

SCORE
AN AUTOMATED CROSS SECTION
EVALUATION SYSTEM



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SCORE
AN AUTOMATED CROSS SECTION
EVALUATION SYSTEM

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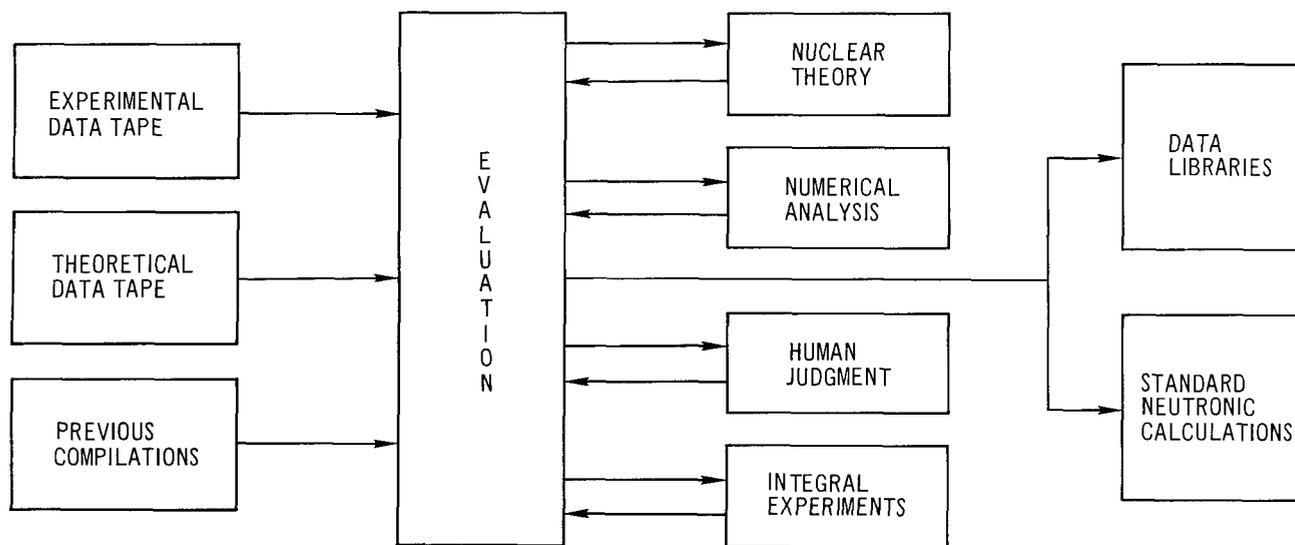
ABSTRACT

The ability to analyze and evaluate the increasing amount of new neutron cross section information is a vital part of the effort to design economic nuclear reactors. By application of computer graphics techniques, one may supply the cross section evaluator with the tools which are necessary. By permitting man-computer interaction through computer graphics, both the rapidity and quality of evaluations will be greatly increased. A brief description of a prototype system, SCORE, is described in this document. Methods tested during the development of this prototype evaluation system have widespread general applications as well.

I. INTRODUCTION

Evaluation of neutron cross section data for use in nuclear reactor design usually requires major nontechnical efforts, quite often to the exclusion of detailed physics analysis of data. This nontechnical effort consists chiefly of such multistep operations as data compilation, forming, reformatting, plotting, curve fitting, etc. Since the previously-mentioned operations, however necessary, are for the most part time-consuming and yield only a minimal amount of physics evaluation, it is of extreme importance that these procedures be fully automated in order that evaluators will be able to meet the more stringent data requirements of future nuclear reactor design. In addition, the difficulties of conventional neutron cross section evaluation are being multiplied enormously by the increasing flow of new experimental data.

A brief sketch of a proposed comprehensive evaluation system has been given previously.⁽¹⁾ A schematic diagram of this system is shown in Figure 1. This diagram illustrates the future direction which this automated evaluation project will take. The present project has evolved as part of the national cross section evaluation effort, ENDF/B,⁽²⁾ and has been designated SCORE (SCISRS Conversion Routine).



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Figure 1. General Flowchart for SCORE

The basic concept which makes an automated cross section evaluation system feasible is a rapid yet convenient conversational mode operating between the evaluator and his computer. In the past this conversational capability has been absent, but recent developments in auxiliary computer hardware (namely, the cathode-ray-tube console) now provide the conversational mechanism. The SCORE system is designed to make optimum use of the cathode ray tube (CRT) and computer graphics as both a visual and digital interface between the various components of an evaluation scheme. By using the CRT as an input-output device, the evaluator has a flexible and convenient tool for control of the logical flow of computer operations.

An operating version of SCORE, Version I, is now available for production operations. SCORE, Version I, contains only a fraction of the system described in Figure 1. The present version was limited to the general area of retrieval and display of experimental neutron cross section information. In this connection, data retrieval problems associated with medium-sized data-sets have been solved, data display routines have been written and checked out, and mechanisms for man-computer interactions through the display console have been tested. The successful completion of this preliminary phase has provided valuable information for use in creating the highly sophisticated evaluation system planned.

The SCORE program will retrieve experimental neutron cross section data from a SCISRS I⁽³⁾ type data file. The methods for storage and retrieval will be described in detail in Section III. Briefly, the method utilizes a combined tape and disk system. Input data is supplied by the evaluator who enters this data through a series of active displays on the console. In addition, the evaluator directs the flow of SCORE by means of actions taken at the console in any desired sequence of operations which include data sorting, data display in one of several available modes, data correcting, data listing, etc.

SCORE was developed for the IBM-360, Model 50 (360-50) and is operating on this computer at the IBM Scientific Center, Palo Alto, California. The computer is supported by disk drives and magnetic tape units with a printer and a card reader-punch. The display console is an IBM-2250 which has a 4K buffer, keyboard, light pen, and character generator. Programming of SCORE is

principally in FORTRAN IV, Levels G and H. For computer graphics applications, machine language routines are used to generate displays on the IBM-2250. All other subroutines are written in FORTRAN IV.

The SCORE system has been used in a partitioned memory system under OS/360. Such an operating system, with the 2250 given the highest priority, is extremely efficient. Our experience has shown that the operation of SCORE consumes between 5 and 10% of the 360-50 operating time. Most of that usage is due to data retrieval. Regular batch processing can be run in the background partition with no noticeable effect on the speed of that processing. In addition, the response time for the display console is as good in the partitioned memory system described above as when operating in a nonpartitioned environment.

All available experimental cross section data for an isotope or an element are stored as a hexadecimal sequential data file on a magnetic tape. When a particular isotope is requested, the file handling features of OS/360 are used to position the tape to the correct data file. This file is then copied into a direct-access data-set on a disk so that the direct record-access feature of FORTRAN IV, Level G, may be used. A preliminary search for the desired data is made using a condensed table. The output from such a search is a record number. This record number is then used to initiate a sequential search in the direct-access data-set within 250 data points of the required data. The advantage of this method over a purely sequential search through a data file containing tens of thousands of records is obvious.

Extensive use of the light pen and keyboard features of the 2250 has been made in such a way as to allow the evaluator maximum flexibility in controlling the sequence of his operations. Problem data is entered through the alpha-numeric keyboard. The displays on the console guide the user as to what information is required. The data appears on the screen as it is entered from the keyboard. When all data have been supplied, further action may be initiated in one of two ways: (1) When the only logical option is to continue the program, an END key on the alpha-numeric keyboard is used; (2) when several options are available, an area of the screen lists the available options. A light-pen detect on one of these options can then initiate further action. This technique is used, for example, to add error limits to the display of experimental cross section data.

The following three sections will describe in more detail the operation of SCORE, Version I, the data storage and retrieval methods, and the use of the display console. The SCORE system is now ready for future development in the areas of curve fitting and evaluated data overlay comparisons.

II. OPERATION OF SCORE

The SCORE system may be operated by an individual working at the console of an IBM-2250 display device. The system has been constructed so that the console may be operated as part of a remote terminal as well as directly linked to a large digital computer. This chapter has the dual purpose of explaining what SCORE can do and providing a user manual.

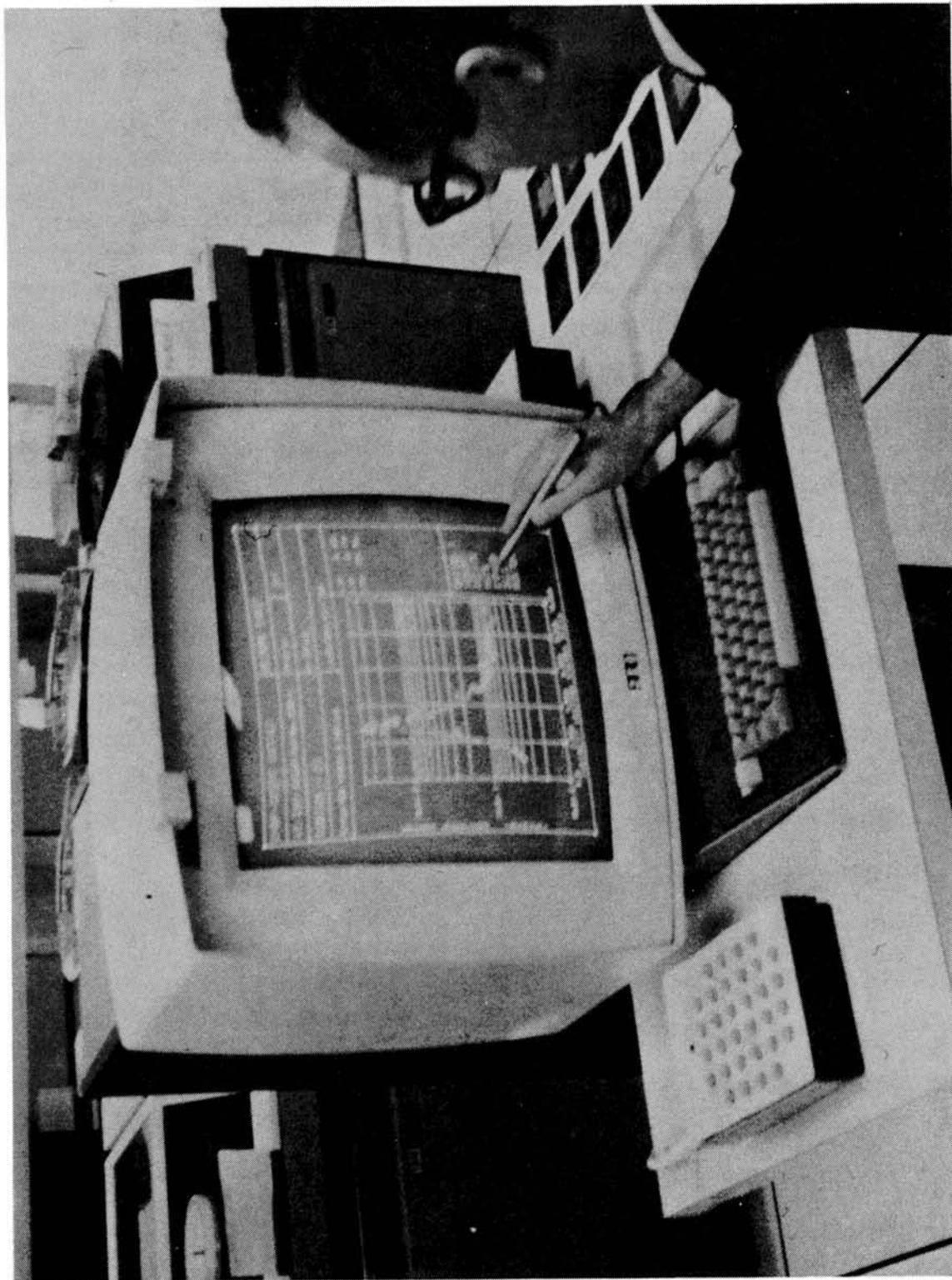
No data cards are necessary to operate SCORE, but a set of control cards are required to load the program into the highest priority partition of the computer and initiate execution. The experimental cross section information resides on a series of tapes in a hexadecimal adaption of the SCISRS format.⁽³⁾ (A detailed description of this format as well as the data storage and retrieval system of SCORE is given in Section III.) The console used by the evaluator to execute SCORE consists of a CRT on which the graphical displays appear, an alpha-numeric keyboard which can be used to communicate with the CRT, and a light-sensitive pen useful for similar communication functions. This equipment is shown in Figure 2.

At the beginning of each case an active display appears on the CRT screen. An active display means a display through which an evaluator may transmit information to the system. This active display with a part of the input data already appearing is shown in Figure 3. This display permits the evaluator to provide identifying information; namely,

- 1) Laboratory
- 2) Evaluator
- 3) Date
- 4) Problem identification number

In addition, data necessary for retrieval of the desired experimental quantities are supplied; namely,

- 5) Element atomic number
- 6) Element mass number
- 7) Reaction type



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Figure 2. Graphic Display Console (IBM-2250)

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LABORATORY: AI - IBM

EVALUATOR: C.L.DUNFORD

DATE: 10/31/67

PROBLEM I.D.: 1

ELEMENT: 11

MASS NUMBER: 23

REACTION: NA

MINIMUM ENERGY (MEV): 6.0

MAXIMUM ENERGY (MEV):

LEVEL ENERGY (MEV):

PLEASE FILL IN OR CHANGE APPROPRIATE VALUES.
SIGNAL 'END' WHEN COMPLETE

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Figure 3. Initial Data Input Display

- 8) Minimum energy
- 9) Maximum energy
- 10) Level energy

Items 5, 6, and 7 follow the SCISRS⁽³⁾ nomenclature, with the natural element (a mixture of isotopes) mass number given as 000. Table 1 lists the reaction types that are presently available and their symbols. The minimum and maximum energies desired are supplied in Mev. In the case where an angular distribution is requested, SCORE will retrieve the first angular distribution available between the specified energy limits. In the case of an inelastic interaction, an excited level energy may be required.

TABLE 1
REACTION TYPES RECOGNIZED BY SCORE

Symbol	Reaction
NA	n, alpha
ND	n, deuteron
NF	n, fission
NG	n, gamma
NH	n, He ³
NP	n, proton
NT	n, triton
NNG	(n,n'γ)
N2N	(n,2n)
N3N	(n,3n)
SEL	(n,n)
SIN	(n,n') (has secondary)
TOT	Total cross section
DEL	Differential elastic scattering
DIN	Differential inelastic scattering (has secondary)
DIT	Differential elastic and inelastic scattering

A short line called a cursor may be seen in Figure 3. The cursor indicates the position at which a character entered in the keyboard will appear on the screen. This cursor may be moved to any position in the active area of the display by a key on the keyboard. Thus, there is complete freedom to enter and correct any input data on the screen. When all required data have been correctly specified, the evaluator strikes the END key which will cause the program to continue execution.

