11 ENDF

The Evaluated Nuclear Data File (ENDF) is a numeric data file containing reference nuclear data for use in the development and implementation of nuclear technologies such as fission and fusion power, medicine, etc. The ENDF data base contains evaluated nuclear data for the interaction of particles, primarily neutrons, with either elements or nuclei, but also for charged-particle and photon induced reactions. The file also contains data on radiations from nuclear isotopes. The types of data contained in this data file include cross sections, secondary particle distributions, photon production, fission product yields, and data covariance matrices.

The ENDF format and the first ENDF data library were prepared between 1964 and 1966 by the Cross Section Evaluation Working Group coordinated by the National Nuclear Data Center of Brookhaven National Laboratory. The data library produced by this organization is called ENDF/B. In the intervening years, other countries or groups of countries have created their own libraries of evaluated data in the ENDF format. These evaluated data libraries have been included in the ENDF data base. The data base contains the following data libraries:

ENDF/B produced by the United States,

JEF produced by the Western European countries,

JENDL produced in Japan,

BROND produced in Russia,

CENDL produced in China.

11.1 ENDF Organization

Each data library contains only a single evaluation for a combination of target material and incident particle, for example neutrons incident on ^{238}U. Evaluations also can be made for a material with no incident particle. These evaluations contain spectra from radioactive decay of a material (isotope). An evaluation is organized into "files" identified by an MF number. A "file" contains information about a reaction or decay quantity such as cross sections (File 3), secondary neutron energy distributions (File 5), photon production multiplicities (File 10), etc. A "file" is further divided into "sections". Each section is identified by an MT number and contains the numeric data for a given reaction. For example, file 3, section 16 contains the (n,2n) cross section and file 6, section 103 contains the secondary proton energy-angle distribution from the (n,p) reaction.

The section contains numeric data in tabular form. In addition, the method for interpolation between data points is defined. Each "file" has its own format for storing the evaluated data. The simplest format is for cross sections which is basically a two-dimensional function. The storage of secondary energy-angle distributions is much more complex due to the three-dimensional nature of the data. The ENDF format is documented in V. McLane et al., "ENDF-102, Data Formats and Procedures for the Evaluated Nuclear Data File", BNL-NCS-44945 (1997), which is available electronically from the DOCUMENTS option (see Section 15.2.2).

11.2 ENDF Options

The main menu and the associated options are summarized in the following diagram. The options listed on the top line of the diagram represent the top-level menu. Where an option is itself a menu of sub-options, the secondary menu items are listed vertically below the top-level option. Each option and sub-option will be described in detail below. All top-level options will be given in the text all in capital letters; sub-options will also be given in capital letters with a slash between the option and sub-option. For example RETRIEVE and RETRIEVE/OVERLAY. A sample top-level menu in video mode after an evaluation has been selected is illustrated at the bottom of the page. See Section 5.6 and Section 5.5 for a discussion of the CITE and HELP options respectively.

Select	Retrieve	New_file	Format	Cite	Help	Exit
	List All Plot Overlay Send New_file Format Done					

Top Level Menu in the Video Environment

Evaluated Nuclear Data File - ENDF

EVALUATED NUCLEAR DATA FILE (ENDF) RETRIEVAL PROGRAM

Data Base Last Updated on 9-May-1997

Format : **Narrow Table** File : **User Terminal**

JEF-2 library **Neutron projectile** **92-U-238 (9237)**

JEF COLLAB EVAL-JUN89 MCM,MGS,FHF,CN,YN,KANDA ET AL

SELECT **RETRIEVE** **NEW_FILE** **FORMAT** **CITE** **HELP** **EXIT**

RETRIEVE - Retrieve data from selected evaluation

11.3 SELECT

One must first select an evaluation from the contents of the data base. The RETRIEVE option is not active until an evaluation has been selected. This selection is done by specifying first a target nucleus and then a projectile. If there are no evaluations for the selected combination of target material and projectile, a message is displayed and the user is returned to the top-level menu. This step is illustrated in the following figure, First Video Panel.

Target — A target nuclide can be specified by its chemical symbol, representing the number of protons in its nucleus, and by its atomic number, the number of neutrons and protons in its nucleus. Either of the two standard representations is accepted, that is 238U or U-238. Almost all target materials are in their ground state. If you wish to select a target material in an excited state, then enter the isomer level number preceeded by an -M, for example AM-243-M1. If you wish to select a natural element target, either do not enter the atomic number or enter a zero for it; for natural iron, enter FE or Fe-0. Some evaluations exist for target nuclei which are chemical compounds, heavy water for example. In these cases the data exist only for incident neutrons. To select a compound enter COMP for the target material. A list chemical compounds will be presented from which you may select.

Projectile — A projectile or incident particle can be specified its standard symbol shown in the following table.

G	gamma ray
N	neutron
P	proton
D	deuteron
T	triton
HE-3	^{3}He nucleus
A	alpha particle
DECAY	radioactive decay (no projectile)
PHOTON	photo-atomic data (natural elements only)

To specify fission product yields, one must give the projectile/FPY. For neutron fission product yields, enter N/FPY; for spontaneous fission product yields, enter DECAY/FPY.

