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INSPECT - INTERACTIVE COMPUTER CODE FOR
UNFOLDING NEUTRON SPECTRA FROM
ACTIVATION MEASUREMENTS

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**INSPECT - AN INTERACTIVE COMPUTER CODE FOR
UNFOLDING NEUTRON SPECTRA FROM ACTIVATION MEASUREMENTS**

by

R. E. Narum

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AEROJET NUCLEAR COMPANY

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ABSTRACT

A computer program which uses interactive graphics techniques for unfolding neutron spectra from activation measurements is described.

The program allows the user to communicate with the program through an IBM-2250 graphics display unit attached to an IBM-360/75J computer. The user may use the interactive facility to manipulate libraries of foil activation cross section sets, and monitor the iterative process used for unfolding a neutron spectrum using those sets.

CONTENTS

ABSTRACT	ii
I. INTRODUCTION	1
1. THE MATHEMATICAL METHOD	2
II. PROGRAM DESCRIPTION	3
1. CHOOSING THE RUN LIBRARY TYPE	3
2. DISPLAYING A LIBRARY TABLE OF CONTENTS	5
3. MODIFICATION OF A SELECTED FOIL CROSS SECTION	10
4. CHANGING A FOIL'S IDENTIFICATION	24
5. PLACING FOILS ON THE RUN LIBRARY	24
6. FOIL SELECTION FOR COMPUTATIONS	29
7. SETTING THE ERROR TOLERANCE AND ITERATION INTERVAL	33
8. DISPLAYING THE TRIAL FLUX	33
9. MONITORING THE ITERATIONS	37
10. RENORMALIZING THE CURRENT FLUX	41
11. DETERMINING CONVERGENCE	41
12. RUNNING ANOTHER FIT	44
13. TUTORIAL DISPLAYS	51
14. HARDCOPY CAPABILITY	51
III. PROGRAM INPUT PREPARATION	51
1. TITLE CARD	54
2. FOIL CROSS SECTION LIBRARY	54
3. TRIAL FLUX SPECTRA	55
4. MEASURED ACTIVITIES	56
IV. REFERENCES	58
APPENDIX A -- THE IBM 2250 GRAPHICS DISPLAY CONSOLE	59
APPENDIX B -- USE OF THE PROGRAMMED FUNCTION KEYBOARD IN INSPECT	61
APPENDIX C -- USE OF THE ALPHANUMERIC KEYBOARD IN INSPECT	63
APPENDIX D -- JCL REQUIRED TO EXECUTE INSPECT AT THE NRTS	65

FIGURES

Figure 2.1.	Introductory Display	4
Figure 2.2.	Library Type Request	6
Figure 2.3.	PERMANENT Selected	7
Figure 2.4.	New Library Given Name "ANY NAME"	8
Figure 2.5.	Libraries Available For This Run	9
Figure 2.6.	BOBSLIB Selected	11
Figure 2.7.	Table of Contents For BOBSLIB	12
Figure 2.8.	BOBSLIB and ALLFOILS Selected	13
Figure 2.9.	Tables of Contents For BOBSLIB And ALLFOILS	14
Figure 2.10.	Asterisk Indicates Light Pen Selection of MN55(NG)MN56	15
Figure 2.11.	Plot of Cross Section For MN55(NG)MN56	16
Figure 2.12.	Result of Light Pen Selection of "*LINE IN" MESSAGE	17
Figure 2.13.	Intensified Grid Lines Mark Portion of Plot For Expansion	18
Figure 2.14.	Expand Portion of Grid	20
Figure 2.15.	Column of Dashes Through A Point	21
Figure 2.16.	Plot With Selected Points Ordinate Changed By Light Pen	22
Figure 2.17.	Selection of Two Foil Names By Light Pen	23
Figure 2.18.	Comparative Plot of Selected Foils Cross Section	25
Figure 2.19.	Entry of New Name For Selected Foil	26
Figure 2.20.	New Foil Name Placed On Library ALLFOILS	27
Figure 2.21.	BOBSLIB Selected As The Run Library	28
Figure 2.22.	Completed Permanent Library Name Added to Library List	30

Figure 2.23.	A Listing of The Run Library Table of Contents	31
Figure 2.24.	Activity For MN55(NG)MN56 Entered Through Keyboard . .	32
Figure 2.25.	Request For An Error Tolerance	34
Figure 2.26.	New Error Tolerance Entered By Keyboard	35
Figure 2.27.	A Value of 10 Added For The Iteration Interval	36
Figure 2.28.	A Plot Of The Trial Flux	38
Figure 2.29.	Flux After 50 Iterations	39
Figure 2.30.	Current Flux And Trial Flux Comparison	40
Figure 2.31.	Smoothed Flux For Iteration 50	42
Figure 2.32.	Current Errors	43
Figure 2.33.	Options Available After Convergence	45
Figure 2.34.	Current Least Squared Activity Error Displayed	46
Figure 2.35.	Options For Running Another Fit	47
Figure 2.36.	New Title Entered For The Next Fit	49
Figure 2.37.	"*COMPARE TO PREVIOUS" Message For Next Fit	50
Figure 2.38.	Function Key Assignments For Keys 0-11	52
Figure 2.39.	Function Key Assignments For Keys 12-31	53
Figure 3.1.	Foil Cross Section Library On Cards	54
Figure 3.2.	Input Differential Flux Spectrum	57
Figure 3.3.	Input Foil Activities	57

TABLE

Table B.1 --	Function Key Assignments For INSPECT	61
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INSPECT - AN INTERACTIVE COMPUTER CODE FOR UNFOLDING NEUTRON SPECTRA FROM ACTIVATION MEASUREMENTS

I. INTRODUCTION

In Greer, et al^[1], a mathematical technique is described for unfolding neutron spectra from activation measurements. A computer program, SPECTRA, is also described, which uses this theoretical analysis to determine neutron spectra numerically.

In order to obtain reasonable fluxes from SPECTRA, several computer runs are usually required. The program is run, the resulting flux smoothed, and the smoothed flux submitted as a new trial flux for the next run. This process may have to be repeated several times before a satisfactory differential flux spectrum is obtained. In addition, other computer runs may be required to find a satisfactory trial flux or in order to obtain an optimal collection of cross section sets. The obtaining of a good flux spectrum usually requires several days, and multiple computer runs. Thus, the analyst is unable to adequately experiment with many combinations of trial flux and cross section sets and still obtain a good computed spectrum in a short time.

The program INSPECT uses the same mathematical technique as the SPECTRA code, but allows the user to solve for a flux spectrum, smooth the resulting flux, and rerun without resorting to a multiple program submittal. This is accomplished by running in an interactive mode with the user communicating with the program through an IBM 2250 graphics console^[a] attached to an IBM 360/75 computer. In addition, INSPECT allows a very flexible capability for experimenting with various trial fluxes, combinations of activation cross sections, and activation measurements.

1. THE MATHEMATICAL METHOD

Only a brief description of the method of solution is presented here. For a complete discussion of the method, the reader is referred to [1,2].

