to allow entering or modifying large data arrays with minimum effort. Special advantage is taken of patterns of repetition or symmetry wherever possible. The FIDO system was patterned after the input method used with the FLOCO coding system at Los Alamos and was first applied by Atomics International to the DTF-II code. Since that time, numerous features requested by users have been added, a free-field option has been developed, and the application of FIDO has spread to innumerable codes.

The data are entered in units called "arrays." An array comprises a group of contiguous storage locations which are to be filled with data at one time. These arrays usually correspond on a one-to-one basis with FORTRAN arrays used in the program. A group of one or more arrays read with a single call to the FIDO package forms a "block," and a special delimiter is required to signify the end of each block. Arrays within a block may be read in any order with respect to each other, but an array belonging to one block must not be shifted to another. The same array can be entered repeatedly within the same block. For example, an array could be filled with "0" using a special option, and then a few scattered locations could be changed by reading in a new set of data for that array. If no entries to the arrays in a block are required but the condition requiring the block is met, the delimiter alone satisfies the input requirement.

Three major types of input are available: fixed-field input, free-field input, and user-field input.

Fixed-field Input - Each card is divided into six 12-column data fields, each of which is divided into three subfields. The following sketch illustrates a typical data field. The three subfields always comprise two, one, and nine columns, respectively.

To begin the first array of a block, an array originator field is placed in any field on a card:

Subfield 1: An integer array identifier < 100 specifying the data array to read.

Subfield 2: An array-type indicator -
 "\$" if the array is integer data
 "*" of the array is real data

Subfield 3: Blank

Data are then placed in successive fields until the required number of entries has been accounted for.

In entering data, it is convenient to think of an "index" or "pointer" which is under control of the user, and which specifies the position in the array into which the next data entry is to go. The pointer is always positioned at array location #1 by entering the array originator field. The pointer subsequently moves according to the data operator chosen. Blank fields are a special case in that they do not cause any data modification and do not move the pointer.

A data field has the following form:

Subfield 1: The data numerator, an integer < 100 . We refer to this entry as N_1 in the following discussion.

Subfield 2: One of the special data operators listed below.

Subfield 3: A nine-character data entry, to be read in F9.0 format.

It will be converted to an integer if the array is a "\$" array or if a special array operator such as "Q" is being used. Note that an exponent is permissible but not required. If no decimal is supplied, it is assumed to be immediately to the left of the exponent, if any, otherwise to the right of the last column.

This entry is referred to as N_3 in the following discussion.

A list of data operators and their effect on the array being input follows:

"Blank" indicates a single entry of data. The data entry in the third subfield is entered in the location indicated by the pointer, and the pointer is advanced by 1. However, an entirely blank field is ignored.

"+" or "-" indicates exponentiation. The data entry in the third field is entered and multiplied by $10^{\pm N_1}$, where N_1 is the data numerator in the first subfield, given the sign indicated by the data operator itself. The pointer is advanced by 1. In cases where an exponent is needed, this option allows the entering of more significant figures than the blank option.

"&" has the same effect as "+" on IBM systems.

"R" indicates that the data entry is to be repeated N_1 times. The pointer is advanced by N_1 .

"I" indicates linear interpolation. The data numerator, N_1 , indicates the number of interpolated points to be supplied. The data entry in the third subfield is entered, followed by N_1 interpolated entries equally spaced between that value and the data entry found in the third subfield of the next non-blank field. The pointer is advanced by $N_1 + 1$. The field following an "I" field is then processed normally, according to its own data operator. The "I" entry is especially valuable for specifying a spatial mesh. In "\$" arrays, interpolated values will be rounded to the nearest integer.

"L" indicates logarithmic interpolation. The effect is the same as that of "I" except that the resulting data are evenly separated in log-space. This is especially convenient for specifying an energy mesh.

"Q" is used to repeat sequences of numbers. The length of the sequence is given by the third subfield, N_3 . The sequence of N_3 entries is to be repeated N_1 times. The pointer is advanced by $N_1 * N_3$. If either N_1 or N_3 is 0, then a sequence of $N_1 + N_3$ is repeated one time only, and the pointer is advanced by $N_1 + N_3$. This feature is especially valuable for geometry specification.

"G" has the same effect as Q, except that the sign of the sequence is changed each time it is entered.