When the target material and projectile have been entered, the program will generate a list of evaluated data libraries which contain an evaluation for the desired target nucleus and projectile. The user can now select the library from which to retrieve the desired material evaluation. If none of the evaluated data libraries is desired, select QUIT to return to the top-level menu. If the selected evaluation is available both in the original evaluated file and in the 300 degree-K doppler broadened file, then a menu is presented for your further selection. The original evaluation (called BASIC) generally has a resonance parameter representation in the resonance region. The doppler broadened file will have the parameters expanded to a pointwise data file which has been doppler broadened to 300 degrees-K.

Evaluation Selection in Video Environment
First Video Panel

Evaluated Nuclear Data File - ENDF

SELECT

Format : **Narrow Table**　　　File : **User Terminal**

Select Evaluation

Target (Z-A-LEVEL_NUMBER) - **U-238**

Projectile (N, P, G, etc) - **N**

Video The library selection list illustrated in the following figure (Second Panel) is used to choose an evaluated data library. Each library name is displayed in the list along with a brief description. The highlighted library can be changed by using the UP-ARROW or DOWN-ARROW key. When the desired library is highlighted, press the RETURN key to complete selection. The last item in the list is QUIT which when selected will return the program to the top-level menu. If a doppler broadened version of the file exists, a menu will appear with two items, BASIC and 300 DEGREE K. Choose either the original evaluated file (BASIC) or the doppler broadened file, (300 DEGREE K).

Sequential In sequential mode, the ENDF module will list the data libraries containing the desired combination of target material and projectile along with an integer identification number. At the prompt, enter the identification number for the data library desired. A RETURN without a preceeding identification code will select the current default data library which is denoted by an * preceding the identification number. By selecting QUIT, the user is returned to the top-level menu.

Evaluation Selection in Video Environment (cont.)

Second Video Panel

Evaluated Nuclear Data File - ENDF

SELECT

Format : **Narrow Table** File : **User Terminal**

Select a Data Library

Target - **U-238** Projectile - **N**

ENDF/B-VI	-	United States evaluated nuclear data file
JEF-2	-	Western European evaluated nuclear data file
CENDL-2	-	Chinese evaluated nuclear data file
JENDL-3	-	Japanese evaluated nuclear data file
BROND-2	-	Russian evaluated nuclear data file
QUIT	-	No evaluation selected; return to option menu

Third Video Panel

Evaluated Nuclear Data File - ENDF

SELECT

Format : **Narrow Table** File : **User Terminal**

Select a Data Library

Target - **U-238** Projectile - **N** Data library - **JEF-2**

BASIC DATA **300 DEGREE K**

300 DEGREE K - Data file prossed to give pointwise data at 300 K

11.4 RETRIEVE

When the desired nuclear data evaluation has been selected, having specified the target material, the projectile, the data library and perhaps whether the data is desired in doppler broadened form, the user can then select the RETRIEVE option. A menu of options for retrieving and displaying the data appears. The RETRIEVE options are LIST, ALL, PLOT, OVERLAY, NEW_FILE, FORMAT and DONE. The video mode display is illustrated below. The options are displayed along with descriptive material about the evaluation.

RETRIEVE Option Menu in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE

Format : Narrow Table File : User Terminal

JEF-2 library Neutron projectile 92-U-238 (9237)

JEF COLLAB EVAL-JUN89 MCM,MGS,FHF,CN,YN,KANDA ET AL

LIST **ALL** **PLOT** **OVERLAY** **NEW_FILE** **FORMAT** **DONE**

LIST - Retrieve data from selected evaluation

11.5 RETRIEVE/LIST

With the RETRIEVE/LIST option, the user can display the data in text format on the terminal or store the retrieved information in a disk file depending on whether or not the selected output is a disk file. This selection is set using the NEW_FILE option (see Section 11.14). The standard ENDF format, 80-character text records is always available as output. Two other formats, an 80-character and a 132-character wide tabular format are available for displaying some data types such as cross sections (see Section 11.15). If output is requested for one of the table formats when there is no table format for that data such as double differential particle emission distributions (MF=6), then the data is displayed in the standard ENDF format. If you have a terminal which can interpret REGIS or TEKTRONIX graphics instructions, then terminal graphical displays for many data types are possible.

In order to retrieve ENDF data, one must select a reaction, a quantity and then in cases where table format is desired, an incident particle energy range. The following three figures illustrate this sequence of actions in video mode.

Reaction Selection — The reactions for which data is available for the selected evaluation appears in a scrolling window. Use the scrolling menu functions to navigate up and down until the desired reaction appears in the window. For each reaction, the corresponding MT number is given along with the quantities for the reaction for which data is available. The quantities are represented by their MF number. Select the CHOOSE option and enter the MT corresponding to the desired reaction (see figure below). If a blank is entered for the MT number, the program returns to the RETRIEVE option menu.