Using the data supplied through the first display, SCORE retrieves the requested experimental data from the SCISRS library. Details of the storage and retrieval system are given in Section III. If the requested isotope or element is not residing in the direct-access data-set on the disk, a table is searched to find its location by tape, and the file on that tape. The program then checks to see if the tape is mounted. If the correct tape is not mounted, a message appears on the 360-50 console telling the operator to mount the tape. When the correct tape is mounted, the requested isotope or element is loaded into the direct-access data-set, the required data retrieved, and SCORE is ready to proceed.

If the isotope or reaction type is not allowed, or no data are available for the reaction type or energy range specified, an error message (Figure 4) appears. Any one of three options (CONTINUE, RESTART, or TERMINATE) may be selected by a light-pen detect on the appropriate characters on the screen. The first two options (CONTINUE and RESTART) return to the first display (Figure 2) so that the evaluator may modify the input parameters. The TERMINATE option ends the job.

When requested data is retrieved, the data limits are displayed along with two options, SORT and NOSORT (Figure 5). Either option may be chosen by a light-pen detect. The displayed characters of the chosen option change from the small to the large size and the chosen option is executed.

If additional restrictions on the initial data retrieved are desired, then the SORT option is chosen and the display in Figure 6 appears. In addition to the

*** REACTION TYPE XXXX IS NOT ACCEPTABLE. TRY AGAIN.**

CONTINUE

RESTART

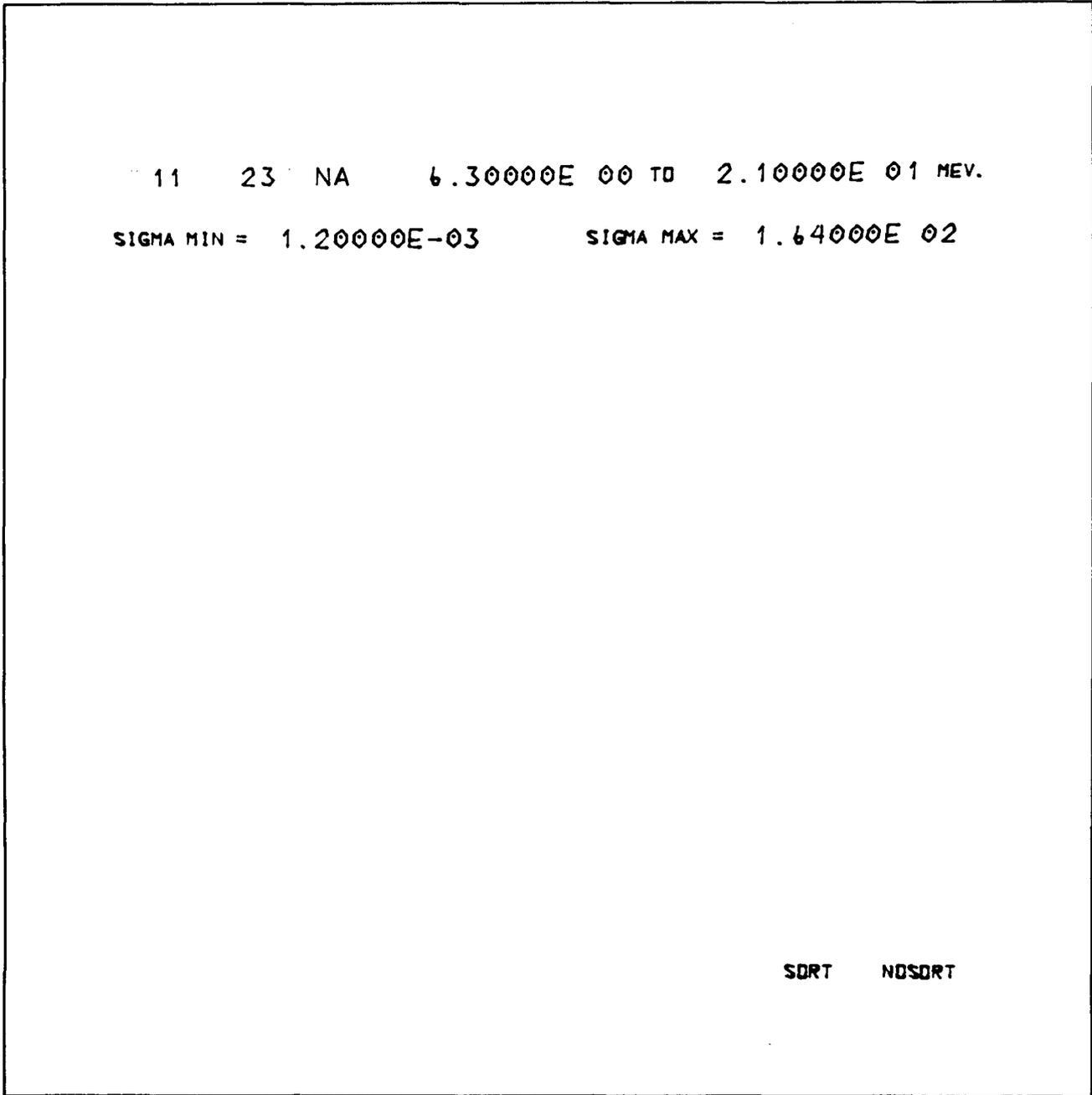
TERMINATE

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Figure 4. Error Message

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Figure 5. Display of Limits of Retrieved Data

11 23 NA 6.30000E 00 TO 2.10000E 01 MEV.
SIGMA MIN = 1.20000E-03 SIGMA MAX = 1.64000E 02

A PR	122, 1877
B ZN	15A, 200
C NP	36, 38
D NP	63, 673
E PPS	77, 508

REFERENCE: ABCDE_
ENERGY 6.30000E 00 TO 2.10000E 01 MEV.

SORT NOSORT

Figure 6. SORT Option

data limits, all references are displayed. The references are light-pen sensitive so that when more than 10 references have been retrieved, a light-pen detect moves the next 10 (or less) into the display. Successive detects continue to move new references into the display until all references have been displayed. Then a detect recycles by bringing in the first 10 references again.

Each reference is identified by an alphabetic character. If the user wishes to add or delete all data for a reference or references from the data to be displayed, then the identifying alphabetic character for each desired reference must be typed in the area of the screen to the right of the word REFERENCE. If no change in references from the previous specification is desired, then that area is left blank. The default condition is that all references retrieved will be plotted, and this condition exists until the evaluator has made a change in the list of references from which data will be displayed. Each light-pen detect on the reference list (see previous paragraph) clears this array and stores the characters which were entered from the keyboard. Finally, the energy limits of the data, or (in the case of angular distributions) the angular limits desired, are entered into the bottom line through the keyboard.

When all data are entered, striking the END key initiates the final data sort. If there are no data within the restricted limits an error message similar to Figure 4 appears. The options RESTART and TERMINATE have the same meaning as before. The CONTINUE option returns to the display in Figure 6 and allows the evaluator to correct the error or errors.

If the NOSORT option had been chosen or when the final data sort is completed, the display in Figure 7 appears. The limits on the final set of data to be displayed now appear in the upper two lines. The remaining information relating to the details of the data display must be supplied by the user. Each axis may be either logarithmic or linear. The choices are made by a light-pen detect. The option chosen will appear in large characters. The axis units are also chosen in a similar manner. There are three options for the energy axis, MEV, KEV, or EV; or two choices for angular data, LAB or CM (center-of-mass).

```
11 23 NA 6.30000E 00 TO 2.10000E 01 MEV.  
SIGMA MIN = 1.20000E-03 SIGMA MAX = 1.64000E 02  
  
X-AXIS: LOG LIN Y-AXIS: LOG LIN  
  
UNITS  
X-AXIS MEV KEV EV LAB CM  
Y-AXIS B MB B/ST MB/ST  
  
X-MIN 6.0E 00 X-MAX 2.1E 01  
Y-MIN 1.0E-03 Y-MAX 2.0E 02  
  
DELTA X 3.0E 00 DELTA Y 3.0E 01  
  
SORT NOSORT
```

Figure 7. NOSORT Option

The y-axis may be in barns (B) or millibarns (MB) for cross sections or barns/steradian (B/ST) or millibarns/steradian (MB/ST) for angular data.

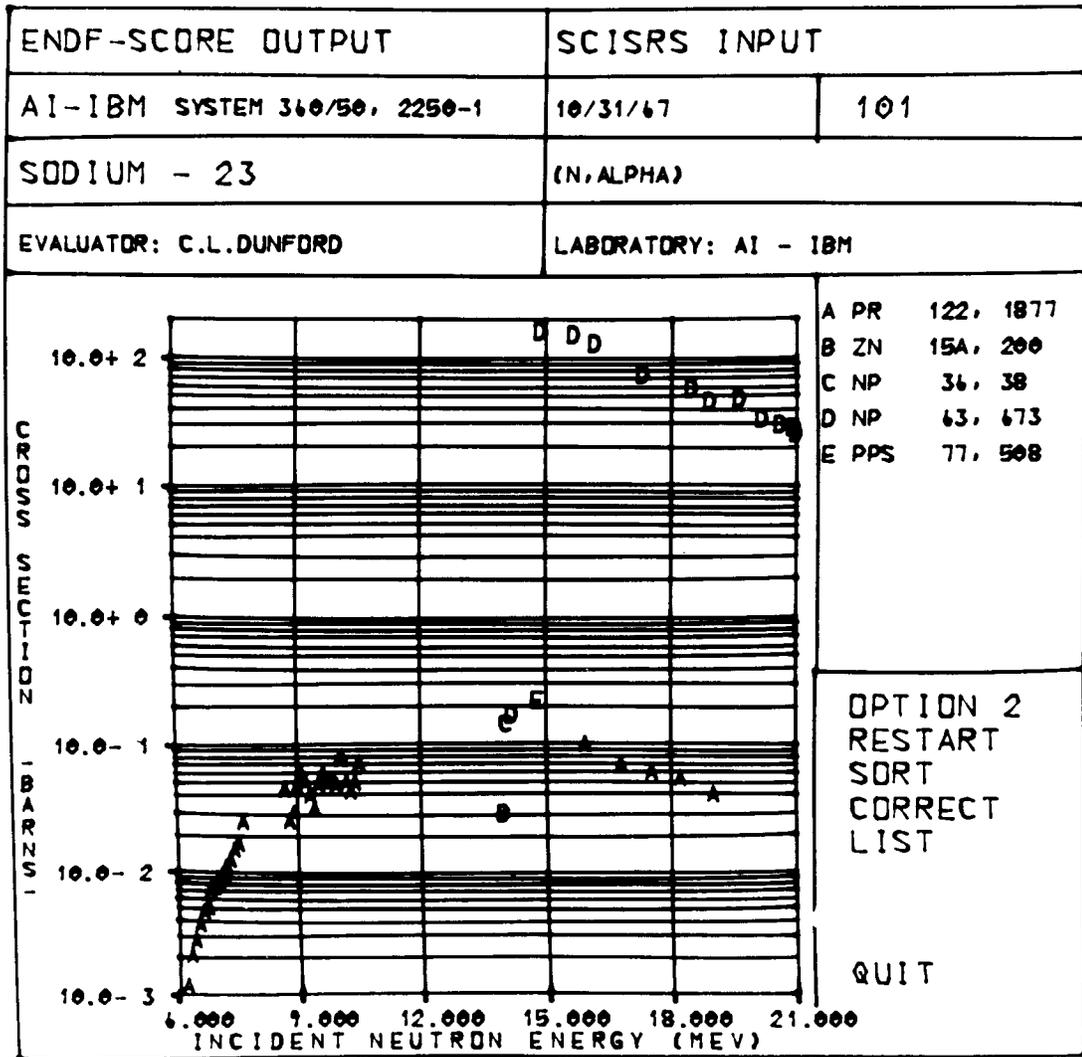
The remaining three lines of Figure 7 allow the user to design a display grid. The minimum and maximum of the x- and y-axis are supplied. In the case of log plotting, 0.0 or a negative value may not be requested for that axis. The minimum is reset by SCORE to the nearest lower decade when log plotting is requested. The quantities DELTA X and DELTA Y are grid units which specify the separation between grid lines for linear plotting. For log plotting, these values are ignored and set internally. In all cases the values must be specified in the same units given in the upper two lines of the display, not in the chosen axis units.

When all required data have been specified, the END key is struck causing the program to continue. If an error was made in specifying the units for either axis, an error message appears with the three options: CONTINUE, RESTART, or TERMINATE. If CONTINUE is chosen, the previous display appears and the error can be corrected.

The data are displayed upon completion of the information required by the previous display (Figure 7). An example of the data display is shown in Figure 8. The upper part of the display consists of identifying information. In the right center of the display are the data references up to a maximum of 10. These short reference identifiers may be checked for more details in Reference 4. If more than 10 references have been retrieved, each subsequent 10 references may be displayed when a light-pen detect occurs in that area. The lower right-hand side is also light-pen sensitive and consists of up to 10 key words. A light-pen detect on a word will initiate a program option.

The remainder of the display (9 by 9 in.) is used for the graphical display of the experimental data. Each data point is represented by an alphabetic character which corresponds to one of the references displayed in the right-center of the screen. The axes are either log or linear depending upon the data supplied in the previous display.

The display shown in Figure 8 has six light-pen options available. They are OPTION 2, RESTART, SORT, CORRECT, LIST, and QUIT. Options may be initiated through a light-pen detect, and are described on the following pages.

