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PREPRO 2007
2007 ENDF/B Pre-processing Codes
(ENDF/B-VII Tested)

Owned, Maintained and Distributed
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Abstract: The codes are named "the Pre-processing" codes, because they are designed to pre-process ENDF formatted data, for later, further processing for use in applications. This is a modular set of computer codes, each of which reads and writes evaluated nuclear data in the ENDF format. Each code performs one or more independent operations on the data, as described below. These codes are designed to be computer independent, and are presently operational on every type of computer from large mainframe computer to small personal computers, such as IBM-PC and Power MAC. The codes are available on CD-ROM or diskettes from the IAEA Nuclear Data Section, free of charge upon request or can be downloaded from http://www-nds.iaea.org/ndspub/endf/prepro/

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Note

The IAEA-NDS-reports should not be considered as formal publications. When a nuclear data library is sent out by the IAEA Nuclear Data Section, it will be accompanied by an IAEA-NDS-report which should give the data user all necessary documentation on contents, format and origin of the data library.

IAEA-NDS-reports are updated whenever there is additional information of relevance to the users of the data library.

Neither the originator of the data libraries nor the IAEA assume any liability for their correctness or for any damages resulting from their use.

Citation guidelines

For citations care should be taken that credit is given to the author of the data library and/or to the data center which issued the data library. The editor of the IAEA-NDS-report is usually not the author of the data library.

This computer code package should be cited as follows: D.E. Cullen, "PREPRO 2007: 2007 ENDF/B Pre-processing Codes", report IAEA-NDS-39, Rev. 13, March 17, 2007

Nuclear Data Section Introduction

ENDF is the internationally agreed upon format for dissemination of evaluated nuclear data. The ENDF/B data library has now been through seven (VII) versions; the latest identified as ENDF/B-VII. Documentation for the current ENDF format and convention is available in ENDF-102, from the National Nuclear Data Center, Brookhaven National Laboratory
http://www.nndc.bnl.gov/nndcscr/documents/endf/endf102/
or the Nuclear Data Section of the IAEA
http://www-nds.iaea.org/ndspub/endf/prepro/DOCUMENT/DOCUMENT.HTM

The 2007 ENDF/B Pre-processing codes process nuclear data formatted in any version of the ENDF formats; ENDF/B-I through ENDF/B-VII evaluations. These codes can be used on virtually any computer: everything from large mainframe computers, to workstations, to IBM-PC (Windows or Linux) and Power MAC (OSX).

These codes are available free of charge on CD_ROM upon request from the Nuclear Data Section (see addresses on cover page) or downloaded from the Nuclear Data Section Web page
http://www-nds.iaea.org/ndspub/endf/prepro/

The present documentation (revision 13) completely supersedes all previous documentation of earlier versions of the ENDF/B Pre-processing data. **It is strongly recommended that you use ONLY the latest 2007 version of the PREPRO codes.** Failure to heed this warning can lead to completely erroneous results.

Conditions for use of the codes

Any comments on the use of the codes, including difficulties encountered or any suggestions should be sent to the IAEA Nuclear Data Section. If any results obtained from using these codes are used or referenced in a publication, a copy of the publication should be sent to the IAEA Nuclear Data Section.

Dedication

Regardless of whose name appears on the cover of this report, most of the work involved in maintaining, testing and distributing the previous and current versions of the PREPRO codes, was done by Kevin McLaughlin, Nuclear Data Section, IAEA, Vienna. For over 20 years Kevin has played an invaluable role in updating and testing the PREPRO codes. After all of these years I am sorry to have to report that Kevin has now retired. I think I can speak for all present and past members of the Nuclear Data Section in saying that Kevin will be greatly missed both as a coworker and as a good friend.

Acknowledgement

I gratefully acknowledge the contribution of Andrej Trkov in continuing to propose interesting and useful extensions to these codes; keep those great ideas coming Andrej. I acknowledge the contribution of Ivan Sirakov in testing these codes and reporting all problems that he found; Ivan's testing has greatly improved the reliability of these codes. I also acknowledge Jennie Manneschmidt, RSICC, Oak Ridge, for her review of the documentation and testing of the codes prior to their distribution through RSICC.

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History and Terminology

Originally the Evaluated Nuclear Data File (ENDF) was divided into two different **formats**: ENDF/A which was designed to contain partial evaluations that might later be incorporated into complete evaluations, and ENDF/B which was designed to contain complete evaluations for use in applications. Originally these were physically two different formats, but circa 1970 both adopted the same format. Here I distinguish between the format, such as the current **ENDF-6 format**, and the data in the format, such as the current **ENDF/B-VII data**.

I try to distinguish between the **ENDF-6 format**, and **the ENDF/B data** that is coded into this format. The **ENDF-6** format is now used universally to store evaluated nuclear data: in the **ENDF/B-VII** library in the United States, in **JEFF** in Western Europe, in **JENDL** in Japan, in **CENDL** in China, in **BROND** in Russia, etc. Here I will not be concerned with the differences between the contents of these data libraries. My only concern will be with the common **ENDF-6 format**, that all of these data libraries use. The PREPRO codes are designed to process evaluated data in any version of the ENDF format. The **ENDF format** has now been through six major versions, with the current format defined as **ENDF-6**.

Features of 2007 Version

Compared to earlier versions of these codes the 2007 version has the following features,

Running Time

It wasn't too many years ago that in order to process major ENDF/B evaluations we needed super, million dollar computers, and even then it could take days to process a large evaluation, such as U-238.

Need I say it: those days are gone forever. Today even small personal computers can be used to quickly process any ENDF evaluations. For example, on my IBM-PC, Pentium IV, 3.6 GHz computer [not a million dollar computer, a $ 1,000 computer (year 2007)], I can process U-238 in the time it takes me to go and get a cup of coffee - and with the next generation, it will require even less time.

So I am not going to list typical running times for the codes, for two reasons: 1) the running times have now become trivial, and 2) by the time you get a copy of this report any times I quote here will be outdated by the availability of newer, faster, and cheaper computers.

Bottom line: running time is no longer a major concern in processing ENDF data, and even small personal computers are now powerful enough to be used to process all ENDF evaluations.

All ENDF Formats and Procedures

These codes can automatically determine the ENDF format version that each evaluation is coded in and use the appropriate procedures. It should be particularly noted, that these codes now handle all ENDF formats and procedures through ENDF-6, and they have even been tested with all of the new ENDF/B-VII.0 evaluations that were approved by CSEWG in November 2006 and released for public use in December 2006

WARNING: The 2007 codes include extensions to handle all current ENDF formats and procedures, and corrections to problems that existed in earlier versions of these codes. As such the 2007 codes **completely supersede all earlier versions and it is strongly recommended that all users of these codes only use the 2007 version of these codes**. Failure to heed this warning can lead to completely erroneous results.

Consistent Handling of All ENDF Formatted Data

All of the codes now use exactly the same routines to handle all ENDF formatted input and output. This has resulted in a completely consistent interpretation of all ENDF formatted data by all of the codes, and has also allowed the precision of the ENDF output to be consistently extended in all codes. For 2007 the ENDF output is completely consistent for input into C and C++ codes, while still maintaining the accuracy of the data.

Optional Input Parameters

All of the codes now allow input parameter files and ALL input parameters to be optional; all input parameters now have built-in default values. Of particular note is that allowable uncertainties are now optional input. This allows us to select what we consider the best choices, based on the most recent advances in the speed and size of computer.

Computer Independence

The only computer dependence in the 2007 codes is to define running time. Routines to define running time are supplied for most types of computers, and instructions are provided in this report to help you define a timing routine for any other type of computer.

MAC OSX Executables

Earlier versions of PREPRO supplied executables for MAC OS9. The current PREPRO supplies executable for MAC OSX (there is no executables for OS9). Under OSX the codes run much faster than under OS9. Under OSX the codes appear to the user very similar to how they appear on a UNIX or LINUX computer. The exception being the on-screen graphics codes COMPLOT and EVALPLOT, which use the UNIX X11 graphics library. On a MAC to execute these codes you must first start an X11 window and use this as if it were a UNIX or Linux Window.

Bigger, Faster, Improved Accuracy

In line with the enormous increase in computer sizes during the last few years, the 2007 versions are **bigger**, allowing more complicated problems to be run much more efficiently, and in general allowing each problem to be run much **faster**.

All of the codes now use double precision throughout, resulting in **improved accuracy**. Compared to the earlier versions that used a mixture of single and double precision, with modern compilers and hardware, using double precision throughout has also contributed to making the codes **faster**.

On-Line Reports

All of the codes now include an on-line report to your screen, and a report to an output file; the on-line report allows users to monitor the progress of each code as it executes. Earlier versions had no on-line report; as far as what the user saw, the code started and ran to conclusion without printing anything on-line. This made it impossible to monitor the progress of each code, and for long running problems often resulted in users terminating the codes before they completed execution, because it appeared that the codes weren't doing anything.

Execution Timing

The codes now include a timer, to print execution time at the end of processing each evaluation (MAT), and at the end of execution.

Features of All Versions

Code Documentation

These codes are designed to be self-documenting, in the sense that the latest documentation for each code is included as comments at the beginning of each code. Printed documentation, such as this report, is periodically published and consists mostly of a copy of the comment lines from the beginning of each code.

The user should be aware that the comment lines within the codes are continually updated to reflect the most recent status of the codes and these comments within the codes should always be considered to be the most recent documentation for the codes and may supersede published documentation, such as this document. Therefore users are advised to always read the documentation within the actual code that is being used.

Data Documentation

It is essential that the pedigree of the evaluated data be documented. This is the purpose of the comment lines at the beginning of each ENDF/B evaluation. The PREPRO codes are designed to document any operations that they perform on ENDF/B data. If one of these codes produces ENDF/B formatted output which in any way effects the actual evaluated data, what the code did is documented by adding additional comment lines at the end of the comment lines at the beginning of

each evaluation, defining the code and input parameters that it used. The sequence of all such comments completely documents all of the operations that have been performed on the data. Code users are advised that it is very important to leave this documentation directly inside each evaluation, i.e., please do not modify these codes or the evaluations to remove this documentation.

Obtaining the Codes

These codes are available free of charge on CD ROM upon request from the Nuclear Data Section (see addresses on cover page) or downloaded from the Nuclear Data Section Web page

http://www-nds.iaea.org/ndspub/endf/prepro/

Your Feedback is IMPORTANT!!!

We are trying to develop a set of codes that are as computer independent as possible. In this effort your feedback is IMPORTANT!!! It is impossible for us to test these codes on all available computer/compiler combinations. Therefore your experience, on your specific computer/compiler can help us to improve the computer independence of these codes. It is also in your best interest to share your experience with us, since it will insure that future versions of these codes are as compatible as possible to meet your needs.

Please send all feedback via e. mail at,

mailto:services@iaeand.iaea.org

Implementing the Codes

What Computers do the codes run on?

The codes are designed to run on virtually any computer. The exceptions to this rule are the interactive graphics codes **complot** and **evalplot**, which are designed to produce on-screen graphics on UNIX workstations, IBM-PC, PowerMAC and VMS, i.e., not mainframe computers. However, even these codes can be used in their non-interactive mode, named **comhard** and **evalhard** (note the names to indicate **hard**copy output), to produce Postscript formatted files that can be printed on any Postscript printer.

For use on IBM-PC running Windows or Linux, and on PowerMAC, the distribution includes executables, ready to use immediately. For use on a variety of UNIX based computers, the distribution includes a batch file for each type of computer, to compile and load all programs, and to then clean up by deleting everything not required to execute the programs. For other types of computers, see the section below on, Details of Compiling and Loading Codes

The Most Up-to-Date Installation Instructions

The most up-to-date installation instructions, documentation, and the codes, can be downloaded from the website,

http://www-nds.iaea.org/ndspub/endf/prepro/

Read the text and then select “Download Codes” or “Download Documentation”

We try to maintain these installation instructions as up-to-date as possible, based on user feedback. So if you have any problems or suggestions regarding installation please e.mail them to the Nuclear Data Section at,

mailto:services@iaeand.iaea.org

Register as a User

We try to maintain these codes and data as up-to-date as possible. So if you are using any of these codes it is important that you tell us about this, so that the Nuclear Data Section can put your name on the distribution list to inform you about the latest updates. This is a FREE!!! service which is provided to users of these codes. We have tried to make this as easy as possible for you - PLEASE take a moment to e.mail to mailto:services@iaeand.iaea.org, and tell what codes you are using, and what type of computer(s) you are using - it’s as simple as that.

Use of Codes

Read the Output Reports

MOST IMPORTANT! You cannot use these codes like a black box and assume that everything is perfect. Don't make the mistake of assuming that all ENDF/B data is perfect, or that these codes are perfect. It's up to you, the code user, to check and be sure that the data output by these codes is accurate and can be used in applications. If you don't, you are wasting your time, and will produce inaccurate results in your applications.

You can do this by reading the output reports produced by each code. These output reports will generally be quite small. They are intended to be used by you to quickly scan through them and look for WARNING or ERROR messages - these indicate problems with the ENDF/B data that you should check before using the data in any applications. You need not read each output report in detail; it is sufficient to merely search for the words WARNING or ERROR – these will always accompany important messages.

Checking these output reports doesn't take very much time, but failing to check them can cause you to waste an awful lot of time and can cause you headaches later, if you try to use data that a code has clearly indicated to be bad. If there are errors in the ENDF/B data, you are clearly in a “garbage in, garbage out” situation as far as the result you calculate in your applications. **Caveat Emptor!**

Standard and Variable Filenames

Currently all input files and input parameters are optional, and have built-in default values.

All of the codes have standard, built-in, filenames, that they will use by default, unless input parameters explicitly define other filenames.

The default filenames have been defined to make it easy for you to remember, and to be compatible with as many operating systems as possible, e.g., DOS, that only allows short filenames, and Unix, that allows longer filenames. The default filenames are all of the form NAME.EXT, where NAME identifies a program name, and EXT identifies the type of file. All default filenames use **ONLY** upper case characters. The basic filenames include,

1) **???.INP** - The **INP**ut parameters for each code, where ??? is the name of the code. For example, the input parameters for **RECENT** are in a file named **RECENT.INP**. This name cannot be changed by input. Currently these input files are optional; if they are not present default values are used for all input parameters.

2) **???.LST** - The output **L**i**ST**ing from each code, where ??? is the name of the code. For example, the output listing from **RECENT** is in a file named **RECENT.LST**. This name cannot be changed by input.

3) **???.IN** - ENDF formatted data to be read (**IN**put) be each code, where ??? is the name of the code. For example, the ENDF/B data read by **RECENT** are in a file named **RECENT.IN**. This name can be changed by input.

4) **???.OUT** - ENDF formatted data written (**OUT**put) be each code, where ??? is the name of the code. For example, the ENDF/B data written by **RECENT** are in a file named **RECENT.OUT**. This name can be changed by input.

The above simple filename conventions will allow you to easily remember for each code, where the input parameters and output report are located, as well as where the ENDF/B data that is read and written by the code are located.

By input you can change the filenames of the ENDF formatted data files; data read and/or written.

If you input blank filenames the codes will use the default names (described above).

If you input anything else, the code will use the filenames you have defined. Variable filenames for each code can be up to 60 characters long. This allows you to specify directory structures, so that you can store your ENDF/B data in some rational way within a directory file structure.

For example if you store all of the ENDF/B-VI data files in a directory named ENDFB6, the following input filename used with **linear** will read a file named za092238 on an IBM-PC,

\ENDFB6\ORIGINAL\za092238

or on a Unix workstation,

/ENDFB6/ORIGINAL/za092238

Warning - generally on Unix workstations you will have to include the complete path to files. For example, the path to my files on my workstation may be /home/pd11/cullen, in which case my filename should be,

/home/pd11/cullen/ENDFB6/ORIGINAL/za092238

The ability to directly reference file structures is a very powerful facility that you should not overlook in organizing your ENDF/B data.

Brief Description

Linear	- Linearize cross sections
Recent	- Reconstruct cross sections from resonance parameters
Sigma1	- Doppler broaden cross sections
Activate	- Generate activation cross sections (MF=10) from MF=3 and 9 data
Legend	- Calculate/correct angular distributions
Sixpak	- Convert double differential data (MF=6) to single differential
Fixup	- Correct format and cross sections, define cross sections by summation
Dictin	- Create reaction dictionary (MF=1, MT=451)
Merger	- Retrieve and/or Merge evaluated data
Groupie	- Calculate group averages and multi-band parameters
Complot	- Plot comparisons of cross sections (MF=3, 23); Comhard for hardcopy
Evalplot	- Plot evaluated data (MF=3, 4, 5, 23, 27); Evalhard for hardcopy
Mixer	- Calculate mixtures of cross sections
Virgin	- Calculated transmitted uncollided (virgin) flux and reactions
Convert	- Convert codes for computer/precision/compiler
Relabel	- Relabel and sequence programs

Detailed Description

The codes can be used to: 1) extensively check and correct evaluated data prior to using them in applications, 2) pre-process the data into a form that will make subsequent use of the data much easier.

The normal sequence in which the codes are used is described below. **WARNING** - this is the recommended sequence of codes that you should run to produce **LEGAL** ENDF formatted data, that conforms to **ALL** ENDF formats and conventions. Note in particular that if you do not run **FIXUP** and **DICTIN** at the end of this sequence the resulting ENDF data **WILL NOT** conform to all ENDF formats and conventions, and may cause problem if you subsequently try to use the data.

1) **LINEAR** - Linearize cross sections. ENDF format allows cross sections to be represented as tables of data points using a number of different interpolation laws

between tabulated points; in order to obtain accurate results it is important to interpret the data using these interpolation laws. The interpolation laws are very useful during evaluation, but can present problems when they are used in applications. The subsequent use of the data can be greatly simplified and the accuracy of results improved by first linearizing all of the cross sections, i.e., replace the original tabulated data points and interpolation law by a new table where one can use linearly interpolation between tabulated points to within any required accuracy.

2) **RECENT** - Add the contribution of resonances to the cross sections. ENDF format allows cross sections to be represented as a contribution of resonance parameters and tabulated background corrections. This code will add the resonance contribution to the background cross sections in order to define the cross sections as linearly interpolable tables at 0 Kelvin (cold). Therefore subsequent codes need only deal with tabulated, linearly interpolable, 0 Kelvin cross sections.

3) **SIGMA1** - Doppler broaden cross sections to any temperature of interest in applications. As in the case of LINEAR and RECENT all cross sections read and written by this code are tabulated, linearly interpolable. All subsequent codes need not explicitly consider temperature effects and need only deal with tabulated, linearly interpolable cross sections at a given temperature.

4) **ACTIVATE** – Combine neutron interaction cross sections (MF=3) and multipliers (MF=9) to create activation cross sections (MF=10). LINEAR and GROUPIE have been updated to process multipliers (MF=9) and activation cross sections (MF=10). The sequence of codes LINEAR, ACTIVATE, and GROUPIE allow you to produce group averaged activation cross sections.

5) **LEGEND** - Convert tabulated distributions and Legendre coefficients to linearly interpolable tables (similar to what **LINEAR** does for cross sections). Check all angular distributions and Legendre coefficients, in particular check for negative angular distributions and if found, correct the distributions to make them positive. Note, negative angular distributions can lead to numerical instabilities and unreliable results if they are used in applications.

6) **SIXPAK** - ENDF-6 format introduced double differential data (MF=6) into the ENDF/B system for the first time. If your application codes have not yet been updated to handle double differential data, you can use **SIXPAK** to obtain single differential (MF=4 and 5) approximations to double differential data. Earlier versions of SIXPAK only output results for outgoing (emitted) neutrons and photons, however currently SIXPAK will output angular distributions for discrete charged particle levels.

7) **FIXUP** - Define all cross sections to be consistently exactly equal to the sum of their parts, make format corrections, and a number of other tests and corrections to the data, BEFORE the data is actually used in applications. It is extremely important for use in applications to guarantee that the cross sections are exactly consistent. For example, the total cross section MUST to defined as equal to the sum of its parts at all energies that appear in one or more of the contributing parts. In addition it should be mentioned that the total will be equal to the sum of its parts at all energies (not just the energies at which the total is tabulated), only if all of the cross sections are

linearly interpolable; this illustrates the importance of the steps described above in processing data through each of these codes. Note, if FIXUP's option to output all cross sections on a uniform energy grid is used, the FIXUP output is compatible for use as **NJOY** input.

8) **DICTIN** - Update the section index in MF=1, MT=451. This step need only be run if the subsequent codes that use the data refer to this index. If you are unsure whether or not this is the case, it is always best to include this step, since relative to the other codes described above this step requires very little running time.

After this sequence of codes has been run the results will be evaluated data that has been carefully checked for consistency and has been reduced to a form that can be used more easily and reliably in subsequent applications.

In addition to the codes mentioned above, this package includes a number of useful utility codes including,

1) **MERGER** - Retrieve and/or combine evaluated data. This code can be used to create a single file of data in the ENDF format from a number of different files, each of which is in the ENDF format. It can also be used to retrieve specific evaluated data from a larger ENDF/B library in order to simplify and optimize the subsequent use of the data in applications, e.g., if you have an entire ENDF/B library, but will only be using five evaluations for your applications, you can first use this code to create a mini-library containing only the five evaluations that you need for your application.

2) **GROUPIE** - Calculates self-shielded, multigroup cross sections and multiband parameters. This code can be used as a simple and very economical means of obtaining multigroup cross sections, in the ENDF format, which can be used in many applications where only multigroup cross sections are required, e.g., dosimetry. For comparing data using **COMPLOT** this code can be used to reduce evaluations that have many resonances, to a form in which integral differences through the resonance region can be more easily seen.

3) **COMPLOT** – Plot a comparison of cross sections from two different evaluations. This code can be used to compare cross sections, for each reaction, to define exactly how two evaluations differ. This can be extremely important if one has already used a given evaluation in applications and wishes to quickly and inexpensively determine whether or not a newer evaluation can be expected to produce significantly different results when used in applications. It is also an excellent and simple means of documenting the differences between two evaluations, e.g., what's the difference between the ENDF/B-VI, Release 4 and 5, U-235 cross sections? See the above comments under **GROUPIE** for suggestions concerning comparing evaluations that have many resonances. This code can be used as a simple means of visually checking all of these cross section data types and is often very useful to help understand the results obtained when data is used in applications. In addition, the graphic Postscript output can serve as a part of the documentation for evaluations. Two versions of exactly the same code are provided: **complot** to produce on-screen graphics, and **comhard** to produce Postscript, hardcopy, output.