Reaction Selection in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE   LIST   **SELECT_REACTION**

JEF-2 library   **Neutron projectile**   **92-U-238 (9237)**

JEF COLLAB   EVAL-JUN89   MCM,MGS,FHF,CN,YN,KANDA ET AL

MT	Reaction	Quantities Evaluated
451	DOCUMENTATION	1
151	(n,resonance data)	2
1	(n,Total)	3, 33
2	(n,Elastic)	3, 4, 33
4	(n,Inelastic)	3, 13, 14, 15, 33
51	(nn') 1-st level	3, 4, 12, 14, 33
52	(nn') 2-nd level	3, 4, 12, 14, 33
53	(nn') 3-rd level	3, 4, 12, 14, 33
54	(nn') 4-th level	3, 4, 12, 14, 33
55	(nn') 5-th level	3, 4, 12, 14, 33
56	(nn') 6-th level	3, 4, 12, 14, 33
57	(nn') 7-th level	3, 4, 12, 14, 33
58	(nn') 8-th level	3, 4, 12, 14, 33

Select a reaction by entering its MT number - **52**

Quantity Selection — The quantities for which data is available for the selected reaction are then listed on the terminal. For each quantity, the corresponding MF number is given. Enter the MF corresponding to the desired reaction (see figure below). If a blank is entered for the MF number, the program returns to the RETRIEVE option menu. If data is available only for a single quantity, then this input is not requested.

Quantity Selection in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE LIST **SELECT_QUANTITY**

JEF-2 library **Neutron projectile** **92-U-238 (9237)**

JEF COLLAB EVAL-JUN89 MCM,MGS,FHF,CN,YN,KANDA ET AL

(n,n') 2-nd level

MF	Quantity Definition
3	Reaction Cross Section
4	Emitted Neutron Angular Distributions
12	Photon Multiplicities (Neutron Induced)
14	Photon Angular Distributions (Neutron Induced)
33	Reaction Cross Section Covariance Data

Select a quantity by entering its MF number - **3**

Energy Selection — If a table format output has been requested, then the user is next asked to specify the range of incident energies to be presented. This query returns to the screen at the completion of each table display so that different energy regions can be examined. A blank response to the query will return the program to the RETRIEVE option menu.

An incident particle energy is normally given in MeV. An energy range is entered as a floating point number pair separated by a minus. One of the following letters: MV for mv, E for eV, or K for keV, preceded by a comma may be appended to the energy range specification to modify the default input energy units. A missing lower or upper energy indicates the lowest possible and highest possible energies respectively. Selecting ALL, will retrieve the entire energy range.

```
Examples:   .1-10.        (for .1 to 10. MeV)
            .1-10.,K      (for .1 to 10. keV)
```

Energy Selection in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE LIST **SELECT_ENERGY**

Format : **Narrow Table** File : **User Terminal**

JEF-2 library **Neutron projectile** **92-U-238 (9237)**

(n,n') 2-nd level **Reaction Cross Section**

Select energy range in MeV (E(min)-E(max)) or ALL - **1.–20.,M**

11.6 Data Output

When the data selection process has been completed, the chosen data is either displayed on the user's terminal or written to a disk file depending on the current status of the output device (see Section 11.14). If you have a terminal that can display Regis or Tektronix instructions, then graphical output is also possible. Data is displayed in a scrolling window. If ENDF is the selected format, then the data is displayed in the 80-character record ENDF format. All data can be displayed in this mode. Interpreted tabular format is available for cross sections (MF=3), secondary angular distributions (MF=4), secondary energy distributions (MF=5), fission product yields (MF=8), neutron fission multiplicities (MF=1) and photon interaction cross sections (MF=23). Disk and terminal display presentations for the various formats are identical.

11.6.1 Cross Sections

The following figure illustrates the terminal data display when a cross section (MF=3) has been selected. The data display and option selection menu are the same in video and in sequential mode. The first three lines of the display identify the data. The next three lines are column headers. If there is insufficient room on the remainder of the screen to display the complete data table, then the data lines can be scrolled while the identifier and column header lines remain fixed. At the beginning of the data table, the energy range is given along with the average and the (1/E)-weighted average cross section are given. The display for fission neutron multiplicities (MF=1) and for photon interaction cross sections (MF=23) are identical except the no (1/E)-weighted average is given. The multiplicity in MF=1 is given in units of neutrons per fission.

Evaluated Nuclear Data File - ENDF

JEF-2 library **Neutron projectile** **92-U-238 (9237)**
(n,n') 2-nd level **Reaction Cross Section**
Q-value = −0.1484 MeV

Retrieved energy range is 0.14903 to 20.0 MeV.
Average cross section = 71.36 millibarns
Average 1/E weighted cross section = 0.1335 barns

Energy MeV	Sigma Barns	Energy MeV	Sigma Barns	Energy MeV	Sigma Barns
0.14903	0.00000E+00	0.16000	6.84606E−04	0.18000	2.69774E−03
0.20000	5.40651E−03	0.23000	1.09760E−02	0.26000	1.83930E−02
0.30000	3.09516E−02	0.30850	3.39808E−02	0.32500	4.44180E−02
0.34000	5.12410E−02	0.35000	5.57900E−02	0.35566	5.86110E−02
0.40000	8.27270E−02	0.42500	9.76830E−02	0.45000	0.11343
0.50000	0.14677	0.52220	0.16216	0.55000	0.18174
0.56110	0.18971	0.60000	0.21884	0.62500	0.23853
0.65000	0.25896	0.68288	0.28299	0.70000	0.29303
0.73510	0.30803	0.75000	0.31212	0.79335	0.32469

FORWARD **END** **ONE_VALUE** **VIEW** **DONE**

FORWARD - Go to the next window of displayed information.