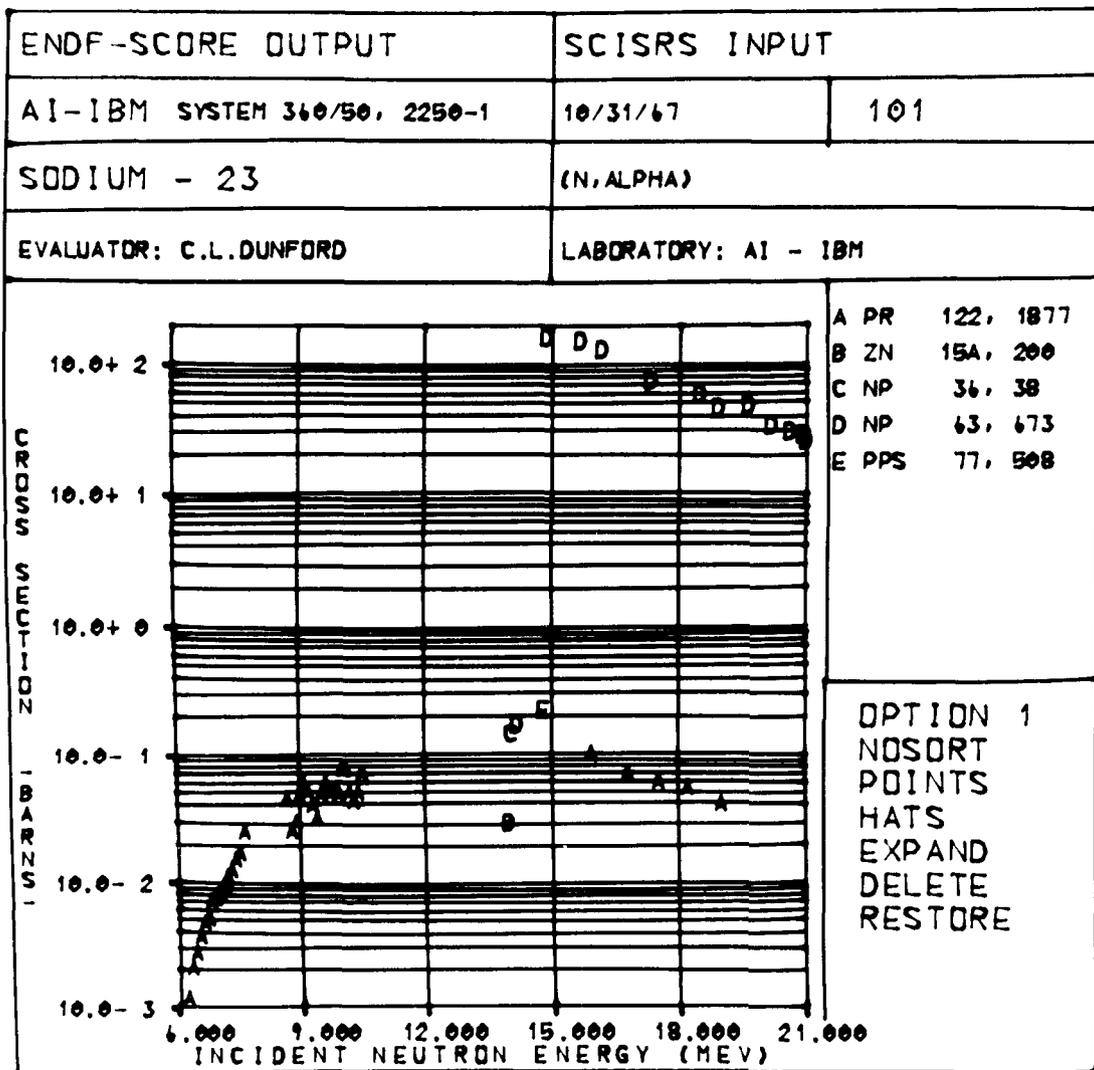


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Figure 8. Basic Data Display

- 1) OPTION 2 – This option brings the display shown in Figure 9 onto the screen. The only difference between this display and the preceding display is that a new set of seven light-pen options is available.
- 2) RESTART – A light-pen detect on RESTART returns the program to the initial display (Figure 3) so that data may be supplied to initiate a new case.



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Figure 9. Data Display with Alternate Light-Pen Options

- 3) SORT – In this case the program is returned to the display in Figure 6. Any one of the sorting options may then be initiated. The evaluator may then proceed to redisplay the revised data in the manner previously described.
- 4) CORRECT – If any of the data in a display are incorrect (as for example the data from Reference D in Figure 8), action may be taken to correct this data. The light pen is used to select the CORRECT option. Immediately the graphical part of the display is expanded to full screen size (see EXPAND option) and the data points are made sensitive to detection by the light pen. Each data point which the evaluator wishes to modify is successively detected with the light pen. Each point, as chosen, disappears from the screen and is stored for future use. If a point has been detected and deleted from the display, it may be restored by striking the CANCEL key, providing that no other succeeding point has been detected and deleted.

When the evaluator has completed selection of the incorrect data, he strikes the END key. The display shown in Figure 10 appears on the screen. In addition to the identifying information, there are four columns of data displayed. The left two columns are the incorrect values of the X and Y coordinates, respectively. The right two columns are initially duplicates of the left-hand pair of columns. Any changes made in the data by the evaluator appear in these columns.

Data may be corrected in either of two ways: (1) The display contains two locations – TIMES and PLUS – into which multiplicative and additive factors can be entered from the keyboard. This linear transformation can then be applied to any piece of data in the right-hand pair of columns by detecting the desired coordinates with the light pen. (2) Also, the cursor may be placed at any character position in the right-hand columns and a new character entered in that position from the keyboard.

The display will hold only 15 data points at one time. If more than 15 data points are to be corrected, then successive displays are required. Each succeeding display is reached by striking the END key.

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NO. 103

LIGHT PEN DATA TIMES 1.00 -03 PLUS 0.00 +00

INCORRECT DATA

CORRECTED DATA

ENERGY (MEV)	SIGMA (BARNs)	ENERGY (MEV)	SIGMA (BARNs)
1.48900E 01	1.64000E 02	1.48900E 01	1.64000E-01
1.56700E 01	1.53000E 02	1.56700E 01	1.53000E-01
1.61500E 01	1.34000E 02	1.61500E 01	1.34000E-01
1.73300E 01	7.55000E 01	1.73300E 01	7.55000E-02
1.84900E 01	6.00000E 01	1.84900E 01	6.00000E-02
1.89200E 01	4.56000E 01	1.89200E 01	4.56000E 01
1.96100E 01	4.90000E 01	1.96100E 01	4.90000E 01
2.01900E 01	3.40000E 01	2.01900E 01	3.40000E 01
2.06300E 01	3.07000E 01	2.06300E 01	3.07000E 01
2.09000E 01	2.90000E 01	2.09000E 01	2.90000E 01
2.10000E 01	2.58000E 01	2.10000E 01	2.58000E 01

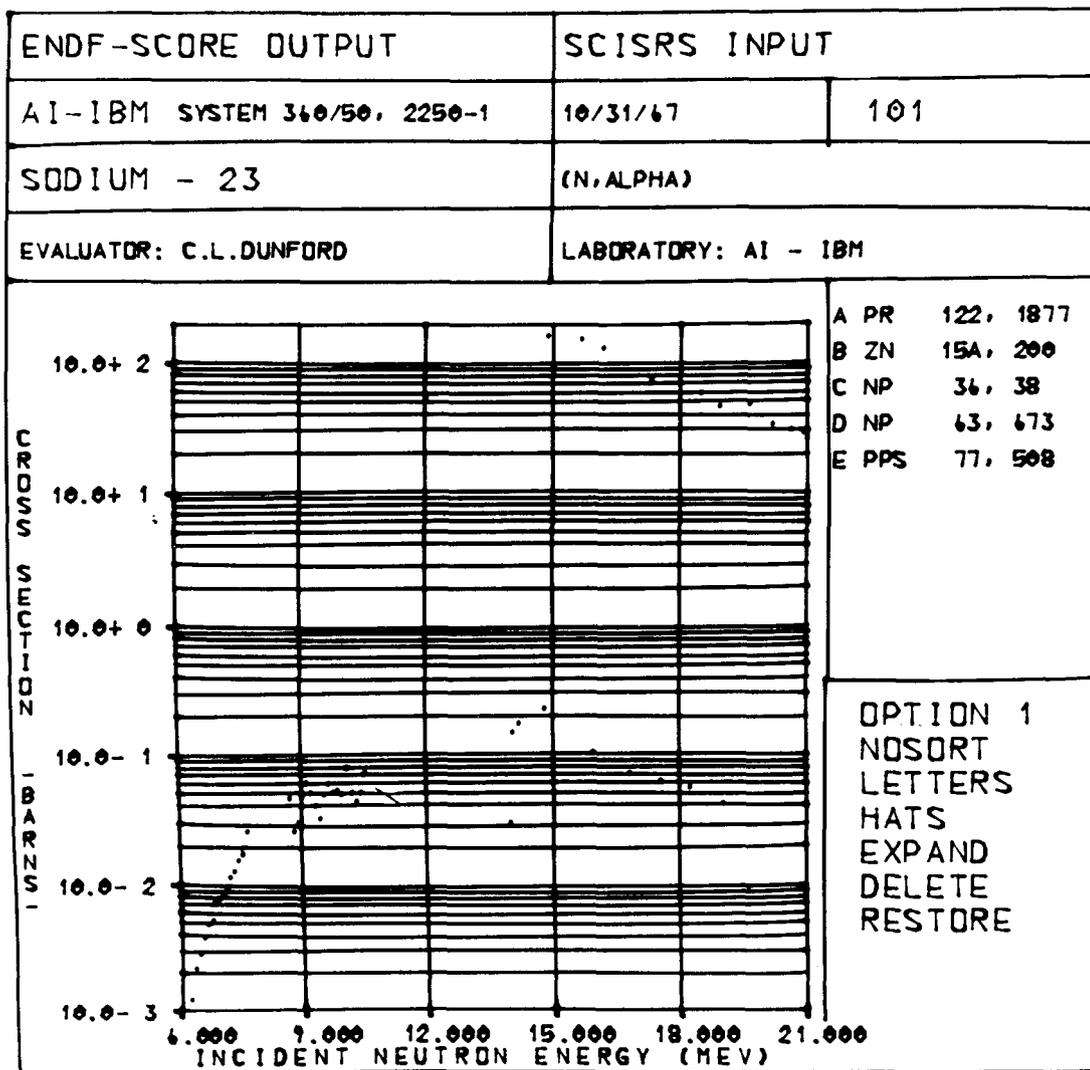
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Figure 10. Display for Data Correction Option

If all points in the correction array have been displayed, the END key is used to return to continue execution of SCORE. Figure 7 appears first so that any display parameters may be modified to improve the display of the new corrected data.

- 5) LIST – If an alpha-numeric display of the data in a display is desired, the LIST option may be chosen by a light-pen detect. The result is a picture with a format similar to the CORRECT option (Figure 10). Now the left-hand columns and those on the right have different data points, permitting a maximum of 30 points to be displayed at a time. The END key is used to initiate display of successive sets of data points until all have been displayed; then the END key returns directly to the graphical display. If one wishes to terminate the list option part of the way through the sequences of displays, the CANCEL key may be used.
- 6) QUIT – This option terminates the job. If operating in a partitioned memory system, the partition is released to another job. In order to restart SCORE, the program must again be loaded into core from the library.
- 7) OPTION 1 – This is the first light-pen option in the second set of options (Figure 9). A choice of this option causes the display to revert to that in Figure 8 so that any of the previously described options may be executed.
- 8) NOSORT – Choice of this option returns to the display in Figure 7. In the manner described previously, any display parameter can be modified and the data re-displayed.
- 9) POINTS - LETTERS – This option permits choice of the plotting mode. Initially, all data points are plotted with characters (LETTERS) corresponding to the references listed. The word POINTS appears in the light-pen option area (Figure 9). If the POINTS option is chosen, Figure 11 appears in the display. Now all data points are plotted as points rather than characters. The word LETTERS now appears in the light-pen option area. A detect on the LETTERS option returns the display to character mode plotting.



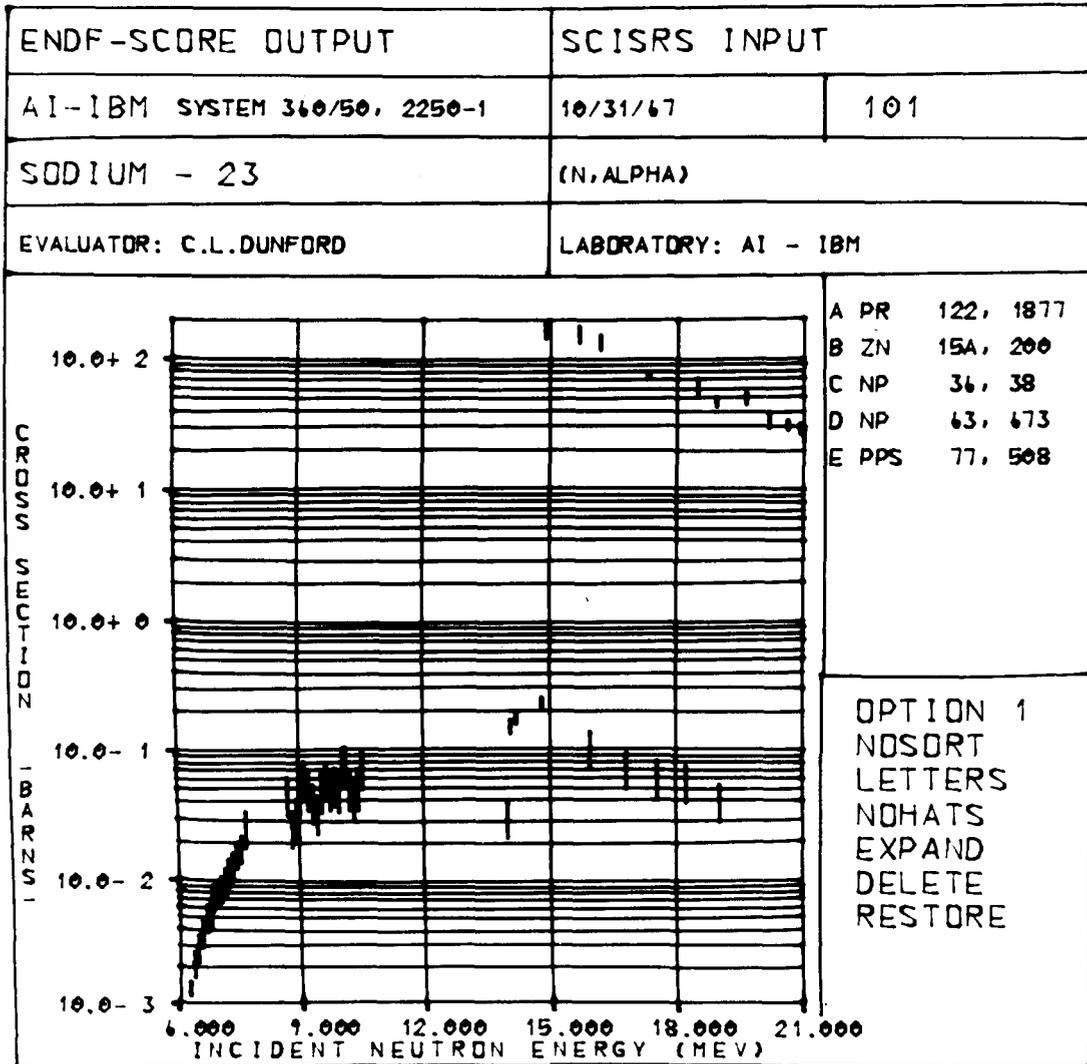
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Figure 11. Data Display with Points Instead of Characters

- 10) HATS - NOHATS – The normal plotting mode does not display the error hats. The word HATS is displayed in the light-pen option area. If the error hats are desired, the word HATS may be chosen by the light pen and the display in Figure 12 appears. Error hats are added to the data points for which experimental errors are available. The light-pen option area now contains the word NOHATS. A detect on NOHATS returns to a display without error hats.
- 11) EXPAND – The EXPAND option causes the graphical part of the display to enlarge to full screen size (12 by 12 in.). The detailed titling, references, and light-pen options disappear and are replaced by a pair of short titles (Figure 13). This enlarged display is also the basic figure for the CORRECT and DELETE options. The END key is used to revert to the normal sized display.
- 12) DELETE – Choice of the delete option causes the graphical display to expand to full size. Individual points may then be deleted from the display by detecting them with the light pen (Figure 14). These points will remain deleted from all further operations until the RESTORE, CORRECT, or RESTART option is chosen. However, any single point may be restored to the display if the CANCEL key is struck before another point is deleted. The END key is used to continue the program operation.
- 13) RESTORE – This option will restore all deleted points to the display.