The "N" option has the same effect as "Q", except that the order of the sequence is reversed each time it is entered. This is valuable for the type of symmetry possessed by quadrature coefficients.

"M" has the same effect as "N" except that the sign of each entry in the sequence is reversed each time the sequence is entered. For example, the entries:

1 2 3 2M2

would be equivalent to:

1 2 3 -3 -2 2 3

This option is also useful in entering quadrature coefficients.

"Z" causes $N_1 + N_3$ locations to be set to 0. The pointer is advanced by $N_1 + N_3$.

"C" causes the position of the last array item entered to be printed. This is the position of the pointer, less 1. The pointer is not moved.

"O" causes the print trigger to be turned on. The trigger is originally off. When the trigger is on, each card image is listed as it is read.

"P" causes the print trigger to be turned off.

"S" indicates that the pointer is to skip N_1 positions leaving those array positions unchanged. If the third subfield is non-blank, that data entry is entered following the skip, and the pointer is advanced by $N_1 + 1$.

"A" moves the pointer to the position N_3 , specified in the third subfield.

"F" fills the remainder of the array with the datum entered in the third subfield.

"E" skips over the remainder of the array. The array length criterion is always satisfied by an "E", no matter how many entries have been specified. No more entries to an array may be given following an "E", except that data entry may be restarted with an "A".

The reading of data to an array is terminated when a new array origin field is supplied, or when the block is terminated. If an incorrect number of positions has been filled, an error edit is given, and a flag is set which will later abort execution of the problem. FIDO then continues with the next array if an array origin was read. Otherwise, it returns control to the calling program.

A block termination consists of a field having "T" in the second subfield. All entries following "T" on a card are ignored, and control is returned from FIDO to the calling program.

Comment cards can be entered within a block by placing a slash (') in column 1. Then columns 2-80 will be listed, with column 2 being used for printer carriage control. Such cards have no effect on the data array or pointer.

Free-field Input - With free-field input, data are written without fixed restrictions as to field and subfield size and positioning on the

card. The options used with fixed-field input are available, although some are slightly restricted in form. In general, fewer data cards are required for a problem, the interpreting print is easier to read, a card listing is more intelligible, the cards are easier to keypunch, and certain common keypunch errors are tolerated without affecting the problem. Data arrays using fixed- and free-field input can be intermingled at will within a given block.

The concept of three subfields per field is still applicable to free-field input; but if no entry for a field is required, no space for it need be left. Only columns 1-72 may be used, as with fixed-field input.

The array originator field can begin in any position. The array identifiers and type indicators are used as in fixed-field input. The type indicator is entered twice, to designate free-field input (i.e., "\$\$" or "***"). The blank third subfield required in fixed-field input is not required. For example: 31** indicates that array 31, a real-data array, will follow in free-field format.

Data fields may follow the array origin field immediately. The data field entries are identical to the fixed-field entries with the following restrictions:

- (1) Any number of blanks may separate fields, but at least one blank must follow a third subfield entry if one is used.
- (2) If both first and second subfield entries are used, no blanks may separate them, i.e., 24S, but not 24 S.

- (3) Numbers written with exponents must not have imbedded blanks, i.e., 1.0E+4, 1.0E4, 1.0+4, or even 1+4, but not 1.0 E4.
- (4) In third-subfield data entries, only nine digits, including the decimal but not including the exponent field, can be used, i.e., 123456.89E07, but not 123456.789E07.
- (5) The Z entry must be of the form: 738Z, not Z738 or 738 Z.
- (6) The + or - data operators are not needed and are not available.
- (7) The Q, N, and M entries are restricted: 3Q4, 1N4, or M4, but not 4Q, 4N, or 4M. G is similarly restricted.
- (8) A field must not span two cards.
- (9) All items on a card entered after a slash in any column except the first are ignored.

User-field Input - If the user follows the array identifier in the array originator field with the character "U" or "V", the input format is to be specified by the user. If "U" is specified, the FORTRAN FORMAT to be used must be supplied in columns 1-72 of the next card. The format must be enclosed by the usual parentheses. Then the data for the entire array must follow on successive cards. The rules of ordinary FORTRAN input as to exponents, blanks, etc., apply. If the array data do not fill the last card, the remainder must be left blank.

"V" has the same effect as "U" except that the format read in the last preceding "U" array is used.

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