4) **EVALPLOT** - Plot cross sections, angular distributions, Legendre coefficients and/or energy distributions, for neutron interaction data, neutron induced photon production data, and photon interaction data. This code can be used as a simple means of visually checking all of these data types and is often very useful to help understand the results obtained when data is used in applications. In addition, the graphic Postscript output can serve as a part of the documentation for evaluations. Two versions of exactly the same code are provided: **evalplot** to produce on-screen graphics, and **evalhard** to produce Postscript, hardcopy, output.

5) **MIXER** - Can be used to define the cross sections for a combination of materials, e.g., stainless steel. This code can be used in combination with **COMPLOT** to see which energy ranges are important for each material and each constituent of a material. This code can also be used to define the correct total cross section for use in transmission calculations (see, **VIRGIN**), as well as in self-shielding calculations (see, **GROUPIE**), in order to avoid the approximations normally incoherent in the Bonderenko method of self-shielding. Since ENDF/B-VI has moved in the direction of representing separate isotopes for each element, this code is particularly useful if your applications only requires a natural mixture of isotopes, e.g., use MIXER to combine isotopes into the natural element.

6) **VIRGIN** - Can be used to perform exact uncollided (virgin) transmission calculations (exact, assuming the tabulated, linearly interpolable cross sections are exact - no other approximations are used). By using the data that has been prepared by a combination of **LINEAR, RECENT, SIGMA1, MIXER,** etc., this code can be used to simulate transmission through any given material, or layers of different materials, at any given temperature. The results include both transmitted flux and reaction rates (as measured in self-indication measurements) vs. material thickness. The results can be obtained either on a continuous energy basis, or they can be binned (energy integrated) to simulate any given experimental resolution.

In addition there are two utility codes that operate on the codes, rather than on ENDF/B data.

1) **RELABEL** - Is a file maintenance code used to maintain all of the codes in this package. This code will normally not be used by users, unless they plan to modify these codes.

2) **CONVERT** - Format and optimize codes for use at any given computer installation. This code is no longer required by the PREPRO, since the codes are now completely computer independent. It is still included in this package only because users have found it useful for other purposes. Generally this code was used only once to format all of the codes prior to their first use on any computer.

Verifying Implementation

This distribution comes with a file named VERIFY, which is designed to run all of the codes, one after another, with the final two steps being to run EVALPLOT and COMPLOT, so that you can see the final results. VERIFY is a simple text file; its contents are shown below,

linear
recent
sigma1
activate
legend
fixup
dictin
groupie
mixer
virgin
evalplot
complot

When executed as a batch file, this will run the codes in the order indicated. The distributed input parameters have been defined so that each code reads the ENDF formatted data file produced by the preceding code, and writes the ENDF formatted data file that will be read by the following code.

To verify implementation immediately after you have installed the codes, DO NOT change any input parameters for ANY codes, and execute VERIFY. It will take between 5 minutes and an hour (depending on the speed of your computer), to run all of the codes. When you get to the final two graphics codes, EVALPLOT and COMPLOT, you can be assured that all of the codes have run successfully.

COMPLOT will compare the cross sections calculated by you on your computer to a standard set of results distributed with PREPRO 2007. In both cases cross sections are calculated by each code to within an accuracy of 1 %. Therefore when COMPLOT compares the results you may find differences of about 1 %. This difference is o.k., and merely indicates the differences due to precision to which the cross sections have been calculated. Subsequently, for use in your applications you can feel free to modify the input parameters for each code to meet the precision that you require.

WARNING – for UNIX users - some UNIX systems now include diction as a system command. In order to avoid this conflict, in PREPRO 2007 the code previously named diction has been renamed dictin.

Use of the Codes in Combination

Almost any computer will allow you to submit a batch job, in which case you can perform any number of operations one after the other, as is done in the above verification. These computers can utilize this facility to run any number of these codes in combination, minimize the total amount of disk space used, and most important, optimize the use of your time.

In order to run any number of codes one after the other, all you need is the facility to: 1) start a program, 2) rename a file, 3) delete a file, if you want to minimize disk space.

For example, if I want to run the sequence of codes, **LINEAR, RECENT, SIGMA1, ACTIVATE, LEGEND, FIXUP** and **DICTIN** and only keep the original data read by **LINEAR** and the final results output by **DICTIN**, I can use the standard ENDF filenames for the data read and written by each code, and submit the following batch file on an IBM-PC,

```
linear
rename LINEAR.OUT RECENT.IN
recent
delete RECENT.IN
rename RECENT.OUT SIGMA1.IN
sigma1
delete SIGMA1.IN
rename SIGMA1.OUT ACTIVTE.IN
activate
delete ACTIVATE.IN
rename ACTIVATE.OUT LEGEND.IN
legend
delete LEGEND.IN
rename LEGEND.OUT FIXUP.IN
fixup
delete FIXUP.IN
rename FIXUP.OUT DICTIN.IN
dictin
delete DICTIN.IN
```

Note, when each code finishes the above batch deck renames the ENDF formatted data output by the code to the filename of the ENDF formatted data input to the next code. When the next code finishes, the ENDF formatted data input to it is deleted (we no longer need it), and the cycle starts for the next code. More efficiently you could have defined ENDF input and output file names in the input parameter files for each code to link them together, e.g., instead of copying LINEAR.OUT to RECENT.IN, you could have defined the input file to RECENT to be named LINEAR.OUT.

The result will be the original data read by **LINEAR** is still in the file named **LINEAR.IN**, and the final result is in the file named **DICTIN.OUT**. All other intermediate files have been deleted.

On any other system, such as Unix, the names **delete** and **rename** may be different, but the basic idea remains the same.

An alternative to the above approach is to use the facility of the codes to read and write files from any file structure. For example, assume I have a directory named ENDFB6, and within this directory I have three sub-directories: ORIGINAL, TMP, and K300 (data Doppler broadened to 300 Kelvin). What I can do is define **LINEAR** input parameters to read a file from ENDFB6/ORIGINAL, define input parameters to **RECENT, SIGMA1, ACTIVATE, LEGEND** and **FIXUP** to produce ENDF output in ENDFB6/TMP, and have each code read the output from the preceding code. Finally I can define **DICTIN** input parameters to write the ENDF output into

ENDFB6/K300, with its final filename. In this case if I do not worry about deleting the intermediate files, the batch input need only be the names of the codes to run, i.e.,

linear
recent
sigma1
activate
legend
fixup
dictin

Using a batch approach can save you a great deal of your precious time. You don't have to sit there and babysit your terminal in order to start each code as the preceding one finishes. You can use batch jobs to combine code executions, and go off to work (or play) until the sequence of codes finishes. If you then want to be sure that everything ran correctly, you can read the output reports from each code, i.e., see the **???.LST** from each code, e.g., for RECENT see RECENT.LST – **it is HIGHLY Recommended that you always read these files.**

Details of Compiling and Loading Codes

For use on IBM-PC running Windows or Linux, and on PowerMAC, the distribution includes executables, ready to immediately use. For use on a variety of UNIX based computers, the distribution includes a batch file for each type of computer, to compile and load all programs, and to then clean up by deleting everything not required to execute the programs. Only for other types of computers need you be concerned with the details concerning compiling and loading the codes, which are described here.

Parts of the Codes

The codes have now been divided into a number of parts that should be combined when compiling and loading; see, example compile/load instructions below. The parts are,

1) The basic code

2) An include file to define code storage

3) Routines to allow all codes to now uniformly treat all ENDF formatted input and output (**endfio.f**)

4) Routines to allow scratch files to be defined either with or without file names,
scratcha.f = with file name
scratchb.f = without file name

Most compilers/computers allow scratch files to be defined without scratch file names, so use either **scratcha.f** or **scratchb.f**. However, some compilers/system combinations get confused when there are multiple scratch files without file names,

e.g., Lahey on IBM-PC (use **scratcha.f**), and some compilers do not allow scratch files with file names, e.g., ABSOFT on IBM-PC and Power MAC (use **scratchb.f**).

4) A timer, to define the execution time for each code. The standard timer routine (**timer.f**) distributed with the codes uses the standard Unix routine **ETIME**; on some computers you will have to consult the on-line manual to see how to link to **ETIME**, e.g., HP.

If you are not using a Unix based computer, you will have to supply your own timing routine. It is recommended that you use the distributed version of **timer.f**, and add a function **ETIME**, that defines the execution time on your computer - see, the timing routines included for a variety of UNIX computers

If you do define a non-standard timer, try to define EXECUTION - NOT WALL CLOCK time - on some computers this isn't possible, e.g., IBM-PC running DOS - in which case use whatever you can.

If you can't figure out how to define running time, or you don't want the codes to print running time, instead of using the distributed **timer.f**, define and use the following dummy routine,

```
SUBROUTINE TIMER
RETURN
END
```

If you do define a non-standard timer, PLEASE send us a copy, identifying what computer/compiler you are using - over a period of time we intend to build up a library of timer routines for as many different computers as possible - which we will then distribute with the codes = future versions will be more compatible to meet your needs.

5) A graphics interface, for complot and evalplot.

Compiling/Loading

This section applies to all of the codes, except the graphics codes, **complot** and **evalplot**; see, below under graphics codes. Below is an example of how to compile/load the codes on a Unix based computer. For this example I illustrate how to create executables on a SUN workstation; timing routines are provided for most types of computers. Note,

1) No special libraries are used by these codes, so that compile/load instructions are very simple.
2) How the pieces are combined.
3) Use the HIGHEST LEVEL OPTIMIZATION available on your computer - this can make a BIG difference in running time.
4) SUN.f is the timing routine to use on a SUN workstation. Similar timing routines are provided for most types of computers.

```
f77 -o linear  -O linear.f  endfio.f scratchb.f timer.f SUN.f
f77 -o recent  -O recent.f  endfio.f scratchb.f timer.f SUN.f
```

```
f77 -o sigma1  -O sigma1.f  endfio.f scratchb.f timer.f SUN.f
f77 -o fixup   -O fixup.f   endfio.f scratchb.f timer.f SUN.f
f77 -o legend  -O legend.f  endfio.f scratchb.f timer.f SUN.f
f77 -o sixpak  -O sixpak.f  endfio.f scratchb.f timer.f SUN.f
f77 -o mixer   -O mixer.f   endfio.f scratchb.f timer.f SUN.f
f77 -o merger  -O merger.f  endfio.f scratchb.f timer.f SUN.f
f77 -o dictin  -O dictin.f  endfio.f scratchb.f timer.f SUN.f
f77 -o virgin  -O virgin.f  endfio.f scratchb.f timer.f SUN.f
f77 -o groupie -O groupie.f endfio.f scratchb.f timer.f SUN.f
f77 -o relabel -O relabel.f
f77 -o convert -O convert.f
```

Graphics Codes

The graphics codes - **complot** and **evalplot** - can be used to produce either,

1) Postscript output files for printed hardcopy, using executables named **comhard** and **evalhard**.
2) On screen graphics, using executables named **complot** and **evalplot**.

The two executables, **complot** and **comhard**, are exactly the same code, loaded with different graphics interfaces; both executables use the same input and output files, **COMPLOT.INP** and **COMPLOT.LST**. Similarly, the two executables, **evalplot** and **evalhard**, are exactly the same code, loaded with different graphics interfaces; both executables use the same input and output files, **EVALPLOT.INP** and **EVALPLOT.LST**.

Postscript Output Files

The Postscript graphics interface should be completely computer independent, and as such should run on any computer.

It will create a series of output files - none of which are sent to your printer during execution of the code.

Output for each plot is saved on disk, so when the code ends all of the plot files will still be on disk, and you can then send them to your printer, and/or, save them for later use.

WARNING - the codes always use the same file names, **PLOT0001.ps, PLOT0002.ps**, etc. So that running a code again will overwrite any files that you previously created. If you want to save files, moved them or rename them before running a code again.

To use this method to create these Postscript files use **hardsave.f** with the codes.

For Postscript graphics, no special libraries are used, and an example of how to compile/load the codes on a Unix based computer is shown below - this is very similar to the compile instructions shown above, with the addition of hardsave.f,

```
f77 -o comhard  -O complot.f  endfio.f scratchb.f timer.f hardsave.f
SUN.f
f77 -o evalhard -O evalplot.f endfio.f scratchb.f timer.f hardsave.f
SUN.f
```

Note, that here the executables are given the names for the hardcopy versions of the codes, **comhard** and **evalhard**.

On Screen Graphics

For on screen graphics the codes are loaded with **screen.f**, in contrast to the hardcopy version of the codes, described above, for Postscript graphics that are loaded with **hardsave.f**.

Example Makefiles are included for a variety of Unix systems.

On screen graphics is VERY computer dependent, so on Unix computers you may have to modify the Unix Makefile - this should only involve finding out where the X11 graphics library is on your computer, and setting the correct path in the Makefile.

If you do have to modify the Makefile, please send me a copy of the modified file, identifying your computer, so that we can build up a library of Makefiles to be distributed with the codes then future versions will be compatible with your needs.

The codes are distributed with graphics interfaces for,

1) Unix, MAC OSX, and openVMS systems, using the X11 graphics library (**screen.f**, **nodash.c, dash.c**)

2) If you are using any other system, you will have to supply your own graphics interface - see, **screen.f** for a description of the simple interface used by these codes.

Interacting with Graphics

When you are using **evalplot** there is no true on-screen interaction with the plots. If you wish to view different data over different energy ranges your only option is to change your input parameters in the file **EVALPLOT.INP**.

When you are using **complot** you can interact with the on-screen plots. Once a plot is displayed on your screen if you would like to see a portion of the energy range of the plot in greater detail, you can do this by using your mouse to zoom in by indicating the lower and upper energy limits of the energy range you would like to see. As soon as you select the range the next zoomed plot will appear on your screen, with the same data as on the previous plot, but only over the energy range that you have selected. WARNING – **complot** only generates plots when the two evaluations differ by more than the allowable uncertainty you define by input in the file **COMPLOT.INP**. This also applies when you interact with the plots. Therefore, if you use your mouse to select an energy range over which the two evaluations do not differ by more than your allowable uncertainty a zoomed plot will not be produced,

but the results of the comparison will be reported in the output file COMPLOT.LST, and **complot** will proceed to its next comparison.

Comments from Codes

These codes are designed to be self-documenting, in the sense that the most up-to-date documentation is included as comments at the beginning of each code. Periodically documentation, such as this report, is published. But the user is warned that the comments in the codes are continuously updated and it is these comments within the codes that should be considered to be the most up-to-date documentation, and the user should read these comments before, and while, using these codes.

The following section contains a listing of the comments from the codes as of the publication date of this report. The comments are listed for each code alphabetically according to the name of the code, including,