Using SCORE, the evaluator may retrieve any experimental data of the type listed in Table 1 available in a SCISRS library, and perform any sequence of the many manipulator operations previously described to obtain a data display. All operations are documented by means of a comprehensive printed output for each case. The methods of data storage, retrieval, and display will be examined in more detail in the next two sections.



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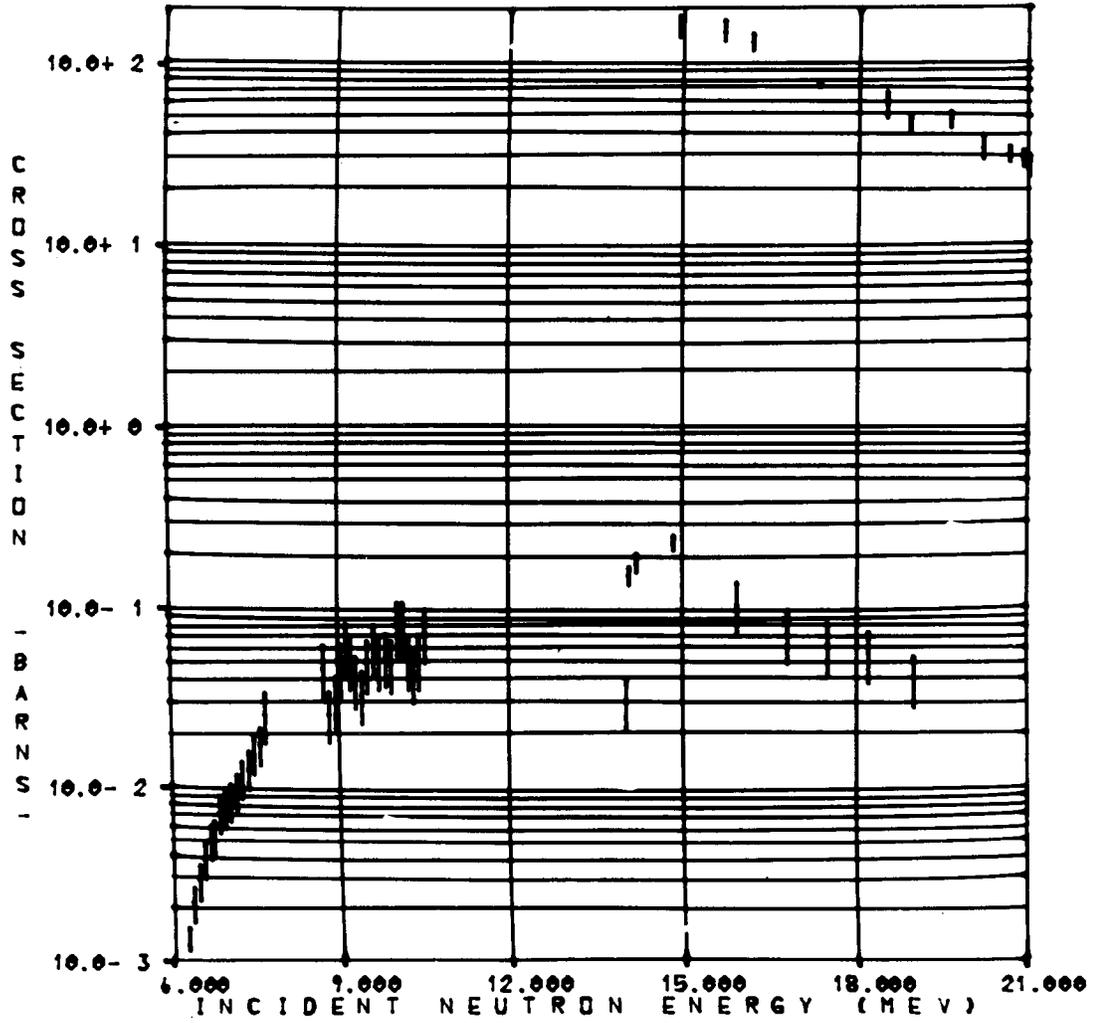
7701-4642

Figure 12. Data Display with Points and Error Hats Added

SODIUM - 23

(N,ALPHA)

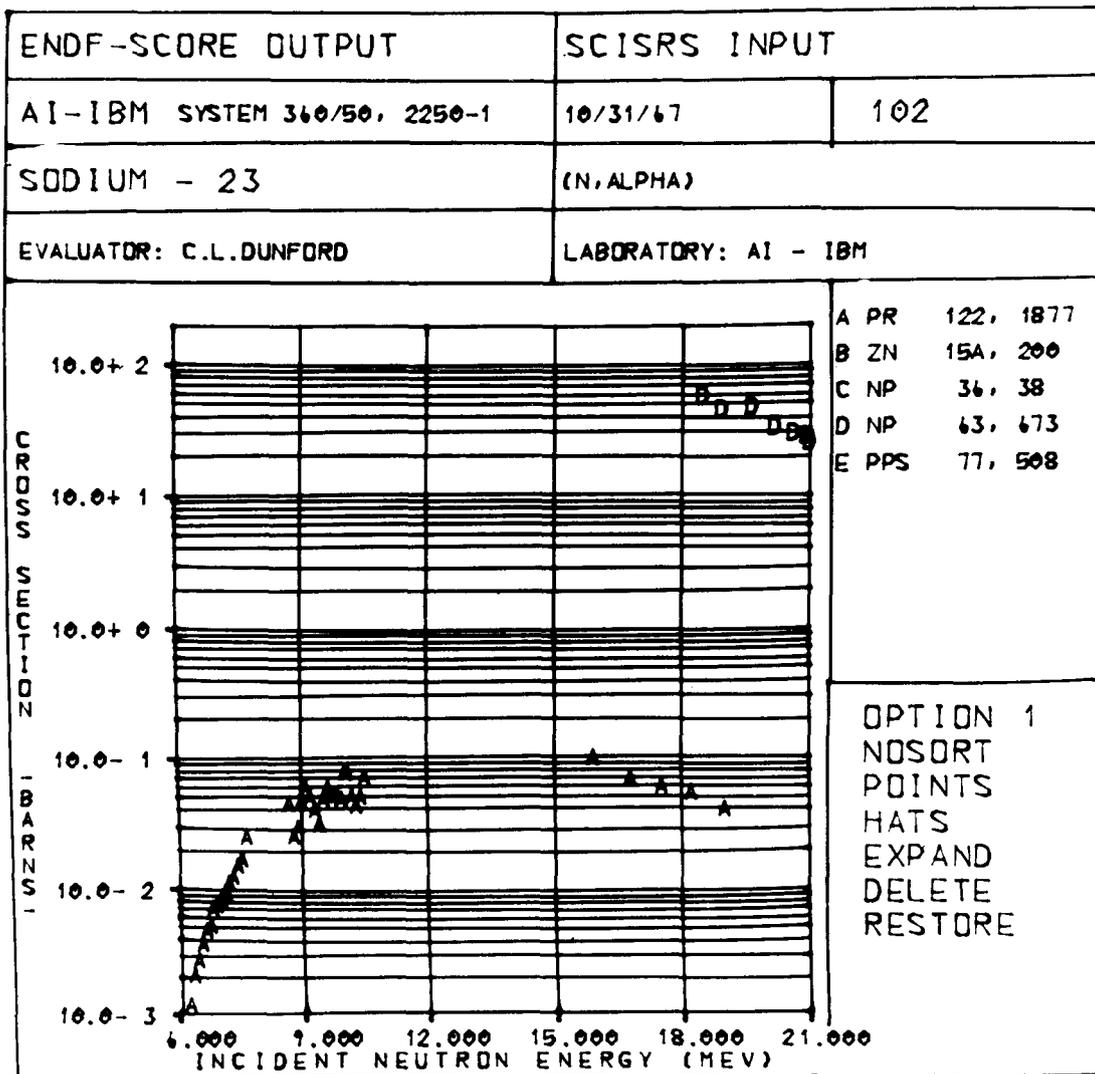
NO. 101



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Figure 13. Expanded Data Display



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Figure 14. Data Display with Some Points Deleted

III. DATA STORAGE AND RETRIEVAL

A. METHOD

The evaluator requests a particular isotope, reaction type, energy range, and level energy (if applicable) by entering data in the initial display (Figure 3). The problem then is to retrieve the requested information in the most efficient manner, in order to minimize the time during which the evaluator must wait before continuing with SCORE.

The retrieval scheme chosen uses both tape and disk storage. All the available experimental cross section data for an isotope or a natural element are stored as a hexadecimal sequential data file on one of several multi-file magnetic tapes. In addition to experimental data, each file contains identification information and two tables which describe the contents of the file.

When a new isotope is requested by the evaluator, a table is searched to find the tape and file containing that isotope. If the correct tape is not mounted when the request for a new isotope is made, a message will be printed on the computer operator's typewriter giving him tape-mounting instructions. If the correct tape is mounted, the file-handling features of OS/360^(5,6) are used to position the tape to the correct data file. This file is copied into a direct-access data-set on a disk so that the direct record-access feature of FORTRAN IV, Level G,^(5,7) may be used.

In order to retrieve the requested data with the reaction type and energy range restrictions imposed by the evaluator, two tables which catalogue the data file as to reaction types and energy regions are searched. The result of that search is a record number which is used to initiate a sequential search in the direct-access data-set. This sequential search is started within 250 data points (5 reads off the disk) of the requested data. The advantage of this method over a purely sequential search through a data file containing tens of thousands of records is obvious.

If the desired isotope already resides in the direct-access data-set, all subsequent requests for different reaction types, energy ranges, etc. for this isotope are retrieved from this data-set using the methods described in the previous paragraph. An isotope remains in the direct-access data-set until a different isotope is requested.

The following sections describe in detail the tape layout, the direct-access data-set, and the search procedure.

B. SCISRS LIBRARY TAPE FOR SCORE

The SCISRS library tape used by SCORE is basically a record-by-record transformation from a standard BCD SCISRS tape.⁽³⁾ The first step is to convert the BCD SCISRS data tape to EBCD and reblock the records using the OS/360 utility program IEBGENER.⁽⁸⁾ Reblocking the tape increases the efficiency of the next step, which utilizes an auxiliary program, SAP (Appendix II), to make or add to a SCORE data tape.

When the SAP program creates a new SCORE hexadecimal tape, the first file of that tape holds a single record containing the tape identifier. This record is made up of 16 words. The first two words are the tape identifier and the last 14 words may be any arbitrary information. The tape identifier is checked by SCORE when a new isotope is requested. If this identifier does not agree with the identifier for this isotope stored in the table described in Section III-D, a message will be printed on the computer operator's typewriter telling him to mount the required tape.

All subsequent files on the tape consist of records containing 16 hexadecimal words, and blocked with 56 records to the block. (This block size was chosen for reasons explained in Section III-C.) The first record is a title with 16 words which may be any arbitrary information. The second record contains 5 words of information and 11 dummy words to fill out the record (Table 2).

TABLE 2
FORMAT OF THE SECOND RECORD OF EACH ISOTOPE FILE

Entry	Symbol	Input Format
1) Element Atomic Number	ZNUM	(A2)
2) Element Mass Number	ANUM	(A3)
3) Atomic Weight	AMASS	(E)
4-5) Date of Entry	DATE (2)	(2A4)

The succeeding records are a record-by-record transformation of the corresponding information from the EBCD SCISRS tape. Each record contains the 16 words enumerated in Table 3. Each entry in Table 3 is detailed in the SCISRS document.⁽³⁾

TABLE 3
FORMAT OF SAP EXPERIMENTAL DATA RECORD

Entry	Symbol	Input Format
1) Energy	EN	(E)
2) Energy Error/Resolution	*	(E)
3) Secondary Energy or Other Numerical Quantity	EN2	(E)
4) Cos θ	U	(E)
5) Cos θ Error or Resolution	*	(E)
6) Value of Cross Section	SIG1	(E)
7) Error in Value	ERS	(E)
8) Identification of Secondary Energy or Other Numerical Quantity, Error Type, Lab System Indicator Information Source	STYPE2 ETYPE CML SOURCE	(A1) (A1) (A1) (A1)
9-12) Reference	REFER (4)	(4A4)
13) Energy Error Units, Energy Error Type, Cos θ Error Resolution Units, Cos θ Error or Resolution Indicator	* * * *	(A1) (A1) (A1) (A1)
14) Status, Method	* *	(1X, A1, A2)
15) Standard, Institution	* *	(A1, A3)
16) Date of Entry, Comment Entries	* *	(A3, A1)

*This item is stored by SAP but is not used in SCORE

The next group of records contains a table of the reaction types (σ -type in the SCISRS document) for which data are available. Each entry in this table has an associated index number. This index gives the location of the initial point in the energy table which is associated with this reaction type. The table is stored as pairs of reaction type and index, 8 pairs per record, for as many records as are needed.