In addition to the scroll options, the menu contains the ONE_VALUE option and a VIEW option if the output terminal can handle graphics output from the program. Select DONE to return to the RETRIEVE/LIST menu.

ONE_VALUE — Use this option to display the cross section at any energy. When this menu item is selected, the user is prompted to enter an incident particle energy which must be within the energy limits of the data appearing in the table. The energy is requested to be given in MeV. However, other units are possible by appending the symbol for the chosen units in the manner used for entering an energy range as described above. The cross section at the chosen incident energy is then displayed on the terminal. If the energy requested is not one of the energies in the table, then the requested value is obtained by interpolation using the interpolation scheme defined for the cross section in the evaluated data file. One may continue to select incident energies for which the cross section is displayed until a blank is entered in response to the incident energy prompt. Then the ONE_VALUE option is terminated.

VIEW — This option appears in the data display menu if the user terminal has the required graphics capability. When this option is selected, the data in the cross section table is plotted. When finished viewing the plot, press the RETURN-key to return to the table display.

11.6.2 Angular and Energy Distributions

Secondary angular distributions (MF=4) and energy distributions (MF=5) of emitted neutrons are displayed for each incident energy within the selected energy range. Any legendre-coefficient representations of secondary angular distributions are expanded to give differential cross section as a function of the emitted neutron angle. Tabular representations are presented as stored in the data base. Secondary energy distributions are expanded to tabular form and summed in the case that there are multiple partial representations. A sample terminal output display for an angular distribution is shown in the following figure. Output for secondary energy distributions is identical in presentation.

In addition to the usual scrolling options, the menu has two options, DONE and QUIT. By selecting the DONE option, the user can display the angular distribution at the next available incident energy within the selected energy range. The QUIT option will terminate display of the selected angular distributions and return the program to the incident energy range selection prompt.

VIEW — This option appears in the data display menu when the user terminal has the required graphics capability. When this option is selected, the data in the angular distribution table is plotted. When finished viewing the plot, press the RETURN-key to return to the table display.

Secondary Angular Distribution Output in the Video Environment

Evaluated Nuclear Data File - ENDF

JEF-2 library **Neutron projectile** **92-U-238 (9237)**
(n,elastic) **Emitted Neutron Angular Distributions**
Energy = 5.00000 MeV

Angle Degrees	Dsigma #/sr	Angle Degrees	Dsigma #/sr	Angle Degrees	Dsigma #/sr
0.0000	12.923	2.5000	12.770	5.0000	12.323
7.5000	11.608	10.000	10.670	12.500	9.5644
15.000	8.3532	17.500	7.0998	20.000	5.8640
22.500	4.6971	25.000	3.6395	27.500	2.7186
30.000	1.9487	32.500	1.3317	35.000	0.85967
37.500	0.51691	40.000	0.28317	42.500	0.13625
45.000	5.44057E−02	47.500	1.80937E−02	50.000	1.10527E−02
52.500	2.07705E−02	55.000	3.83995E−02	57.500	5.82803E−02
60.000	7.72439E−02	62.500	9.38440E−02	65.000	0.10765
67.500	0.11868	70.000	0.12702	72.500	0.13263
75.000	0.13529	77.500	0.13471	80.000	0.13062
82.500	0.12291	85.000	0.11177	87.500	9.77242E−02
90.000	8.16195E−02	92.500	6.45472E−02	95.000	4.77329E−02

FORWARD **END** **VIEW** **DONE** **QUIT**

FORWARD - Go to the next window of displayed information.

11.6.3 Fission Product Yields

Fission product yields, independent and cumulative, are not given as continuous functions of incident energy. Therefore, instead of a prompt to enter the incident energy range, a menu is presented giving the energies for which data is available. These are generally spectrum averaged energies, THERMAL, FAST, and 14. MEV. Select the DONE option to return to the RETRIEVE/LIST menu. After the energy is selected, one is asked to choose to display yields for a given nuclear mass number (MASS) or yields for a given element (CHARGE) or DONE to return to the energy selection menu. If MASS or CHARGE are selected, one enters either the desired mass or charge number at the prompt. The following figure shows a sample output. If the data overflows the window, scrolling options appear in the menu as well as DONE. Selecting DONE returns you to the mass/charge selection menu.