ACTIVATE
CONVERT
COMPLOT
DICTIN
EVALPLOT
FIXUP
GROUPIE
LEGEND
LINEAR
MERGER
MIXER
RECENT
RELABEL
SIGMA1
SIXPAK
VIRGIN

```
====================================================================== Activate
                                                                       Activate
     PROGRAM ACTIVATE                                                  Activate
     VERS. 2000-1 (APRIL 2000)   *INITIAL VERSION.                     Activate
     VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS            Activate
     VERS. 2004-1 (JAN. 2004)    *CORRECTED ERROR - FIRST RECORD AFTER  Activate
                                  MF=10 WAS MISSING.                   Activate
                                 *ADDED INCLUDE TO DEFINE COMMON       Activate
                                 *INCREASED MAX. POINTS FROM 100,000   Activate
                                  TO 1,000,000.                        Activate
     VERS. 2007-1 (JAN. 2007)    *CHECKED AGAINST ALL ENDF/B-VII       Activate
                                                                       Activate
     Acknowledgement 2004                                              Activate
     --------------------                                              Activate
     Currently almost all improvements to this code are based upon     Activate
     feedback from code users who report problems. This feedback       Activate
     benefits ALL users of this code, and ALL users are encouraged     Activate
     to report problems.                                               Activate
                                                                       Activate
     Improvements on the 2004 version of this code based on user       Activate
     feedback including,                                               Activate
     1) Andrej Trkov - reported that the first record of the section   Activate
                       after an inserted MF=10 was missing.            Activate
                                                                       Activate
     OWNED, MAINTAINED AND DISTRIBUTED BY                              Activate
     ------------------------------------                              Activate
     THE NUCLEAR DATA SECTION                                          Activate
     INTERNATIONAL ATOMIC ENERGY AGENCY                                Activate
     P.O. BOX 100                                                      Activate
     A-1400, VIENNA, AUSTRIA                                           Activate
     EUROPE                                                            Activate
                                                                       Activate
     ORIGINALLY WRITTEN BY                                             Activate
     ------------------------------------                              Activate
     DERMOTT E. CULLEN                                                 Activate
     UNIVERSITY OF CALIFORNIA                                          Activate
     LAWRENCE LIVERMORE NATIONAL LABORATORY                            Activate
     L-159                                                             Activate
     P.O. BOX 808                                                      Activate
     LIVERMORE, CA 94550                                               Activate
     U.S.A.                                                            Activate
     TELEPHONE  925-423-7359                                           Activate
     E. MAIL    CULLEN1@LLNL.GOV                                       Activate
     WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                            Activate
                                                                       Activate
     AUTHORS MESSAGE                                                   Activate
     ---------------                                                   Activate
     THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION  Activate
     FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED Activate
     THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE Activate
     READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION.                 Activate
                                                                       Activate
     AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER Activate
     INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE    Activate
     OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT Activate
     IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY      Activate
     COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO  Activate
     IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF   Activate
     THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR         Activate
     COMPUTER.                                                         Activate
                                                                       Activate
     PURPOSE                                                           Activate
     -------                                                           Activate
     THIS PROGRAM IS DESIGNED TO CREATE FILE 10 ACTIVATION CROSS       Activate
     SECTIONS BY COMBINING FILE 3 CROSS SECTIONS AND FILE 9 MULTIPLIERS Activate
                                                                       Activate
     IN THE FOLLOWING DISCUSSION FOR SIMPLICITY THE ENDF/B TERMINOLOGY  Activate
     ---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE    Activate
```

```
TAPE, CARDS, DISK OR ANY OTHER MEDIUM.                                  Activate
                                                                        Activate
ASSUMPTIONS                                                             Activate
-----------                                                             Activate
IT IS ASSUMED THAT THE FILE 3 AND 9 DATA HAVE BEEN LINEARIZED           Activate
BEFORE THIS CODE IS USED - FILE 3 AND 9 DATA CAN BE LINEARIZED          Activate
USING PROGRAM LINEAR.                                                   Activate
                                                                        Activate
IT IS ASSUMED THAT THE FILE 9 MULTIPLIERS ARE FAIRLY SMOOTH VERSUS      Activate
ENERGY, AND THAT THE ACTIVATION CROSS SECTIONS FOR FILE 10 CAN BE       Activate
DEFINED AT EXACTLY THE SAME ENERGIES AS THE FILE 3 CROSS SECTIONS,      Activate
AND THAT THESE NEED MERELY BE MULTIPLIED BY THE FILE 9 TO DEFINE        Activate
THE FILE 10 ACTIVATION CROSS SECTIONS.                                  Activate
                                                                        Activate
ENDF/B FORMAT                                                           Activate
-------------                                                           Activate
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS          Activate
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION        Activate
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT).      Activate
                                                                        Activate
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B            Activate
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS          Activate
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE       Activate
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE               Activate
CORRECTLY OUTPUT ON ALL LINES. THE FORMAT OF SECTION MF=1, MT=451       Activate
AND ALL SECTIONS OF MF=3 MUST BE CORRECT. THE PROGRAM COPIES ALL        Activate
OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO        Activate
THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.                 Activate
                                                                        Activate
OUTPUT FORMAT                                                           Activate
-------------                                                           Activate
ALL ENERGIES WILL BE OUTPUT IN F (INSTEAD OF E) FORMAT IN ORDER         Activate
TO ALLOW ENERGIES TO BE WRITTEN WITH UP TO 9 DIGITS OF ACCURACY.        Activate
COMPARISON OF THE NORMAL ENDF/B CONVENTION OF 6 DIGITS TO THE 9         Activate
DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE TO USE         Activate
THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA DUE TO          Activate
TRUNCATION OF ENERGIES TO 6 DIGITS DURING OUTPUT.                       Activate
                                                                        Activate
CONTENTS OF OUTPUT                                                      Activate
------------------                                                      Activate
ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE PROCESSED DATA, E.G.,       Activate
ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO INCLUDED.                     Activate
                                                                        Activate
DOCUMENTATION                                                           Activate
-------------                                                           Activate
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED       Activate
BY THE ADDITION OF 3 COMMENT LINES AT THE END OF EACH HOLLERITH         Activate
SECTION IN THE FORM                                                     Activate
                                                                        Activate
***************** PROGRAM ACTIVATE (2007-1) ****************           Activate
FILE 10 ACTIVATION CROSS SECTIONS HAVE BEEN DEFINED BY COMBINING        Activate
FILE 3 CROSS SECTIONS AND FILE 9 MULTIPLIERS. FILE 9 DELETED.           Activate
                                                                        Activate
THE ORDER OF SIMILAR COMMENTS (FROM RECENT, SIGMA1 AND GROUPIE)         Activate
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON            Activate
THE DATA BY THESE PROGRAMS.                                             Activate
                                                                        Activate
THESE COMMENT LINES ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,      Activate
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT      Activate
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF           Activate
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451         Activate
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF           Activate
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF           Activate
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO               Activate
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND        Activate
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT       Activate
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                           Activate
                                                                        Activate
```

```
REACTION INDEX                                                  Activate
--------------                                                  Activate
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN  Activate
SECTION MF=1, MT=451 OF EACH EVALUATION.                        Activate
                                                                Activate
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451. Activate
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT      Activate
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS Activate
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING Activate
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE Activate
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM Activate
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.  Activate
                                                                Activate
SECTION SIZE                                                    Activate
------------                                                    Activate
SECTIONS OF MF=9 MULTIPLIERS ARE LIMITED TO A MAXIMUM OF 10,000 Activate
ENERGY POINTS.                                                  Activate
                                                                Activate
THERE IS NO LIMIT ON THE NUMBER OF ENERGY POINTS IN MF=3 AND 10 Activate
TABLES.                                                         Activate
                                                                Activate
SELECTION OF DATA                                               Activate
-----------------                                               Activate
THE PROGRAM PROCESSES ALL ENDF/B DATA ON A SERIES OF ENDF/B TAPES. Activate
                                                                Activate
PROGRAM OPERATION                                               Activate
-----------------                                               Activate
PASS #1                                                         Activate
-------                                                         Activate
THE ENTIRE MAT IS COPIED TO A SCRATCH FILE IN THE ENDF/B ASCII  Activate
FORMAT AND WHILE COPYING IT TO SCRATCH MF=3, 9, AND 10 ARE ALSO Activate
COPIED TO SEPERATE SCRATCH FILES, I.E., THERE ARE A TOTAL OF 4  Activate
SCRATCH FILES - SEE THEIR DEFINITIONS BELOW.                    Activate
                                                                Activate
PASS #2                                                         Activate
-------                                                         Activate
IF NO MF=9 MULTIPLIERS ARE FOUND DURING PASS #1, THE ENTIRE MAT Activate
IS COPIED FROM SCRATCH TO THE OUTPUT FILE, WITHOUT ANY CHECKS.  Activate
                                                                Activate
IF MF=9 MULTIPLIERS ARE FOUND THEY ARE USED WITH MF=3 CROSS     Activate
SECTIONS TO CREATE MF=10 ACTIVATION CROSS SECTIONS.             Activate
                                                                Activate
FOR ANY SECTION OF MF=10 DATA FOR WHICH NO MF=9 MULTIPLIERS ARE Activate
FOUND, THE ORIGINAL MF=10 IS OUTPUT.                            Activate
                                                                Activate
FOR CONSISTENCY ALL MF=9 MULTIPLIERS ARE DELETED, I.E., THEY ARE Activate
NOT INCLUDED IN THE OUTPUT.                                     Activate
                                                                Activate
KEEP EVALUATED DATA POINTS                                      Activate
--------------------------                                      Activate
THE FILE 10 OUTPUT WILL BE AT EXACTLY THE SAME ENERGY POINTS AS Activate
THE FILE 3 CROSS SECTIONS USED TO DEFINE THE FILE 10 ACTIVATION Activate
CROSS SECTIONS.                                                 Activate
                                                                Activate
INPUT FILES                                                     Activate
-----------                                                     Activate
UNIT  DESCRIPTION                                               Activate
----  -----------                                               Activate
   2  INPUT LINES (BCD - 80 CHARACTERS/RECORD)                  Activate
  10  ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)         Activate
                                                                Activate
OUTPUT FILES                                                    Activate
------------                                                    Activate
UNIT  DESCRIPTION                                               Activate
----  -----------                                               Activate
   3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)               Activate
  11  FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)            Activate
                                                                Activate
```

```
    SCRATCH FILES                                                       Activate
    -------------                                                       Activate
    UNIT  DESCRIPTION                                                   Activate
    ----  -----------                                                   Activate
      12  SCRATCH FILE FOR ALL MAT (BCD - 80 CHARACTERS/RECORD)         Activate
      14  SCRATCH FILE FOR MF=3 DATA (BCD - 80 CHARACTERS/RECORD)       Activate
      15  SCRATCH FILE FOR MF=9 DATA (BCD - 80 CHARACTERS/RECORD)       Activate
      16  SCRATCH FILE FOR MF=10 DATA (BCD - 80 CHARACTERS/RECORD)      Activate
                                                                        Activate
    OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)                Activate
    ----------------------------------------------------                Activate
    UNIT  FILE NAME                                                     Activate
    ----  ----------                                                    Activate
      2   ACTIVATE.INP                                                  Activate
      3   ACTIVATE.LST                                                  Activate
     10   ENDFB.IN                                                      Activate
     11   ENDFB.OUT                                                     Activate
     12   (SCRATCH)                                                     Activate
     14   (SCRATCH)                                                     Activate
     15   (SCRATCH)                                                     Activate
                                                                        Activate
    INPUT PARAMETERS                                                    Activate
    ----------------                                                    Activate
                                                                        Activate
    LINE  COLS.  DESCRIPTION                                            Activate
    ----  -----  -----------                                            Activate
       1   1-60  ENDF/B INPUT DATA FILENAME                             Activate
                 (STANDARD OPTION = ENDFB.IN)                           Activate
       2   1-60  ENDF/B OUTPUT DATA FILENAME                            Activate
                 (STANDARD OPTION = ENDFB.OUT)                          Activate
                                                                        Activate
    ANY NUMBER OF PAIRS OF INPUT LINES MAY BE USED, TO PROCESS ANY      Activate
    NUMBER OF ENDF/B TAPES, ONE AFTER ANOTHER.                          Activate
                                                                        Activate
    EXAMPLE INPUT NO. 1                                                 Activate
    -------------------                                                 Activate
    PROCESS ENDF/B TAPES NAMED, TAPE121, TAPE122, AND TAPE123, AND      Activate
    NAME THE OUTPUT FILES ACTIVATE121, ACTIVATE122, AND ACTIVATE123.    Activate
                                                                        Activate
    IN THIS CASE THE FOLLOWING 6 INPUT LINES ARE REQUIRED               Activate
                                                                        Activate
 TAPE121                                                                Activate
 ACTIVATE121                                                            Activate
 TAPE122                                                                Activate
 ACTIVATE122                                                            Activate
 TAPE123                                                                Activate
 ACTIVATE123                                                            Activate
                                                                        Activate
    EXAMPLE INPUT NO. 2                                                 Activate
    -------------------                                                 Activate
    SAME AS THE ABOVE CASE, EXCEPT THAT IN THIS CASE THE ORIGINAL       Activate
    3 TAPES ARE IN A DIRECTORY NAMED \ENDFB6\ORIGINAL, AND THE          Activate
    RESULTS WILL BE WRITTEN INTO A DIRECTORY NAMED \ENDFB6\ACTIVATE.    Activate
                                                                        Activate
    IN THIS CASE THE FOLLOWING 6 INPUT LINES ARE REQUIRED               Activate
                                                                        Activate
 \ENDFB6\ORIGINAL\TAPE121                                               Activate
 \ENDFB6\ACTIVATE\ACTIVATE121                                           Activate
 \ENDFB6\ORIGINAL\TAPE122                                               Activate
 \ENDFB6\ACTIVATE\ACTIVATE122                                           Activate
 \ENDFB6\ORIGINAL\TAPE123                                               Activate
 \ENDFB6\ACTIVATE\ACTIVATE123                                           Activate
                                                                        Activate
=========================================================================== Activate
```

```
====================================================================== Complot
                                                                       Complot
     PROGRAM COMPLOT                                                   Complot
     ===============                                                   Complot
     VERSION 83-1 (FEBRUARY, 1983)                                     Complot
     VERSION 83-2 (MAY, 1983)                                          Complot
     VERSION 83-3 (DECEMBER, 1983) *MAJOR MODIFICATION.                Complot
                                   *ADDED SELECTION OF PLOTS BY MAT OR  Complot
                                    ZA/MT/ENERGY RANGE (EV).           Complot
                                   *ADDED VARIABLE AXIS UNITS (PROGRAM  Complot
                                    CONTROLLED..X=MILLI-EV, EV, KEV,   Complot
                                    MEV...Y=MILLI-BARNS, BARNS).       Complot
     VERSION 84-1 (APRIL, 1984)    *ADDED SELECTION BY REACTION/ENERGY  Complot
                                    RANGE.                             Complot
                                   *ADDED IDENTIFY DATA POINTS OPTION   Complot
                                    (SMALL BOX DRAWN AROUND EACH CROSS  Complot
                                     SECTION AND RATIO POINT).         Complot
                                   *IMPROVED NON-IBM GRAPHICS INTERFACE Complot
                                    (ALL CHARACTER POSITIONING NOW      Complot
                                     BASED ON CHARACTER, NOT RASTER,    Complot
                                     SIZE).                            Complot
     VERSION 85-1 (APRIL, 1985)    *SPECIAL I/O ROUTINES TO GUARANTEE   Complot
                                    ACCURACY OF ENERGY.                Complot
                                   *DOUBLE PRECISION TREATMENT OF       Complot
                                    ENERGY (REQUIRED FOR NARROW        Complot
                                    RESONANCES).                       Complot
                                   *ADDED (ZA,MT) EQUIVALENCE OPTION.   Complot
                                   *ADDED SMALL PLOT OPTION.            Complot
     VERSION 85-2 (AUGUST, 1985)   *FORTRAN-77/H VERSION               Complot
     VERSION 86-1 (JANUARY, 1986)  *ENERGY DEPENDENT SCATTERING RADIUS  Complot
     VERSION 86-2 (DECEMBER, 1986) *DOUBLE PRECISION PLOT SCALING       Complot
                                    (REQUIRED FOR NARROW ENERGY RANGES) Complot
     VERSION 88-1 (JULY 1988)      *MAJOR REVISION TO MAKE CODE EASILY  Complot
                                    INTERFACEABLE TO ALMOST ANY PLOTTER Complot
                                   *WARNING..INPUT PARAMETERS FROM BEEN Complot
                                    CHANGED (SEE, DESCRIPTION BELOW)   Complot
                                   *COMPUTER INDEPENDENT SOFTWARE       Complot
                                    CHARACTERS.                        Complot
                                   *COLOR PLOTS.                        Complot
                                   *MT NUMBER DEFINITIONS FROM DATA     Complot
                                    FILE READ BY PROGRAM               Complot
                                   *FORTRAN-77 REQUIRED (FORTRAN-H NO   Complot
                                    SUPPORTED BY THIS PROGRAM).        Complot
                                   *OPTION...INTERNALLY DEFINE ALL I/O  Complot
                                    FILE NAMES (SEE, SUBROUTINE FILEIO Complot
                                    FOR DETAILS).                      Complot
                                   *IMPROVED BASED ON USER COMMENTS.    Complot
     VERSION 88-2 (OCTOBER 1988)   *IMPROVED BASED ON USER COMMENTS.    Complot
                                   *ADDED LIVERMORE CIVIC COMPILER      Complot
                                    CONVENTIONS.                       Complot
                                   *UPDATED TO USE NEW PROGRAM CONVERT  Complot
                                    KEYWORDS.                          Complot
     VERSION 89-1 (JANUARY 1989)   *PSYCHOANALYZED BY PROGRAM FREUD TO  Complot
                                    INSURE PROGRAM WILL NOT DO ANYTHING Complot
                                    CRAZY.                             Complot
                                   *FORTRAN-77/FORTRAN-H COMPATIBLE     Complot
                                   *SPECIAL ENDF/B MATERIAL DEFINITIONS Complot
                                    (ZA.LT.1000) FROM DATA FILE READ    Complot
                                    BY PROGRAM.                        Complot
     VERSION 89-2 (MARCH 1989)     *ADDED ENDF/B-V AND VI MT            Complot
                                    DEFINITIONS. PROGRAM WILL DETERMINE Complot
                                    ENDF/B FORMAT BASED ON MF=1,        Complot
                                    MT=451 AND USE AS PPROPRIATE MT     Complot
                                    DEFINITIONS. IF NO MF=1, MT=451     Complot
                                    PROGRAM WILL USE ENDF/B-VI          Complot
                                    MT DEFINITIONS.                    Complot
     VERSION 90-1 (AUGUST 1990)    *A NEW PROGRAM                       Complot
                                   *ADDED INTERACTIVE MOUSE INPUT       Complot
```

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                              *ADDED 3 CHARACTER FONTS             Complot
                              *ADDED PHOTON DATA, MF=23 AND 27     Complot
                              *ADDED FORTRAN SAVE OPTION.          Complot
                              *ADDED MAXIMUM RATIO RANGE WHEN      Complot
                               PLOTTING RATIOS.                    Complot
                              *ADDED GRID TYPES                    Complot
                              *ADDED VARIABLE LINE THICKNESS       Complot
                              *WARNING...INPUT PARAMETER FORMAT    Complot
                               HAS BEEN CHANGED...SEE DESCRIPTION  Complot
                               BELOW.                              Complot
VERSION 92-1 (JANUARY 1992)   *ADDED INCIDENT CHARGED PARTICLES    Complot
                               (IDENTIFIED IN PLOT TITLES)         Complot
                              *ADDED COMPLETELY COMPATIBLE I/O     Complot
                               FOR READING FLOATING POINT NUMBERS. Complot
VERSION 92-2 (MAY 1992)       *CORRECTED DESCRIPTION OF INPUT      Complot
                               PARAMETERS AND EXAMPLE PROBLEMS.    Complot
                              *ADDED VARIABLE CHARACTER SIZE INPUT Complot
VERSION 93-1 (MARCH 1993)     *UPDATE FOR ON SCREEN GRAPHIC        Complot
                               OUTPUT USING THE LAHEY COMPILER     Complot
                              *ADDED NU-BAR (TOTAL, DELAYED,       Complot
                               PROMPT).                            Complot
VERSION 94-1 (JANUARY 1994)   *VARIABLE ENDF/B DATA FILENAMES      Complot
                               TO ALLOW ACCESS TO FILE STRUCTURES  Complot
                               (WARNING - INPUT PARAMETER FORMAT   Complot
                               HAS BEEN CHANGED)                   Complot
                              *CLOSE ALL FILES BEFORE TERMINATING  Complot
                               (SEE, SUBROUTINE ENDIT)             Complot
VERSION 95-1 (MARCH 1995)     *CORRECTED CROSS SECTION             Complot
                               MULTIPLIER FOR EQUIVALENCES         Complot
                              *CORRECTED RATIO SCALING, FOR        Complot
                               MAXIMUM RATIO LESS THAN 1.0         Complot
VERSION 96-1 (JANUARY 1996)   *COMPLETE RE-WRITE                   Complot
                              *IMPROVED COMPUTER INDEPENDENCE      Complot
                              *ALL DOUBLE PRECISION                Complot
                              *UNIFORM TREATMENT OF ENDF/B I/O     Complot
                              *IMPROVED OUTPUT PRECISION           Complot
                              *DEFINED SCRATCH FILE NAMES          Complot
                              *INCREASED PAGE SIZE FROM 24000      Complot
                               TO 48000 POINTS                     Complot
VERSION 97-1 (APRIL 1997)     *INCREASED PAGE SIZE FROM 48000      Complot
                               TO 480000 POINTS                    Complot
VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING       Complot
                             POINT READ FOR MORE DIGITS            Complot
                            *UPDATED TEST FOR ENDF/B FORMAT        Complot
                             VERSION BASED ON RECENT FORMAT CHANGE Complot
                            *GENERAL IMPROVEMENTS BASED ON         Complot
                             USER FEEDBACK                         Complot
VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON         Complot
                             USER FEEDBACK                         Complot
VERS. 2002-1 (MAY 2002)     *INPUT PARAMETERS OPTIONAL             Complot
                            *CONTROL MINIMUM RATIO RANGE BY INPUT  Complot
                            *OPTIONAL BLACK OR WHITE BACKGROUND    Complot
VERS. 2004-1 (SEPT. 2004)   *ADDED INCLUDE FOR COMMON               Complot
                            *INCREASED PAGE SIZE FROM 480000       Complot
                             TO 600000 POINTS                      Complot
                            *ADDED NEW REICH-MOORE TO FILE2 TO     Complot
                             ALLOW IDENTIFICATION OF RESOLVED AND  Complot
                             ANY FOLLOWING UNRESOLVED RESONANCE    Complot
                             REGIONS.                              Complot
VERS. 2007-1 (JAN.  2007)   *CHECKED AGAINST ALL ENDF/B-VII.       Complot
                            *INCREASED MAXLOAD TO 600,000 FROM     Complot
                             12,000                                Complot
                                                                   Complot
OWNED, MAINTAINED AND DISTRIBUTED BY                               Complot
-----------------------------------                                Complot
THE NUCLEAR DATA SECTION                                           Complot
INTERNATIONAL ATOMIC ENERGY AGENCY                                 Complot
P.O. BOX 100                                                       Complot
```

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A-1400, VIENNA, AUSTRIA                                                 Complot
EUROPE                                                                  Complot
                                                                        Complot
ORIGINALLY WRITTEN BY                                                   Complot
-------------------------------------                                   Complot
DERMOTT E. CULLEN                                                       Complot
UNIVERSITY OF CALIFORNIA                                                Complot
LAWRENCE LIVERMORE NATIONAL LABORATORY                                  Complot
L-159                                                                   Complot
P.O. BOX 808                                                            Complot
LIVERMORE, CA 94550                                                     Complot
U.S.A.                                                                  Complot
TELEPHONE  925-423-7359                                                 Complot
E. MAIL    CULLEN1@LLNL.GOV                                             Complot
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                  Complot
                                                                        Complot
                                                                        Complot
AUTHORS MESSAGE                                                         Complot
---------------                                                         Complot
THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENTATION        Complot
ALL RECENT IMPROVEMENTS. PLEASE READ ALL OF THESE COMMENTS BEFORE,      Complot
PARTICULARLY THE COMMENTS CONCERNING MACHINE DEPENDENT CODING.          Complot
                                                                        Complot
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER      Complot
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE          Complot
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT      Complot
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY            Complot
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO       Complot
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF         Complot
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR              Complot
COMPUTER.                                                               Complot
                                                                        Complot
PURPOSE                                                                 Complot
-------                                                                 Complot
COMPARE ENDF/B FORMATTED DATA FROM TWO SEPARATE INPUT TAPES.            Complot
REACTIONS ARE CONSIDERED TO BE COMPARABLE IF THEY HAVE THE SAME         Complot
(ZA,MF,MT). RESULTS ARE PRESENTED IN GRAPHICAL FORM.                    Complot
                                                                        Complot
IN THE FOLLOWING FOR SIMPLICITY THE ENDF/B TERMINOLOGY--ENDF/B          Complot
TAPE--WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS,       Complot
DISK OR ANY OTHER MEDIUM.                                               Complot
                                                                        Complot
ON WHAT COMPUTERS WILL THE PROGRAM RUN                                  Complot
---------------------------------------------------------------------- Complot
THE PROGRAM HAS BEEN IMPLEMENTED ON A VARIETY OF COMPUTERS FROM         Complot
CRAY AND IBM MAINFRAME TO SUN WORKSTATIONS TO AN IBM-AT PC. THE         Complot
PROGRAM IS SMALL ENOUGH TO RUN ON VIRTUALLY ANY COMPUTER.               Complot
                                                                        Complot
THE PROGRAM USES A SIMPLE CALCOMP LIKE GRAPHICS INTERFACE               Complot
(DESCRIBED BELOW) AND ALLOWS THE USER SPECIFY THE PHYSICAL SIZE         Complot
OF THE PLOTTER BEING USED, BY INPUT PARAMETERS. USING THESE             Complot
CONVENTIONS THIS PROGRAM CAN BE EASILY INTERFACED TO VIRTUALLY          Complot
ANY PLOTTER.                                                            Complot
                                                                        Complot
FOR SPECIAL CONSIDERATIONS SEE THE SECTIONS BELOW ON,                   Complot
(1) COMPUTER DEPENDENT CODING                                           Complot
(2) PLOTTER/GRAPHICS TERMINAL INTERFACE                                 Complot
                                                                        Complot
GRAPHICS INTERFACE                                                      Complot
---------------------------------------------------------------------- Complot
THIS PROGRAM USES A SIMPLE CALCOMP LIKE GRAPHICS INTERFACE WHICH        Complot
REQUIRES ONLY 3 SUBROUTINES...PLOTS, PLOT AND PEN (DESCRIBED IN         Complot
DETAIL BELOW). ALL CHARACTERS AND SYMBOLS ARE DRAWN USING TABLES        Complot
OF PEN STROKES (SUPPLIED WITH THIS PROGRAM). USING THIS METHOD          Complot
THE PROGRAM SHOULD BE SIMPLE TO INTERFACE TO VIRTUALLY ANY PLOTTER      Complot
OR GRAPHICS TERMINAL AND THE APPEARANCE AND LAYOUT OF THE PLOTS         Complot
SHOULD BE INDEPENDENT OF WHICH PLOTTER IS USED.                         Complot
                                                                        Complot
```

```
ON WHAT PLOTTERS WILL THE PROGRAM RUN                                Complot
-------------------------------------------------------------------- Complot
THE PLOTTER MAY USE UNITS OF INCHES, CENTIMETERS, MILLIMETERS,       Complot
VIRTUALLY ANYTHING. INTERNALLY THE PROGRAM WILL DEFINE PLOTS IN      Complot
APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. AS PART OF THE          Complot
INPUT THE USER DEFINES THE ACTUAL SIZE OF THE PLOT IN THE UNITS      Complot
(I.E., INCHES, CENTIMETERS, MILLIMETERS, WHATEVER) OF THE REAL       Complot
PLOT. THE PLOT IS TRANSFORMED TO THE SIZE OF THE LOCAL PLOTTER       Complot
AND OUTPUT. USING THIS CONVENTION THIS PROGRAM SHOULD BE EASY        Complot
TO INTERFACE TO VIRTUALLY ANY PLOTTER OR GRAPHICS TERMINAL.          Complot
                                                                     Complot
PROGRAM IDENTIFICATION                                               Complot
----------------------                                               Complot
AS DISTRIBUTED THE FIRST FRAME OF PLOTTED OUTPUT WILL DOCUMENT       Complot
THE PROGRAM NAME, VERSION AND INSTALLATION. THIS INFORMATION IS      Complot
STORED AS DATA IN THE ARRAY VERSES NEAR THE BEGINNING OF             Complot
SUBROUTINE FRAME1. IF YOU WISH TO CUSTOMIZE THE OUTPUT TO IDENTIFY   Complot
YOUR INSTALLATION CHANGE THE LAST TWO LINES OF THE ARRAY (VERSES).   Complot
                                                                     Complot
ENDF/B FORMAT                                                        Complot
-------------                                                        Complot
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS       Complot
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION     Complot
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT).   Complot
                                                                     Complot
BOTH SETS OF EVALUATED DATA MUST BE IN THE ENDF/B FORMAT. ONLY       Complot
SECTIONS OF FILE 2 (RESONANCE PARAMETERS) AND FILES 3, 23 AND 27     Complot
(TABULATED DATA) WILL BE READ AND ALL OTHER SECTIONS WILL BE         Complot
SKIPPED. IN FILE 2 THE ONLY IMPORTANT INFORMATION IS THE ENERGY      Complot
LIMITS OF THE RESOLVED AND UNRESOLVED RESONANCE REGION WHICH IS      Complot
LOCATED IN THE SAME FIELDS IN ALL VERSIONS OF THE ENDF/B FORMAT.     Complot
SIMILARLY THE FORMAT OF FILES 3, 23 AND 27 IS THE SAME IN ALL        Complot
VERSIONS OF ENDF/B. THEREFORE THIS PROGRAM CAN BE USED WITH DATA     Complot
IN ANY ENDF/B FORMAT (I.E. ENDF/B-I, II, III, IV, V OR VI).          Complot
                                                                     Complot
CROSS SECTION INTERPOLATION                                          Complot
---------------------------                                          Complot
CROSS SECTIONS MUST BE IN EITHER HISTOGRAM (I.E., INTERPOLATION      Complot
LAW 1) OR LINEARLY INTERPOLABLE (I.E. INTERPOLATION LAW 2) FORM.     Complot
IF THEY ARE NOT A WARNING MESSAGE WILL BE PRINTED AND EXECUTION      Complot
WILL BE TERMINATED. SEE INSTRUCTIONS BELOW ON HOW TO CONVERT         Complot
DATA TO HISTOGRAM OR LINEARLY INTERPOLABLE FORM.                     Complot
                                                                     Complot
REACTION INDEX                                                       Complot
--------------                                                       Complot
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN       Complot
SECTION MF=1, MT=451 OF EACH EVALUATION.                             Complot
                                                                     Complot
SECTION SIZE                                                         Complot
------------                                                         Complot
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT    Complot
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS        Complot
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                   Complot
                                                                     Complot
DATA SELECTION                                                       Complot
--------------                                                       Complot
THE USER MAY SPECIFYING THE DATA TO BE COMPARED BY INPUTTING UP      Complot
TO 100 MAT/MT/ENERGY OR ZA/MT/ENERGY RANGES. IF THE UPPER LIMIT      Complot
OF THE MAT OR ZA RANGE IS LESS THAN THE LOWER LIMIT IT WILL BE SET   Complot
EQUAL TO THE LOWER LIMIT (I.E. THIS INDICATE ONLY COMPARE ONE        Complot
MAT OR ZA). IF THE UPPER LIMIT IS STILL ZERO IT WILL BE SET TO       Complot
9999 (NO LIMIT). IF THE UPPER MF OR MT LIMIT IS ZERO IT WILL BE      Complot
SET TO 99 OR 999, RESPECTIVELY (NO LIMIT). IF THE UPPER ENERGY       Complot
LIMIT IS ZERO IT WILL BE SET TO A LARGE NUMBER (NO LIMIT).           Complot
                                                                     Complot
THE LIST OF RANGES MUST BE TERMINATED BY A BLANK LINE (I.E. ZERO     Complot
LOWER AND UPPER MAT/MF/MT OR ZA/MF/MT LIMITS).                       Complot
                                                                     Complot
```