[a]See Appendix A for a description of the IBM 2250.

If a neutron sensitive detector is exposed to a neutron flux $\phi(E)$, for a period of time which is short compared to the half-life of the radioactive species produced, then the integral response, or activity per unit mass of the detector is given by the integral equation

$$b = k \int_0^{\infty} \sigma(E) \phi(E) dE \quad (1)$$

where $\sigma(E)$ is the energy dependent activation cross section.

In practice, one obtains measurements of the integral responses of several detectors and wishes to solve a system of Fredholm integral equations of the first kind

$$b_k = \int_{E_{\min}}^{E_{\max}} \sigma_k(E) \phi(E) dE \quad k=1, 2, \dots, n. \quad (2)$$

In the INSPECT code, a piecewise linear approximation is used for the $\sigma_k(E)$'s and assumed for $\phi(E)$. This results in the set of n integral equations being reduced to a set of n simultaneous linear equations.

$$b = A\phi \quad (3)$$

where b is an n vector of known activities, ϕ is an m vector of unknown flux values, and A is an $n \times m$ matrix of approximate integrals of the cross sections. Each of the Equations (3) is divided by b_k resulting in a set of equations of the form

$$\{1\} = C\phi \quad (4)$$

where $\{1\}$ is an n vector whose components are all identically one.

An iterative solution procedure is used which obtains a vector ϕ_{k+1} at each stage which minimizes the error function

$$\epsilon_{k+1} = (b_{k+1} - 1)^T (b_{k+1} - 1) + (\phi_{k+1} - \phi_k)^T G^2 (\phi_{k+1} - \phi_k) \quad (5)$$

where $b_{k+1} = C\phi_{k+1}$ and G is the $m \times n$ diagonal matrix with diagonal values equal to the corresponding values of the reciprocal of the initial flux

vector $(\frac{1}{\phi_0})$. The minimization of the Equation (5) then results in the iterative algorithm

$$\phi_{k+1} = B[C^T(1) + G^2\phi_k] \quad (6)$$

where

$$B = (C^TC + G^2)^{-1} \quad (7)$$

II. PROGRAM DESCRIPTION

The INSPECT program is designed to allow the user control of the program flow through his interaction at the IBM 2250 graphics console^[b]. The user can direct the creation and modification of libraries of foil cross sections and control the iterative process of computing the neutron flux from foil activation data. The first, or editing function, can be used independently of the second, or computational function. The computations, however, are always preceded by an edit of cross section libraries.

The first display (Figure 2.1) to appear on the display's Cathode Ray Tube (CRT) is an introductory display consisting of several short paragraphs describing the program flow and control. The actual program execution is initiated either through the function keyboard^[c] or by selecting the "*BEGIN" message on the CRT with the light pen.

1. CHOOSING THE RUN LIBRARY TYPE

Each time INSPECT is executed a foil cross section library, called the run library, must be designated. The run library is a data set which contains all of the cross section information required for the run. The run library may be a previously created library or a new library which is to be created during the run. If a new library is to be created, it must

[b]Appendix A contains a brief description of the IBM 2250 Graphic Display Unit.

[c]The programmed assignments for the function keyboard are listed in Appendix B.

WELCOME TO THE WORLD OF INTERACTIVE SPECTRAL ANALYSIS.

INSPECT RUNS IN TWO PHASES. IN THE FIRST OR EDITING PHASE YOU EXAMINE AND MANIPULATE THE VARIOUS CROSS SECTION LIBRARIES WHICH YOU HAVE SUPPLIED. YOU ALSO BUILD A RUN LIBRARY CONTAINING THOSE FOILS YOU WISH TO USE IN THE FLUX COMPUTATIONS.

IN THE SECOND OR COMPUTATIONAL PHASE YOU FIRST SELECT THOSE FOILS FROM THE RUN LIBRARY WHICH ARE TO BE USED IN THE COMPUTATIONS, AND ENTER ACTIVITIES FOR EACH OF THEM. THEN YOU MONITOR THE ITERATIVE PROCESS SMOOTHING THE FLUX WHEN NECESSARY. AFTER COMPLETING A FIT YOU MAY TELL THE PROGRAM TO GO BACK AND RUN ANOTHER FIT TO THE SAME OR ANOTHER TRIAL FLUX USING NEW FOILS AND/OR ACTIVITIES.

WHEN YOU ARE READY TO BEGIN PRESS FUNCTION KEY NO. 0 OR LIGHT PEN THE *BEGIN MESSAGE.

IF YOU WISH TO TERMINATE THE JOB AT ANY TIME PRESS FUNCTION KEY NUMBER 31

GOOD LUCK

* BEGIN

Figure 2.1. Introductory Display

be designated as either a permanent library to be saved on magnetic tape, or as a temporary library which is deleted at the end of the run.

The second display (Figure 2.2) to appear on the CRT asks the user which type of library, if any, is to be created during the run. The user indicates his choice by selecting either the word "PERMANENT" or the word "TEMPORARY" on the display with the light pen. In Figure 2.3, the word "PERMANENT" was selected by light pen, and the selection echoed by changing the character size on the display.

If a permanent library is to be created (the word "PERMANENT" is selected) the program will request that a name for the run library be input through the alphanumeric keyboard^[d] on the console. In Figure 2.3, the word "PERMANENT" was selected on the display and the new library name request added. The run library may be assigned any name of up to eight characters. In Figure 2.4, the characters "ANY NAME" have been typed as the name for the new library for this run. If a new library is not to be saved for the run, the word "TEMPORARY" should be selected. The program then assigns the temporary name TEMPLIB to the data set.

2. DISPLAYING A LIBRARY TABLE OF CONTENTS

After the run library type has been selected, and a library name supplied, a list of libraries is added to the display (Figure 2.5). This list contains the word "CARDS" and the names of permanent libraries stored on magnetic tape which have been supplied for this run.

As many as three permanent cross section libraries, called source libraries, stored on magnetic tape may be supplied for each run, and one additional library may be supplied on punched cards^[e].

Each library name may be selected from the list by light pen and the library's table of contents displayed by using a programmed function

[d]See Appendix C for a description of the use of the alphanumeric keyboard in INSPECT.

[e]Section III contains a description of the cross section library card format.

INSPECT

TITLE

THE LIBRARY CREATED IN THIS RUN IS

1. PERMANENT

CHOOSE WITH LIGHT PEN.

2. TEMPORARY

Figure 2.2. Library Type Request

INSPECT

TITLE

THE LIBRARY CREATED IN THIS RUN IS

1. PERMANENT

CHOOSE WITH LIGHT PEN.

2. TEMPORARY

NEW LIBRARY NAME = _

Figure 2.3. PERMANENT Selected

INSPECT

TITLE

THE LIBRARY CREATED IN THIS RUN IS

1. PERMANENT

CHOOSE WITH LIGHT PEN.

2. TEMPORARY

NEW LIBRARY NAME = ANY NAME

Figure 2.4. New Library Given Name "ANY NAME"

INSPECT

TITLE

THE LIBRARY CREATED IN THIS RUN IS

1. PERMANENT

CHOOSE WITH LIGHT PEN.