Fission Product Yield Output in the Video Environment

Evaluated Nuclear Data File - ENDF

ENDF/B-VI library **Neutron fission product yields** **92-U-238 (9237)**

Independent Yields **Fast Fission Product Yields**

Z	**A**	**I**	**Yield(%/fission)**		
52	145	0	6.0781E−10	+−	3.8900E−10
53	145	0	1.1700E−05	+−	7.4879E−06
54	145	0	1.3002E−02	+−	8.3215E−03
55	145	0	0.5556	+−	0.3558
56	145	0	2.58	+−	0.8237
57	145	0	0.7089	+−	0.4537
58	145	0	1.2735E−02	+−	8.1504E−03
59	145	0	1.1400E−05	+−	7.2961E−06
60	145	0	5.3400E−10	+−	3.4176E−10

The total yield for mass 145 is 3.871 +− 1.007 %/fission

DONE

DONE - Finished displaying this table.

11.7 RETRIEVE/ALL

This option provides the capability to retrieve a complete evaluation or a complete "file" (data for all reactions for a quantity such as cross sections). The output is only in ENDF format. First the user is prompted to choose a "file" by entering a value of MF. If the entry is a blank, then the entire evaluation will be retrieved. You will be then prompted for a label for retrieved data. This label is the first 66 characters of the first record in the output file. The comments section (MF=1, MT=451) is always retrieved when output is to disk.

The option was designed to provide a convenient method to retrieve an entire evaluation or a "file" from an evaluation for transmission to at remote computer. However it is possible to view the data on a terminal one section at a time. In this case sections are successively displayed in a scrolling window. In addition to the scrolling options, the window menu has DONE and QUIT. Selection of DONE will bring the next ENDF section unto the scrolling window. Selection of QUIT will terminate the RETRIEVE/ALL option and return the user to the RETRIEVE menu.

11.8 RETRIEVE/PLOT

This option can be used to create plots in PostScript format in a disk file so that the files can be transferred and printed remotely. The process of selecting the reaction, quantity and energy range to be plotted is identical to that in for the RETRIEVE/LIST option (see Section 11.5).

When the required evaluated data has been retrieved, the user is prompted for the name of the output file. If no name is entered, the default, ENDF_PLOT, is used. The extension PS is appended to all supplied names. All plots generated from the selected data will be placed in the file named. A new file will be required for each subsequent data selected for plotting. For cross sections, there will be a single plot per file. For secondary particle distributions, the plot file will contain as many plots as there are incident energies in the selected energy range.

On completion of the plot(s) requested, the user will be asked if it is desired to send the file to another computer. If yes, the dialog will be the same as detailed in Section 15.1.3.

11.9 RETRIEVE/OVERLAY

The overlay option allows the visual intercomparison of a cross section from one or more of the evaluated data libraries in the ENDF data base. In addition the user may place one or more data points on the plot. In this way, an experimental data set can be intercompared with existing evaluations. This overlay capability is similar to that in the CSISRS module of the online service, the difference being that experimental data sets from the CSISRS data base can also be placed on the plot.

If the user has a terminal which can process REGIS or TEKTRONIX graphic instructions, terminal display of the plot generated can be made. Plots stored in a disk file contain PostScript instructions. These files can be downloaded and printed on a PostScript printer.

11.9.1 Reaction Selection

After selecting the RETRIEVE/OVERLAY option, a display is presented which lists all of the reactions for which cross section data (MF=3) are available in the selected evaluation, excluding partial excitation cross sections such as inelastic scattering to some level (MT=51–91). If there are more reactions than can fit in the window, the menu will contain scrolling options. Select the reaction to be plotted by selecting CHOOSE from the menu and then entering the reaction's MT number at the prompt.

Overlay Reaction Selection in the Video Environment

```
                Evaluated Nuclear Data File - ENDF
RETRIEVE   OVERLAY   SELECT_REACTION

JEF-2 library            Neutron projectile         92-U-238  (9237)
   JEF COLLAB   EVAL-JUN89   MCM,MGS,FHF,CN,YN,KANDA ET AL
 MT      Reaction
  1      (n,Total)
  2      (n,Elastic)
  4      (n,Inelastic)
 16      (n,2n)
 17      (n,3n)
 18      (n,fission)
452      Fission Neutron Yields
453      Delayed Fission Neutron Yields
456      Prompt Fission Neutron Yields
102      (n,g)

   Select a reaction by entering its MT number  -  [16]
```

11.9.2 Library Selection

The selected evaluation will always be displayed on the overlay plot. After choosing the reaction to be plotted, a display is presented from which you can select any or all of the other evaluated libraries for overlay and intercomparison with the primary selection. The video-mode display is illustrated below.

Video The list of evaluated data libraries containing the selected evaluation is displayed in a scrolling window on the terminal with a menu on the bottom of the screen. Each library is given on a single line of the window. If there are more data libraries than can be displayed in the scrolling window, then the scrolling options, FORWARD, BACKWARD, START and END are added to the bottom menu to move the window over the list. In all cases, the options CHOOSE, ALL, NONE, and DONE appear in the menu.