The next group of records contains the table of energy points and their associated record numbers. This table is also generated by SAP. The energy for the initial data point and every 250th point thereafter of each reaction type and the record number in the direct-access data-set for that point are stored in the table. This table is stored as pairs of energy and record number, 8 pairs per record, for as many records as are needed.

The last record of the file has 4 words of information and 12 dummy words to fill out the record. This record contains 4 constants which control the reading of the direct-access data-set (Table 4).

TABLE 4
DIRECT-ACCESS CONTROL INFORMATION

Item	Symbol	Input Format
1) The starting record number of the table of reaction types	ISAVE	(I)
2) The number of pairs in the table of reaction types	KU	(I)
3) The number of pairs in the table of energy points	KE	(I)
4) The total number of records in the file	NRS	(I)

The file is organized in this manner so that SAP can do a one-pass record-by-record transformation from the EBCD SCISRS tape to the SCORE tape. At the same time, SAP builds the tables and control information which are placed after the last record of SCISRS information, followed by an end-of-file mark.

C. DIRECT-ACCESS DATA-SET

The direct-access data-set is an intermediate storage area on an IBM-2311 disk into which the requested isotope is copied from the appropriate tape and file. The block size on the tape was chosen so that SCORE would read a block from the tape into core, and then write the entire block as a record which fills a full track on the disk. This is repeated until the end-of-file on tape is sensed and all the information has been written onto the disk.

The 56 blocking factor for the tape was chosen because this is the maximum number of 16-word records which may be collapsed into one record to fill a single track on the 2311 disk. This is important since transmission time to or from the disk can be greatly reduced by reading or writing an entire track at a time. The collapsing of the 56 records into one record for the disk, and the deblocking of a record from the disk, are done in-core by using a doubly dimensioned array 16 by 56.

The direct-access data-set is formatted, written, and read by using the direct-access input-output statements in FORTRAN IV, Level G.^(5,7) Once this data-set is created it should be kept, since the initial formatting of a direct-access data-set may take several minutes.

The following statement defines the direct-access data-set:

```
DEFINE FILE 17 (500, 896, U, IV) .
```

Data-set reference 17 refers to 500 records; each record has a maximum of 896 words, and the record is to be read or written without format control. This data-set will hold almost 28,000 SCISRS data points. It requires 500 tracks or one-fourth of a 2311 disk pack.

Only the DIRECT and the RECORD subroutines (Appendix I) reference this data-set, and they are the only ones which must be compiled with the FORTRAN IV, Level G, compiler.

D. SEARCH PROCEDURE

If the isotope requested is not in the direct-access data-set, a table is searched to find the corresponding tape and file number. This table and a table

of tape identifiers are stored on disk and are read into SCORE at the beginning of the program. This table contains the isotope identification number ($Z*1000 + A$), the tape and file number ($NT*100 + NF$), the date of entry, and the tape and file number for the previous data file (now obsolete) for this isotope.

By storing the previous tape and file number, one has a traceback record of updates, and also has a record of what is stored on every tape. New additions to the table are always added at the end; therefore, the table is searched backward to obtain the latest entry for an isotope. The previous tape and file number, and the tape and file number, are stored in one integer number as follows:

$$N = (NT*100 + NF)*10000 + NT_p *100 + NF_p ,$$

where the subscript p stands for "previous."

The tape number is the index of the corresponding tape identifier table entry. The tape identifier is then used to make certain that the correct tape is mounted. The file number is used to compute a data-set reference number ($NF + 20$), which has an associated data-definition (DD) card defining the $NF + 1$ file on a non-labeled tape (See Appendix III). By using non-labeled tapes, and assigning each file a different data-set reference number, OS/360 will do all the tape positioning, and the one set of DD cards will work for all the SCORE tapes.

Once the tape is positioned, 56 records (one block) at a time are read into core, and then written as one record into the direct-access data-set. This continues until the end-of-file is sensed. Since the control information (ISAVE, KU, KE, and NRS) is in the last record prior to the end-of-file, and is now in-core, it is used to read the table of reaction types and the table of energy points from the direct-access data-set into core.

A search is now made in the table of reaction types for the requested reaction. If a match occurs, the associated index is used to locate the initial point in the energy table for beginning the search for the requested minimum energy. When the minimum energy is less than an energy point in the table, or the last entry for this reaction type has been checked, the corresponding record number is then used in a direct-access read to begin a sequential search for the desired

energy range. This starting point will be within 250 data points (5 disk records) of the requested data. The first 500 points in the requested range will then be processed as described in Section II. If the requested reaction is not found, or there are no data points in the requested range, an error message is displayed and the evaluator may proceed accordingly.

The direct-access data-set is always checked first to see if it already contains the requested isotope. When a file is copied into this data-set, the isotope identification number and the total number of records (NRS) are written into the dummy word area of the first disk record. This record is read and the identification checked. If it is not the desired isotope, the program proceeds as described previously. If it is the desired isotope, NRS is used in a direct-access read to obtain the control information (ISAVE, KU, and KE). This data is then used to read the tables from the direct-access data-set into core. In either case, once the tables are in-core they will be used until another isotope is requested.

IV. GRAPHIC DISPLAYS

The IBM-2250 display unit⁽⁹⁾ is designed to require a minimum amount of control from the host computer. The 2250 Model 1, which SCORE has been developed to use, contains a core memory of 4096 bytes. A set of orders, representing a particular picture, is created in the graphical subprograms and is inserted into the 2250 core. These orders are then executed autonomously by the 2250 creating the desired display on the screen face. The regeneration of the display 40 times every second and keyboard input and/or editing is handled by the 2250 itself; no control is required from the main computer.

When the 2250 demands some action from the host computer, an attention is generated. The detection of a point with the light pen, or a depression of the END or CANCEL key, produces such an attention. At this point, the main processor must make an appropriate decision; subsequent action may then change the picture in the 2250 or produce a new one. It is only during these attention-handling periods that the host computer is required to act. Since the behavior of people tends to be much slower than the time necessary to create a picture, only a small fraction of the computer time needs to be utilized.

This free time during the operation of SCORE is released to other jobs which may be operating on the machine. The facilities available for this machine sharing are available under a special⁽¹⁰⁾ version of OS/360, Release 10. Operation under the standard Release 11 of OS/360 and subsequent versions will allow all the machine time not necessary for SCORE to be released to other concurrent jobs.

The design goals of SCORE required the graphics support to be responsive, flexible, independent, and compatible. The graphical subprograms contained in Version 1 of SCORE have been specifically designed to provide responsive interaction with the user. As in all systems where the user is on-line to a computer, the smallest delays can be aggravating. In addition, the flexibility of each graphical figure with respect to content, placement of information on the screen, and interactive control by the user has been a design goal. Some attempt to consolidate only functions pertinent to each display has led to the isolation of each figure; any change in one graphical routine does not affect any other for

the most part. Finally, some small effort was expended to make the calling sequences and the information passed by them convenient to the main body of the FORTRAN code.

The implementation of the graphical routines was carried out in OS/360 assembly language⁽¹¹⁾ using the input-output facilities of Express graphics.⁽¹²⁾ As noted before, the operating system was modified to allow immediate attention-handling without polling for interrupts. The system modifications are no longer necessary with Basic graphics support,⁽¹³⁾ and the distributed version of SCORE uses these facilities. Operation of the system under pre-Release 11 systems is possible only on a special basis; arrangement with the authors is necessary.

Subsequent versions of SCORE will use an IBM supported graphics system⁽¹⁴⁾ (GSP) for use with FORTRAN. This new supported graphics system will allow any programmer to write programs which use the 2250. Since this graphics system was in the design stage and the utility of available graphics support was questionable, we made the decision to stay with our own graphics code. The time scale of the initial development of SCORE attests to the correctness of this decision.

The special organization of the graphic programs should be of interest to any serious 2250 programmer. However, these details do not lend themselves easily to documentation. It is sufficient to say that the subprograms attack general areas in some modest fashion. Among these are generation of minimum length order strings, probability of light-pen detects versus correlation-table size, maximization of the autonomy of the 2250, display reaction to the user both in time and type of action, animation techniques, and finally, utilization of main memory to provide continuous displays of order strings longer than the 2250 buffer size.

V. CONCLUSION

A. DEVELOPMENT RESULTS

During this initial phase of the development of the SCORE system, several important results have been obtained. The most important conclusion is that automated neutron cross section evaluation employing computer graphics techniques is not only feasible, but also economic. Experience has shown that computer graphics does provide a convenient mechanism for improving man-computer communication. The ease and rapid response of this man-computer interaction leads to a more efficient use of technical manpower and computing facilities.

A data storage and retrieval scheme has been designed to handle experimental neutron cross section information which is the cross section evaluator's raw data. Data stored in the unpacked SCISRS⁽³⁾ format may be directly translated to a hexadecimal tape format for use by the SCORE system. The data is stored with one isotope/element per file. The required file is transferred to a direct-access data-set on a disk when requested by SCORE. Techniques using a preliminary search of a condensed data-set index combined with the direct-access feature of FORTRAN G have resulted in highly efficient retrieval from data-sets with more than 10,000 records.

On-line data display capabilities have been developed. This ability is basic to any automated neutron cross section evaluation scheme. However, the inherent uneconomical aspect of on-line operation of peripheral hardware such as a display console has been largely overcome through use of a partitioned memory system. In such an operating mode, approximately 90% of the central processing unit operating time can be used to process other jobs. Such a large saving results because times of inactivity at the scope or communication by means of the keyboard do not require the central processing unit. Such other operations as the handling of light-pen detects and loading the scope buffer for a new display requires times of the order of a second or less.

B. FUTURE WORK

The version of SCORE described in this document is intended as a demonstration system only. In order to make the prototype version of SCORE operable

in a production mode, several features will be added to the system. The most important feature required in order to produce evaluated data libraries is a curve-fitting capability. None of the conventional curve-fitting procedures show as much promise of success in fitting experimental data as spline curves. It is hoped that previous difficulties in fitting spline curves to experimental data may be overcome by allowing the evaluator to use his experience to assist in obtaining a physically meaningful solution to the data fitting problem.

In order to permit more flexibility in using the display console, the large, special-purpose machine language subroutines used to generate the graphic displays will be modified. A series of small, generalized, FORTRAN callable subroutines will be written to provide a set of basic routines from which graphic displays may be easily generated and active interaction through the display console controlled. When these subroutines are complete, the SCORE system will be more easily convertible to another computing system, providing sufficient software is available.

A final feature required to make SCORE an operational system is a hard copy capability. The most direct route for producing hard copy would be to use the contents of the display console buffer. A conversion program to use the 2250 buffer contents to produce hard copy (35 mm and paper) on an SC-4020 or SC-4060 is needed.

The accomplishment of these additional capabilities will be achieved in the near future. Then it will be possible to add many of the physics analysis capabilities briefly envisioned in Figure 1.

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APPENDICES

NAA-SR-MEMO-12529

APPENDIX I DESCRIPTION OF SUBROUTINES

MAIN

The MAIN program of SCORE is used primarily to control the logical flow of the program. Parameter initialization is performed first; then the initial display is executed and the initial case data are incorporated. The requested experimental data are retrieved and further initialization is performed on the basis of the retrieved data.

Next, the MAIN program provides the control for preparing the data display. This consists of a sequence of active displays through which the evaluator may specify final display parameters. Finally, the MAIN program generates the data display.

AAAA

This multiple subroutine contains six entry points AAAA, BBBB, CCCC, DDDD, EEEE, and FFFF. Each entry is used to convert a set of data from hexadecimal to hollerith or from hollerith to hexadecimal.

LIGTOP

The logic for all the light-pen options (Section III) is contained in this subroutine. When a return to the main program is executed, the preset value of IPATH controls the subsequent path through the main program.

BLOCK DATA

In this routine data in COMMON areas are initialized. Data consist of numeric and alpha-numeric information as well as large blocks of titling information.

FIG1P

All initial case data are printed by this subroutine. This printed output provides a record of all case data supplied by the evaluator through the display in Figure 3.

LABEL

Hollerith titling information containing the isotope (e.g., the characters SODIUM-23) and the reaction (e.g., N-ALPHA) are prepared from the requested element charge and mass numbers and the reaction type, respectively. In order to prepare quality titling, character manipulation within data arrays is required. Two North American Rockwell system routines, INFILQ and CMBDC, are required for these operations.

INPUT

This is the control subroutine for reading in and storing the requested reaction type, energy range, etc. It does the sequential search for the data after calling DIRECT to locate the initial starting point. It will store the first 500 data points found in the requested range, except that any data point whose Error Type (ETYPE) is not a blank, an "L", or a "P" will not be stored. The Error in Value (ERS) for an "L" Error Type has been converted to percent by the SAP program.

POINT is called to bring in one data point. CORLIM is called to determine the minima and maxima of the data which were found. If no data are found, an error message and a corresponding error flag is returned to the main program.

DIRECT

This subroutine must be compiled with the FORTRAN IV, Level G compiler, since it uses direct-access input-output statements. It contains the search procedure and copies the requested isotope from the tape into the direct-access data-set, unless it already resides there. If the wrong tape is mounted, WTOR is called to tell the computer operator which tape to mount. RECORD is called to bring in 16 words at a time indirectly from the direct-access data-set.

POINT

This subroutine calls RECORD to retrieve a data point indirectly from the direct-access data-set.

RECORD

This subroutine must be compiled with the FORTRAN IV, Level G compiler, since it uses direct-access input statements. It reads one record from the direct-access data-set into a doubly dimensioned array (16 by 56) and/or it returns 16 words from this array.

CONVRT

This is a multiple entry conversion routine for changing data from one mode to another.

Entry CONVRT changes the numeric data representing the axis scale marker to hollerith required in the data display.

Entry ETOBCD converts a hexadecimal number to E format (1PE12.5,) and then to hollerith for display purposes.

Entry BCDTOE converts hollerith data as supplied through an active display (6.0 E + 04) to a hexadecimal number for numeric calculations.

Entry ROUND will round off a floating point number to I significant figures where $1 \leq I \leq 8$.

Entry GTØBCD converts a hexadecimal number to E format (1PE8.1) and then to hollerith for display purposes.

All entries require the NAR system routine INFILQ and a machine language routine RTADJ.

PRINT

All data retrieved and all data in each different data display are printed by this subroutine. If IWHEN=1, the raw, unnormalized experimental data retrieved by INPUT are listed as well as titling information. If IWHEN=2, the data to be displayed are listed in the requested units. This listing occurs each time a new display is created and is accompanied by a listing of the display parameters such as axis minima and maxima.