2. TEMPORARY

NEW LIBRARY NAME = ANY NAME

THE FOLLOWING LIBRARIES ARE ONLINE

1 BOBSLIB

2 ALLFOILS

3 CARDS

SELECT THE ONLINE LIBRARY TO BE USED WITH THE LIGHT PEN.

THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.5. Libraries Available For This Run

key. The selection of the word "CARDS" causes a cross section library to be read from the card reader. If no library has been supplied on punched cards, the word CARDS must not be selected.

In Figure 2.6, the library called BOBSLIB was selected from the display list, and the choice echoed by the program. In Figure 2.7, the table of contents for the selected library, BOBSLIB, is displayed on the CRT.

The tables of contents of any two of the libraries in the list can be chosen to be displayed. In Figure 2.8, the names BOBSLIB and ALLFOILS have been selected with the light pen and in Figure 2.9, the tables of contents displayed. The third column of this display is for the table of contents of the run library (see Section II.5).

3. MODIFICATION OF A SELECTED FOIL CROSS SECTION

The cross section for each foil on a library may be plotted on the CRT for examination and possible modification. In Figure 2.10, the asterisk in the left hand margin of the table of contents for BOBSLIB indicates that the foil MN55(NG)MN56 was selected with the light pen. The subsequent use of a programmed function key then resulted in the cross section for MN55(NG)MN56 being plotted as shown in Figure 2.11. The cross section in barns is plotted versus the energy in Mev on a log-log scale.

Selection of the "*LINE IN" message (shown in Figure 2.11) with the light pen results in the points on the curve being connected by straight lines as shown in Figure 2.12. With the line inserted, the message is changed to read "*LINE OUT", and its selection by light pen will return the plot to its original form (Figure 2.11).

The grid lines on the display illustrated in Figure 2.11 are light pen sensitive. The selection of two vertical grid lines followed by the selection of two horizontal grid lines marks a portion of the plot which is to be expanded and replotted. The lines are intensified as they are selected and become noticeably brighter. Figure 2.13 shows the plot after four grid lines were selected. The area bounded by these four lines was

INSPECT

TITLE

THE LIBRARY CREATED IN THIS RUN IS

1. PERMANENT

CHOOSE WITH LIGHT PEN.

2. TEMPORARY

NEW LIBRARY NAME = ANY NAME

THE FOLLOWING LIBRARIES ARE ONLINE

1 BOBSLIB

2 ALLFOILS

3 CARDS

SELECT THE ONLINE LIBRARY TO BE USED WITH THE LIGHT PEN.

THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.6. BOBSLIB Selected

INSPECT	
BOBSLIB	TEMLIB
FOIL	NAME
1	MN55(NG)MN56
2	AU197(NG)AU198
3	CU63(NG)CU64
4	IN115(NN)IN115M
5	ZN64(NP)CU64
6	FE56(NP)MN56
• ALL	

SELECT FOILS BY LIGHT PEN.
THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.7. Table of Contents For BOBSLIB

INSPECT

TITLE

THE FOLLOWING LIBRARIES ARE ONLINE

- 1 BOBSLIB
- 2 ALLFOILS
- 3 CARDS

SELECT THE ONLINE LIBRARY TO BE USED WITH THE LIGHT PEN.

THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.8. BOBSLIB and ALLFOILS Selected

INSPECT		
BOBSLIB	ALLFOILS	ANY NAME
FOIL	NAME	FOIL
1	MN55(NG)MN56	1
2	AU197(NG)AU198	2
3	CU63(NG)CU64	3
4	IN115(NN)IN115M	4
5	ZN64(NP)CU64	5
6	FE56(NP)MN56	6
• ALL		7
		8
		9
		10
		11
		• ALL

SELECT FOILS BY LIGHT PEN.
THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.9. Tables of Contents For BOBSLIB And ALLFOILS

INSPECT	
BOBSLIB	ANY NAME
FOIL	NAME
• 1	MN55(NG)MN56
2	AU197(NG)AU198
3	CU63(NG)CU64
4	IN115(NN)IN115M
5	ZN64(NP)CU64
6	FE56(NP)MN56
•	ALL

SELECT FOILS BY LIGHT PEN.
THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.10. Asterisk Indicates Light Pen Selection of MN55(NG)MN56

INSPECT

TITLE

Figure 2.11. Plot of Cross Section For MN55(NG)MN56

INSPECT

TITLE

Figure 2.12. Result of Light Pen Selection of "*LINE IN" Message

INSPECT

TITLE

Figure 2.13. Intensified Grid Lines Mark Portion of Plot for Expansion

expanded and replotted as shown in Figure 2.14. On the expanded plot format, the points are replaced by asterisks.

The points (asterisks) which have been replotted in the expanded format can be made light pen sensitive by selecting the message "CHANGE A POINT" with the light pen. Subsequent selection of a point on the graph then results in the vertical column of dashes through the point as shown in Figure 2.15.

The value of the cross section (ordinate) for the selected point can now be changed to any one of the values indicated by the dashes. This is accomplished by selecting the dash which has the desired ordinate by light pen and storing the new value by function key. Figure 2.16 shows the plot after such a change was made. Any number of points can be changed by repeating this process. Once all desired changes have been made, a return to the original plot is made by using a programmed function key. If no other areas are to be expanded, then a return to the table of contents display is made by using the function keyboard.

Each time the user expands a portion of the plot, the program assumes that changes were made to the selected foil's cross section. Thus, the "new" cross section is written onto the library to replace the "old" cross section. Any subsequent request to display the cross section for this foil results in the "new" cross section being plotted.

Modification of the foil cross sections on a library does not change the cross sections on the permanent copy on magnetic tape. This is because INSPECT creates a temporary working copy of all on-line libraries on disk for each run. In order to create a permanent copy of a modified cross section, the user must place it on a permanent run library.

All modified cross sections are output to the printer for later examination and correlation with microfilm copies of the plots (see Section II.14).

Any two of the foil cross sections in the libraries whose tables of contents are being displayed can be plotted simultaneously. The two foils can both be from the same library or each can be from a different library. In Figure 2.17, two foil names have been selected from the

INSPECT

TITLE

Figure 2.14. Expand Portion of Grid

Figure 2.15. Column of Dashes Through A Point

Figure 2.16. Plot With Selected Points Ordinate Changed By Light Pen

INSPECT				
BOBSLIB		ALLFOILS		ANY NAME
FOIL	NAME	FOIL	NAME	
• 1	MN55(NG)MN56	1	AL27(NHE)NA24	
2	AU197(NG)AU198	2	MG24(NP)NA24	
3	CU63(NG)CU64	3	FE54(NP)MN54	
4	IN115(NN)IN115M	4	NI58(NP)C058	
5	ZN64(NP)CU64	5	SC45(NG)SC46	
6	FE56(NP)MN56	6	MN55(NG)MN56	
• ALL		7	AU197(NG)AU198	
		• 8	CU63(NG)CU64	
		9	IN115(NN)IN115M	
		10	ZN64(NP)CU64	
		11	FE56(NP)MN56	
		• ALL		

SELECT FOILS BY LIGHT PEN.
THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.17. Selection of Two Foil Names By Light Pen

display using the light pen, and in Figure 2.18, the two cross sections have been plotted for comparison. The two smaller plots are the same, except for scale, as the larger plots described above.