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IF THE FIRST RANGE LINE IS BLANK THIS LINE WILL TERMINATE THE      Complot
LIST OF REQUESTS (I.E. A SECOND BLANK LINE NEED NOT BE INPUT)      Complot
AND ALL PHYSICALLY COMPARABLE DATA WILL BE PLOTTED.                Complot
                                                                   Complot
WHICH REACTIONS WILL BE PLOTTED                                    Complot
------------------------------                                     Complot
THOSE REACTIONS WITH THE SAME (ZA, MF, MT) WILL BE COMPARED, BUT   Complot
ONLY THOSE DATA WHICH DIFFER BY A USER SPECIFIED ALLOWABLE         Complot
DIFFERENCE WILL BE PLOTTED. IN ORDER TO FORCE ALL COMPARABLE       Complot
REACTIONS TO BE PLOTTED THE USER NEED ONLY SPECIFY AN ALLOWABLE    Complot
DIFFERENCE OF ZERO.                                                Complot
                                                                   Complot
EQUIVALENT REACTIONS                                               Complot
--------------------                                               Complot
IN ORDER TO COMPARE REACTIONS WHICH HAVE DIFFERENT ZA, MF OR MT    Complot
THE USER IS ALLOWED TO SPECIFY AN EQUIVALENCE LIST OF UP TO        Complot
100 (ZA,MF,MT) COMBINATIONS ON THE MASTER FILE WHICH ARE TO BE     Complot
EQUATED TO DIFFERENT (ZA,MF,MT) ON THE SECOND FILE. THIS OPTION    Complot
MAY BE USED TO COMPARE SIMILAR REACTIONS FROM DIFFERENT MATERIALS  Complot
(E.G. IRON AND NICKEL INELASTIC SCATTERING) OR DIFFERENT REACTIONS Complot
FROM THE SAME OR DIFFERENT MATERIALS (E.G. U-235 CAPTURE AND       Complot
FISSION - IN WHICH CASE THE RATIO WILL BE THE CAPTURE TO FISSION   Complot
RATIO) OR THE SAME REACTION IN DIFFERENT VERSIONS OF THE ENDF/B    Complot
FORMAT WHICH MAY BE ASSIGNED DIFFERENT MT NUMBERS, E.G., THE       Complot
PHOTOELECTRIC CROSS SECTION IS MT=602 IN ENDF/B-V AND EARLIER      Complot
VERSIONS OF ENDF/B, BUT IS MT=522 IN ENDF/B-VI.                    Complot
                                                                   Complot
IN THESE EQUIVALENCE LISTS A ZERO FIELD IMPLIES ALL. FOR EXAMPLE,  Complot
TO EQUATE MT=522 FROM ONE FILE TO MT=602 ON THE OTHER, FOR ALL     Complot
MATERIALS, ONE NEED ONLY SPECIFY ZA=0, MF=23, MT=522 EQUIVALENT    Complot
TO ZA=0, MF=23 AND MT=602.                                         Complot
                                                                   Complot
PLOT FORMATS                                                       Complot
------------                                                       Complot
THE TWO CROSS SECTIONS ARE CONSIDERED TO BE A STANDARD (THE FIRST  Complot
CROSS SECTION) AND A CROSS SECTION TO BE COMPARED TO THE STANDARD  Complot
(THE SECOND CROSS SECTION). THE OUTPUT FROM THIS PROGRAM IS A      Complot
SERIES OF PLOTS. EACH PLOT WILL CONTAIN THE STANDARD CROSS SECTION Complot
AND IN ADDITION THE USER MAY SPECIFY THAT EACH PLOT ALSO CONTAIN   Complot
THE SECOND CROSS SECTION AND/OR THE RATIO OF THE SECOND CROSS      Complot
SECTION TO THE FIRST CROSS SECTION.                                Complot
                                                                   Complot
THE USER MAY SELECT ONE OF THE FOLLOWING FIVE PLOT FORMATS (THE    Complot
NUMBER PRECEDING THE OPTION IS THE VALUE OF THE PLOT MODE SELECTOR Complot
THAT THE USER SHOULD SPECIFY AS INPUT ON THE FIRST LINE).          Complot
                                                                   Complot
(0) THE STANDARD CROSS SECTION (I.E. FIRST EVALUATION) AND THE     Complot
    RATIO OF THE SECOND EVALUATION TO THE FIRST EVALUATION. THE    Complot
    DATA WILL BE PRESENETED AS TWO SUB-PLOTS PER PLOT WITH THE     Complot
    STANDARD CROSS SECTION IN THE UPPER HALF OF THE PLOT AND THE   Complot
    RATIO IN THE LOWER HALF OF THE PLOT.                           Complot
                                                                   Complot
(1) THE STANDARD CROSS SECTION (I.E. FIRST EVALUATION) AND THE     Complot
    SECOND EVALUATION. THE DATA WILL BE PRESENTED AS TWO SUB-PLOTS Complot
    PER PLOT WITH THE STANDARD CROSS SECTION ON THE UPPER HALF     Complot
    OF THE PLOT AND THE SECOND CROSS SECTION IN THE LOWER HALF OF  Complot
    THE PLOT.                                                      Complot
                                                                   Complot
(2) THE STANDARD CROSS SECTION (I.E. FIRST EVALUATION) AND THE     Complot
    SECOND EVALUATION. THE DATA WILL BE PRESENTED AS ONE PLOT      Complot
    CONTAINING BOTH THE STANDARD AND SECOND CROSS SECTION. THE     Complot
    STANDARD CROSS SECTION WILL BE PRESENTED AS A SOLID LINE AND   Complot
    THE SECOND CROSS SECTION WILL BE PRESENTED AS A DASHED LINE.   Complot
                                                                   Complot
(3) THE STANDARD CROSS SECTION, SECOND CROSS SECTION AND RATIO OF  Complot
    THE SECOND CROSS SECTION TO THE FIRST CROSS SECTION. THE DATA  Complot
    WILL BE PRESENTED AS THREE SUB-PLOTS PER PLOT WITH THE         Complot
    STANDARD CROSS SECTION IN THE UPPER THIRD OF THE PLOT, THE     Complot
```

```
    SECOND CROSS SECTION IN THE MIDDLE THIRD AND THE RATIO OF THE  Complot
    TWO IN THE LOWER THIRD OF THE PLOT (RECOMMENDED OPTION).       Complot
                                                                   Complot
(4) THE STANDARD CROSS SECTION, SECOND CROSS SECTION AND RATIO OF  Complot
    THE SECOND CROSS SECTION TO THE FIRST CROSS SECTION. THE DATA  Complot
    WILL BE PRESENTED AS TWO SUB-PLOTS PER PLOT WITH THE STANDARD  Complot
    AND SECOND CROSS SECTION ON THE SAME SUB-PLOT IN THE UPPER     Complot
    TWO THIRDS OF THE PLOT AND THE RATIO OF THE TWO IN THE LOWER   Complot
    THIRD OF THE PLOT. THE STANDARD CROSS SECTION WILL BE          Complot
    PRESENTED AS A SOLID LINE AND THE SECOND CROSS SECTION WILL BE Complot
    PRESENTED AS A DASHED LINE.                                    Complot
                                                                   Complot
ADDITIONAL PLOT FEATURES                                           Complot
------------------------                                           Complot
IN ADDITION TO THE CROSS SECTIONS AND/OR RATIO THE FOLLOWING       Complot
INFORMATIONS WILL BE INCLUDED ON EACH PLOT.                        Complot
                                                                   Complot
(1) AN IDENTIFICATION FOR EACH SET OF CROSS SECTIONS (UP TO 30     Complot
    CHARACTERS FOR EACH SET).                                      Complot
                                                                   Complot
(2) THE MAXIMUM NEGATIVE AND POSITIVE PER-CENT DIFFERENCE BETWEEN  Complot
    THE TWO CROSS SECTIONS.                                        Complot
                                                                   Complot
(3) ARROWS INDICATING THE ENERGY AT WHICH THE MAXIMUM DIFFERENCES  Complot
    (MINIMUM AND MAXIMUM RATIO) OCCUR.                             Complot
                                                                   Complot
(4) THE ENERGY LIMITS OF THE RESOLVED AND UNRESOLVED RESONANCE     Complot
    REGION (IF THEY FALL WITHIN THE ENERGY LIMITS OF THE PLOT).    Complot
                                                                   Complot
RATIO DATA                                                         Complot
----------                                                         Complot
IF RATIO OUTPUT IS REQUESTED THE RATIO WILL BE DEFINED AT EACH     Complot
ENERGY THAT APPEARS IN EITHER EVALUATION. BETWEEN THESE ENERGIES   Complot
THE RATIO WILL BE PLOTTED ASSUMING LINEAR DEPENDENCE BETWEEN       Complot
TABULATED VALUES. FOR HISTOGRAM OR LINEARLY INTERPOLABLE CROSS     Complot
SECTIONS THIS REPRESENTATION WILL POINT OUT ALL EXTREMA OF THE     Complot
RATIO, BUT NOT NECESSARILY THE ENERGY DEPENDENCE BETWEEN TABULATED Complot
VALUES.                                                            Complot
                                                                   Complot
IF THE EVALUATED DATA IS NOT IN EITHER HISTOGRAM OR LINRARLY       Complot
INTERPOLABLE FORM THE RATIO MAY NOT EVEN FIND ALL EXTREMA. FOR     Complot
EXAMPLE, IF ONE EVALUATION IS LINEARLY INTERPOLABLE AND THE        Complot
OTHER NON-LINEAR, BUT BOTH AGREE AT ALL TABULATED ENERGIES THE     Complot
RATIO WILL APPEAR TO BE EQUAL TO UNITY AT ALL ENERGIES, BUT IN     Complot
FACT THE CROSS SECTION BETWEEN TABULATED ENERGIES MAY BE QUITE     Complot
DIFFERENT USING LINEAR VS. NON-LINEAR INTERPOLATION. FOR THIS      Complot
REASON ONLY LINEARLY INTERPOLABLE OR HISTOGRAM DATA IS ALLOWED     Complot
AS INPUT TO THIS PROGRAM.                                          Complot
                                                                   Complot
LINEAR INTERPOLABLE                                                Complot
-------------------                                                Complot
ALL CROSS SECTIONS MAY BE CONVERTED TO LINEARLY INTERPOLABLE FORM   Complot
BE USING PROGRAM LINEAR (UCRL-50400, VOL. 17, PART A).             Complot
                                                                   Complot
HISTOGRAM                                                          Complot
---------                                                          Complot
ALL LINEARLY INTERPOLABLE CROSS SECTION MAY BE CONVERTED TO        Complot
HISTOGRAM (I.E. MULTIGROUP) FORM BY USING PROGRAM GROUPIE          Complot
(UCRL-50400, VOL. 17, PART D).                                     Complot
                                                                   Complot
INPUT UNITS                                                        Complot
-----------                                                        Complot
UNIT  DESCRIPTION                                                  Complot
----  -----------                                                  Complot
  2   INPUT LINE                                                   Complot
  9   MT DEFINITIONS.                                              Complot
 10   FIRST ENDF/B FORMATTED EVALUATION (STANDARD).                Complot
 11   SECOND ENDF/B FORMATTED EVALUATION.                          Complot
```

```
 17   SOFTWARE CHARACTERS.                                              Complot
 18   SOFTWARE SYMBOLS AND LINE TYPES                                   Complot
                                                                        Complot
 OUTPUT UNITS                                                           Complot
 ------------                                                           Complot
 UNIT  DESCRIPTION                                                      Complot
 ----  -----------                                                      Complot
   3   NORMAL OUTPUT REPORT.                                            Complot
  16   PLOTTER UNIT                                                     Complot
                                                                        Complot
 SCRATCH UNITS                                                          Complot
 -------------                                                          Complot
 UNIT  DESCRIPTION                                                      Complot
 ----  -----------                                                      Complot
  12   SCRATCH UNIT FOR FIRST EVALUATION                                Complot
  13   SCRATCH UNIT FOR SECOND EVALUATION                               Complot
  14   SCRATCH UNIT FOR RATIO (ONLY USED IF RATIOS REQUESTED).          Complot
                                                                        Complot
 OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)        Complot
 ---------------------------------------------------------------        Complot
 UNIT  FILE NAME                                                        Complot
 ----  ----------                                                       Complot
   2   COMPLOT.INP                                                      Complot
   3   COMPLOT.LST                                                      Complot
   9   MT.DAT                                                           Complot
  10   ENDFB.IN1    (OR AS READ FROM INPUT)                             Complot
  11   ENDFB.IN2    (OR AS READ FROM INPUT)                             Complot
12-14  (SCRATCH)                                                        Complot
  15   PLOT.CHR                                                         Complot
  16   (PLOTTER UNIT...USUALLY A DUMMY)                                 Complot
                                                                        Complot
 INPUT PARAMETERS                                                       Complot
 ---------------------------------------------------------------------- Complot
 LINE  COLUMNS  FORMAT  DESCRIPTION                                     Complot
 ----  -------  ------  -----------                                     Complot
   1     1-11    E11.4  LOWER X LIMIT OF PLOTTER                       Complot
        12-22    E11.4  UPPER X LIMIT OF PLOTTER                       Complot
        23-33    E11.4  LOWER Y LIMIT OF PLOTTER                       Complot
        34-44    E11.4  UPPER Y LIMIT OF PLOTTER                       Complot
        45-55     I11   NUMBER OF PLOTS PER FRAME IN X DIRECTION       Complot
        56-66     I11   NUMBER OF PLOTS PER FRAME IN Y DIRECTION       Complot
        67-70     F4.1  CHARACTER SIZE MULTIPLIER                      Complot
                        = 0 TO 1    - NORMAL CHARACTER SIZE             Complot
                        = OTHERWISE - CHARACTERS SCALED BY THIS         Complot
                                      FACTOR                            Complot
                                                                        Complot
                        PLOT ORIENTATION IS BASED ON THE UPPER X        Complot
                        LIMIT                                           Complot
                        = .GT.0 - X HORIZONTAL/Y VERTICAL               Complot
                        = .LT.0 - Y HORIZONTAL/X VERTICAL               Complot
                        AFTER TESTING THE UPPER X LIMIT WILL BE         Complot
                        SET TO ITS ABSOLUTE VALUE.                      Complot
   2     1-72     A60   FILENAME FOR FIRST ENDF/B DATA FILE             Complot
                        (LEAVE BLANK FOR ENDFB.IN1)                     Complot
   3     1-72     A60   FILENAME FOR SECOND ENDF/B DATA FILE            Complot
                        (LEAVE BLANK FOR ENDFB.IN2)                     Complot
   4     1-11     I11   RETRIEVAL MODE (0=MAT, 1=ZA)                   Complot
        12-22     I11   GRID (SPEED) OPTION.                           Complot
                        = 0 - TICK MARKS ON BORDER                      Complot
                        = 1 - SOLID AT COARSE INTERVALS                 Complot
                        = 2 - DASHED AT COARSE INTERVALS                Complot
                        = 3 - SOLID AT COARSE AND FINE INTERVALS        Complot
                        = 4 - DASHED AT COARSE AND FINE INTERVALS       Complot
                        = 5 - SOLID COARSE/DASHED FINE INTERVALS        Complot
        23-33     I11   SHOULD BORDER BE PLOTTED AROUND EACH PLOT       Complot
                        = 0 - NO                                        Complot
                        = 1 - YES                                       Complot
```

```
          34-44     I11   LINE THICKNESS                                  Complot
                          = 0 TO  5 - LINES AND CHARACTERS                Complot
                          =-1 TO -5 - ONLY LINES                          Complot
          45-55     I11   OUTPUT MODE                                     Complot
                          =-1 - ONLY COMPARISON LISTING. NO PLOTS.        Complot
                          = 0 - CROSS SECTION OVER RATIO.                 Complot
                          = 1 - CROSS SECTION OVER CROSS SECTION.         Complot
                          = 2 - TWO CROSS SECTIONS ON SAME PLOT.          Complot
                          = 3 - CROSS SECTION OVER CROSS SECTION OVER     Complot
                                RATIO.                                    Complot
                          = 4 - TWO CROSS SECTIONS ON SAME PLOT OVER      Complot
                                RATIO.                                    Complot
          56-66     I11   STARTING PLOT NUMBER                            Complot
                          = 0     - DO NOT NUMBER PLOTS                   Complot
                          = .GT.0 - NUMBER PLOTS IN LOWER LEFT HAND       Complot
                                    CORNER STARTING WITH INPUT NUMBER     Complot
          67-70     I41   BACKGROUND COLOR                                Complot
                          = 0         = BLACK                             Complot
                          = OTHERWISE = WHITE                             Complot
     5     1-11   E11.4   ALLOWABLE FRACTIONAL DIFFERENCE. USED WHEN      Complot
                          PLOTTING RATIOS. ANY REACTION WHERE THE         Complot
                          TWO EVALUATIONS DIFFER BY MORE THAN THE         Complot
                          ALLOWABLE DIFFERENCE WILL BE PLOTTED. IF        Complot
                          ZERO IS INPUT THE STANDARD ALLOWABLE            Complot
                          DIFFERENCE OF 0.001 (0.1 PER-CENT) WILL BE      Complot
                          USED.                                           Complot
          12-22   E11.4   MAXIMUM ALLOWABLE RATIO. IF RATIOS ARE          Complot
                          PLOTTED THEY WILL BE IN THE RANGE RATMAX        Complot
                          TO 1/RATMAX. IF 0.0 IS INPUT THERE WILL         Complot
                          BE NO LIMIT ON THE RANGE OF THE RATIOS.         Complot
                          THIS OPTION MAY BE USED TO IGNORE LARGE         Complot
                          DIFFERENCES OVER VERY NARROW ENERGY RANGES      Complot
                          (WHICH MAY BE UNIMPORTANT) AND ALLOW ONE        Complot
                          TO SEE IMPORTANT, BUT SMALLER DIFFERENCES,      Complot
                          OVER EXTENDED ENERGY RANGES.                    Complot
      6     1-40    40A1   IDENTIFICATION FOR UPPER EVALUATIONS            Complot
      7     1-40    40A1   IDENTIFICATION FOR LOWER EVALUATIONS            Complot
                           (IDENTIFICATIONS SHOULD BE LEFT ADJUSTED        Complot
                           TO START IN COLUMN 1).                          Complot
  8-N      1- 6     I6    LOWER MAT OR ZA LIMIT (SEE SELECTION MODE,      Complot
                           INPUT LINE 1, COLUMNS 1-11).                    Complot
           7- 8     I2    LOWER MF LIMIT                                  Complot
           9-11     I3    LOWER MT LIMIT                                  Complot
          12-22   E11.4   LOWER ENERGY LIMIT                              Complot
          23-28     I6    UPPER MAT OR ZA LIMIT (SEE SELECTION MODE,      Complot
                          INPUT LINE 1, COLUMNS 1-11).                    Complot
          29-30     I2    UPPER MF LIMIT                                  Complot
          31-33     I3    UPPER MT LIMIT                                  Complot
          34-44   E11.4   UPPER ENERGY LIMIT                              Complot
          45-55     I11   IDENTIFY EVALUATED DATA POINTS OPTION.           Complot
                          = 0 - DO NOT IDENTIFY DATA POINTS.              Complot
                          = 1 - IDENTIFY DATA POINTS (BY DRAWING A        Complot
                                SMALL BOX AROUND EACH POINT).             Complot
          56-66     I11   INTERACTIVE INPUT FLAG                          Complot
                          = 0 - NO INTERACTIVE INPUT ALLOWED              Complot
                          = 1 - INTERACTIVE INPUT ALLOWED                 Complot
                         *SETTING THIS OPTION =1 WILL TURN ON THE         Complot
                          MOUSE AFTER EACH PLOT AND ALLOW YOU TO          Complot
                          INTERACTIVELY SPECIFY PLOT LIMITS.              Complot
                         *IF YOU DO NOT WISH TO INTERACT WITH A PLOT      Complot
                          OR IF YOU HAVE NO INTERACTIVE CAPABILITY        Complot
                          THIS OPTION SHOULD BE SET = 0.                  Complot
                                                                          Complot
                         *WARNING...DATA POINTS IDENTIFIED OPTION IS      Complot
                          NOT RECOMMENDED FOR PLOTS CONTAINING MANY       Complot
                          (I.E. THOUSANDS) OF DATA POINTS SINCE IT        Complot
                          WILL MERELY INCREASE THE RUNNING TIME OF        Complot
                          THE PROGRAM AND STILL NOT ALLOW ONE TO          Complot
```