SORT

When the experimental data retrieved from SCISRS must be further sorted, the SORT routine is used. This subroutine produces a second array of data in which specified references and/or ranges in energy have been deleted. If any individual points have been previously deleted through the DELETE option, they will be discarded in this sort. Maximum and minimum data values are recalculated.

BTIL

The two brief identifying titles for the expanded data display are calculated in this subroutine. One of these titles is also used in the smaller basic data display if an angular distribution and/or an inelastic reaction is displayed.

GRAPH

All data to be plotted are transformed to their proper units for display; e.g., MEV→EV, B →MB. The axis labels are prepared, as are the grid division labels, according to the data specified.

LCML

This subroutine converts an angular data point from the center-of-mass system to the laboratory or from laboratory to center-of-mass.

SCALE

SCALE is used to convert the members of a data array when they are to be plotted on a logarithmic scale. The data array is then proportional to the \log_{10} of the original array.

DELP

Whenever data points are deleted (DELETE option) or corrected (CORRECT option), this subroutine lists the data.

DELETE

This is a double entry routine which handles data point deletions and reinsertions.

Entry DELETE deletes a point from the data plotting array and stores the index of the corresponding point in the array of data retrieved from storage.

Entry RESTO restores the last deleted point to the display array.

SEQSOR

This subroutine sorts and orders an array of less than 101 integers.

CENTER

Any title array of twenty or less words will be centered within the array.

CORECT

CORECT is a double entry routine to handle the logic of the CORRECT and LIST options.

Entry CORECT prepares the display shown in Figure 10. All coordinates of the data points are converted to hollerith and displayed 15 at one time. A data point may be modified with a linear transformation or an individual character may be changed through use of the alpha-numeric keyboard.

Entry DALIST displays the data plotted in the graphical display in alpha-numeric form with up to 30 points per display.

CORLIM

This subroutine calculates the X and Y maxima and minima of the data arrays.

REFFIX

The references displayed in Figures 6 and 8 are prepared in this subroutine.

LIMITS

This subroutine contains an algorithm for calculating the axis limits and the separation of the grid lines for the data display.

PICT

PICT creates a brief artistic display on the tube face when a job is terminated.

COGEN

A 4-byte integer word is converted to EBCDIC characters without leading zeros. This is a North American Rockwell system routine.

CMBCD

This North American Rockwell system routine moves EBCDIC characters from one array to another.

INFILQ

INFILQ allocates temporary buffer storage so that a read or write statement may be executed in-core. A call to this routine always precedes a

READ (I, N) list

or a

WRITE (I, N) list

where I is 98 or 99. This is a North American Rockwell routine.

WTOR

This routine prints a line on the operator's console and returns the operator's one-character reply.

RTADJ

RTADJ removes the blanks from an array of text and right-adjusts the packed result.

HELP

This routine prints one line of text on the 2250 and returns one of three options detected by the user's light pen.

FIG 1

FIG 1 produces the initial data input (Figure 3) display on the 2250 and returns the parameters typed by the user on an END signal.

FIG 2

This routine displays summary information and returns the user's choice of SORT/NOSORT.

FIG 2A

FIG 2A overlays the basic display created by FIG 2. Text representing the selected references and energy limits is returned on an END signal. In addition, the program sets a flag and returns control if the reference list is detected by the light pen.

FIG 2B

FIG 2B overlays the display produced by FIG 2. This subprogram displays light-pen switches for the axis types and units. In addition to returning the selected setting of all the switches, text representing axis limits etc. is returned at the END signal.

FIG 3A

This program creates the basic data display. Return is effected when any light-pen switches are detected; sensitive areas are the option list and the reference list.

FIG 3B

This routine creates the data display. The points, hats, and letters shown on the screen are light-pen sensitive per an argument. Any light-pen detect of sensitive areas, or the END or CANCEL signal, results in an immediate return to the caller with appropriate parameter values.

FIG 4

The picture on the 2250 will either be a list of data points for perusal or a list of data points which may be corrected by use of the keyboard and light pen.

The first option will return control on the END or CANCEL signal. The CORRECT option returns parameters which indicate whether an END or CANCEL was selected. In addition, a light-pen detect of a displayed number causes the index of that number to be returned immediately.

APPENDIX II SCISRS ADAPTION PROGRAM

A. INTRODUCTION

The SCISRS Adaption Program (SAP) is designed to perform the following options:

- 1) Convert SCISRS EBCD data to SCORE input format (see Section III-B)
- 2) Create the identifier file on a new SCORE tape (see Section III-B)
- 3) Create the direct-access data-set used by SCORE (see Section III-C)
- 4) Construct, update, list, and punch the table of tape identifiers and the isotope table (see Section III-D)
- 5) Print the reaction table and the energy table for any data file on a SCORE tape (see Section III-B)
- 6) Print the identifier file of a SCORE tape (see Section III-B)
- 7) Create the final picture data-set for SCORE.

The remainder of this appendix describes the restrictions, data input, and operating procedures.

B. RESTRICTIONS

In converting the SCISRS data, SAP deletes comment cards, data whose σ -type is "SEL" where the secondary energy identification is "L," and data whose secondary energy is non-blank where the secondary energy identification is blank. SAP converts "last figures" error to percent error.

1. Dimensioning Considerations

<u>Item</u>	<u>Maximum Value</u>
Number of pairs in the table of reaction types	175
Number of pairs in the table of energy points	500*
Number of entries in the isotope table	400
Number of entries in the tape identifier table	20

*This is sufficient to allow for the approximately 28,000 data points which SCORE can store in the direct-access data-set.

2. Input-Output Assignments

<u>Symbol</u>	<u>Data-Set Reference Number</u>	<u>Explanation</u>
IN	5	Input stream
IO	6	Printout
N7	7	Punchout
NTAPE	8	SCISRS EBCD tape
NEW	9	SCORE output tape
NOLD	10	SCORE tape for printing of reaction and energy tables
NTAB	11	Tape identifier and isotope table data-set
NPCT	12	Final picture data-set
N17	17	Direct-access data-set

C. INPUT PREPARATION

1. Control Card (2A4, 1X, I3, 5I12)

<u>Symbol</u>	<u>Explanation</u>
DATE	The date, 2 EBCD words (e.g., 12/31/67)
NF	The number of files to be processed on the SCISRS EBCD tape 0 If a SCISRS tape is not to be processed
IFILE 1	0 Do not create the identifier file 1 Create the identifier file on a new SCORE tape
IDACS	0 Do not create the direct-access data-set 1 Create the direct-access data-set
IUPD	-1 Construct the table of tape identifiers and the isotope table based on the processing of the SCISRS EBCD tape (NF not equal to 0), or if NF equals 0 do not print and punch these tables 0 Use the table of tape identifiers and the isotope table from the disk

<u>Symbol</u>	<u>Explanation</u>
	1 Read the table of tape identifiers and the isotope table as input
	For IUPD = 0 or 1:
	If NF does not equal 0, these tables will be updated, written into the data-set, printed, and punched.
	If NF equals 0, these tables will be written into the data-set, printed, and punched.
NPRINT	The number of files to be processed on the SCORE tape for printing of tables or tape identifier
	0 If a SCORE tape is not to be processed for printing
IPICT	0 Do not create the final picture data-set
	1 Create the final picture data-set
2. <u>Identifier File Card (16A4)</u>	
	Omit if IFILE1=0.
TAPEX	The tape identifier, 2 EBCD words (e.g., SCORE001)
HEAD	14 EBCD words of arbitrary information
3. <u>Final Picture Data (19A4)</u>	
	Omit if IPICT=0.
	The final picture data deck is 170 EBCD cards which are distributed with SAP.
4. <u>Tape Identifier and Isotope Tables</u>	
	Omit if IUPD≠1.
a. <u>Control Card (2I12)</u>	
NIS	Number of entries in the isotope table to be read in (0<NIS≤400)
NTS	Number of tape identifiers in table to be read in (0<NTS≤20)

b. Tape Identifier Table (2A4, 4X, 2A4, 4X, etc.)

TAPE(J, I) NTS tape identifiers (2 EBCD words each) are read in 6 per
card (J=1, 2 and I=1, NTS), where I is the tape number NT

c. Isotope Table (2I12, 2A4, 4X, I12)

ISOTOP(I) Isotope number $Z*1000+A$

ISNUM(I) Tape and file number of the current data-set and tape and
file number of the data-set which this supercedes (see
Section III-D)

$$=(NT*100+NF)*10000+NT \underset{P}{*}100+NF \underset{P}$$

DATEIS(J, I) Date, 2 EBCD words, (J=1, 2)

NRECS(I) The total number of records in this file

NIS cards are read in (I=1, NIS)

5. Selected Isotopes (for conversion from SCISRS to SCORE format)

Omit if NF=0.

a. Title Card (16A4)

TITLE 16 EBCD words of arbitrary information

b. Isotope Card (A2, A3, 7X, E12.8, 2I12)

ZNUM Two-character EBCD Z number (e.g., 03 or 26)

ANUM Three-character EBCD A number (e.g., 007 or 000)

AMASS Atomic weight (based on $C^{12} = 12.0$)

NT Tape number (NT) (see Section III-D)

NF File number (NF) excluding the identifier file (see Sec-
tion III-D)

Repeat Cards a and b for each selected isotope. The selected isotope cards must be arranged in the order the isotopes appear in the SCISRS EBCD file, or the order of the DD cards, if in separate files. ZNUM and ANUM must agree identically with the corresponding values on the SCISRS EBCD tape.

D. SAMPLE INPUT SHEETS

FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 1 of 4 JOB NO. _____

	NUMBER	IDENTIFICATION	DESCRIPTION	DO NOT KEY PUNCH
1	2 / 3 1 / 6 7	2	DATE, NF	
13		1	IFILE1	
25		1	IDACS	
37		1	IUPD	
49		3	NPRINT	
61		1 0	IPICT	(2A4, 1X, I3, 5I12)
1	S C O R E 0 0 2 S E C		TAPEX, HEAD	
13	O N D S C O R E T A			
25	P E 1 2 / 3 1 / 6 7			Omit if IFILE1=0.
37	B E R L A N D , D U N F			
49	O R D , C R E A S Y	73 80		
61		2 0		(16A4)
1			Final Picture Data	
13			(170 cards)	
25				
37				Omit if IPICT=0.
49		73 80		
61		3 0		(19A4)
1		3	NIS	
13		1	NTS	
25				Omit if IUPD#1.
37				
49		71 80		
61		4 0		(2I12)

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FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 2 of 4 JOB NO. _____

	NUMBER	IDENTIFICATION	DESCRIPTION	DO NOT KEY PUNCH
1	S C O R E 0 0 1		TAPE	
13				
25				Omit if IUPD#1.
37				
49		73 80		
61		5 0		(2A4, 4X, 2A4, 4X, etc.)
1	1 1 0 2 3		ISOTOP	
13	1 0 1 0 0 0 0		ISNUM	
25	1 1 / 1 9 / 6 7		DATEIS	Omit if IUPD#1.
37	2 2 3 0		NRECS	
49		73 80		
61		6 0		(2I12, 2A4, 4X, I12)
1	2 6 0 0 0		ISOTOP	
13	1 0 2 0 0 0 0		ISNUM	
25	1 1 / 1 9 / 6 7		DATEIS	
37	7 4 8 5		NRECS	
49		73 80		
61		7 0		
1	2 6 0 5 4		ISOTOP	
13	1 0 3 0 0 0 0		ISNUM	
25	1 1 / 2 0 / 6 7		DATEIS	
37	2 3 8		NRECS	
49		71 80		
61		8 0		

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FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 3 of 4 JOB NO. _____

NUMBER	IDENTIFICATION	DESCRIPTION	DO NOT KEY PUNCH
1 13 25 37 49 61	PLUTONIUM 2	TITLE	
4	1 FROM BNL		
1	2 / 1 5 / 6 7		Omit if NF=0
73			
80			
9 0			(16A4)
1 13 25 37 49 61	9 4 2 4 1	ZNUM, ANUM	
2 4 1 . 0 5 6 6		AMASS	
2		NT	
1		NF	
73			
80			
1 0 0			(A2, A3, 7X, E12.8, 2I12)
1 13 25 37 49 61	NATURAL LIT HIUM FROM BN	TITLE	
L	1 2 / 2 0 / 6 7		
73			
80			
1 1 0			
1 13 25 37 49 61	0 3 0 0 0	ZNUM, ANUM	
6 . 9 3 6 1 2		AMASS	
1		NT	
4		NF	
73			
80			
1 2 0			

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FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 4 of 4 JOB NO. _____

NUMBER	IDENTIFICATION	DESCRIPTION	DO NOT KEY PUNCH
1 13 25 37 49 61	LITHIUM 7 F	TITLE	
R	OM BNL 1 2 / 2		
0 / 6 7			
73			
80			
1 3 0			
1 13 25 37 49 61	0 3 0 0 7	ZNUM, ANUM	
7 . 0 1 6		AMASS	
1		NT	
5		NF	
73			
80			
1 4 0			
1 13 25 37 49 61			
73			
80			

114-C-17

E. OPERATING INSTRUCTIONS

1. SCISRS BCD to SCISRS EBCD

The following job control language (JCL) cards are designed to convert a standard BCD SCISRS data tape (isotope, reaction, energy, etc., sorted) to a blocked EBCD SCISRS tape using the OS/360 utility program IEBGENER.

TAPE-TAPE PROCEDURE

```
//GO EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD UNIT=2400-2, DISP=OLD, LABEL=(K1†, NL), X
// DSNAME=BCDDATA, VOLUME=SER=YYYYYY, X
// DCB=(DEN=1, TRTCH=ET, RECFM=F, BLKSIZE=84, LRECL=84)
//SYSUT2 DD UNIT=2400, DISP=(NEW, KEEP), LABEL=(K2§, NL), X
// DSNAME=EBCDDATA, VOLUME=SER=ZZZZZZ, X
// DCB=(RECFM=FB, LRECL=80, BLKSIZE=4480)
//SYSIN DD *
GENERATE MAXFLDS=1
RECORD FIELD=(80, 1, HE, 1)
/*
```

[†]K1 is the desired file on the SCISRS BCD.

[§]K2 is the next available file on the SCISRS EBCD tape.

2. SAP Procedure

The following job control language (JCL) cards are designed to execute SAP from a job library. The load module for SAP, the direct-access data-set, the tape and file tables, and the data for PICT are all on the same disk pack. The SCORE tapes must be non-labelled.