4. CHANGING A FOIL'S IDENTIFICATION

It is often desirable to change the 16 character name which identifies a foil. This is particularly desirable when the foil's cross section has been altered. To change the name of a foil, the user selects the foil with the light pen and indicates his desire to change its name with a programmed function key. The program then inserts a cursor into the display as shown in Figure 2.19, and the user types the new foil identification with the alphanumeric keyboard. After the new name is completed, it replaces the old name in the table of contents as shown in Figure 2.20.

5. PLACING FOILS ON THE RUN LIBRARY

The run library can be created by the user in two ways. The foils may be selected singly or severally from the different permanent on-line libraries and placed on the run library, or any one of the on-line libraries may be designated as the run library.

In order to designate one of the on-line libraries as the run library, the user selects the library from the list, displays its table of contents, and uses a programmed function key to indicate that it is to be used as the run library. The completion of this operation is indicated by the program as shown in Figure 2.21. If this option is selected, the user must be sure that no foils, other than those on the selected library, will be required in the run library. Once the run library has been marked as complete by the program, no further additions or corrections may be made.

To include foils from different source libraries in the run library, the user may select each foil singly from a table of contents and move it to the run library with a function key. If the entire contents of a library are to be included in the run library the user may light pen the message "*ALL" which appears on the display below the table of contents.

Figure 2.18. Comparative Plot of Selected Foils Cross Sections

INSPECT			
80BSL18		ALLFOILS	ANY NAME
FOIL	NAME	FOIL	NAME
1	MN55(NG)MN56	• 1	AL27(NHE)NA24
2	AU197(NG)AU198	2	MG24(NP)NA24
3	CU63(NG)CU64	3	FE54(NP)MN54
4	IN115(NN)IN115M	4	NI58(NP)C058
5	ZN64(NP)CU64	5	SC46(NG)SC46
6	FE56(NP)MN56	6	MN55(NG)MN56
• ALL		7	AU197(NG)AU198
		8	CU63(NG)CU64
		9	IN115(NN)IN115M
		10	ZN64(NP)CU64
		11	FE56(NP)MN56
		• ALL	

ENTER NEW NAME HERE AL27(NHE)NA24A_

SELECT FOILS BY LIGHT PEN.
THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.19. Entry of New Name For Selected Foil

INSPECT		
BOBSLIB	ALLFOILS	ANY NAME
FOIL	NAME	FOIL NAME
1	MN55(NG)MN56	1 AL27(NHE)NA24A
2	AU197(NG)AU198	2 MG24(NP)NA24
3	CU63(NG)CU64	3 FE54(NP)MN54
4	IN115(NN)IN115M	4 NI58(NP)C058
5	ZN64(NP)CU64	5 SC45(NG)SC46
6	FE56(NP)MN56	6 MN55(NG)MN56
• ALL		7 AU197(NG)AU198
		8 CU63(NG)CU64
		9 IN115(NN)IN115M
		10 ZN64(NP)CU64
		11 FE56(NP)MN56
		• ALL

SELECT FOILS BY LIGHT PEN.
THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.20. New Foil Name Placed On Library ALLFOILS

INSPECT			
BOBSLIB		BOBSLIB	
FOIL	NAME	FOIL	NAME
1	MN55(NG)MN56	1	MN55(NG)MN56
2	AU197(NG)AU198	2	AU197(NG)AU198
3	CU63(NG)CU64	3	CU63(NG)CU64
4	IN115(NN)IN115M	4	IN115(NN)IN115M
5	ZN64(NP)CU64	5	ZN64(NP)CU64
6	FE56(NP)MN56	6	FE56(NP)MN56
• ALL			
SELECT FOILS BY LIGHT PEN. THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.			

Figure 2.21. BOBSLIB Selected As The Run Library

When all the desired foils have been placed on the run library, the user indicates its completion by using a programmed function key.

After the run library has been completed, it is added to the list of source libraries by the program. If the run library is designated as a permanent library, the name supplied by the user will be added as in Figure 2.22. If the run library is designated as a temporary library, then the program supplied name, TEMPLIB is added to the list. If one of the source libraries is designated as the run library, then the list remains unchanged. Should the number of source libraries exceed four in number, the newly created run library's name displaces the bottom name in the list (usually the data card library). The displaced library then becomes unavailable for the remainder of the run.

Cross sections may be modified before they are placed on the run library. In this case, they reside on both the source library and the run library in modified form. Also, the cross sections may be modified after they are placed on the run library. In this case, the cross sections on the source library and the run library will be different.

6. FOIL SELECTION FOR COMPUTATIONS

After the run library is completed it is made available to the computations section of INSPECT. The display shown in Figure 2.23 is a listing of the run library table of contents with a request for the selection of foils to be used in the computations.

The foils, and associated measured activities, can be supplied on cards or entered by the user at the console with the alphanumeric keyboard. If the foils and activities are to be supplied on data cards, the user indicates this by selecting the message "DATA CARDS" which appears at the end of the list of foils. To enter activities the user selects each foil to be used from the table of contents with the light pen and enters its activity through the alphanumeric keyboard.

Figure 2.24 shows the run library contents after selection of the foil MN55(NG)MN56 and entry of its activity through the keyboard.

INSPECT

TITLE

THE FOLLOWING LIBRARIES ARE ONLINE

1	BOBSLIB
2	ALLFOILS
3	CARDS
4	ANY NAME

SELECT THE ONLINE LIBRARY TO BE USED WITH THE LIGHT PEN.

THEN PRESS THE FUNCTION KEY WHICH GIVES THE DESIRED ACTION.

Figure 2.22. Completed Permanent Library Name Added to Library List

INSPECT

SELECT THE FOILS TO BE USED IN THIS RUN BY LIGHT PEN
AND ENTER MEASURED ACTIVITIES BY KEYBOARD.

IF FOILS AND ACTIVITIES ARE TO BE ENTERED ON CARDS
LIGHT PEN THE 'DATA CARDS' MESSAGE BELOW.

FUNCTION KEY 16 AFTER LIGHT PEN CAUSES THE
SELECTED X-SECTION TO BE PLOTTED.

1 MN55(NG)MN56
2 AU197(NG)AU198
3 CU63(NG)CU64
4 IN115(NN)IN115M
5 ZN64(NP)CU64
6 FE56(NP)MN56

7 DATA CARDS

Figure 2.23. A Listing of The Run Library Table of Contents

INSPECT

SELECT THE FOILS TO BE USED IN THIS RUN BY LIGHT PEN
AND ENTER MEASURED ACTIVITIES BY KEYBOARD.