```
                          ACCURATELY SEE DATA POINTS.                Complot
                                                                     Complot
                         *UP TO 100 MAT OR ZA RANGES ARE ALLOWED.    Complot
                          THE LIST IS TERMINATED BY A BLANK LINE.    Complot
                          IF THE UPPER LIMIT IS LESS THAN THE LOWER  Complot
                          LIMIT IT WILL BE SET EQUAL TO THE LOWER    Complot
                          LIMIT. IF THE FIRST RANGE LINE IS BLANK    Complot
                          ALL DATA WILL BE RETRIEVED. IF THE UPPER   Complot
                          MT LIMIT IS ZERO IT WILL BE SET EQUAL TO   Complot
                          999 (NO LIMIT). IF THE UPPER ENERGY LIMIT  Complot
                          IS ZERO IT WILL BE INTREPRETED TO MEAN NO  Complot
                          LIMIT. IF THE FIRST RANGE LINE SPECIFIES   Complot
                          ZERO LOWER AND UPPER MAT OR ZA RANGE IT    Complot
                          WILL TERMINATE THE LIST BE RANGE LINES     Complot
                          (A SECOND BLANK LINE NEED NOT BE INPUT)    Complot
                          AND THE ENTIRE RANGE OF MATS WILL BE       Complot
                          COMPARED FOR THE SPECIFIED MT AND ENERGY   Complot
                          RANGES.                                    Complot
                                                                     Complot
N+1-M                     EQUIVALENCES                               Complot
          1- 6      I6    MASTER ZA.                                 Complot
          7- 8      I2    MASTER MF.                                 Complot
          9-11      I3    MASTER MT.                                 Complot
         12-17      I6    EQUIVALENT ZA FROM SECOND FILE.            Complot
         18-19      I2    EQUIVALENT MF FROM SECOND FILE.            Complot
         20-22      I3    EQUIVALENT MT FROM SECOND FILE.            Complot
         23-33    E11.4   MULTIPLICATION FACTOR. ANY EQUATED ZA,MF,  Complot
                          MT DATA WILL BE MULTIPLIED BY THIS FACTOR. Complot
                         *THIS OPTION MAY BE USED TO RE-NORMALIZE    Complot
                          THE SECOND CROSS SECTION OR IF COMPARING   Complot
                          ONE CONSTITUENT OF A MIXTURE TO THE MIXED  Complot
                          CROSS SECTION THIS MAY BE USED TO CONVERT  Complot
                          THE SECOND CROSS SECTION TO BARNS PER MIXED Complot
                          ATOM BY USING A MULTIPLICATION FACTOR WHICH Complot
                          IS EQUAL TO THE NUMBER OF ATOMS OF THE ONE Complot
                          CONSTITUENT PER ATOM OF THE MIXTURE.       Complot
                          = 0.0 - ON INPUT WILL BE INTERPRETED AS 1.0 Complot
                          (WITH THIS CONVENTION THE USER NEED ONLY   Complot
                          INPUT MULTIPLICATION FACTORS IF THEY ARE   Complot
                          NOT 1.0).                                  Complot
                         *UP TO 100 MAT OR ZA EQUIVALENCES ARE       Complot
                          ALLOWED.                                   Complot
                         *THE LIST IS TERMINATED BY A BLANK LINE.    Complot
                         *A ZERO INPUT FIELD IMPLIES ALL. TO EQUATE  Complot
                          A GIVEN MT NUMBER TO ANOTHER MT NUMBER YOU Complot
                          NEED MERELY SPECIFY ZA=0 ON INPUT.         Complot
                         *NOTE, IN ALL CASES THE TITLE AT TOP OF PLOT Complot
                          WILL ONLY INDENTIFY MASTER (ZA,MF,MT). THE Complot
                          USER INPUT TITLES MUST BE USED TO IDENTIFY Complot
                          THE SECOND REACTION (SEE, EXAMPLE INPUT 4  Complot
                          BELOW).                                    Complot
                                                                     Complot
                                                                     Complot
  EXAMPLE DEFINITION OF PLOTTER                                      Complot
  ----------------------------                                       Complot
  THE FIRST INPUT LINE DEFINES THE DIMENSIONS OF THE PLOTTER BEING   Complot
  USED IN ANY UNITS (INCHES, CENTIMETERS, MILLIMETERS, ANYTHING)     Complot
  WHICH APPLY TO THE PLOTTER. IN ADDITION THE FIRST LINE DEFINES     Complot
  HOW MANY PLOTS SHOULD APPEAR ON EACH FRAME. THE PLOTTING AREA      Complot
  DEFINED ON THE FIRST INPUT LINE MAY BE SUBDIVIDED INTO ANY NUMBER  Complot
  OF PLOTS IN THE X AND Y DIRECTION. FOR EXAMPLE, TO PRODUCE A       Complot
  SERIES OF FRAMES EACH CONTAINING 3 PLOTS IN THE X DIRECTION AND    Complot
  2 PLOTS IN THE Y DIRECTION (6 PLOTS PER FRAME) COLUMN 45-55 OF     Complot
  THE FIRST INPUT LINE SHOULD BE 3 AND COLUMNS 56-66 SHOULD BE 2.    Complot
                                                                     Complot
  IF THE LOCAL PLOTTER USES DIMENSIONS OF INCHES IN ORDER TO OBTAIN  Complot
  10 X 10 INCH FRAMES WITH 3 X 2 PLOTS PER FRAME THE FIRST INPUT     Complot
  LINE SHOULD BE,                                                    Complot
```

```
                                                                      Complot
  0.0       10.0      0.0     10.0              3          2        Complot
                                                                      Complot
IF THE LOCAL PLOTTER USES DIMENSION OF MILLIMETERS THE SAME           Complot
PHYSICAL SIZE PLOT MAY BE OBTAINED IF THE FIRST INPUT LINE IS,        Complot
                                                                      Complot
  0.0      254.0      0.0    254.0              3          2        Complot
                                                                      Complot
FOR SIMPLICITY THE FOLLOWING EXAMPLE INPUTS WILL NOT DISCUSS THE      Complot
PHYSICAL DIMENSIONS OF THE PLOTTER AND THE FIRST INPUT LINE WILL      Complot
IN ALL CASES INDICATE 10 X 10 INCH PLOTS WITH ONLY 1 PLOT PER         Complot
FRAME.                                                                Complot
                                                                      Complot
IN THE FOLLOWING EXAMPLES IN ALL CASES THESE OPTIONS WILL BE USED,    Complot
1) DASHED GRID       - COLUMNS 12-22 OF SECOND INPUT LINE =  1        Complot
2) NO BORDER         - COLUMNS 23-33 OF SECOND INPUT LINE =  0        Complot
3) LINE THICKNESS    - COLUMNS 34-44 OF SECOND INPUT LINE = -2        Complot
4) OUTPUT MODE       - COLUMNS 45-55 OF SECOND INPUT LINE =  3        Complot
5) FIRST PLOT NUMBER - COLUMNS 56-66 OF SECOND INPUT LINE =  1        Complot
                                                                      Complot
EXAMPLE INPUT 1                                                       Complot
---------------                                                       Complot
RETRIEVE MATS 1023, 1056 AND 1065 THROUGH 1072, MT = 1 AND 2          Complot
(TOTAL AND ELASTIC) FROM THE FIRST INPUT FILE AND COMPARE TO          Complot
ANY SECTION FROM THE SECOND FILE THAT HAS THE SAME ZA/MF/MT. ONLY     Complot
COMPARE DATA OVER THE ENERGY RANGE 0.1 EV TO 1 KEV. IDENTIFY          Complot
THE TWO SETS OF DATA AS ENDF/B-V AND ENDF/B-IV, RESPECTIVELY.         Complot
ONLY PLOT THOSE REACTIONS WHICH DIFFER AT ONE OR MORE ENERGIES        Complot
BY MORE THAN 1 PER-CENT (NOTE, 1 PER-CENT = 0.01 AS INPUT             Complot
FRACTION). NO EQUIVALENT REACTIONS ARE SPECIFIED. FILERNAMES          Complot
ARE STANDARD (THSE CAN EITHER BE EXPLICITLY INCLUDED, OR SIMPLY       Complot
LEFT BLANK).                                                          Complot
                                                                      Complot
THE FOLLOWING 12 INPUT LINES ARE REQUIRED.                            Complot
                                                                      Complot
   0.0       10.0      0.0     10.0              3          2        Complot
ENDFB.IN1                                                             Complot
ENDFB.IN2                                                             Complot
     0          1        0       -2              3          1        Complot
  0.01        0.0                                                     Complot
ENDF/B-V DATA (STANDARD)                                              Complot
ENDF/B-IV DATA                                                        Complot
1023 3  1 0.1            3  2 1000.0              0                  Complot
1056 3  1 0.1            3  2 1000.0              0                  Complot
1065 3  1 0.1       1072 3  2 1000.0              0                  Complot
                                  (TERMINATES REQUEST LIST)           Complot
                                  (TERMINATES EQUIVALENCE LIST)       Complot
                                                                      Complot
EXAMPLE INPUT 2                                                       Complot
---------------                                                       Complot
TO USE ALL OF THE SAME OPTIONS AS SPECIFIED IN EXAMPLE INPUT 1,       Complot
EXCEPT TO RETRIEVE U-235, U-238 AND PU-239 THROUGH PU-242 THE         Complot
FOLLOWING 12 INPUT LINES ARE REQUIRED.                                Complot
                                                                      Complot
   0.0       10.0      0.0     10.0              3          2        Complot
ENDFB.IN1                                                             Complot
ENDFB.IN2                                                             Complot
     1          1        0       -2              3          1        Complot
  0.01        0.0                                                     Complot
ENDF/B-V DATA (STANDARD)                                              Complot
ENDF/B-IV DATA                                                        Complot
92235 3  1 0.1            3  2 1000.0              0                  Complot
92238 3  1 0.1            3  2 1000.0              0                  Complot
94239 3  1 0.1      94242 3  2 1000.0              0                  Complot
                                  (TERMINATES REQUEST LIST)           Complot
                                  (TERMINATES EQUIVALENCE LIST)       Complot
EXAMPLE INPUT 3                                                       Complot
---------------                                                       Complot
```

```
    TO USE ALL OF THE SAME OPTIONS AS SPECIFIED IN EXAMPLE INPUT 1,    Complot
    EXCEPT TO RETRIEVE AND COMPARE ALL MATS THE FOLLOWING 10 INPUT     Complot
    LINES ARE REQUIRED.                                                Complot
                                                                       Complot
      0.0       10.0      0.0     10.0              3          2       Complot
 ENDFB.IN1                                                             Complot
 ENDFB.IN2                                                             Complot
       0          1        0       -2              3          1       Complot
     0.01        0.0                                                   Complot
ENDF/B-V DATA (STANDARD)                                               Complot
ENDF/B-IV DATA                                                         Complot
    1 1  1 0.0       999999999 0.0                  0                  Complot
                                    (TERMINATES REQUEST LIST)          Complot
                                    (TERMINATES EQUIVALENCE LIST)      Complot
                                     NOTE, ZERO LOWER AND UPPER        Complot
                                     MAT LIMITS INDICATES NO LIMIT.    Complot
                                                                       Complot
    EXAMPLE INPUT 4                                                    Complot
    ---------------                                                    Complot
    RETRIEVE U-235 AND EQUATE THE FISSION CROSS SECTION (MT=18) ON     Complot
    THE MASTER FILE TO CAPTURE (MT=102) ON THE SECOND FILE. PLOT       Complot
    THE CAPTURE, FISSION AND CAPTURE TO FISSION RATIO OVER THE ENERGY  Complot
    RANGE 0.0253 EV TO 1 KEV. THE FOLLOWING 11 INPUT LINES ARE         Complot
    REQUIRED.                                                          Complot
                                                                       Complot
      0.0       10.0      0.0     10.0              3          2       Complot
 ENDFB.IN1                                                             Complot
 ENDFB.IN2                                                             Complot
        1          1        0       -2              3          1       Complot
     0.01        0.0                                                   Complot
 FISSION                                                               Complot
 CAPTURE                                                               Complot
92235 3 18 0.0253   92235 3 18 1000.0                 0                Complot
                                    (TERMINATES REQUEST LIST)          Complot
92235 3 18 92235 3102               (MULTIPLICATION OF 1.0 INFERRED)   Complot
                                    (TERMINATES EQUIVALENCE LIST)      Complot
                                                                       Complot
    EXAMPLE INPUT 5                                                    Complot
    ---------------                                                    Complot
    IN DIFFERENT VERSIONS OF THE ENDF/B FORMAT DIFFERENT MT NUMBERS    Complot
    ARE ASSIGNED TO THE SAME REACTION. FOR EXAMPLE, IN ENDF/B-V AND    Complot
    EARLIER VERSIONS OF ENDF/B THE PHOTOELECTRIC CROSS SECTION IS      Complot
    MT=602, WHILE IN ENDF/B-VI IT IS MT=522. IN ORDER TO COMPARE       Complot
    ASSUMING THAT THE MASTER IS ENDF/B-VI AND THE OTHER ENDF/B FILE    Complot
    IS ENDF/B-V (OR EARLIER) YOU MAY EQUATE MT=522 TO 602.             Complot
                                                                       Complot
    WHEN COMPARING PHOTOELECTRIC CROSS SECTIONS WE EXPECT THERE TO BE  Complot
    LARGE DIFFERENCES NEAR EDGES, SINCE IT IS UNLIKELY THAT TWO        Complot
    INDEPENDENT EVALUATIONS USE EXACTLY THE SAME EDGE ENERGIES. FROM   Complot
    A PRACTICAL VIEWPOINT THESE DIFFERENCES ARE NOT IMPORTANT IF THEY  Complot
    ONLY OCCUR OVER NARROW ENERGY RANGES NEAR ENERGIES. HOWEVER THESE  Complot
    LARGE DIFFERENCES MAY MAKE IT DIFFICULT TO SEE DIFFERENCES OVER    Complot
    OTHER ENERGY RANGES, WHICH MAY BE IMPORTANT. IN ORDER TO BE ABLE   Complot
    TO SEE IMPORTANT DIFFERENCES IN THE FOLLOWING COMPARISON WE WILL   Complot
    CONSTRAIN THE PLOTTED RATIO TO THE RANGE ABOUT 0.9 TO 1.1 IN       Complot
    ORDER TO BE ABLE TO SEE DIFFERENCES OF UP TO 10 PER-CENT. WE WILL  Complot
    DO THIS BY SPECIFYING A MAXIMUM RATIO OF 1.1, WHICH WILL IN TURN   Complot
    DEFINE A MINIMUM RATIO OF 1/1.1, OR ABOUT 0.9.                     Complot
                                                                       Complot
    IN ORDER TO COMPARE THE PHOTOELECTRIC CROSS SECTION FOR ALL        Complot
    MATERIALS THE FOLLOWING 11 INPUT LINES ARE REQUIRED.               Complot
                                                                       Complot
      0.0       10.0      0.0     10.0              3          2       Complot
 ENDFB.IN1                                                             Complot
 ENDFB.IN2                                                             Complot
       0          1        0       -2              3          1       Complot
     0.01        1.1                                                   Complot
ENDF/B-VI                                                              Complot
```

```
 ENDF/B-V                                                                Complot
    023522           999923522                     0                   Complot
                                      (TERMINATES REQUEST LIST)         Complot
    023522     023602                 (MULTIPLICATION OF 1.0 INFERRED)  Complot
                                      (TERMINATES EQUIVALENCE LIST)     Complot
                                                                        Complot
     EXAMPLE INPUT 6                                                    Complot
     --------------                                                     Complot
     THE SAME EXAMPLE AS ABOVE, EXCEPT THAT DIFFERENT FILENAMES WILL    Complot
     BE USED TO READ THE DATA FROM A FILE TREE STRUCTURE. THE FOLLOWING Complot
     11 INPUT LINES ARE REQUIRED.                                       Complot
                                                                        Complot
       0.0       10.0      0.0     10.0              3          2       Complot
  /Evaluated/ENDFB6/PHOTON.IN                                           Complot
  /Evaluated/ENDFB5/PHOTON.IN                                           Complot
         0          1        0       -2              3          1       Complot
      0.01        1.1                                                   Complot
 ENDF/B-VI                                                              Complot
 ENDF/B-V                                                               Complot
    023522           999923522                     0                   Complot
                                      (TERMINATES REQUEST LIST)         Complot
    023522     023602                 (MULTIPLICATION OF 1.0 INFERRED)  Complot
                                      (TERMINATES EQUIVALENCE LIST)     Complot
                                                                        Complot
     EXAMPLE INPUT 7                                                    Complot
     --------------                                                     Complot
     THE OUTPUT FOR ALL OF THE ABOVE EXAMPLES ARE ORIENTED WITH X       Complot
     HORIZONTAL AND Y VERTICAL. TO CHANGE THE ORIENTATION OF THE PLOTS  Complot
     YOU NEED MERELY SPECIFY A NEGATIVE UPPER X LIMIT OF THE SIZE OF    Complot
     THE PLOTS ON THE FIRST INPUT LINE.                                 Complot
                                                                        Complot
     THE FOLLOWING EXAMPLE IS EXACTLY THE SAME AS THE ABOVE EXAMPLE,    Complot
     EXCEPT THAT THE ORIENTATION OF THE PLOTS HAS BEEN CHANGED. THE     Complot
     FOLLOWING 11 INPUT LINES ARE REQUIRED.                             Complot
                                                                        Complot
       0.0      -10.0      0.0     10.0              3          2       Complot
  /Evaluated/ENDFB6/PHOTON.IN                                           Complot
  /Evaluated/ENDFB5/PHOTON.IN                                           Complot
         0          1        0       -2              3          1       Complot
      0.01        1.1                                                   Complot
 ENDF/B-VI                                                              Complot
 ENDF/B-V                                                               Complot
    023522           999923522                     0                   Complot
                                      (TERMINATES REQUEST LIST)         Complot
    023522     023602                 (MULTIPLICATION OF 1.0 INFERRED)  Complot
                                      (TERMINATES EQUIVALENCE LIST)     Complot
                                                                        Complot
===== PLOTTER/GRAPHICS TERMINAL INTERFACE ============================== Complot
                                                                        Complot
      NON-INTERACTIVE                                                   Complot
     ------------------------------------------------------------------ Complot
      THIS PROGRAM USES A SIMPLE CALCOMP LIKE INTERFACE INVOLVING       Complot
      ONLY 5 SUBROUTINES,                                               Complot
                                                                        Complot
      STARPLOT     - INITIALIZE PLOTTER                                 Complot
      NEXTPLOT     - CLEAR SCREEN FOR NEXT PLOT                         Complot
      ENDPLOTS     - TERMINATE PLOTTING                                 Complot
                                                                        Complot
      PLOT(X,Y,IPEN)        - DRAW OR MOVE FROM LAST LOCATION TO (X,Y), Complot
                              END OF CURRENT PLOT OR END OF PLOTTING.   Complot
            IPEN =   2 - DRAW                                           Complot
                 =   3 - MOVE                                           Complot
                                                                        Complot
      PEN(IPEN)             - SELECT COLOR.                             Complot
          IPEN- COLOR = 1 TO N (N = ANY POSITIVE INTEGER)               Complot
                                                                        Complot
      BOXCOLOR(X,Y,IFILL,IBORDER) - FILL A RECTANGLE WITH COLOR         Complot
               X,Y                = DEFINE THE CORNERS OF THE BOX       Complot
```