SAP PROCEDURE

```
//JOB LIB DD UNIT=2311, VOLUME=SER=SCPACK, DSNNAME=SCLMOD, DISP=OLD
//GO EXEC PGM=SAP
//FT05F001 DD DDNAME=SYSIN
//FT06F001 DD SYSOUT=A, DCB=(, RECFM=UA)
//FT07F001 DD UNIT=(SYSCP, , DEFER), DISP=(MOD, PASS), DCB=(STACK=2)
//FT08F001 DD UNIT=2400, DISP=OLD, LABEL=(M1†, NL), X
//          DSNNAME=EBCDDATA, VOLUME=SER=ZZZZZZ, X
//          DCB=(RECFM=FB, LRECL=80, BLKSIZE=4480)
//FT08F002 DD DISP=OLD, LABEL=(M2†, NL), X
//          DSNNAME=MOREDATA, VOLUME=REF=*. FT08F001 X
//          DCB=(RECFM=FB, LRECL=80, BLKSIZE=4480)
    Etc.
//FT09F001 DD UNIT=2400, DISP=(NEW, KEEP), LABEL=(N1§, NL), X
//          DSNNAME=FILE1, VOLUME=SER=WWWWW, X
//          DCB=(RECFM=V, LRECL=68, BLKSIZE=72)
//FT09F002 DD DISP=(NEW, KEEP), LABEL=(N2§, NL), X
//          DSNNAME=FILE2, VOLUME=REF=*. FT09F001, X
//          DCB=(RECFM=VB, LRECL=68, BLKSIZE=3812)
    Etc.
//FT10F001 DD UNIT=2400, DISP=OLD, LABEL=(L1††, NL), X
//          DSNNAME=FILE1, VOLUME=SER=XXXXXX, X
//          DCB=(RECFM=V, LRECL=68, BLKSIZE=72)
//FT10F002 DD DISP=OLD, LABEL=(L2††, NL), X
//          DSNNAME=FILE2, VOLUME=REF=*. FT10F001, X
//          DCB=(RECFM=VB, LRECL=68, BLKSIZE=3812)
    Etc.
//FT11F001 DD UNIT=2311, VOLUME=SER=SCPACK, DISP=OLD, X
//          DSNNAME=TFTABLE, DCB=(RECFM=V, LRECL=3620, BLKSIZE=3624), X
//          SPACE=(TRK, (2, 1))
//FT12F001 DD UNIT=2311, VOLUME=SER=SCPACK, DISP=(NEW, KEEP), X
//          DSNNAME=PICTDATA, DCB=(RECFM=V, LRECL=3620, BLKSIZE=3624), X
//          SPACE=(TRK, (5, 1))
//FT17F001 DD UNIT=2311, VOLUME=SER=SCPACK, DISP=(NEW, KEEP), X
//          DSNNAME=SCDIRECT, SPACE=(3584, (500, 1)), X
//          DCB=(RECFM=F, BLKSIZE=3584)
//SYSIN DD *
```

[DATA]

/*

†M1,M2 are the desired files on the SCISRS EBCD tape.

§N1,N2 are the output files on the SCORE tape.

††L1,L2 are the desired files for printing.

6. Sample Output

PU241

THIS FILE WAS ADDED TO THE TAPE 11/27/67

THE ELEMENT ID IS Z = 94 A = 241 THE MASS IS 2.41000E 02

REACTION TYPE	LOWER ENERGY	RECORD NUMBER
S	1.47400E-05	3
EN	5.80000E-06	15
GF	2.50000E-07	19
GG	2.50000E-07	23
GT	2.50000E-07	27
WGN	2.50000E-07	81
WGO	1.27500E-05	101
GFS	4.32000E-06	146
GTS	2.50000E-07	156
SF	2.55000E-07	157
STF	1.50000E-05	158
ABS	2.53000E-08	159
FTA	2.53000E-02	171
NF	2.53000E-09	172
NF	1.35500E-08	422
NF	2.50000E-08	672
NF	4.29000E-08	922
NF	9.14999E-08	1172
NF	2.57000E-07	1422
NF	5.73000E-07	1672
NF	1.78900E-06	1922
NF	5.31200E-06	2172
NF	8.70199E-06	2422
NF	1.31100E-05	2672
NF	1.87800E-05	2922
NF	2.29500E-05	3172
NF	2.66400E-05	3422
NF	3.11400E-05	3672
NF	3.71200E-05	3922
NF	4.46600E-05	4172
NF	5.45499E-05	4422
NF	6.73499E-05	4672
NF	8.32299E-05	4922
NF	9.96599E-05	5172
NF	1.25400E-04	5422
NF	1.60800E-04	5672
NF	2.23700E-04	5922
NF	4.04900E-04	6172
NF	9.56400E-04	6422
NF	3.68600E-03	6672
NF	1.58000E-02	6922
NF	3.41000E-01	7172
NFE	2.53000E-09	7312
NG	2.53000E-08	7324
NU	2.53000E-02	7328
RIF	4.50000E-07	7329

NAA-SR-MEMO-12529

TOT	1.05000E-08	7331
TOT	1.97000E-07	7581
TOT	2.64000E-06	7831
TOT	3.30800E-06	8081
TOT	4.13000E-06	8331
TOT	4.75000E-06	8581
TOT	5.66500E-06	8831
TOT	6.95900E-06	9081
TOT	8.68499E-06	9331
TOT	1.03100E-05	9581
TOT	1.23300E-05	9831
TOT	1.33400E-05	10081
TOT	1.44100E-05	10331
TOT	1.52900E-05	10581
TOT	1.64500E-05	10831
TOT	1.77500E-05	11081
TOT	1.93100E-05	11331
TOT	2.13500E-05	11581
TOT	2.35300E-05	11831
TOT	2.55400E-05	12081
TOT	2.77600E-05	12331
TOT	3.04560E-05	12581
TOT	3.37700E-05	12831
TOT	3.74200E-05	13081
TOT	4.09200E-05	13331
TOT	4.52000E-05	13581
TOT	4.98900E-05	13831
TOT	5.60499E-05	14081
TOT	6.30799E-05	14331
TOT	7.11800E-05	14581
TOT	8.09499E-05	14831
TOT	9.49099E-05	15081
TOT	1.18200E-04	15331
TOT	1.56600E-04	15581
TOT	2.19600E-04	15831
TOT	3.32500E-04	16081
TOT	6.87500E-04	16331
TDE	2.50000E-08	16401

TOTAL NUMBER OF RECORDS IS 16544
NUMBER OF REACTION TYPES IS 20
RECORD NUMBER FOR THE REACTION TABLE IS 16530

SCORE TABLE OF CONTENTS 11/30/67

I	Z	A	DATE	TAPE	FILE	RECORDS	UPDATES	
							TAPE	FILE
1	11	23	7/19/67	1	1	2230	0	0
2	26	C	7/19/67	1	2	7485	0	0
3	26	54	7/20/67	1	3	238	0	0
4	3	C	7/20/67	1	4	1123	0	0
5	3	7	7/20/67	1	5	1037	0	0
6	94	241	11/27/67	2	1	16544	0	0

TAPE	ID	FILES	TOTAL NUMBER OF RECORDS
1	SCORE001	5	12113
2	SCORE002	1	16544

APPENDIX III
SYSTEM 360 CONTROL LANGUAGE

The following job-control-language (JCL) cards are designed to execute SCORE from a job library. The load module for SCORE, the direct-access data-set, the tape and file tables, and the data for PICT are all on the same disk pack. The tape must be non-labelled.

SCORE PROCEDURE

```
//JOB LIB DD UNIT=2311, VOLUME=SER=SCPACK, DSN= SCLMOD, DISP=OLD
//GO EXEC PGM=SCORE
//FT05F001 DD DDNAME=SYSIN
//FT06F001 DD SYSOUT=A, DCB=(, RECFM=UA)
//FT08F001 DD UNIT=2311, VOLUME=SER=SCPACK, DISP=OLD, X
//          DSN= TFTABLE, DCB=(RECFM=V, LRECL=3620, BLKSIZE=3624), X
//          SPACE=(TRK, (2, 1))
//FT10F001 DD UNIT=2311, VOLUME=SER=SCPACK, DISP=OLD, X
//          DSN= PICTDATA, DCB=(RECFM=V, LRECL=3620, BLKSIZE=3624) X
//          SPACE=(TRK, (5, 1))
//FT17F001 DD UNIT=2311, VOLUME=(, RETAIN, SER=SCPACK), DISP=OLD, X
//          DSN= SCDIRECT, SPACE=(3584, (500, 1)), X
//          DCB=(RECFM=F, BLKSIZE=3584)
//FT20F001 DD UNIT=(2400, , DEFER), DISP=OLD, LABEL=(1, NL), X
//          DSN= FILE1, VOLUME=(, RETAIN, SER=XXXXXX), X
//          DCB=(RECFM=V, LRECL=68, BLKSIZE=72)
//FT21F001 DD DISP=OLD, LABEL=(2, NL), X
//          DSN= FILE2, VOLUME=REF=*. FT20F001, X
//          DCB=(RECFM=VB, LRECL=68, BLKSIZE=3812)
//FT22F001 DD DISP=OLD, LABEL=(3, NL), X
//          DSN= FILE3, VOLUME=REF=*. FT21F001 X
//          DCB=(RECFM=VB, LRECL=68, BLKSIZE=3812)
.
.
.
//FTMNF001 DD DISP=OLD, LABEL=(K, NL), X
//          DSN= FILEK, VOLUME=REF=*. FTMMF001, X
//          DCB=(RECFM=VB, LRECL=68, BLKSIZE=3812)
//SCOPE DD UNIT=2250
//SYSIN DD DUMMY
†K=MN-20+1
§MM=MN-1
```


APPENDIX IV PRINTED OUTPUT

This section illustrates a typical set of printed output from a SCORE run. The printed output from SCORE is designed to give a complete record of the actions of the evaluator and will serve as a supplement to the planned hard copy output. This illustrative printed output corresponds to several illustrations in this document.

SCORE - AN AUTOMATED CROSS SECTION EVALUATION SYSTEM

A JOINT RESEARCH PROJECT

ATOMIC S INTERNATIONAL AND IBM - PALO ALTO

VERSION I JULY 20, 1967

CASE NUMBER 100

LABORATORY: AI - IBM
EVALUATOR: C.L.DUNFORD
DATE: 10/31/67
ELEMENT: 11
MASS NUMBER: 23
REACTION TYPE: XXXX
MINIMUM ENERGY (MEV): 6.
MAXIMUM ENERGY (MEV): 22.
LEVEL ENERGY (MEV): C.

* REACTION TYPE XXXX IS NOT ACCEPTABLE. TRY AGAIN.

CASE NUMBER 100

LABORATORY: AI - IBM
EVALUATOR: C.L.DUNFORD
DATE: 10/31/67
ELEMENT: 11
MASS NUMBER: 23
REACTION TYPE: NA
MINIMUM ENERGY (MEV): 6.
MAXIMUM ENERGY (MEV): 22.
LEVEL ENERGY (MEV): 0.

SODIUM - 23

(N,ALPHA)

ENERGY RANGE 6.3000E 00 ME V TO 2.1000E 01 MEV
 CROSS SECTION 1.2000E-03 B TO 1.5400E 02 B

REFERENCES

A J PR 122, 1877
 B J ZN 15A, 200
 C J NP 36, 38
 D K NP 63, 673
 E J PPS 77, 508

I	ENERGY (MEV)	CROSS SECTION (B)	CROSS SECTION UNCERTAINTY		REFERENCE
			LOWER	UPPER	
1	6.300E 00	1.2000E-C3	5.1200E-04	1.4880E-03	A
2	6.400E 00	2.1000E-C3	1.5960E-03	2.6040E-03	A
3	6.500E 00	2.8000E-C3	2.1280E-03	3.4720E-03	A
4	6.600E 00	3.7000E-C3	2.8120E-03	4.5880E-03	A
5	6.700E 00	4.8000E-C3	3.6480E-03	5.9520E-03	A
6	6.800E 00	5.1000E-C3	3.8760E-03	6.3240E-03	A
7	6.900E 00	7.0000E-C3	5.3200E-03	8.6800E-03	A
8	7.000E 00	7.5000E-C3	5.7000E-03	9.3000E-03	A
9	7.100E 00	8.2000E-C3	6.2320E-03	1.0168E-02	A
10	7.200E 00	9.3000E-C3	7.0680E-03	1.1532E-02	A
11	7.300E 00	1.1000E-C2	8.3600E-03	1.3640E-02	A
12	7.400E 00	1.2300E-C2	9.3480E-03	1.5252E-02	A
13	7.500E 00	1.5100E-C2	1.1476E-02	1.8724E-02	A
14	7.600E 00	1.6800E-C2	1.2768E-02	2.0832E-02	A
15	7.700E 00	2.5000E-C2	1.6750E-02	3.3250E-02	A
16	8.700E 00	4.5000E-C2	3.0150E-02	5.9850E-02	A
17	8.800E 00	2.5000E-C2	1.6750E-02	3.3250E-02	A
18	8.900E 00	3.0000E-C2	2.0100E-02	3.9900E-02	A
19	9.000E 00	4.6000E-C2	3.0820E-02	6.1180E-02	A
20	9.100E 00	6.0000E-C2	4.0200E-02	7.9800E-02	A
21	9.200E 00	5.0000E-C2	3.3500E-02	6.6500E-02	A
22	9.300E 00	3.9000E-C2	2.6130E-02	5.1870E-02	A
23	9.400E 00	3.2000E-C2	2.1440E-02	4.2560E-02	A
24	9.500E 00	4.8000E-C2	3.2160E-02	6.3840E-02	A
25	9.600E 00	5.9000E-C2	3.9530E-02	7.8470E-02	A
26	9.700E 00	5.0000E-C2	3.3500E-02	6.6500E-02	A
27	9.800E 00	5.2000E-C2	3.4840E-02	6.9160E-02	A
28	9.900E 00	4.8000E-C2	3.2160E-02	6.3840E-02	A
29	1.000E 01	7.8000E-C2	5.2260E-02	1.0374E-01	A
30	1.010E 01	7.8000E-C2	5.2260E-02	1.0374E-01	A
31	1.020E 01	5.0000E-C2	3.3500E-02	6.6500E-02	A
32	1.030E 01	4.2000E-C2	2.8140E-02	5.5860E-02	A
33	1.040E 01	5.0000E-C2	3.3500E-02	6.6500E-02	A
34	1.050E 01	7.1000E-C2	4.7570E-02	9.4430E-02	A
35	1.400E 01	2.9000E-C2	2.0000E-02	3.8000E-02	B
36	1.405E 01	1.4700E-C1	1.2900E-01	1.6500E-01	C
37	1.418E 01	1.7200E-C1	1.5200E-01	1.9200E-01	D
38	1.480E 01	2.2200E-C1	1.9980E-01	2.4420E-01	E
39	1.489E 01	1.6400E-C2	1.4200E-02	1.8600E-02	D
40	1.567E 01	1.5300E-C2	1.3300E-02	1.7300E-02	D
41	1.590E 01	1.0000E-C1	6.7000E-02	1.3300E-01	A
42	1.615E 01	1.3400E-C2	1.1900E-02	1.4900E-02	D
43	1.680E 01	6.9000E-C2	4.6230E-02	9.1770E-02	A
44	1.733E 01	7.5500E-C1	7.4500E-01	7.6500E-01	D
45	1.750E 01	6.0000E-C2	4.0200E-02	7.9800E-02	A
46	1.820E 01	5.4000E-C2	3.6180E-02	7.1820E-02	A
47	1.849E 01	6.0000E-C1	5.0000E-01	7.0000E-01	D
48	1.892E 01	4.5600E-C1	4.1600E-01	4.9600E-01	D
49	1.900E 01	3.9000E-C2	2.6130E-02	5.1870E-02	A
50	1.961E 01	4.9000E-C1	4.4000E-01	5.4000E-01	D
51	2.019E 01	3.4000E-C1	2.9000E-01	3.9000E-01	D
52	2.063E 01	3.0700E-C1	2.7700E-01	3.3700E-01	D
53	2.090E 01	2.9000E-C1	2.6000E-01	3.2000E-01	D
54	2.100E 01	2.5800E-C1	2.2800E-01	2.8800E-01	D