To choose one or more libraries, select CHOOSE, ALL or NONE. The CHOOSE option begins the selection process without changing any prior selections. If ALL is selected, all libraries are preselected. If NONE is selected, no libraries are preselected and any previously selected data sets are deselected. This is a multiple selection menu which is described in detail in Section 3.2.1 as is the use of the keys to make the desired data set selections. These keys are also briefly described below the scrolling window. The current menu item is given in inverse-video. Selected items are given in bold-underline. When selection is completed, use the X-key to return to the scrolling menu.

Sequential The initial list of data libraries is displayed on the screen in a non-video scrolling window. The mode of operation and available options are identical to those described in the video mode operation above. When the CHOOSE option is selected, a prompt appears and data libraries to be be included in the overlay plot are entered one at a time. Enter the numbers for the data libraries you wish to select. A negative number will deselect a data library. Entering a blank will complete the CHOOSE option. The CHOOSE option may be selected again if changes are desired. If the ALL menu item is selected, all data data libraries are selected. If the NONE menu item is selected, all data libraries are deselected. Then use CHOOSE to deselect particular undesired data libraries or to select desired data libraries. Select DONE to complete the data library selection process.

Library Selection for Overlays in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE OVERLAY **EVALUATIONS**

SELECT EVALUATED DATA OVERLAYS

ENDF/B – United States ENDF/B-VI evaluated data file
CENDL – Chinese evaluated data file
JENDL – Japanese evaluated data file
BROND – Russian evaluated data file

UP_ARROW – move up one line. DOWN_ARROW – move down one line.
RETURN – Toggle SELECT/DESELECT. X – selection completed.

11.9.3 Energy Selection

When the data libraries to be overlaid have been selected, the names of the selected libraries are displayed with the primary library first and boldfaced. At the bottom of the screen is a prompt for entering the range of incident energies to be plotted. The default response is ALL. An incident particle energy is normally given in MeV. An energy range is entered as a floating point number pair separated by a minus. One of the following letters: MV for mv, E for eV, or K for keV may be appended to the energy range specification to modify the default input energy units. A missing lower or upper energy indicates the lowest possible and highest possible energies respectively. Selecting ALL, will retrieve the entire energy range.

```
Examples:   .1-10.        (for .1 to 10. MeV)
            .1-10.,K      (for .1 to 10. keV)
```

11.10 RETRIEVE/OVERLAY options

When the data libraries to overlay and the incident energy range for the evaluated data have been selected, The program is ready to display the data. The figure below shows the video-mode display which appears on the screen. Many details of the plot can be modified by selecting from the menu items at the bottom of the screen.

RETRIEVE/OVERLAY Master Menu in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE **OVERLAY**

Evaluations of 92-U-238 (n,2n) Being Compared

JEF – European evaluated data file
ENDF/B – United States ENDF/B-VI evaluated data file
JENDL – Japanese evaluated data file

EVALUATIONS POINTS E-RANGE X-AXIS Y-AXIS GRID $\boxed{\text{PLOT}}$ DONE

PLOT - Generate plot with current specifications.

11.10.1 PLOT

When the plot option is selected, a display appears giving the present values of all of the parameters for the plot. The menu at the bottom has three items, two, if you do not have a terminal with REGIS or TEKTRONIX capability. If the current parameter values are unsatisfactory, select NOPLOT to return to the RETRIEVE/OVERLAY menu.. Select VIEW to display plot on your terminal. Select PLOT to create a disk file with the plot instructions in PostScript.

The plot appearing on your screen when VIEW is selected, will have the legend box on the right, outside of the display. To return to the master PLOT menu, press RETURN. If PLOT is selected, then you will be prompted for the name for the disk file. When the plot has been generated, you will be asked whether or not to transmit the file to another computer. If yes, then the file will be transmitted as described in Section 15.1.3. When the plotting has been completed, the user is returned to the RETRIEVE/OVERLAY menu.

Plot Menu in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE OVERLAY **PLOT**

Evaluations of 92-U-238 (n,2n) Being Compared

JEF – European evaluated data file

Selected energy range (eV) **0.000E+00–2.000E+07**

Selected evaluated data overlays **ENDF/B** **JENDL**

	X-AXIS	Y-AXIS
Axis MIN	**0.000E+00**	
Axis MAX	**2.000E+07**	
Axis STEP		
Axis UNITS	**Auto**	**Auto**
Axis SCALE	**Auto**	**Auto**

No grid drawn on plot No user supplied data points

VIEW **PLOT** **NOPLOT**

PLOT - Plot with current parameters to disk.

11.10.2 EVALUATIONS

If you wish to change the evaluated libraries being overlaid in the display, select the EVALUATIONS option. This option is the same as the overlay library selection described in Section 11.9.2.

11.10.3 E-RANGE

If you wish to change the range of incident energies plotted, then select E-RANGE. The option is the same as the initial plotting incident energy range selection described in

Section 11.9.3.

11.10.4 X-AXIS

Select the X-AXIS menu item if you wish to modify the x-axis plotting parameters, the axis minimum and maximum values, the axis scaling (logarithmic or linear), the energy units (MeV, keV, etc.) and in the case of linear scaling, the increment between major axis divisions. The video input form is illustrated below.