IF FOILS AND ACTIVITIES ARE TO BE ENTERED ON CARDS
LIGHT PEN THE 'DATA CARDS' MESSAGE BELOW.

FUNCTION KEY 16 AFTER LIGHT PEN CAUSES THE
SELECTED X-SECTION TO BE PLOTTED.

1	MN55(NG)MN56	1.6353E+6
2	AU197(NG)AU198	
3	CU63(NG)CU64	
4	IN115(NN)IN115M	
5	ZN64(NP)CU64	
6	FE56(NP)MN56	

7 DATA CARDS

Figure 2.24. Activity For MN55(NG)MN56 Entered Through Keyboard

The foil cross sections which have been placed on the run library may be modified at this time as described in Section II.3. This allows the analyst to make changes in some cross sections on subsequent fits of this or another trial flux (see Section II.12).

7. SETTING THE ERROR TOLERANCE AND ITERATION INTERVAL

Since INSPECT is an interactive program, the current average least squared activity error used to determine convergence is always available for display to the user. Thus, the user can determine when the error is sufficiently small for his purposes. In practice, constant monitoring of the error tends to require excessive user attention so that an error tolerance of 10^{-4} has been built into the program. The iterations will be automatically interrupted whenever the average least squared activity error becomes less than or equal to 10^{-4} , unless the user changes the value of the error tolerance.

The display shown in Figure 2.25 informs the user of the current value of the error tolerance and asks whether a new value is desired. The user selects either "YES" or "NO" on the display with the light pen. If "YES" is selected, the program asks that a new value for the error tolerance be entered through the alphanumeric keyboard. In Figure 2.26, the user has selected "YES" with the light pen and entered the new value, 10^{-2} , with the keyboard. Selection of "NO" with the light pen causes the request to be omitted from the display.

After entering the new value for the error tolerance, or if "NO" is selected with the light pen, the request shown in Figure 2.27 is added to the display. The number requested is the number of iterations, K, to be completed between displays of the neutron flux. In Figure 2.27, the user has entered the value 10. for K. Both the error tolerance and K may be altered at any time after the completion of a set of K iterations.

8. DISPLAYING THE TRIAL FLUX

After entering the error tolerance and iteration interval K, the user starts the computations with the "continue" button on the function

INSPECT

THE CURRENT ERROR TOLERANCE IS 0.100000000-03

DO YOU WISH TO UPDATE THIS VALUE

•YES •NO

Figure 2.25. Request For An Error Tolerance

INSPECT

THE CURRENT ERROR TOLERANCE IS 0.100000000D-03
DO YOU WISH TO UPDATE THIS VALUE

*YES *NO

PLEASE TYPE THE VALUE. THEN PRESS FUNCTION KEY

THE NEW VALUE = 10.E-3

Figure 2.26. New Error Tolerance Entered By Keyboard

INSPECT

THE CURRENT ERROR TOLERANCE IS 0.100000000D-03
DO YOU WISH TO UPDATE THIS VALUE

*YES *NO

PLEASE TYPE THE VALUE. THEN PRESS FUNCTION KEY

THE NEW VALUE = 10.E-3

HOW MANY ITERATION ARE DESIRED BETWEEN DISPLAYS
PLEASE TYPE THE VALUE. THEN PRESS FUNCTION KEY

THE NEW VALUE = 10.

Figure 2.27. A Value of 10 Added For The Iteration Interval

keyboard. The next display is, then, a plot of the normalized trial flux. An illustration of a trial flux display is shown in Figure 2.28. The display format used is the same one that is used to display the foil cross sections in the editing phase of INSPECT. The "LINE IN" message on the display is light pen sensitive. Selection of this message with the light pen causes the plotted points to be connected with straight lines. The "COMPARE TO INITIAL" message is also light pen sensitive. Its use will be explained in Section II.9.

The grid lines on the plot of the initial flux are light pen sensitive. Light pen selection of grid lines is used to mark sections of the plot which are to be compared and possibly changed. The user can change the initial flux guess. The process used is explained in detail in Section II.9.

When the user is satisfied that the initial flux guess is correct, he starts the first set of K iterations with the "return/continue" function key.

9. MONITORING THE ITERATIONS

After the completion of each set of K iterations, the program stops the iterative process and displays the current value of the neutron flux spectrum. The program then waits until the user initiates the next set of K iterations with the "continue" button on the programmed function keyboard. In Figure 2.29, the program has completed 50 iterations using the trial flux shown in Figure 2.28. The value of K used was 10 so that the program stopped iterating to allow the user to examine the current flux after every set of 10 iterations.

Selection of the message "COMPARE TO INITIAL", on the display shown in Figure 2.29, results in the trial flux being plotted on the grid along with the current neutron flux spectrum. The trial flux is plotted using asterisks as shown in Figure 2.30. The light pen sensitive message is changed to "REMOVE COMPARISON", and its selection results in the removal of the trial flux from the grid.

The grid lines are light pen sensitive allowing portions of the grid to be expanded so that the current flux can be modified between every set

INSPECT

TITLE

Figure 2.28. A Plot Of The Trial Flux

INSPECT

TITLE

Figure 2.29. Flux After 50 Iterations

INSPECT

TITLE

Figure 2.30. Current Flux And Trial Flux Comparison

of K iterations. The user can monitor the iterative process, and, whenever needed, the user can modify or smooth the current flux curve. In Figure 2.31, the flux, originally plotted as Figure 2.29, has been smoothed before being submitted as the input flux to the next iteration. This smoothing was accomplished by expanding several different pieces of the grid and changing the ordinates of the points via light pen. After each such expansion, the "corrected" flux is printed.

If the user determines that the change in the flux is too great between displays, or so small, that little or no change can be seen in successive displays, he can change the value of the iteration interval, K. To do this, the user directs the program, via the function keyboard, to return to the request for a value of K (Figures 2.26-2.27). The user then enters the new value through the alphanumeric keyboard. The "return/continue" button on the function keyboard then returns the current flux curve display.

10. RENORMALIZING THE CURRENT FLUX

After each set of K iterations, the user's modified flux is submitted to the program as the input to the next iteration. This submittal flux is not renormalized using the current activity ratios. The user may direct the program to renormalize this flux by using the function keyboard. Once the renormalization flag has been set, it remains set until the user turns it off again via the function keyboard. When the renormalization flag is left on, the flux is renormalized every K iteration.

11. DETERMINING CONVERGENCE

The convergence behavior of the iterative algorithm can be monitored by the user. To do this a programmed function key is used to obtain the display shown in Figure 2.32. This display shows the current error tolerance, the current values for the average least square activity error, the average least square flux error, the calculated activity for each foil, and the calculated activity ratio for each foil.