DISPLAY NUMBER IS 101 FOR THIS DATA SET

ENERGY RANGE 6.3000E 00 MEV TO 2.1000E 01 MEV
 CROSS SECTION 1.2000E-03 B TO 1.5400E 02 B

REFERENCES

A J PR 122, 1877
 B J ZN 15A, 2C0
 C J NP 36, 38
 D K NP 63, 673
 E J PPS 77, 5C8

I	ENERGY (MEV)	CROSS SECTION (B)	CROSS SECTION UNCERTAINTY		REFERENCE
			LOWER	UPPER	
1	6.300E 00	1.2000E-03	5.1200E-04	1.4880E-03	A
2	6.400E 00	2.1000E-03	1.5960E-03	2.6040E-03	A
3	6.500E 00	2.8000E-03	2.1280E-03	3.4720E-03	A
4	6.600E 00	3.7000E-03	2.8120E-03	4.5880E-03	A
5	6.700E 00	4.8000E-03	3.6480E-03	5.9520E-03	A
6	6.800E 00	5.1000E-03	3.8760E-03	6.3240E-03	A
7	6.900E 00	7.0000E-03	5.3200E-03	8.6800E-03	A
8	7.000E 00	7.5000E-03	5.7000E-03	9.3000E-03	A
9	7.100E 00	8.2000E-03	6.2320E-03	1.0168E-02	A
10	7.200E 00	9.3000E-03	7.0680E-03	1.1532E-02	A
11	7.300E 00	1.1000E-02	8.3600E-03	1.3640E-02	A
12	7.400E 00	1.2300E-02	9.3480E-03	1.5252E-02	A
13	7.500E 00	1.5100E-02	1.1476E-02	1.8724E-02	A
14	7.600E 00	1.6800E-02	1.2768E-02	2.0832E-02	A
15	7.700E 00	2.5000E-02	1.6750E-02	3.3250E-02	A
16	8.700E 00	4.5000E-02	3.0150E-02	5.9850E-02	A
17	8.800E 00	2.5000E-02	1.6750E-02	3.3250E-02	A
18	8.900E 00	3.0000E-02	2.0100E-02	3.9900E-02	A
19	9.000E 00	4.6000E-02	3.0820E-02	6.1180E-02	A
20	9.100E 00	6.0000E-02	4.0200E-02	7.9800E-02	A
21	9.200E 00	5.0000E-02	3.3500E-02	6.6500E-02	A
22	9.300E 00	3.9000E-02	2.6130E-02	5.1870E-02	A
23	9.400E 00	3.2000E-02	2.1440E-02	4.2560E-02	A
24	9.500E 00	4.8000E-02	3.2160E-02	6.3840E-02	A
25	9.600E 00	5.9000E-02	3.9530E-02	7.8470E-02	A
26	9.700E 00	5.0000E-02	3.3500E-02	6.6500E-02	A
27	9.800E 00	5.2000E-02	3.4840E-02	6.9160E-02	A
28	9.900E 00	4.8000E-02	3.2160E-02	6.3840E-02	A
29	1.000E 01	7.8000E-02	5.2260E-02	1.0374E-01	A
30	1.010E 01	7.8000E-02	5.2260E-02	1.0374E-01	A
31	1.020E 01	5.0000E-02	3.3500E-02	6.6500E-02	A
32	1.030E 01	4.2000E-02	2.8140E-02	5.5860E-02	A
33	1.040E 01	5.0000E-02	3.3500E-02	6.6500E-02	A
34	1.050E 01	7.1000E-02	4.7570E-02	9.4430E-02	A
35	1.400E 01	2.9000E-02	2.0000E-02	3.8000E-02	B
36	1.405E 01	1.4700E-01	1.2900E-01	1.6500E-01	C
37	1.418E 01	1.7200E-01	1.5200E-01	1.9200E-01	D
38	1.480E 01	2.2200E-01	1.9980E-01	2.4420E-01	E
39	1.489E 01	1.6400E-02	1.4200E-02	1.8600E-02	D
40	1.567E 01	1.5300E-02	1.3300E-02	1.7300E-02	D
41	1.590E 01	1.0000E-01	6.7000E-02	1.3300E-01	A
42	1.615E 01	1.3400E-02	1.1900E-02	1.4900E-02	D
43	1.680E 01	6.9000E-02	4.6230E-02	9.1770E-02	A
44	1.733E 01	7.5500E-01	7.4500E-01	7.6500E-01	D
45	1.750E 01	6.0000E-02	4.0200E-02	7.9800E-02	A
46	1.820E 01	5.4000E-02	3.6180E-02	7.1820E-02	A
47	1.849E 01	6.0000E-01	5.0000E-01	7.0000E-01	D
48	1.892E 01	4.5600E-01	4.1600E-01	4.9600E-01	D
49	1.900E 01	3.9000E-02	2.6130E-02	5.1870E-02	A
50	1.961E 01	4.9000E-01	4.4000E-01	5.4000E-01	D
51	2.019E 01	3.4000E-01	2.9000E-01	3.9000E-01	D
52	2.063E 01	3.0700E-01	2.7700E-01	3.3700E-01	D
53	2.090E 01	2.9000E-01	2.6000E-01	3.2000E-01	D
54	2.100E 01	2.5800E-01	2.2800E-01	2.8800E-01	D

PARAMETERS FOR 2250 DISPLAY

SODIUM - 23 (N,ALPHA) NO. 101

X-AXIS LINEAR 3.0000E 00 UNITS PER DIVISION TO 2.1000E 01
 INCIDENT NEUTRON ENERGY (MEV) 5.0000E 00
 Y-AXIS LOGARITHMIC 3.77283E 01 UNITS PER CYCLE TO 2.0000E 02
 CROSS SECTION -BARN- 1.0000E-03

NAA-SR-MEMO-12529

DISPLAY NUMBER IS 102

DATA FROM PREVIOUS DISPLAY NO. 101 HAVE BEEN USED WITH THE FOLLOWING DELETIONS

I	ENERGY MEV	CROSS SECTION BARNs	REFERENCE
35	1.4000E 01	2.9000E-02	B
36	1.4050E 01	1.4700E-01	C
37	1.4180E 01	1.7200E-01	D
38	1.4800E 01	2.2200E-01	E
39	1.4890E 01	1.6400E 02	D
40	1.5670E 01	1.5300E 02	D
42	1.6150E 01	1.3400E 02	D
44	1.7330E 01	7.5500E 01	D

DATA OF DISPLAY NUMBER 101 HAVE BEEN RESTORED

DISPLAY NUMBER IS 103 FOR THIS DATA SET

ENERGY RANGE 6.3000E 00 MEV TO 2.1000E 01 MEV
 CROSS SECT ION 1.2000E-03 B TO 1.5400E 02 B

REFERENCES

A J PR 122, 1877
 B J ZN 15A, 200
 C J NP 36, 38
 D K NP 63, 673
 E J PPS 77, 508

I	ENERGY (MEV)	CROSS SECTION (B)	CROSS SECTION UNCERTAINTY		REFERENCE
			LOWER	UPPER	
1	6.300E 00	1.2000E-03	5.1200E-04	1.4880E-03	A
2	6.400E 00	2.1000E-03	1.5960E-03	2.6040E-03	A
3	6.500E 00	2.8000E-03	2.1280E-03	3.4720E-03	A
4	6.600E 00	3.7000E-03	2.8120E-03	4.5880E-03	A
5	6.700E 00	4.8000E-03	3.6480E-03	5.9520E-03	A
6	6.800E 00	5.1000E-03	3.8760E-03	6.3240E-03	A
7	6.900E 00	7.0000E-03	5.3200E-03	8.6800E-03	A
8	7.000E 00	7.5000E-03	5.7000E-03	9.3000E-03	A
9	7.100E 00	8.2000E-03	6.2320E-03	1.0168E-02	A
10	7.200E 00	9.3000E-03	7.0680E-03	1.1532E-02	A
11	7.300E 00	1.1000E-02	8.3600E-03	1.3640E-02	A
12	7.400E 00	1.2300E-02	9.3480E-03	1.5252E-02	A
13	7.500E 00	1.5100E-02	1.1476E-02	1.8724E-02	A
14	7.600E 00	1.6800E-02	1.2768E-02	2.0832E-02	A
15	7.700E 00	2.5000E-02	1.6750E-02	3.3250E-02	A
16	8.700E 00	4.5000E-02	3.0150E-02	5.9850E-02	A
17	8.800E 00	2.5000E-02	1.6750E-02	3.3250E-02	A
18	8.900E 00	3.0000E-02	2.0100E-02	3.9900E-02	A
19	9.000E 00	4.6000E-02	3.0820E-02	6.1180E-02	A
20	9.100E 00	6.0000E-02	4.0200E-02	7.9800E-02	A
21	9.200E 00	5.0000E-02	3.3500E-02	6.6500E-02	A
22	9.300E 00	3.9000E-02	2.6130E-02	5.1870E-02	A
23	9.400E 00	3.2000E-02	2.1440E-02	4.2560E-02	A
24	9.500E 00	4.8000E-02	3.2160E-02	6.3840E-02	A
25	9.600E 00	5.9000E-02	3.9530E-02	7.8470E-02	A
26	9.700E 00	5.0000E-02	3.3500E-02	6.6500E-02	A
27	9.800E 00	5.2000E-02	3.4840E-02	6.9160E-02	A
28	9.900E 00	4.8000E-02	3.2160E-02	6.3840E-02	A
29	1.000E 01	7.8000E-02	5.2260E-02	1.0374E-01	A
30	1.010E 01	7.8000E-02	5.2260E-02	1.0374E-01	A
31	1.020E 01	5.0000E-02	3.3500E-02	6.6500E-02	A
32	1.030E 01	4.2000E-02	2.8140E-02	5.5860E-02	A
33	1.040E 01	5.0000E-02	3.3500E-02	6.6500E-02	A
34	1.050E 01	7.1000E-02	4.7570E-02	9.4430E-02	A
35	1.400E 01	2.9000E-02	2.0000E-02	3.8000E-02	B
36	1.405E 01	1.4700E-01	1.2900E-01	1.6500E-01	C
37	1.418E 01	1.7200E-01	1.5200E-01	1.9200E-01	D
38	1.480E 01	2.2200E-01	1.5980E-01	2.4420E-01	E
39	1.489E 01	1.6400E 02	1.4200E 02	1.8600E 02	D
40	1.567E 01	1.5300E 02	1.3300E 02	1.7300E 02	D
41	1.590E 01	1.0000E-01	6.7000E-02	1.3300E-01	A
42	1.615E 01	1.3400E 02	1.1900E 02	1.4900E 02	D
43	1.680E 01	6.9000E-02	4.6230E-02	9.1770E-02	A
44	1.733E 01	7.5500E 01	7.4500E 01	7.6500E 01	D
45	1.750E 01	6.0000E-02	4.0200E-02	7.9800E-02	A
46	1.820E 01	5.4000E-02	3.6180E-02	7.1820E-02	A
47	1.849E 01	6.0000E 01	5.0000E 01	7.0000E 01	D
48	1.892E 01	4.5600E 01	4.1600E 01	4.9600E 01	D
49	1.900E 01	3.9000E-02	2.6130E-02	5.1870E-02	A
50	1.961E 01	4.9000E 01	4.4000E 01	5.4000E 01	D
51	2.019E 01	3.4000E 01	2.9000E 01	3.9000E 01	D
52	2.063E 01	3.0700E 01	2.7700E 01	3.3700E 01	D
53	2.090E 01	2.9000E 01	2.6000E 01	3.2000E 01	D
54	2.100E 01	2.5800E 01	2.2800E 01	2.8800E 01	D

PARAMETERS FOR 2250 DISPLAY

SODIUM - 23 (N,ALPHA) NO. 103

X-AXIS LINEAR 3.0000E 00 UNITS PER DIVISION
 INCIDENT NEUTRON ENERGY (MEV) 5.0000E 00 TO 2.1000E 01

Y-AXIS LOGARITHMIC 3.7728E 01 UNITS PER CYCLE
 CROSS SECTION -BARN- 1.0000E-03 TO 2.0000E 02

NAA-SR-MEMO-12529

THE FOLLOWING DATA HAVE BEEN CORRECTED

I	ENERGY MEV	CROSS SECTION BARNs	REFERENCE
39	1.4890E 01	1.6400E-01	D
40	1.5670E 01	1.5300E-01	D
42	1.6150E 01	1.3400E-01	D
44	1.7330E 01	7.5500E-02	D
47	1.8490E 01	6.0000E-02	D
48	1.8920E 01	4.5600E 01	D
50	1.9610E 01	4.9000E 01	D
51	2.0190E 01	3.4000E 01	D
52	2.0630E 01	3.0700E 01	D
53	2.0900E 01	2.9000E 01	D
54	2.1000E 01	2.5800E 01	D