Video A plotting parameter value can be changed by moving to that field with the UP-ARROW or DOWN-ARROW key. For items which are free form entry, the axis MIN, MAX and STEP, simply enter the new value. For items which require selection from a list of possible values, use the SPACE BAR to move sequentially through the possible values until the desired value is displayed. At the bottom of the display is brief information on the form and contents required for data entry in the selected field. The last item in the form is an OK/QUIT toggle which can be changed by depressing the SPACE BAR. Entry of a RETURN key on this field will modify the axis parameters when OK is selected. If the selected item is QUIT when the RETURN key is pressed, the axis plotting parameter are not changed. In either case you are returned to the RETRIEVE/OVERLAY menu.

Sequential A list of plotting parameters for the x-axis is presented in the form. Each field is displayed along with its current value and an integer identification number. At the prompt, select the fields to modify by entering the ID numbers separated by a comma. Entering ALL will select all parameters. You will be prompted for a new parameter value for each chosen field one at a time. Enter a new value, or a question mark (?) for brief information on the form and contents required for data entry in the selected field. A RETURN without any preceding characters will leave the field unchanged. After responding for all chosen fields, the parameter selection form appears again with updated parameter values. At this point, additional fields may be modified. By entering DONE, the parameters will be changed to the new values. By entering QUIT, the parameters will not be changed. In either case you are returned to the RETRIEVE/OVERLAY menu.

X-Axis Minimum, Maximum and Step —These axis parameters for the independent variable, incident particle energy, are normally given in eV. One of the following letters: MV for mv, K for keV or M for MeV may be appended to the energy specification to modify the default input energy units. If the minimum and maximum energies are left blank the program will calculate them from the data being plotted. The energy increment or step may be left blank also. For linear scaling, the program will calculate a value in this case. For logarithmic scaling, the step is ignored.

```
Examples:   10.E+3 or 10.,K     (for 10 keV)
```

X-Axis units —The energy can be plotted in MeV, keV, eV, mV or muv (for microelectron volts). If Auto is selected, the program will choose the units on the basis of the data plotted.

X-Axis scale —This parameter can have only three values, Log, Linear and Auto. If the selection is Auto, then the programs selects either Log or Linear based on the data to be plotted

Axis Parameter Form in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE   OVERLAY   **X-AXIS**

X-AXIS PLOT SPECIFICATIONS (0.000E+00 to 2.000E+07 eV)

Axis MIN	(eV)	**2.000E+06**
Axis MAX	(eV)	**2.000E+07**
Axis STEP	(eV)	**2.,M**
Axis UNITS		**Auto**
Axis SCALE		**LIN**
OK/QUIT		**OK**

Enter the distance between x-axis labels in eV. A letter may be appended to the energy specification to modify the default input energy units. Use a comma followed by MV for milli-ev, K for keV, or M for MeV. For example

2.0E-3   or   2.,MV   for 2 milli-ev

For logarithmic scaling, the value is ignored. If blank for linear scaling, the program calculates a value.

Use the UP- and DOWN-ARROWS to move between fields.

11.10.5 Y-AXIS

Select the Y-AXIS menu item if you wish to modify the y-axis plotting parameters, the axis minimum and maximum values, the axis scaling (logarithmic or linear), the cross section units (barns, mb, etc.) and in the case of linear scaling, the increment between major axis divisions. The video input form is similar to that for the X-axis illustrated above.

Video A plotting parameter value can be changed by moving to that field with the UP-ARROW or DOWN-ARROW key. For items which are free form entry, the axis MIN, MAX and STEP, simply enter the new value. For items which require selection from a list of possible values, use the SPACE BAR to move sequentially through the possible values until the desired value is displayed. At the bottom of the display is brief information on the form and contents required for data entry in the selected field. The last item in the form is an OK/QUIT toggle which can be changed by depressing the SPACE BAR. Entry of a RETURN key on this field will modify the axis parameters when OK is selected. If the selected item is QUIT when the RETURN key is pressed, the axis plotting parameter are not changed. In either case you are returned to the RETRIEVE/OVERLAY menu.

Sequential A list of plotting parameters for the y-axis is presented in the form. Each field is displayed along with its current value and an integer identification number. At the prompt, select the fields to modify by entering the ID numbers separated by a comma. Entering ALL will select all parameters. You will be prompted for a new parameter value for each chosen field one at a time. Enter a new value, or a question mark (?) for brief information on the form and contents required for data entry in the selected field. A RETURN without any preceding characters will leave the field unchanged. After responding for all chosen fields, the parameter selection form appears again with updated parameter values. At this point, additional fields may be modified. By entering DONE, the parameters will be changed to the new values. By entering QUIT, the parameters will not be changed. In either case you are returned to the RETRIEVE/OVERLAY menu.