INSPECT

TITLE

Figure 2.31. Smoothed Flux For Iteration 50

INSPECT

ITERATION NO. 50

CURRENT ERROR TOLERANCE = 0.10000000D-01

AVERAGE LEAST SQUARE ACTIVITY ERROR = 0.45806210E-01

AVERAGE LEAST SQUARE FLUX ERROR = 0.53359210E-04

FOIL	TYPE	ACTIVITY	ACTIVITY RATIO
1	MN55(NG)MN56	0.82960944E 06	0.50731331E 00
2	AU197(NG)AU198	0.66994688E 05	0.92210674E 00
3	CU63(NG)CU64	0.97750000E 05	0.10924835E 01
4	IN115(NN)IN115M	0.11728294E 06	0.10149088E 01
5	ZN64(NP)CU64	0.16250590E 05	0.87270230E 00
6	FE56(NP)MN56	0.35907744E 04	0.10323954E 01

Figure 2.32. Current Errors

Whenever the current least square activity error becomes less than or equal to the error tolerance the iterations are automatically interrupted, and the display shown in Figure 2.33 is generated. This display has four light pen sensitive messages which allow the user the following options:

1. DISPLAY LAST ITERATION.

Selection of this message causes the last completed iteration to be plotted using the format shown in Figure 2.29. The curve may then be smoothed as desired by the user. Subsequent use of the "return/continue" function key returns the program to the display in Figure 2.33.

2. BRANCH TO UPDATE TOLERANCE.

Selection of this message causes the display shown in Figure 2.25 to be regenerated. The user may then update the error tolerance in order to continue iterating with the current flux. The program returns to the display of the current flux automatically after the new tolerance has been entered and iterations continue as through uninterrupted.

3. TERMINATE THIS SET OF ITERATIONS.

Selection of this message causes the current flux to be accepted as the final fitted flux for this set of iterations. If Option 1 has been used and the flux smoothed, the new or smoothed flux is printed out as the final flux. After selection of this message the program transfers to the display shown in Figure 2.35 (see Section II.12).

4. DISPLAY CURRENT LEAST SQUARED ACTIVITY ERROR.

Selection of this message causes the current value of the average least squared activity error to be added to the bottom of this display as shown in Figure 2.34.

12. RUNNING ANOTHER FIT

After a satisfactory differential flux is obtained the user may direct the program to the display shown in Figure 2.35. This is accomplished either with the light pen as described in Section 11 or by using the function keyboard. This display has four light pen sensitive messages which give the user the following options:

INSPECT

THE LEAST SQUARED ACTIVITY ERROR IS NOW
BELOW THE INPUT TOLERANCE VALUE 0.999000000 00

USE LIGHT PEN ON MESSAGES TO SELECT OPTIONS

1. DISPLAY LAST INTERATION
2. BRANCH TO UPDATE TOLERANCE
3. TERMINATE THIS SET OF ITERATIONS
4. DISPLAY CURRENT LEAST SQUARED ACTIVITY ERROR

Figure 2.33. Options Available After Convergence.

INSPECT

THE LEAST SQUARED ACTIVITY ERROR IS NOW
BELOW THE INPUT TOLERANCE VALUE 0.999000000 00

USE LIGHT PEN ON MESSAGES TO SELECT OPTIONS

1. DISPLAY LAST INTERATION
2. BRANCH TO UPDATE TOLERANCE
3. TERMINATE THIS SET OF ITERATIONS
4. DISPLAY CURRENT LEAST SQUARED ACTIVITY ERROR

0.138106410 00

Figure 2.34. Current Least Squared Activity Error Displayed

INSPECT

SELECT OPTIONS BELOW WITH THE LIGHT PEN.

PROGRAM EXECUTION IS RESTARTED USING FUNCTION KEY 4
AFTER SELECTION OF OPTIONS 2 OR 3.

1. ENTER TITLE FOR THIS FIT.*
2. READ NEW TRIAL FLUX FROM CARDS FOR NEXT FIT.
3. CONTINUE TO FIT CURRENT TRIAL FLUX.
4. TERMINATE PROGRAM EXECUTION.

* NOTE-- IF A NEW TITLE IS NOT ENTERED THE TITLE FOR
THE LAST FIT WILL BE USED.

Figure 2.35. Options For Running Another Fit

1. ENTER TITLE FOR THIS FIT.

Selection of this message causes a cursor to be added to the display as shown in Figure 2.36. The user may then type a title to be used for the next fit. Any 40 EBCDIC characters may be used. The new title will replace the title used for the previous fit^[f]. The entering of a new title is optional as noted on the display.

2. READ NEW TRIAL FLUX FROM CARDS FOR NEXT FIT.

Selection of this message causes the program to attempt to read a new flux from the card reader. The program attempts to read cards when the "return/continue" button on the function keyboard is depressed. If no cards are available or if an error in format is detected during the reading of the cards, an appropriate message is added to the display so informing the user. The user may then continue to fit the previous trial flux or terminate program execution. If the reading of cards is successful, the program returns to the display shown in Figure 2.23 for foil selection from the run library.

3. CONTINUE TO FIT CURRENT TRIAL FLUX.

Selection of this message combined with the use of the "return/continue" button on the function keyboard causes the program to return to the display shown in Figure 2.23 for foil selection from the run library. The user may then begin a new set of iterations to refit the trial flux.

The same trial flux may be refit any number of times using different combinations of foils from the run library. All displays remain the same for each fit except that shown in Figure 2.37. The message which reads "COMPARE TO INITIAL" (see Figure 2.30) has been changed to read "COMPARE TO PREVIOUS". Selection of this message with the light pen results in the last previous converged flux being displayed on the grid along with the current flux.

[f] See Section III for a description of the title card used with the first fit of each run.

INSPECT

SELECT OPTIONS BELOW WITH THE LIGHT PEN.

PROGRAM EXECUTION IS RESTARTED USING FUNCTION KEY 4
AFTER SELECTION OF OPTIONS 2 OR 3.

1. ENTER TITLE FOR THIS FIT.*
2. READ NEW TRIAL FLUX FROM CARDS FOR NEXT FIT.
3. CONTINUE TO FIT CURRENT TRIAL FLUX.
4. TERMINATE PROGRAM EXECUTION.

ENTER TITLE HERE. NEW TITLE_

* NOTE-- IF A NEW TITLE IS NOT ENTERED THE TITLE FOR
THE LAST FIT WILL BE USED.

Figure 2.36. New Title Entered For The Next Fit

INSPECT

NEW TITLE

Figure 2.37. "*COMPARE TO PREVIOUS" Message For Next Fit

4. TERMINATE PROGRAM EXECUTION.

Selection of this message causes the program to stop. This is simply an alternate to the use of the function keyboard at this point.

13. THE TUTORIAL DISPLAYS

Since there are 19 different programmed function keys used by INSPECT, it is quite likely the analyst will become confused as to the assigned functions. To help overcome this problem a set of two tutorial displays is available. This tutorial information is displayed whenever function key 1 is pressed. Thus, the user need only remember one function key assignment in order to successfully run the program.

The two displays are shown in Figures 2.38 and 2.39. These two displays are an abridged version of Table B.1 in Appendix B.

14. HARDCOPY CAPABILITY

Any of the displays described in this section may be output to the FR-80 microfilm recorder by pressing programmed function key 8. It is usually advisable for the user to make hardcopy of all significant steps in any run.