```
              IFILL          = COLOR TO FILL BOX WITH              Complot
                   IBORDER   = COLOR OF BORDER OF BOX              Complot
                                                                   Complot
 INTERACTIVE                                                       Complot
------------------------------------------------------------------ Complot
 THIS PROGRAM INCLUDES AN INTERACTIVE INTERFACE FOR USE WITH A     Complot
 MOUSE. THE INTERFACE INVOLVES 2 SUBROUTINE,                       Complot
                                                                   Complot
 INTERACT(MYACTION)             - WHETHER OR NOT INTERACTION       Complot
          MYACTION              = 0 - NO (RETURNED BY INTERACT)    Complot
                                = 1 - YES (RETURNED BY INTERACT)   Complot
                                                                   Complot
 MOUSEY(IWAY,XI,YI,IWAY1,IWAY2) - READ POSITION OF MOUSE           Complot
                         IWAY   = 0 - NO INPUT                     Complot
                                = 1 - LEFT BUTTON                  Complot
                                = 2 - MIDDLE BUTTON                Complot
                                = 3 - RIGHT BUTTON                 Complot
                                = 4 - KEYBOARD INPUT               Complot
                         XI     = X POSITION IN LOCAL UNITS        Complot
                         YI     = Y POSITION IN LOCAL UNITS        Complot
                         IWAY1  = MINIMUM ALLOWABLE IWAY           Complot
                         IWAY2  = MAXIMUM ALLOWABLE IWAY           Complot
                                                                   Complot
AS USED BY THIS PROGRAM  IWAY1  = 1                                Complot
                         IWAY2  = 4                                Complot
KEYBOARD INPUT (IWAY=4) MEANS NO ZOOMED PLOT REQUESTED.            Complot
MOUSE INPUT (IWAY=1 TO 3) MEANS A ZOOMED PLOT IS REQUESTED.        Complot
MOUSEY WILL BE CALLED ONCE TO SEE IF A ZOOMED PLOT IS REQUESTED.   Complot
IF IT IS XI WILL BE USED TO DEFINE ONE X (E.G., ENERGY) LIMIT OF   Complot
THE ZOOMED PLOT. MOUSEY WILL THEN BE CALLED A SECOND TIME TO       Complot
DEFINE A SECOND XI TO DEFINE THE OTHER X LIMIT OF THE ZOOMED       Complot
PLOT.                                                              Complot
                                                                   Complot
IF YOU DO NOT WANT INTERACTION YOU SHOULD INCLUDE THE FOLLOWING    Complot
SUBROUTINES IN YOUR GRAPHIC INTERFACE,                             Complot
                                                                   Complot
SUBROUTINE INTERACT(MYACTION)                                      Complot
MYACTION=0                                                         Complot
RETURN                                                             Complot
END                                                                Complot
SUBROUTINE MOUSEY(IWAY,XI,YI,IWAY1,IWAY2)                          Complot
IWAY=4                                                             Complot
XI=0.0                                                             Complot
YI=0.0                                                             Complot
RETURN                                                             Complot
END                                                                Complot
                                                                   Complot
ALTERNATIVE INTERACTIVE                                            Complot
------------------------------------------------------------------ Complot
IF YOU DO NOT HAVE A MOUSE BUT WOULD STILL LIKE TO INTERACTIVE     Complot
INPUT YOU CAN REPLACE SUBROUTINE ACTION IN THIS PROGRAM.           Complot
                                                                   Complot
AS DISTRIBUTED SUBROUTINE ACTION USES A MOUSE TO DEFINE LOWER      Complot
AND UPPER ENERGY (OR X) LIMITS WHICH ARE USED TO PRODUCE THE       Complot
NEXT PLOT. A CALL TO ACTION IS OF THE FORM,                        Complot
                                                                   Complot
CALL ACTION(KACTV,XACT1,XACT2)                                     Complot
                                                                   Complot
            KACTV   = 0 - NO INTERACTIVE INPUT                     Complot
                    = 1 - INTERACTIVE INPUT                        Complot
            XACT1   = LOWER ENERGY LIMIT                           Complot
            XACT2   = UPPER ENERGY LIMIT                           Complot
                                                                   Complot
IF THERE IS NO INTERACTIVE INPUT THE PROGRAM WILL PROCEED TO THE   Complot
NEXT PLOT REQUESTED BY NON-INTERACTIVE INPUT.                      Complot
                                                                   Complot
IF THERE IS INTERACTIVE INPUT THE PROGRAM WILL USE XACT1 AND       Complot
XACT2 TO DEFINE THE ENERGY LIMITS OF THE NEXT PLOT USING THE       Complot
```

```
SAME DATA AS APPEARED ON THE LAST PLOT. AS WITH NON-INTERACTIVE    Complot
INPUT, IF YOU SELECT AN ENERGY RANGE WHERE THE MAXIMUM DIFFERENCE  Complot
IS LESS THAN THAT SPECIFIED BY INPUT NO PLOT WILL BE PRODUCED      Complot
AND THE CODE WILL PROCEED TO THE NEXT PLOT REQUESTED BY            Complot
NON-INTERACTIVE INPUT.                                             Complot
                                                                   Complot
YOU CAN REPLACE SUBROUTINE ACTION FOLLOWING THE ABOVE CONVENTIONS  Complot
TO ALLOW INTERACTION VIA DIRECT READ OF X LIMITS, LIGHTPEN OR      Complot
WHATEVER FACILITIES YOU HAVE AVAILABLE.                            Complot
                                                                   Complot
INTERFACING                                                        Complot
------------------------------------------------------------------ Complot
IN ORDER TO INTERFACE THIS PROGRAM FOR USE ON ANY PLOTTER WHICH    Complot
DOES NOT USE THE ABOVE CONVENTIONS IT IS MERELY NECESSARY FOR THE  Complot
THE USER TO WRITE 5 SUBROUTINES DESCRIBED ABOVE AND TO THEN CALL   Complot
THE LOCAL EQUIVALENT ROUTINES.                                     Complot
                                                                   Complot
COLOR PLOTS                                                        Complot
------------------------------------------------------------------ Complot
TO SELECT PLOTTING COLORS SUBROUTINE PEN (DESCRIBED ABOVE) IS USED Complot
TO SELECT ONE OF THE AVAILABLE COLORS. WHEN RUNNING ON A MAINFRAME Complot
USING AN IBM GRAPHICS TERMINAL OR ON AN IBM-PC USING A HEWLETT-    Complot
PACKARD PLOTTER THE GRAPHICS INTERFACE (DESCRIBED ABOVE) WILL      Complot
PRODUCE COLOR PLOTS.                                               Complot
                                                                   Complot
BLACK AND WHITE PLOTS                                              Complot
------------------------------------------------------------------ Complot
WHEN PRODUCING BLACK AND WHITE HARDCOPY ON A MAINFRAME THE USER    Complot
SHOULD ADD A DUMMY SUBROUTINE PEN TO THE END OF THE PROGRAM TO     Complot
IGNORE ATTEMPTS TO CHANGE COLOR. ADD THE FOLLOWING SUBROUTINE,     Complot
                                                                   Complot
SUBROUTINE PEN(IPEN)                                               Complot
RETURN                                                             Complot
END                                                                Complot
                                                                   Complot
CHARACTER SET                                                      Complot
------------------------------------------------------------------ Complot
THIS PROGRAM USES COMPUTER AND PLOTTER DEVICE INDEPENDENT SOFTWARE Complot
CHARACTERS. THIS PROGRAM COMES WITH A FILE THAT DEFINES THE PEN    Complot
STROKES REQUIRED TO DRAW ALL CHARACTERS ON AN IBM KEYBOARD (UPPER  Complot
AND LOWER CASE CHARACTERS, NUMBERS, ETC.) PLUS AN ALTERNATE SET OF Complot
ALL UPPER AND LOWER CASE GREEK CHARACTERS AND ADDITIONAL SPECIAL   Complot
SYMBOLS.                                                           Complot
                                                                   Complot
THE SOFTWARE CHARACTER TABLE CONTAINS X AND Y AND PEN POSITIONS TO Complot
DRAW EACH CHARACTER. IF YOU WISH TO DRAW ANY ADDITIONAL CHARACTERS Complot
OR TO MODIFY THE FONT OF THE EXISTING CHARACTERS YOU NEED ONLY     Complot
MODIFY THIS TABLE.                                                 Complot
                                                                   Complot
CONTROL CHARACTERS                                                 Complot
------------------------------------------------------------------ Complot
IN THE SOFTWARE CHARACTER TABLE ALL CHARACTERS TO BE PLOTTED WILL  Complot
HAVE PEN POSITION = 2 (DRAW) OR = 3 (MOVE). IN ADDITION THE TABLE  Complot
CURRENTLY CONTAINS 4 CONTROL CHARACTERS,                           Complot
                                                                   Complot
PEN POSITION = 0                                                   Complot
----------------                                                   Complot
SHIFT THE NEXT PRINTED CHARACTER BY X AND Y. 3 CONTROL CHARACTERS  Complot
ARE PRESENTLY INCLUDED IN THE SOFTWARE CHARACTER TABLE TO ALLOW    Complot
SHIFTING.                                                          Complot
                                                                   Complot
{   = SHIFT UP (FOR SUPERSCRIPTS.............X= 0.0, Y= 0.5)       Complot
}   = SHIFT DOWN (FOR SUBSCRIPTS.............X= 0.0, Y=-0.5)       Complot
\   = SHIFT LEFT 1 CHARACTER (FOR BACKSPACE...X=-1.0, Y= 0.0)      Complot
                                                                   Complot
PEN POSITION =-1                                                   Complot
----------------                                                   Complot
SELECT THE NEXT PRINTED CHARACTER FROM THE ALTERNATE CHARACTER     Complot
```

```
SET. AT PRESENT THIS CONTROL CHARACTER IS,                          Complot
                                                                    Complot
]   = SWITCH TO ALTERNATE CHARACTER SET                             Complot
                                                                    Complot
THESE 4 CONTROL CHARACTERS ARE ONLY DEFINED BY THE VALUE OF THE     Complot
PEN POSITION IN THE SOFTWARE CHARACTER TABLE (I.E., THEY ARE NOT    Complot
HARD WIRED INTO THIS PROGRAM). AS SUCH BY MODIFYING THE SOFTWARE    Complot
CHARACTER TABLE THE USER HAS THE OPTION OF DEFINING ANY CONTROL     Complot
CHARACTERS TO MEET SPECIFIC NEEDS.                                  Complot
                                                                    Complot
THESE CHARACTERS MAY BE USED IN CHARACTER STRINGS TO PRODUCE        Complot
SPECIAL EFFECTS. FOR EXAMPLE, TO PLOT SUBSCRIPT 5, B, SUPERSCRIPT   Complot
10 USE THE STRING,                                                  Complot
                                                                    Complot
}5B{1{0                                                             Complot
                                                                    Complot
TO PLOT B, SUBSCRIPT 5 AND SUPERSCRIPT 10 WITH THE 5 DIRECTLY       Complot
BELOW THE 1 OF THE 10 WE CAN USE THE BACKSPACE CHARACTER TO         Complot
POSITION THE 1 DIRECTLY ABOVE THE 5 USING THE STRING,               Complot
                                                                    Complot
B}5\{1{0                                                            Complot
                                                                    Complot
TO PLOT UPPER CASE GREEK GAMMA FOLLOWED BY THE WORD TOTAL (I.E.,    Complot
RESONANCE TOTAL WIDTH) USE THE STRING.                              Complot
                                                                    Complot
]G TOTAL                                                            Complot
                                                                    Complot
NOTE, WHEN THESE CONTROL CHARACTERS ARE USED THEY ONLY EFFECT THE   Complot
NEXT 1 PRINTED CHARACTER (SEE, ABOVE EXAMPLE OF PLOTTING SUPER-     Complot
SCRIPT 10 WHERE THE SHIFT UP CONTROL CHARACTER WAS USED BEFORE THE  Complot
1 AND THEN AGAIN BEFORE THE 0 AND THE BACKSPACE AND SHIFT UP        Complot
CONTROL CHARACTERS WERE USED IN COMBINATION).                       Complot
                                                                    Complot
IF THESE 4 CONTROL CHARACTERS ARE NOT AVAILABLE ON YOUR COMPUTER    Complot
YOU CAN MODIFY THE SOFTWARE CHARACTER TABLE TO USE ANY OTHER 4      Complot
CHARACTERS THAT YOU DO NOT NORMALLY USE IN CHARACTER STRINGS (FOR   Complot
DETAILS SEE THE SOFTWARE CHARACTER TABLE).                          Complot
                                                                    Complot
STANDARD/ALTERNATE CHARACTER SETS                                   Complot
------------------------------------------------------------------- Complot
THE SOFTWARE CHARACTER TABLE CONTAINS 2 SETS OF CHARACTERS WHICH    Complot
ARE A STANDARD SET (ALL CHARACTERS ON AN IBM KEYBOARD) AND AN       Complot
ALTERNATE SET (UPPER AND LOWER CASE GREEK CHARACTERS AND SPECIAL    Complot
CHARACTERS). TO DRAW A CHARACTER FROM THE ALTERNATE CHARACTER SET   Complot
PUT A RIGHT BRACKET CHARACTER (]) BEFORE A CHARACTER (SEE THE       Complot
ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS   Complot
CONTROL CHARACTER WILL ONLY EFFECT THE NEXT 1 PLOTTED CHARACTER.    Complot
                                                                    Complot
SUB AND SUPER SCRIPTS                                               Complot
------------------------------------------------------------------- Complot
TO DRAW SUBSCRIPT PRECEED A CHARACTER BY }. TO DRAW SUPERSCRIPT     Complot
PRECEED A CHARACTER BY { (SEE THE ABOVE EXAMPLE AND THE SOFTWARE    Complot
CHARACTER TABLE FOR DETAILS). THESE CONTROL CHARACTER WILL ONLY     Complot
EFFECT THE NEXT 1 PLOTTED CHARACTER.                                Complot
                                                                    Complot
BACKSPACING                                                         Complot
------------------------------------------------------------------- Complot
TO BACKSPACE ONE CHARACTER PRECEED A CHARACTER BY \ (SEE, THE       Complot
ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS   Complot
CONTROL CHARACTER WILL PERFORM A TRUE BACKSPACE AND WILL EFFECT     Complot
ALL FOLLOWING CHARACTERS IN THE SAME CHARACTER STRING.              Complot
                                                                    Complot
PLOT DIMENSIONS                                                     Complot
---------------                                                     Complot
ARE DEFINED BY USER INPUT. INTERNALLY THE PROGRAM WILL CREATE A     Complot
PLOT IN APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. DURING         Complot
OUTPUT THE PLOT IS TRANSFORMED TO THE UNITS (INCHES, CENTIMETERS,   Complot
MILLIMETERS, WHATEVER) OF THE PLOTTER BEING USED AND OUTPUT.        Complot
```

```
                                                                      Complot
===== PLOTTER/GRAPHICS TERMINAL INTERFACE ============================== Complot
======================================================================== Complot
```

```
====================================================================== Convert
                                                                       Convert
     PROGRAM CONVERT                                                   Convert
     VERSION 75-1 (APRIL 1975)                                         Convert
     VERSION 78-1 (JANUARY 1978)                                       Convert
     VERSION 80-1 (AUGUST 1980)  IBM VERSION                           Convert
     VERSION 80-2 (DECEMBER 1980)                                      Convert
     VERSION 82-1 (JANUARY 1982)                                       Convert
     VERSION 83-1 (JANUARY 1983)                                       Convert
     VERSION 86-1 (JANUARY 1986)*NEW PROGRAM                           Convert
                                *FORTRAN-77/H VERSION                  Convert
                                *MULTIPLE INPUT OPTIONS                Convert
     VERSION 88-1 (AUGUST 1988) *OPTION...INTERNALLY DEFINE ALL I/O     Convert
                                 FILE NAMES (SEE, SUBROUTINE FILEIO     Convert
                                 FOR DETAILS).                          Convert
                                *IMPROVED BASED ON USER COMMENTS.       Convert
                                *ADDED NAMES OPTION TO TURN ON/OFF      Convert
                                 STANDARD FILE NAMES.                   Convert
                                *ADDED REWIND OPTION TO TURN ON/OFF     Convert
                                 REWIND AT START OF PROGRAMS.           Convert
                                *DELETED HARWELL AND JAERI OPTIONS      Convert
                                 (PREVIOUSLY ONLY REQUIRED FOR GRAPHIC  Convert
                                 INTERFACE. NO LONGER REQUIRED).        Convert
     VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO     Convert
                                 INSURE PROGRAM WILL NOT DO ANYTHING    Convert
                                 CRAZY.                                 Convert
                                *IMPROVED BASED ON USER COMMENTS.       Convert
                                *ADDED LIVERMORE CIVIC COMPILER         Convert
                                 CONVENTIONS.                           Convert
                                *UPDATED TO USE NEW PROGRAM CONVERT     Convert
                                 KEYWORDS.                              Convert
                                *ADDED ENDFILE OPTION TO OPTIONALLY     Convert
                                 ALLOW END OF FILE TO BE WRITTEN        Convert
     VERSION 91-1 (JUNE 1991)   *ADDED FORTRAN SAVE OPTION             Convert
     VERSION 92-1 (JANUARY 1992)*ADDED ACTION OPTION - TO CONTROL       Convert
                                 INTERACTIVE INPUT TO CODES             Convert
                                *ADDED BLANK DELIMITED KEYWORD INPUT    Convert
                                 (REPLACES EARLIER FIXED FIELD INPUT)   Convert
                                *WARNING...THE INPUT PARAMETER FORMAT   Convert
                                 HAS BEEN GENERALIZED - FOR DETAILS     Convert
                                 SEE BELOW.                             Convert
     VERSION 94-1 (JANUARY 1994)*VARIABLE PROGRAM FILENAMES             Convert
                                 TO ALLOW ACCESS TO FILE STRUCTURES     Convert
                                 (WARNING - INPUT PARAMETER FORMAT      Convert
                                 HAS BEEN CHANGED)                      Convert
                                *CLOSE ALL FILES BEFORE TERMINATING     Convert
                                 (SEE, SUBROUTINE ENDIT)                Convert
                                *ADDED KEYWORD CLOSE.                   Convert
     VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                     Convert
                                 *IMPROVED COMPUTER INDEPENDENCE        Convert
                                 *ALL DOUBLE PRECISION                  Convert
                                 *ON SCREEN OUTPUT                      Convert
     VERSION 99-1 (MARCH 1999)   *GENERAL IMPROVEMENTS BASED ON         Convert
                                  USER FEEDBACK                         Convert
     VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON         Convert
                                  USER FEEDBACK                         Convert
     VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS             Convert
     VERS. 2004-1 (MARCH 2004)   *GENERAL UPDATE                       Convert
     VERS. 2007-1 (JAN.  2007)   *GENERAL UPDATE                       Convert
                                                                       Convert
     OWNED, MAINTAINED AND DISTRIBUTED BY                              Convert
     -----------------------------------                               Convert
     THE NUCLEAR DATA SECTION                                          Convert
     INTERNATIONAL ATOMIC ENERGY AGENCY                                Convert
     P.O. BOX 100                                                      Convert
     A-1400, VIENNA, AUSTRIA                                           Convert
     EUROPE                                                            Convert
                                                                       Convert
```

```
ORIGINALLY WRITTEN BY                                                  Convert
-----------------------------------                                    Convert
DERMOTT E. CULLEN                                                      Convert
UNIVERSITY OF CALIFORNIA                                               Convert
LAWRENCE LIVERMORE NATIONAL LABORATORY                                 Convert
L-159                                                                  Convert
P.O. BOX 808                                                           Convert
LIVERMORE, CA 94550                                                    Convert
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TELEPHONE  925-423-7359                                                Convert
E. MAIL    CULLEN1@LLNL.GOV                                            Convert
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                 Convert
                                                                       Convert
AUTHORS MESSAGE                                                        Convert
---------------                                                        Convert
THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENATION        Convert
FOR THIS PROGRAM INCLUDING ALL RECENT IMPROVEMENTS. PLEASE READ        Convert
ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY THE          Convert
COMMENTS CONCERNING COMPUTER DEPENDENT CODING.                         Convert
                                                                       Convert
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER     Convert
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE         Convert
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT     Convert
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY           Convert
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO      Convert
IMPROVE THIS PROGRAM. IN PARTICULAR IF YOUR FORTRAN COMPILER, OR       Convert
COMPUTER HAS A SET OF REQUIREMENTS THAT ARE DIFFERENT FROM THOSE       Convert
OF CDC, CRAY OR IBM PLEASE NOTIFY THE AUTHOR AND THIS PROGRAM WILL     Convert
BE MODIFIED TO CONSIDER YOUR COMPUTER SEPERATELY. HOWEVER, IN          Convert
ORDER TO PREVENT A PROLIFERATION OF CODING IT IS IMPERATIVE THAT       Convert
YOU IDENTIFY EXACTLY HOW YOUR FORTRAN COMPILER OR COMPUTER DIFFERS     Convert
FROM THOSE ALREADY CONSIDERED BY THIS PROGRAM. HOPEFULLY,IN THIS       Convert
WAY FUTURE VERSIONS OF THIS PROGRAM WILL BE COMPLETELY COMPATIBLE      Convert
FOR USE ON YOUR COMPUTER.                                              Convert
                                                                       Convert
PURPOSE                                                                Convert
-------                                                                Convert
THIS PROGRAM IS DESIGNED TO AUTOMATICALLY CONVERT FORTRAN PROGRAMS     Convert
FOR USE ON ANY ONE OF A VARIETY OF,                                    Convert
(1) COMPUTERS                                                          Convert
(2) COMPILERS                                                          Convert
(3) PRECISIONS (SINGLE OR DOUBLE PRECISION)                            Convert
(4) INSTALLATIONS                                                      Convert
(5) STANDARD OR NON-STANDARD FILE NAMES                                Convert
                                                                       Convert
FORTRAN CODING CONVENTIONS                                             Convert
--------------------------                                             Convert
THIS PROGRAM MAY BE USED TO CONVERT ANY PROGRAM WHICH USES THE         Convert
FOLLOWING CONVENTIONS.                                                 Convert
                                                                       Convert
ALL FORTRAN STATEMENTS THAT DEPEND ON ANY COMBINATION OF COMPUTER,     Convert
COMPILER, PRECISION AND/OR INSTALLATION AND STANDARD FILE NAMES        Convert
SHOULD BE PRECEDED AND FOLLOWED BY A COMMENT LINE THAT CONTAINS,       Convert
                                                                       Convert
C***** DOUBLE ****** ACTIVATE DOUBLE PRECISION (DEFAULT)               Convert
C***** SINGLE ****** ACTIVATE SINGLE PRECISION                         Convert
C***** CHARACTER *** TREAT CHARACTER ARRAYS AS CHARACTERS(DEFAULT)      Convert
C***** INTEGER ***** TREAT CHARACTER ARRAYS AS INTEGERS                 Convert
C***** STOP ******** ACTIVATE STOP TO TERMINATE PROGRAM                 Convert
C***** EXIT ******** ACTIVATE EXIT TO TERMINATE PROGRAM                 Convert
C***** PROGRAM ***** ACTIVATE PROGRAM LINE AND CONTINUATIONS           Convert
C***** NAMES ******* ACTIVATE STANDARD FILENAMES                       Convert
C***** REWIND ****** ACTIVATE REWIND FILES AT START OF PROGRAM         Convert
C***** ENDFILE ***** ACTIVATE ENDFILE AT END OF PROGRAM                Convert
C***** CIVIC ******* ACTIVATE LIVERMORE CIVIC COMPILER CONVENTIONS     Convert
C***** NOID ******** REMOVE LINE ID IN COLUMNS 73-80 (73-80=BLANK)     Convert
C***** SAVE ******** SAVE VARIABLES BETWEEN SUBROUTINE CALLS           Convert
C***** ACTION ****** ACTIVATE INTERACTIVE INPUT TO CODES               Convert
```