Y-Axis Minimum, Maximum and Step —These axis parameters for the dependent variable, the cross section, are must be given in barns(b). If the minimum and maximum cross sections are left blank the program will calculate them from the data being plotted. The cross section increment or step may be left blank also. For linear scaling, the program will calculate a value in this case. For logarithmic scaling, the step is ignored.

```
Examples:   1.E+3 for 100 barns  or  3.-3 for 3 mb.
```

Y-Axis units —The cross section can be plotted in Meb, kb, b, mb or mub (for microbarns). If Auto is selected, the program will choose the units on the basis of the data plotted.

Y-Axis scale —This parameter can have only three values, Log, Linear and Auto. If the selection is Auto, then the programs selects either Log or Linear based on the data to be plotted

11.10.6 GRID

If you wish to include a grid on the plot, select GRID. This option toggles. When a grid is included in the plot, the menu item is NOGRID. Selecting NOGRID will eliminate the grid from the plot and restore the menu item to GRID.

11.10.7 POINTS

Select the POINTS item on the RETRIEVE/OVERLAY master menu in order to supply data points to be shown on the overlay plots. These points are entered as triplets of the form energy, cross section and cross section uncertainty. The data points might be either experimental or calculated data which you may want to compare visually with one or more evaluated data curves.

When the POINTS option is selected, the POINTS entry menu is displayed along with the values of the existing overlay points. This display for the video mode is shown below. In the case that there are no existing user supplied data points, the menu is not presented as the only active option is ADD.

Data Point Entry in the Video Environment

Evaluated Nuclear Data File - ENDF

RETRIEVE OVERLAY **POINTS**

Evaluations of 92-U-238 (n,2n) Being Compared

JEF – European evaluated data file
ENDF/B – United States ENDF/B-VI evaluated data file
JENDL – Japanese evaluated data file

USER SUPPLIED DATA POINTS

1.200E+07 , 1.500E+00 , 3.000E–01 1.500E+07 , 5.000E–01 , 1.000E–01

YES **ADD** **ERASE** **DELETE**

ADD - Add data points.

ADD — When the ADD option has been selected, the user is prompted for an incident energy. The energy is entered in the manner described in Section 11.10.4. When an energy has been specified, then the energy is listed as part of the prompt for a cross section and uncertainty. These items are entered as a pair separated by a comma. These numbers are entered as described in Section 11.10.5. When the entry of one energy is complete, the values are listed with the data points previously entered. The points do not have to be entered in any particular order. If the energy entered is blank, then the ADD option is terminated and the POINTS entry menu reappears with an updated list of points.

ERASE — Select the ERASE option to delete all of the data points that have been entered. Control is returned immediately to the POINTS entry menu.

DELETE — Select the DELETE option to delete the last data point that has been entered. Control is returned immediately to the POINTS entry menu with an updated list of points. If you wish to delete the last two points entered, select DELETE twice.

YES — Select the YES option to end the Point entry option and return to the RETRIEVE/OVERLAY menu.

11.11 RETRIEVE/SEND

Use this option to download the data file containing the current retrieval. This option appears in the menu only when a file of retrieved data exists. This option is identical to the FILE/SEND option described in Section 15.1.3.

11.12 RETRIEVE/NEW_FILE

Use this option to change where the retrieval output will go. This option is identical to the NEW_FILE option described in Section 11.14.

11.13 RETRIEVE/FORMAT

Use this option to change the format of the retrieval output. This option is identical to the FORMAT option described in Section 11.15.

11.14 NEW_FILE

The output from the retrieval can be displayed on the user's terminal or stored in a disk file. This option can be used to change the currently selected output destination. The default destination is the user's terminal. If you wish to direct output to a disk file, you MUST use this option to supply a name for the file before proceding with the retrieval. The disk storage of output files and their naming conventions are discussed in Section 3.4. The user's terminal can be indicated by specifying a file `TT:` or `TTY:`.

When this option is selected, a prompt appears and the user enters a new file specification. Entering a RETURN without a file specification is interpreted as selecting the user terminal for output. The video and sequential mode operation is the same.

11.15 FORMAT

The output can be generated in one of three formats. This option permits the selection of the output format from the three choices. The default selection is **Narrow Table** format.

Narrow Table Format

The **Narrow Table** format is available for some but not all quantity types in the ENDF format. The data is presented as X-Y pairs, three pairs of columns displayed in an 80 character-wide format. For three-dimensional functions, a table is generated for each incident energy.

Wide Table Format

The **Wide Table** format is identical to the **Narrow Table** format except that it is designed for 132-character line output. For terminal output, unless the user has specified that his output device is 132 character capable (see Section **??**), the output will revert to the default **Narrow Table** format. In this format, there are 5 X-Y data pairs per row.

ENDF Format

The **ENDF** format is the basic ENDF format as described in the ENDF format manual (ENDF-102). The format has been designed primarily for machine processing. That is why the table format described above has been introduced in order to make the information easier to read.

Video In the video mode, a menu of the three format options is displayed. Upon selection of a format, the option terminates and the file specification in the screen display is updated.

Sequential The new output format is selected by entering the first character of the format name at the prompt. Entry of a RETURN will select the default format, the **User** format.