III. PROGRAM INPUT PREPARATION

The input deck for a typical INSPECT job consists of Job Control Language (JCL) statements to invoke the INSPECT cataloged procedure^[9], a title card to be used in heading output, and one or more trial flux spectra. In addition optional input on cards may consist of a foil cross section library and foil activation measurements.

[9]See Appendix D for a description of the JCL required to run INSPECT at the NRTS.

INSPECT

PROGRAMMED FUNCTION KEY ASSIGNMENTS FOR INSPEC

KEY	FUNCTION ASSIGNED
0	BEGIN PROGRAM EXECUTION
1	CALL TUTORIAL DISPLAY
2	STORE NEW INFORMATION
3	DISPLAY CURRENT ERRORS, ACTIVITIES, AND ACTIVITY RATIOS
4	RETURN/CONTINUE
5	EXPAND SELECTED AREA ON PLOT
6	RESET GRID LINE SELECTION FOR PLOT EXPANSION
7	UPDATE ERROR TOLERANCE AND ITERATION INTERVAL
8	GENERATE MICROFILM HARDCOPY
9	RESET DISPLAY
10	TURN RENORMALIZATION FLAG ON
11	TURN RENORMALIZATION FLAG OFF

TO DISPLAY ASSIGNMENTS FOR KEYS 12-31 LIGHT PEN THIS MESSAGE

Figure 2.38. Function Key Assignments For Keys 0-11

INSPECT

PROGRAMMED FUNCTION KEY ASSIGNMENTS FOR INSPEC

KEY	FUNCTION ASSIGNED
12	CHANGE SELECTED FOIL NAME
13-14	NOT USED
15	DISPLAY LIBRARY TABLE OF CONTENTS
16	PLOT SELECTED X-SECTION
17	PLACE SELECTED FOIL ON RUN LIBRARY
18	USE DISPLAYED LIBRARY AS RUN LIBRARY
19	RUN LIBRARY IS COMPLETE
20-23	NOT USED
24	TERMINATE THIS SET OF ITERATIONS
25-30	NOT USED
31	TERMINATE PROGRAM EXECUTION

TO DISPLAY ASSIGNMENTS FOR KEYS 0 -11 LIGHT PEN THIS MESSAGE

Figure 2.39. Function Key Assignments For Keys 12-31

All input data cards are in a free field format with the various fields on the cards being separated with commas. Any blanks on a card are ignored so that fields may be put at any convenient location on the card.

1. TITLE CARD

The first card of the input data deck must be a title card. The title may consist of any 40 alphanumeric characters. The title must be placed in the first 40 columns of the card.

2. FOIL CROSS SECTION LIBRARY

Libraries of foil cross sections for use in INSPECT are maintained in permanent form on magnetic tapes and data cards. During execution of INSPECT all such cross section libraries to be used are first copied onto direct access data sets on disk. This allows the program to access any record directly without having to read or skip over unwanted records on tape.

Usually the analyst first supplies cross sections on data cards, and has these stored onto tape by INSPECT for use during later runs. New libraries may be created during any run by manipulating previously created libraries.

The first card of the library is a library name card which has the following format:

Field 1. Name of the library. The name may consist of up to 8 EBCDIC characters. Since data fields are delimited by commas, commas may not be included in the name.

Field 2: A floating point number equal to the number of foil materials for which cross sections are supplied in this library.

There then follows data for each foil in the following format:

Card 1. Consists of four to seven fields of data.

- Field 1. Name of the foil material. The name consists of up to 16 EBCDIC characters (commas not allowed).
- Field 2. Number of data points (energy values) in the cross section data.
- Field 3. Half-life of induced radioactive species in foil material in minutes.
- Field 4. Atomic weight of foil material.
- Field 5 through Field 8. Fields 5 through 8 are optional and permit computing of attenuated cross section data in the event that cadmium or boron shielded detectors are utilized. The format of these fields is: name of material (BORON or CADMIUM), thickness of the material in centimeters.
- Card 2, etc. These cards contain the cross section values for the foil material. The data is in the form: energy value, cross section value, energy value, cross section value, etc. The cross section values are input in barns scaled by $N_0\lambda/A$, where N_0 is Avagadro's number, λ is the decay constant in min.^{-1} , and A is the atomic weight. These cards may contain an arbitrary number of fields per card with all fields in floating point notation (with or without an exponent).

3. TRIAL FLUX SPECTRA

At least one trial flux must be supplied for each fit using INSPECT. Several may be supplied if multiple fits are required. The trial flux is supplied using the following format:

- Card 1. This card has one field containing a floating point number equal to the number of flux values supplied on the cards which follow.
- Card 2, etc. The input differential neutron flux is supplied in the form energy value, flux value, etc. There are an arbitrary number of values per card and all values are

supplied in floating point notation (with or without an exponent). The program assumes that the first and last flux values are zero regardless of the actual input value.

4. MEASURED ACTIVITIES

Measured activities may be supplied on data cards if desired. This is not necessary since there is a provision to input them during the run.

If activities are to be input on data cards, they are supplied one per card with each such card having two fields as follows:

Field 1. The name of the foil material as it appears on the cross section run library to be used.

Field 2. The measured activity for this foil material in floating point (exponential) notation.

Figure 3.1. Foil Cross Section Library On Cards

Figure 3.2. Input Differential Flux Spectrum

Figure 3.3. Input Foil Activities

IV. REFERENCES

1. C. R. Greer, J. A. Halbleib, Sr., J. V. Walker, A Technique For Unfolding Neutron Spectra From Activation Measurements, SC-RR-67-746 (December 1967).
2. J. A. Halbleib, Sr., Theory and Applications Of The Generalized SPECTRA Code, SC-RR-70-251 (April 1970).
3. IBM System/360 Component Description: IBM 2250 Display Unit Model 1, Form A27-2701-2, New York: IBM Corporation, 3rd ed. (January 1969).

APPENDIX A

THE IBM 2250 GRAPHICS DISPLAY CONSOLE

A more complete description of the IBM 2250 Display Console is to be found in [3]. This Appendix is designed to give the unfamiliar user a brief description of the basic hardware features of the graphic display unit.

The IBM 2250 Graphic Display Console is a magnetic deflection Cathode Ray Tube (CRT) together with control hardware and a memory called a buffer. The buffer usually has either 4K or 8K bytes. The buffer holds orders and data which the control hardware converts into deflections of the electron beam in the CRT resulting in a display on the tube face. The display is continuously refreshed by the control hardware by cycling through the scope buffer.

The user of a graphics console can communicate with the program in the main computer memory, and the program, in turn, communicates with the user through the programmed displays on the CRT.

There are three hardware devices which may be attached to the graphics console by which a user may communicate with a program. These devices are an alphanumeric keyboard, a function keyboard and a light sensitive pen.

The alphanumeric keyboard is much like an ordinary typewriter keyboard. The alphanumeric keyboard may be used to enter data to the program from the graphics console.