```
C***** CLOSE ******* ACTIVATE CLOSE ALL FILES BEFORE TERMINATING   Convert
                                                                   Convert
IF THE USER DOES NOT SELECT,                                       Convert
(1) DOUBLE OR SINGLE      - THE PROGRAM WILL ACTIVATE DOUBLE       Convert
(2) CHARACTER OR INTEGER  - THE PROGRAM WILL ACTIVATE CHARACTER    Convert
(3) STOP OR EXIT          - THE PROGRAM WILL ACTIVATE STOP         Convert
                                                                   Convert
IF THE USER SELECTS,                                               Convert
(1) DOUBLE AND SINGLE     - THE PROGRAM WILL ACTIVATE DOUBLE       Convert
(2) CHARACTER AND INTEGER - THE PROGRAM WILL ACTIVATE CHARACTER    Convert
(3) STOP AND EXIT         - THE PROGRAM WILL ACTIVATE STOP         Convert
                                                                   Convert
IF THE USER DOES NOT SELECT PROGRAM, NAMES, REWIND, ENDFILE,       Convert
CIVIC, NOID, SAVE OR ACTION THESE OPTIONS WILL BE TURNED OFF.      Convert
                                                                   Convert
WHERE CODING IS COMPUTER OR COMPILER DEPENDENT CODING WILL BE      Convert
PRESENT FOR ALL POSSIBLE OPTIONS. THIS PROGRAM WILL ALLOW THE      Convert
THE USER TO CONVERT PROGRAMS FOR USE WITH ANY COMBINATION OF       Convert
OPTIONS. FOR EXAMPLES OF HOW THIS CONVENTION IS USED SEE THE       Convert
LISTING OF THIS PROGRAM AND THE COMMENTS BELOW ON COMPUTER         Convert
DEPENDENT CODING.                                                  Convert
                                                                   Convert
INPUT LINES                                                        Convert
-----------                                                        Convert
  LINE   COLS.  DESCRIPTION                                        Convert
  ----   -----  ------------------------------------              Convert
     1   1-72   BLANK DELIMITED KEYWORDS                          Convert
     2   1-60   ENDF/B INPUT DATA FILENAME                        Convert
                (STANDARD OPTION = ENDFB.IN)                       Convert
     3   1-60   ENDF/B OUTPUT DATA FILENAME                       Convert
                (STANDARD OPTION = ENDFB.OUT)                      Convert
                                                                   Convert
*THE FIRST INPUT LINE IS 72 CHARACTERS.                           Convert
*KEYWORDS MAY BE LOCATED ANYWHERE WITHIN THESE 72 CHARACTERS       Convert
*THERE MAY BE ANY NUMBER OF KEYWORDS INPUT                        Convert
*EACH KEYWORD MUST BE BLANK DELIMITED, E.G., DOUBLE CHARACTER     Convert
 IS LEGAL INPUT - DOUBLECHARACTER IS NOT LEGAL INPUT.              Convert
*THERE MUST BE ONE OR MORE BLANKS BETWEEN KEYWORDS                Convert
                                                                   Convert
*NOTE, THIS NEW INPUT PARAMETER FORMAT (VERSION 92-1) IS COMPLETELY Convert
 COMPATIBLE WITH THE OLDER FIXED FIELD FORMAT. SO THAT IF YOU HAVE  Convert
 INPUT THAT YOU HAVE USED IN THE PAST YOU CAN CONTINUE TO USE IT.   Convert
                                                                   Convert
 LEGAL KEYWORDS INCLUDE,                                           Convert
                                                                   Convert
 DOUBLE        ACTIVATE DOUBLE PRECISION (DEFAULT)                 Convert
 SINGLE        ACTIVATE SINGLE PRECISION                           Convert
 CHARACTER     TREAT CHARACTER ARRAYS AS CHARACTERS(DEFAULT)       Convert
 INTEGER       TREAT CHARACTER ARRAYS AS INTEGERS                  Convert
 PROGRAM       ACTIVATE PROGRAM LINE AND CONTINUATIONS             Convert
 NAMES         ACTIVATE STANDARD FILENAMES                         Convert
 REWIND        ACTIVATE REWIND FILES AT START OF PROGRAM           Convert
 ENDFILE       ACTIVATE ENDFILE AT END OF PROGRAM                  Convert
 CIVIC         ACTIVATE LIVERMORE CIVIC COMPILER CONVENTIONS       Convert
 NOID          REMOVE LINE ID IN COLUMNS 73-80 (73-80=BLANK)       Convert
 SAVE          SAVE VARIABLES BETWEEN SUBROUTINE CALLS             Convert
 ACTION        ACTIVATE INTERACTIVE INPUT FOR CODES                Convert
 CLOSE         ACTIVATE CLOSE ALL FILES BEFORE TERMINATING         Convert
                                                                   Convert
 EXAMPLE INPUT NO. 1                                               Convert
 -------------------                                               Convert
 TO USE A PROGRAM IN SINGLE PRECISION, USE THE STANDARD FILE NAMES, Convert
 REWIND ALL UNITS AT THE START OF THE PROGRAM AND TREAT CHARACTER   Convert
 ARRAYS AS CHARACTER (FORTRAN-77 CONVENTION).                       Convert
                                                                   Convert
 READ  \PREPRO93\RECENT\RECENT.OLD AND                             Convert
 WRITE \PREPRO93\RECENT\RECENT.NEW                                 Convert
                                                                   Convert
```

```
THE FOLLOWING 3 INPUT LINES ARE REQUIRED,                          Convert
                                                                   Convert
SINGLE NAMES REWIND CHARACTER                                      Convert
\PREPRO93\RECENT\RECENT.OLD                                        Convert
\PREPRO93\RECENT\RECENT.NEW                                        Convert
                                                                   Convert
NOTE, SINCE CHARACTER IS THE STANDARD OPTION THE KEYWORD CHARACTER Convert
NEED NOT APPEAR ON THE ABOVE INPUT LINE.                           Convert
                                                                   Convert
EXAMPLE INPUT NO. 2                                                Convert
-------------------                                                Convert
TO USE A PROGRAM IN DOUBLE PRECISION AND TREAT ALL CHARACTER       Convert
ARRAYS AS INTEGER (FORTRAN-H CONVENTION).                          Convert
                                                                   Convert
USE THE STANDARD FILENAMES TO READ = CONVERT.IN AND WRITE =        Convert
CONVERT.OUT (THIS CAN BE DONE BY LEAVING THE SECOND AND THIRD      Convert
INPUT LINES BLANK).                                                Convert
                                                                   Convert
THE FOLLOWING 3 INPUT LINES ARE REQUIRED,                          Convert
                                                                   Convert
DOUBLE  INTEGER                                                    Convert
(NOTE, THIS IS A BLANK LINE)                                       Convert
(NOTE, THIS IS A BLANK LINE)                                       Convert
                                                                   Convert
NOTE, SINCE DOUBLE IS THE STANDARD OPTION THE KEYWORD DOUBLE       Convert
NEED NOT APPEAR ON THE ABOVE INPUT LINE.                           Convert
                                                                   Convert
EXAMPLE INPUT NO. 3                                                Convert
-------------------                                                Convert
TO ACTIVATE THE PROGRAM LINE, USE DOUBLE PRECISION AND TREAT ALL   Convert
CHARACTER ARRAYS AS CHARACTER.                                     Convert
                                                                   Convert
                                                                   Convert
READ  \PREPRO93\RECENT\RECENT.OLD AND                              Convert
WRITE THE STANDARD FILENAME = CONVERT.OUT (LEAVE THE THIRD INPUT   Convert
LINE BLANK).                                                       Convert
                                                                   Convert
THE FOLLOWING 3 INPUT LINES ARE REQUIRED,                          Convert
                                                                   Convert
PROGRAM                                                            Convert
\PREPRO93\RECENT\RECENT.OLD                                        Convert
(NOTE, THIS IS A BLANK LINE)                                       Convert
                                                                   Convert
NOTE, SINCE DOUBLE, CHARACTER AND EXIT ARE THE STANDARD OPTIONS    Convert
THEY NEED NOT APPEAR ON THE ABOVE INPUT LINE AND IN THIS EXAMPLE   Convert
HAVE BEEN OMITTED.                                                 Convert
                                                                   Convert
WARNING                                                            Convert
-------                                                            Convert
(1) THE PROGRAM WILL ALWAYS ACTIVATE DOUBLE OR SINGLE, CHARACTER   Convert
OR INTEGER (AS DESCRIBED ABOVE).                                   Convert
                                                                   Convert
(2) CODING IN THE PROGRAM FOR ANY KEYWORDS THAT ARE NOT ACTIVATED  Convert
WILL BE CONVERTED TO COMMENT LINES AND AS SUCH WILL EFFECTIVELY     Convert
DISAPPEAR FROM THE PROGRAM. THEREFORE IF THE KEYWORDS PROGRAM,     Convert
NAMES, REWIND, ENDFILE, CIVIC OR NOID ARE NOT INPUT BY THE USER    Convert
THESE OPTIONS WILL BE TURNED OFF AND ANY CODING USING THESE        Convert
KEYWORDS WILL EFFECTIVELY DISAPPEAR FROM THE PROGRAM.              Convert
                                                                   Convert
(3) THE SERIES OF CODES THAT ARE DESIGNED TO BE AUTOMATICALLY      Convert
TRANSLATED BY THIS PROGRAM REQUIRE THAT ALL CALCULATIONS BE        Convert
PERFORMED IN DOUBLE PRECISION ON SHORT WORD LENGTH COMPUTERS       Convert
(E.G., IBM COMPUTERS). THIS PROGRAM WILL ALLOW YOU TO SPECIFY      Convert
EITHER DOUBLE OR SINGLE PRECISION. HOWEVER, IF YOU SPECIFY         Convert
SINGLE PRECISION THIS PROGRAM WILL PRINT A WARNING MESSAGE THAT    Convert
THE CONVERTED PROGRAM SHOULD ONLY BE USED ON LONG WORD LENGTH      Convert
COMPUTERS (E.G., CDC COMPUTERS).                                   Convert
                                                                   Convert
```

```
      PROGRAM OPERATION                                                  Convert
      -----------------                                                  Convert
      THE PROGRAM WILL SEARCH FOR COMMENT LINES THAT START WITH C**      Convert
      IN COLUMNS 1-3 FOLLOWED BY ANY ONE OF THE ALLOWED KEYWORDS         Convert
      IF THE KEYWORD IS THE SAME AS ONE OF THE KEYWORDS INPUT BY         Convert
      THE USER ALL LINES UP TO THE NEXT LINE WITH C** IN COLUMNS 1-3     Convert
      FOLLOWED BY THE SAME KEYWORD WILL BE SET ACTIVE BY SETTING COLUMN  Convert
      1 TO BLANK. IF THE KEYWORDS DIFFERS FROM THAT INPUT BY THE USER    Convert
      ALL LINES UP TO THE NEXT LINE WITH C** IN COLUMNS 1-3 FOLLOWED BY  Convert
      THE SAME KEYWORD WILL BE SET INACTIVE BY SETTING COLUMN 1 TO C.    Convert
                                                                         Convert
      KEYWORDS MAY NOT BE NESTED (I.E., THIS PROGRAM WILL ONLY OPERATE   Convert
      PROPERLY IF KEYWORDS APPEAR IN PAIRS. ONCE A LINE IS FOUND THAT    Convert
      CONTAINS A KEYWORD, THE NEXT LINE THAT CONTAINS A KEYWORD MUST     Convert
      CONTAIN THE SAME KEYWORD).                                         Convert
                                                                         Convert
      PROGRAM LINE                                                       Convert
      ------------                                                       Convert
      THE FORTRAN FILE MAY START WITH A PROGRAM LINE AND CONTINUATIONS.  Convert
      FOR USE ON CDC-7600 OR CRAY-1 COMPUTERS THIS PROGRAM CAN ACTIVATE  Convert
      THE PROGRAM LINE AND CONTINUATION LINES. FOR USE ON OTHER TYPES OF Convert
      COMPUTERS THIS PROGRAM WILL AUTOMATICALLY DE-ACTIVATE THE PROGRAM  Convert
      LINE AND CONTINUATION LINES. THIS CONVENTIONS HAS BEEN INTRODUCED  Convert
      BECAUSE SOME CDC-7600 COMPILERS CONSIDER IT AN ERROR IF THE FIRST   Convert
      LINE IS NOT A PROGRAM LINE. PRECEEDING COMMENT LINES ARE NOT       Convert
      ALLOWED. THEREFORE THE NORMAL CONVENTION, DESCRIBED ABOVE, OF      Convert
      USING PRECEDING AND FOLLOWING COMMENT LINES, CANNOT BE USED AT     Convert
      THE BEGINNING OF THE PROGRAM.                                      Convert
                                                                         Convert
      COMMENT LINES                                                      Convert
      -------------                                                      Convert
      COMMENT LINES MAY APPEAR ON LINES BETWEEN PAIRS OF KEYWORD LINES   Convert
      ONLY IF THE COMMENT LINES CONTAINS C-- IN COLUMS 1-3. ANY LINE     Convert
      THAT CONTAINS ANYTHING ELSE IN COLUMNS 1-3 MAY BE ACTIVATED        Convert
      BY THIS PROGRAM BY SETTING COLUMN 1 BLANK AND CAN LEAD TO ERRORS   Convert
      DURING COMPILATION AND/OR EXECUTION.                               Convert
                                                                         Convert
      INPUT FILES                                                        Convert
      -----------                                                        Convert
      UNIT  DESCRIPTION                                                  Convert
      ----  -----------                                                  Convert
        2   INPUT LINE (BCD - 80 CHARACTERS/RECORD)                      Convert
       10   ORIGINAL PROGRAM (BCD - 80 CHARACTERS/RECORD)                Convert
                                                                         Convert
      OUTPUT FILES                                                       Convert
      ------------                                                       Convert
      UNIT  DESCRIPTION                                                  Convert
      ----  -----------                                                  Convert
        3   OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                  Convert
       11   RE-FORMATTED PROGRAM (BCD - 80 CHARACTERS/RECORD)            Convert
                                                                         Convert
      OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)    Convert
      ---------------------------------------------------------------    Convert
      UNIT  FILE NAME                                                    Convert
      ----  ----------                                                   Convert
        2   CONVERT.INP                                                  Convert
        3   CONVERT.LST                                                  Convert
       10   CONVERT.IN                                                   Convert
       11   CONVERT.OUT                                                  Convert
                                                                         Convert
    ===================================================================== Convert
```