The function keyboard is an array of 32 pushbuttons which may be assigned desired functions under program control. Each pushbutton on the keyboard has an indicator light which may be activated under program control to indicate which of the pushbuttons have functions assigned to them at any given moment.

When the user presses a button which has a particular function assigned, the control hardware interrupts the main computer and causes control to be passed to the appropriate function.

The light sensitive pen is used to detect parts of the display which have been made sensitive under program control. When the user places the pen against the CRT tube face and activates a switch, control is given to a routine which reads registers in the control hardware giving the buffer location at which the graphic orders generating the detected part of the display are stored. This information is passed to the user's program which decides what action, if any, should be taken.

APPENDIX B

USE OF THE PROGRAMMED FUNCTION KEYBOARD IN INSPECT

The function keyboard is an array of 32 pushbuttons, called function keys, attached to the IBM 2250 console. Each function key may be programmed to provide some function necessary to the program. In the INSPECT program, 19 function keys have been assigned the specific functions described in Table B.1. Each assignment of a function to the keyboard remains constant throughout the program. Each function key contains an indicator light which may be turned on or off under program control. Those functions which are available at any time during the execution of the INSPECT program are indicated by the associated indicator lights.

Table B.1

Function Key Assignments For INSPECT

Key No.	Assigned Function
0	This key begins program execution
1	This key causes the program to display an abridged version of this table on the CRT.
2	This key is used to store new information entered by the user at the console. This includes any information entered through the alphanumeric keyboard, and the new ordinates for plotted points moved with the light pen.
3	This key causes the program to display the average least square activity error, the average least square flux error, the calculated activities, and activity ratios for the last completed iteration.
4	This key is used to either return to the last previous display or to continue processing and bring up the next display whichever is appropriate.
5	This key causes a portion of a plot, selected by light pen, to be expanded.
6	This key is used to reset the selection of an area of a plot to be expanded should an error be made.
7	This key will cause the program to display the requests for error tolerance and iteration interval so that these can be modified.

Table B.1 (continued)

Function Key Assignments For INSPECT

Key No.	Assigned Function
8	This key will cause the display on the scope to be copied to microfilm.
9	This key allows the user to reset the display. That is, re-start the current display from the beginning. It is usually used to recover from error in entering data, etc.
10	This key turns the renormalization flag on.
11	This key turns the renormalization flag off.
12	This key is used after selection of a foil name from a library table of contents to indicate that the name is to be changed.
13-14	Not used.
15	This key causes the program to display the table of contents of a selected library.
16	This key causes the program to plot the cross section of a foil selected by light pen from a library table of contents.
17	This key causes the program to write the cross section of a selected foil onto the run library.
18	This key causes the program to use the library currently displayed as the run library.
19	This key is used to tell the program that the run library is complete.
20-23	Not used.
24	This key causes the program to terminate the current set of iterations and begin another set.
25-30	Not used.
31	This key terminates program execution. The user may use this key to end processing.

APPENDIX C

USE OF THE ALPHANUMERIC KEYBOARD IN INSPECT

The alphanumeric keyboard on the IBM 2250 Graphics Display Console is used to enter alphanumeric data directly into the INSPECT program. The two types of data which are entered into the INSPECT program are: (1) names, and (2) numerical values. A description of the entry of each of the two types follows.

The first type includes the names of foil cross section libraries, and the names of individual foils on those libraries. This information is used internally by the program exactly in the form in which it is input.

To enter this information the name is typed with the keyboard at the location indicated by a program inserted cursor. The name typed may not exceed the predetermined field width. It is not necessary for the user to know the length of the field because the cursor will automatically stop advancing at the end of the field.

When the name being entered is complete, the user indicates its completion to INSPECT either by a programmed function key or by using the END key on the alphanumeric keyboard. The program then removes the cursor from the display and stores the new information.

Data of numerical type includes the measured activities for each foil, the convergence criterion, and the iteration interval. This type of information is converted to machine floating point numbers after entry.

All numerical values entered through the alphanumeric keyboard must have a decimal point. The numbers are all entered into a 16-column wide field and may be placed anywhere in the field. All numbers are read from the scope buffer, right justified and reread with an E16.5 format. Numbers are checked for illegal constructs and rejected if they are not of legal format.

The following are examples of acceptable numerical values:

1.0
1.
.001
.1E+5
1.5E-6
-1.5
-0.15E06

Numbers entered are not allowed to have any embedded blanks. Also, if the exponential form of the number is used, the letter E is the only legal exponent indicator. The exponent indicator may not be omitted if an exponent is supplied. The following are examples of unacceptable numerical values:

5	(no decimal point)
5.0+6	(no exponent indicator)
5.0E 6	(embedded blank)
5. E+6	(embedded blank)
5.0D-7	(wrong type exponent indicator)

Numerical values are typed at the keyboard into the location indicated by a program inserted cursor just as name data values are. When the number being entered is complete, the user indicates its completion by either a programmed function key or by using the END key on the alphanumeric keyboard. If the checking routine in INSPECT rejects the number, the cursor is reinserted on the line and the number must be typed again.

APPENDIX D

JCL REQUIRED TO EXECUTE INSPECT AT THE NRTS

There are only four JCL cards required to execute an INSPECT job on the NRTS IBM 360/75 computer system. They are the standard two card job statement, an EXEC card to call out the INSPECT cataloged procedure, and a /* delimiter card (pink card) at the end of the deck.

The EXEC card required has the following format:

```
// EXEC INSPECT,SCØPE=XXXXX,LIB1='L.XXXXXXX',SER1=T9XXXX,  
// LIB2='L.XXXXXXX',SER1=T9XXXX,LIB3='L.XXXXXXX',  
// SER3=T9XXXX,NEW='L.XXXXXXX'
```

where SCØPE=XXXXX is coded as SCØPE=MSCØPE when the IBM 2250 Mod 1 attached to the IBM 360/75 at the Computer Center is to be used. When running from the IBM 2250 Mod 4 attached to the Remote Terminal at the TRA area, this parameter should not be coded.

The parameters LIB1, LIB2, LIB3 refer to the three cross section libraries which the user may supply on magnetic tape. The parameters SER1, SER2, SER3 are the volume serial numbers for these libraries. If no libraries are supplied on magnetic tape, then these parameters should not be coded. In each of these parameter fields the 'L.XXXXXXX' is replaced by the data set name for the library tape volume and the T9XXXX's are replaced by the library volume serial numbers. For example, to execute INSPECT from the display console at the TRA area, with one cross section library named L.RENLIB with serial number T91234, the user should code

```
// EXEC INSPECT,LIB1='L.RENLIB',SER1=T91234
```

To run the same job from the display console attached to the IBM 360/75, the user should code

```
// EXEC INSPECT,SCØPE=MSCØPE,LIB1='L.RENLIB',SER1=T91234
```

If the user wishes to save the run library on magnetic tape he must code the parameter NEW='L.XXXXXXX' where L.XXXXXXX is replaced by the data set name to be assigned to the run library.

The following illustrates a complete setup for the execution of INSPECT.