```
C======================================================================= Dictin
C                                                                       Dictin
C    PROGRAM DICTIN (Renamed from DICTION to eliminate conflict with    Dictin
C                    UNIX diction command - 12/22/02)                   Dictin
C    ==============                                                     Dictin
C    VERSION 81-1 (SEPTEMBER 1981)                                      Dictin
C    VERSION 82-1 (JANUARY 1982)                                        Dictin
C    VERSION 83-1 (JANUARY 1983)  *KEEP ORIGINAL MOD. NUMBER            Dictin
C                                 *NEW, MORE COMPATIBLE I/O UNITS.      Dictin
C    VERSION 84-1 (SEPTEMBER 1984)*UPDATED TO HANDLE ENDF/B-VI FORMAT.  Dictin
C                                  (PROGRAM WILL NOW WORK ON ALL        Dictin
C                                   VERSIONS OF THE ENDF/B FORMAT).     Dictin
C    VERSION 85-1 (AUGUST 1985)   *FORTRAN-77/H VERSION                 Dictin
C    VERSION 86-1 (JANUARY 1986)  *MAT ORDER CHECK.                     Dictin
C                                 *IF NO HOLLERITH SECTION COPY MAT.    Dictin
C    VERSION 88-1 (JULY 1988)     *OPTION...INTERNALLY DEFINE ALL I/O   Dictin
C                                  FILE NAMES (SEE, SUBROUTINE FILEIO   Dictin
C                                  FOR DETAILS).                        Dictin
C                                 *IMPROVED BASED ON USER COMMENTS.     Dictin
C    VERSION 89-1 (JANUARY 1989)  *PSYCHOANALYZED BY PROGRAM FREUD TO   Dictin
C                                  INSURE PROGRAM WILL NOT DO ANYTHING  Dictin
C                                  CRAZY.                               Dictin
C                                 *IMPROVED BASED ON USER COMMENTS.     Dictin
C                                 *ADDED LIVERMORE CIVIC COMPILER       Dictin
C                                  CONVENTIONS.                         Dictin
C                                 *UPDATED TO USE NEW PROGRAM CONVERT   Dictin
C                                  KEYWORDS.                            Dictin
C    VERSION 92-1 (JANUARY 1992)  *UPDATED BASED ON USER COMMENTS.      Dictin
C                                 *UP TO 6000 SECTIONS PER TAPE.        Dictin
C                                 *CHANGED DEFAULT MOD NUMBER FOR NEW   Dictin
C                                  SECTIONS FROM 0 TO 1                 Dictin
C    VERSION 94-1 (JANUARY 1994)  *VARIABLE ENDF/B DATA FILENAMES       Dictin
C                                  TO ALLOW ACCESS TO FILE STRUCTURES   Dictin
C                                  (WARNING - INPUT PARAMETER FORMAT    Dictin
C                                  HAS BEEN CHANGED)                    Dictin
C                                 *CLOSE ALL FILES BEFORE TERMINATING   Dictin
C                                  (SEE, SUBROUTINE ENDIT)              Dictin
C                                 *ADDED FORTRAN SAVE OPTION            Dictin
C    VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                     Dictin
C                                *IMPROVED COMPUTER INDEPENDENCE        Dictin
C                                *ALL DOUBLE PRECISION                  Dictin
C                                *ON SCREEN OUTPUT                      Dictin
C                                *UNIFORM TREATMENT OF ENDF/B I/O       Dictin
C                                *IMPROVED OUTPUT PRECISION             Dictin
C    VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING       Dictin
C                                 POINT READ FOR MORE DIGITS            Dictin
C                                *UPDATED TEST FOR ENDF/B FORMAT        Dictin
C                                 VERSION BASED ON RECENT FORMAT CHANGE Dictin
C                                *GENERAL IMPROVEMENTS BASED ON         Dictin
C                                 USER FEEDBACK                         Dictin
C    VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON         Dictin
C                                 USER FEEDBACK                         Dictin
C    VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS             Dictin
C                                *RENAMED dictin TO ELIMINATE CONFLICT  Dictin
C                                 WITH UNIX diction COMMAND.            Dictin
C                                *ADDED DOCUMENTATION LINE TO COMMENTS. Dictin
C    VERS. 2004-1 (JAN. 2004)    *GENERAL UPDATE BASED ON USER FEEDBACK Dictin
C                                *UP TO 100,000 SECTIONS PER TAPE.      Dictin
C    VERS. 2007-1 (JAN. 2007)    *CHECKED AGAINST ALL ENDF/B-VII.       Dictin
C                                *UP TO 500,000 SECTIONS PER TAPE.      Dictin
C                                                                       Dictin
C    OWNED, MAINTAINED AND DISTRIBUTED BY                               Dictin
C    ------------------------------------                               Dictin
C    THE NUCLEAR DATA SECTION                                           Dictin
C    INTERNATIONAL ATOMIC ENERGY AGENCY                                 Dictin
C    P.O. BOX 100                                                       Dictin
C    A-1400, VIENNA, AUSTRIA                                            Dictin
C    EUROPE                                                             Dictin
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                                                                      Dictin
ORIGINALLY WRITTEN BY                                                 Dictin
-----------------------------------                                   Dictin
DERMOTT E. CULLEN                                                     Dictin
UNIVERSITY OF CALIFORNIA                                              Dictin
LAWRENCE LIVERMORE NATIONAL LABORATORY                                Dictin
L-159                                                                 Dictin
P.O. BOX 808                                                          Dictin
LIVERMORE, CA 94550                                                   Dictin
U.S.A.                                                                Dictin
TELEPHONE  925-423-7359                                               Dictin
E. MAIL    CULLEN1@LLNL.GOV                                           Dictin
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                Dictin
                                                                      Dictin
AUTHORS MESSAGE                                                       Dictin
---------------                                                       Dictin
THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENATION       Dictin
FOR THIS PROGRAM INCLUDING ALL RECENT IMPROVEMENTS. PLEASE READ       Dictin
ALL OF THESE COMMENTS BEFORE IMPLEMENTATION.                          Dictin
                                                                      Dictin
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER    Dictin
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE        Dictin
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT    Dictin
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY          Dictin
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO     Dictin
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF       Dictin
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR            Dictin
COMPUTER.                                                             Dictin
                                                                      Dictin
PURPOSE                                                               Dictin
-------                                                               Dictin
THIS PROGRAM IS DESIGNED TO CREATE A REACTION INDEX FOR EACH          Dictin
MATERIAL ON AN ENDF/B FORMATTED TAPE AND TO INSERT THIS REACTION      Dictin
INDEX IN FILE 1, SECTION 451 OF EACH MATERIAL.                        Dictin
                                                                      Dictin
IN THE DESCRIPTION THAT FOLLOWS FOR SIMPLICITY THE ENDF/B             Dictin
TERMINOLOGY---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL          Dictin
MEDIUM MAY BE TAPE, CARDS, DISK, OR ANY OTHER MEDIUM.                 Dictin
                                                                      Dictin
ENDF/B FORMAT                                                         Dictin
-------------                                                         Dictin
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS        Dictin
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION      Dictin
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT).    Dictin
                                                                      Dictin
THIS PROGRAM WILL AUTOMATICALLY DETERMINE WHICH VERSION OF THE        Dictin
ENDF/B FORMAT EACH MAT IS IN AND WILL THEN PROPERLY REPLACE THE       Dictin
REACTION INDEX FOR EACH MAT. DIFFERENT MATS ON THE SAME TAPE MAY      Dictin
EVEN BE IN DIFFERENT VERSIONS OF THE ENDF/B FORMAT.                   Dictin
                                                                      Dictin
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B          Dictin
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS        Dictin
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE     Dictin
NUMBERS (COLUMNS 76-80) NEED NOT BE PRESENT ON INPUT, BUT WILL BE     Dictin
CORRECTLY OUTPUT ON ALL LINES.                                        Dictin
                                                                      Dictin
ENDF/B FORMAT VERSION                                                 Dictin
---------------------                                                 Dictin
THE ENDF/B FORMAT CAN BE DETERMINED FROM THE SECOND LINE OF           Dictin
THE HOLLERITH SECTION (MF=1, MT=451).                                 Dictin
ENDF/B-IV = N1 - LINE COUNT (POSITIVE)                                Dictin
ENDFB/-V  = N1 = N2 =0                                                Dictin
ENDF/B-VI = N1 =0, N2= VERSION NUMBER (6 OR MORE)                     Dictin
                                                                      Dictin
SECTION SIZE                                                          Dictin
------------                                                          Dictin
SINCE THIS PROGRAM ONLY READS THE DATA ONE LINE AT A TIME THERE       Dictin
IS NO LIMIT TO THE SIZE OF ANY GIVEN SECTION, E.G. THE TOTAL          Dictin
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    CROSS SECTION MAY BE DESCRIBED BY 200,000 DATA POINTS.             Dictin
                                                                       Dictin
    NUMBER OF SECTIONS PER TAPE                                        Dictin
    ---------------------------                                        Dictin
    IT IS ASSUMED THAT THE ENDF/B TAPE CONTAINS 100,000 OR FEWER       Dictin
    SECTIONS = 100,000 OR FEWER MAT,MF,MT COMBINATIONS. IF THIS LIMIT  Dictin
    IS EXCEEDED THIS PROGRAM WILL TERMINATE EXECUTION. IF NEED BE THIS Dictin
    LIMIT CAN EASILY BE CHANGED BY CHANGING THE DIMENSION STATEMENT    Dictin
    BELOW AND RE-DEFINING THE VARIABLE MAXTAB IN THE BELOW DATA        Dictin
    STATEMENT. ALTERNATIVELY THE ENDF/B TAPE MAY BE DIVIDED INTO A     Dictin
    NUMBER SMALLER TAPES EACH CONTAINING 100,000 OR FEWER SECTIONS.    Dictin
    EACH ENDF/B TAPE CAN THEN RUN THROUGH THIS PROGRAM AND THE OUTPUT  Dictin
    FOR EACH ENDF/B TAPE CAN THEN BE RE-COMBINED (I.E., MERGED BACK    Dictin
    TOGETHER).                                                         Dictin
                                                                       Dictin
    HOLLERITH SECTION                                                  Dictin
    -----------------                                                  Dictin
    IF ANY MATERIAL DOES NOT INITIALLY CONATIN A SECTION MF=1, MT=451  Dictin
    A WARNING MESSAGE WILL BE PRINTED AND THE MATERIAL WILL BE COPIED. Dictin
                                                                       Dictin
    IF ANY MATERIAL INITIALLY CONTAINS A SECTION MF=1, MT=451 A NEW    Dictin
    REACTION INDEX WILL BE CREATED AND INSERTED. THE INITIAL SECTION   Dictin
    MF=1, MT=451 MAY OR MAY NOT CONTAIN A REACTION INDEX.              Dictin
                                                                       Dictin
    IF THE MATERIAL INITIALLY CONTAINS A REACTION INDEX IT WILL BE     Dictin
    USED TO DEFINE THE MOD NUMBER FOR CORRESPONDING SECTIONS IN THE    Dictin
    NEW REACTION INDEX (I.E. IF A SECTION FROM THE ORIGINAL REACTION   Dictin
    INDEX HAS THE SAME MF/MT NUMBERS AS A SECTION IN THE NEW REACTION  Dictin
    INDEX THE MOD NUMBER FROM THE ORIGINAL REACTION INDEX WILL BE USED Dictin
    IN THE NEW REACTION INDEX). OTHERWISE THE MOD NUMBER IN THE NEW    Dictin
    REACTION INDEX WILL BE SET EQUAL TO ZERO.                          Dictin
                                                                       Dictin
    PROGRAM OPERATION                                                  Dictin
    -----------------                                                  Dictin
    THE ENTIRE ENDF/B TAPE IS FIRST READ AND A DICTIONARY ENTRY IS     Dictin
    CREATED FOR EACH SECTION OF THE TAPE. THE ENDF/B TAPE IS THEN      Dictin
    REWOUND AND READ A SECOND TIME. DURING THIS SECOND PASS THE        Dictin
    DICTIONARY OF EACH MAT IS REPLACED. THIS VERSION OF DICTIN         Dictin
    DOES NOT USE SCRATCH FILES AND IS MORE EFFICIENT THAN EARLIER      Dictin
    VERSIONS OF DICTIN.                                                Dictin
                                                                       Dictin
    INPUT LINES                                                        Dictin
    -----------                                                        Dictin
      LINE   COLS.  DESCRIPTION                                        Dictin
      ----   -----  -------------------------------                    Dictin
         1   1-60   ENDF/B INPUT DATA FILENAME                         Dictin
                    (STANDARD OPTION = ENDFB.IN)                       Dictin
         2   1-60   ENDF/B OUTPUT DATA FILENAME                        Dictin
                    (STANDARD OPTION = ENDFB.OUT)                      Dictin
                                                                       Dictin
    EXAMPLE INPUT NO. 1                                                Dictin
    -------------------                                                Dictin
    READ \ENDFB6\K300\ENDFB.IN AND WRITE \ENDFB\K300\ENDFB.OUT. THE    Dictin
    FOLLOWING 2 INPUT LINES ARE REQUIRED,                              Dictin
                                                                       Dictin
\ENDFB6\K300\ENDFB.IN                                                  Dictin
\ENDFB6\K300\ENDFB.OUT                                                 Dictin
                                                                       Dictin
    EXAMPLE INPUT NO. 2                                                Dictin
    -------------------                                                Dictin
    USE THE DEFAULT FILENAMES TO READ ENDFB.IN AND WRITE ENDFB.OUT.    Dictin
    2 BLANK INPUT LINES ARE REQUIRED                                   Dictin
                                                                       Dictin
    INPUT FILES                                                        Dictin
    -----------                                                        Dictin
    UNIT  DESCRIPTION                                                  Dictin
    ----  -----------                                                  Dictin
       2  INPUT PARAMETERS (BCD - 80 CHARACTERS/RECORD)                Dictin
```

```
       10  ORIGINAL TAPE OF ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)    Dictin
                                                                        Dictin
     OUTPUT FILES                                                       Dictin
     ------------                                                       Dictin
     UNIT  DESCRIPTION                                                  Dictin
     ----  -----------                                                  Dictin
        3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                  Dictin
       11  FINAL TAPE OF ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)       Dictin
                                                                        Dictin
     OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)    Dictin
     ---------------------------------------------------------------    Dictin
     UNIT  FILE NAME                                                    Dictin
     ----  ----------                                                   Dictin
       2   DICTIN.INP                                                   Dictin
       3   DICTIN.LST                                                   Dictin
      10   ENDFB.IN                                                     Dictin
      11   ENDFB.OUT                                                    Dictin
                                                                        Dictin
=========================================================================== Dictin
```

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====================================================================== Evalplot
                                                                       Evalplot
      PROGRAM EVALPLOT                                                 Evalplot
      VERSION 75-1 (AUGUST 1975)                                       Evalplot
      VERSION 76-1 (JULY 1976)                                         Evalplot
      VERSION 77-1 (APRIL 1977)                                        Evalplot
      VERSION 78-1 (JULY 1978)                                         Evalplot
      VERSION 79-1 (FEBRUARY 1979)                                     Evalplot
      VERSION 80-1 (JULY 1980)    *IBM VERSION                         Evalplot
      VERSION 80-2 (DECEMBER 1980)                                     Evalplot
      VERSION 81-1 (MARCH 1981)                                        Evalplot
      VERSION 81-2 (AUGUST 1981)  *IMPROVED ZOOM CAPABILITY            Evalplot
      VERSION 82-1 (JANUARY 1982) *IMPROVED COMPUTER COMPATIBILITY      Evalplot
      VERSION 83-1 (JANUARY 1983) *ELIMINATED COMPUTER DEPENDENT CODING. Evalplot
      VERSION 83-2 (OCTOBER 1983) *ADDED PLOTTING OF HISTOGRAM DATA.    Evalplot
      VERSION 84-1 (DECEMBER 1984)*ADDED PLOTS OF LEGENDRE COEFFICENTS  Evalplot
                                   AS A FUNCTION OF ENERGY.            Evalplot
                                  *ADDED SMALL PLOTTING MODE.          Evalplot
      VERSION 85-1 (AUGUST 1985)  *FORTRAN-77/H VERSION                Evalplot
      VERSION 86-1 (JANUARY 1986) *ENDF/B-VI FORMAT                    Evalplot
      VERSION 88-1 (JULY 1988)    *MAJOR REVISION TO MAKE CODE EASILY   Evalplot
                                   INTERFACEABLE TO ALMOST ANY PLOTTER. Evalplot
                                  *WARNING...INPUT PARAMETERS FROM BEEN Evalplot
                                   CHANGED (SEE, DESCRIPTION BELOW)    Evalplot
                                  *COMPUTER INDEPENDENT SOFTWARE       Evalplot
                                   CHARACTERS.                         Evalplot
                                  *COLOR PLOTS.                        Evalplot
                                  *MT NUMBER DEFINITIONS FROM DATA FILE Evalplot
                                   READ BY PROGRAM                     Evalplot
                                  *FORTRAN-77 REQUIRED (FORTRAN-H NO    Evalplot
                                   SUPPORTED BY THIS PROGRAM).         Evalplot
                                  *OPTION...INTERNALLY DEFINE ALL I/O   Evalplot
                                   FILE NAMES (SEE, SUBROUTINE FILEIO  Evalplot
                                   FOR DETAILS).                       Evalplot
                                  *IMPROVED BASED ON USER COMMENTS.     Evalplot
      VERSION 89-1 (JANUARY 1989) *PSYCHOANALYZED BY PROGRAM FREUD TO   Evalplot
                                   INSURE PROGRAM WILL NOT DO ANYTHING Evalplot
                                   CRAZY.                              Evalplot
                                  *UPDATED TO USE NEW PROGRAM CONVERT   Evalplot
                                   KEYWORDS.                           Evalplot
                                  *ADDED LIVERMORE CIVIC COMPILER       Evalplot
                                   CONVENTIONS.                        Evalplot
                                  *FORTRAN-77/FORTRAN-H COMPATIBLE      Evalplot
                                  *SPECIAL ENDF/B MATERIAL DEFINITIONS  Evalplot
                                   (ZA.LT.1000) FROM DATA FILE READ    Evalplot
                                   BY PROGRAM.                         Evalplot
      VERSION 89-2 (MARCH 1989)   *ADDED ENDF/B-V AND VI MT            Evalplot
                                   DEFINITIONS. PROGRAM WILL DETERMINE Evalplot
                                   ENDF/B FORMAT BASED ON MF=1,        Evalplot
                                   MT=451 AND USE ASPPROPRIATE MT      Evalplot
                                   DEFINITIONS. IF NO MF=1, MT=451     Evalplot
                                   PROGRAM WILL USE ENDF/B-V           Evalplot
                                   MT DEFINITIONS.                     Evalplot
      VERSION 89-3 (JUNE 1989)    *3 CHARACTER FONTS                   Evalplot
      VERSION 92-1 (JANUARY 1992) *COMPLETE REWRITE OF CODE            Evalplot
                                  *ADDED PHOTON DATA, MF=23 AND 27      Evalplot
                                  *ADDED INCIDENT CHARGED PARTICLES     Evalplot
                                   (IDENTIFIED IN PLOT TITLES)         Evalplot
                                  *ADDED FORTRAN SAVE OPTION.          Evalplot
                                  *UPDATED BASED ON USER COMMENTS      Evalplot
                                  *ADDED RETRIEVAL BY UP TO 100        Evalplot
                                   MAT/MF/MT OR ZA/MF/MT RANGES        Evalplot
                                  *WARNING...INPUT PARAMETER FORMAT     Evalplot
                                   HAS BEEN CHANGED...SEE DESCRIPTION  Evalplot
                                   BELOW.                              Evalplot
      VERSION 92-2 (FEBRUARY 1992)*ADDED PHOTON SPECTRA, MF=15.        Evalplot
                                  *ADDED MULTIPLICATION OF DISTRIBUTIONS Evalplot
                                   IN MF=5 AND 15 BY PROBABILITY=YIELD. Evalplot
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                           *INCREASED PAGE SIZE TO 12000 POINTS   Evalplot
VERSION 92-3 (MAY 1992)    *CORRECTED DESCRIPTION OF INPUT        Evalplot
                            PARAMETERS AND EXAMPLE PROBLEMS.      Evalplot
                           *CORRECTED FOR ENDF/B-VI DEFINITION OF Evalplot
                            TEMPERATURE FROM MF=1/MT=451.         Evalplot
                           *CORRECTED LOGIC SO THAT EACH REQUEST  Evalplot
                            IS TREATED SEPARATELY TO CREATE A     Evalplot
                            PLOT, UNLESS REQUESTS ARE CHAINED     Evalplot
                            TOGETHER.                             Evalplot
                           *ADDED VARIABLE CHARACTER SIZE INPUT.  Evalplot
VERSION 93-1 (MARCH 1993)  *INCREASED PAGE SIZE FROM 12000        Evalplot
                            TO 210000                             Evalplot
                           *INCREASED THE NUMBER OF ENERGIES      Evalplot
                            VS. LEGENDRE COEFFICIENTS FROM        Evalplot
                            167 TO 7000                           Evalplot
                           *UPDATED FOR ON SCREEN GRAPHICS        Evalplot
                            USING THE LAHEY FORTRAN COMPILER.     Evalplot
VERSION 94-1 (JANUARY 1994) *VARIABLE ENDF/B DATA FILENAMES       Evalplot
                            TO ALLOW ACCESS TO FILE STRUCTURES    Evalplot
                            (WARNING - INPUT PARAMETER FORMAT     Evalplot
                            HAS BEEN CHANGED)                     Evalplot
                           *CLOSE ALL FILES BEFORE TERMINATING    Evalplot
                            (SEE, SUBROUTINE ENDIT)               Evalplot
VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                    Evalplot
                           *IMPROVED COMPUTER INDEPENDENCE        Evalplot
                           *ALL DOUBLE PRECISION                  Evalplot
                           *UNIFORM TREATMENT OF ENDF/B I/O       Evalplot
                           *IMPROVED OUTPUT PRECISION             Evalplot
                           *DEFINED SCRATCH FILE NAMES            Evalplot
                           *ALL DOUBLE PRECISION                  Evalplot
VERSION 97-1 (APRIL 1997)  *INCREASED PAGE SIZE FROM 210000       Evalplot
                            TO 480,000                            Evalplot
VERSION 99-1 (MARCH 1999)  *CORRECTED CHARACTER TO FLOATING       Evalplot
                            POINT READ FOR MORE DIGITS            Evalplot
                           *UPDATED TEST FOR ENDF/B FORMAT        Evalplot
                            VERSION BASED ON RECENT FORMAT CHANGE Evalplot
                           *GENERAL IMPROVEMENTS BASED ON         Evalplot
                            USER FEEDBACK                         Evalplot
VERS. 2000-1 (FEBRUARY 2000)*ADDED MF=10, ACTIVATION CROSS        Evalplot
                            SECTION PLOTS.                        Evalplot
                           *INCREASED DIMENSIONS TO HANDLE MORE   Evalplot
                            SECTIONS - UP TO 1,000                Evalplot
                           *GENERAL IMPROVEMENTS BASED ON         Evalplot
                            USER FEEDBACK                         Evalplot
VERS. 2002-1 (Nov. 2002)   *OPTIONAL INPUT PARAMETERTS            Evalplot
                           *OPTIONAL BLACK OR WHITE BACKGROUND    Evalplot
                           *COLOR POSTSCRIPT FILES                Evalplot
VERS. 2004-1 (MARCH 2004)  *ADDED INCLUDE FOR COMMON              Evalplot
                           *INCREASED PAGE SIZE TO 600,000        Evalplot
                           *INCREASED THE NUMBER OF ENERGIES      Evalplot
                            VS. LEGENDRE COEFFICIENTS FROM        Evalplot
                            7000 TO 20000                         Evalplot
VERS. 2007-1 (JAN.  2007)  *CHECKED AGAINST ALL ENDF/B-VII.       Evalplot
                           *INCREASED PAGE SIZE TO 2,400,000      Evalplot
                            FROM 600,000.                         Evalplot
                            VS. LEGENDRE COEFFICIENTS TO          Evalplot
                            80,000 FROM 20,000 (MUST BE 1/30      Evalplot
                            PAGE SIZE).                           Evalplot
                           *ADDEED (N,REMAINDER) TO FIRST PLOT.   Evalplot
                                                                  Evalplot
OWNED, MAINTAINED AND DISTRIBUTED BY                              Evalplot
-----------------------------------                               Evalplot
THE NUCLEAR DATA SECTION                                          Evalplot
INTERNATIONAL ATOMIC ENERGY AGENCY                                Evalplot
P.O. BOX 100                                                      Evalplot
A-1400, VIENNA, AUSTRIA                                           Evalplot
EUROPE                                                            Evalplot
                                                                  Evalplot
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ORIGINALLY WRITTEN BY                                                  Evalplot
-------------------------------------                                  Evalplot
DERMOTT E. CULLEN                                                      Evalplot
UNIVERSITY OF CALIFORNIA                                               Evalplot
LAWRENCE LIVERMORE NATIONAL LABORATORY                                 Evalplot
L-159                                                                  Evalplot
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U.S.A.                                                                 Evalplot
TELEPHONE  925-423-7359                                                Evalplot
E. MAIL    CULLEN1@LLNL.GOV                                            Evalplot
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                 Evalplot
                                                                       Evalplot
AUTHORS MESSAGE                                                        Evalplot
---------------                                                        Evalplot
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION       Evalplot
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED     Evalplot
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE     Evalplot
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY         Evalplot
THE COMMENTS CONCERNING MACHINE DEPENDENT CODING.                      Evalplot
                                                                       Evalplot
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER     Evalplot
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE         Evalplot
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT     Evalplot
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY           Evalplot
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO      Evalplot
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF        Evalplot
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR             Evalplot
COMPUTER.                                                              Evalplot
                                                                       Evalplot
PURPOSE                                                                Evalplot
-------                                                                Evalplot
THIS PROGRAM IS DESIGNED TO READ EVALUATED DATA FROM THE ENDF/B        Evalplot
FORMAT AND TO PLOT THE DATA. THE USER MAY SELECT CROSS SECTIONS,       Evalplot
PARAMETERS (E.G. NU-BAR, MU-BAR, ETC.), ANGULAR DISTRIBUTIONS          Evalplot
AND/OR ENERGY DISTRIBUTIONS TO BE PLOTTED.                             Evalplot
                                                                       Evalplot
IN THE FOLLOWING FOR SIMPLICITY THE ENDF/B TERMINOLOGY--ENDF/B         Evalplot
TAPE--WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS,      Evalplot
DISK OR ANY OTHER MEDIUM.                                              Evalplot
                                                                       Evalplot
ON WHAT COMPUTERS WILL THE PROGRAM RUN                                 Evalplot
---------------------------------------------------------------------- Evalplot
THE PROGRAM HAS BEEN IMPLEMENTED ON A WIDE VARIETY OF COMPUTERS        Evalplot
FROM THE ONE EXTREME OF LARGE MAINFRAME CRAY AND IBM COMPUTERS         Evalplot
TO THE OTHER EXTREME OF SUN TERMINALS AND IBM PERSONAL COMPUTERS.      Evalplot
THE PROGRAM IS DESIGNED TO RUN ON VIRTUALLY ANY COMPUTER. FOR          Evalplot
SPECIAL CONSIDERATIONS SEE THE SECTIONS BELOW ON,                      Evalplot
(1) COMPUTER DEPENDENT CODING                                          Evalplot
(2) PLOTTER/GRAPHICS TERMINAL INTERFACE                                Evalplot
                                                                       Evalplot
ON WHAT PLOTTERS WILL THE PROGRAM RUN                                  Evalplot
---------------------------------------------------------------------- Evalplot
THE PLOTTER MAY USE UNITS OF INCHES, CENTIMETERS, MILLIMETERS,         Evalplot
VIRTUALLY ANYTHING. INTERNALLY THE PROGRAM WILL DEFINE PLOTS IN        Evalplot
APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. AS PART OF THE            Evalplot
INPUT THE USER DEFINES THE ACTUAL SIZE OF THE PLOT IN THE UNITS        Evalplot
(I.E., INCHES, CENTIMETERS, MILLIMETERS, WHATEVER) OF THE REAL         Evalplot
PLOT. THE PLOT IS TRANSFORMED TO THE SIZE OF THE LOCAL PLOTTER         Evalplot
AND OUTPUT. USING THIS CONVENTION THIS PROGRAM SHOULD BE EASY          Evalplot
TO INTERFACE TO VIRTUALLY ANY PLOTTER OR GRAPHICS TERMINAL.            Evalplot
                                                                       Evalplot
GRAPHICS INTERFACE                                                     Evalplot
---------------------------------------------------------------------- Evalplot
THIS PROGRAM USES A SIMPLE CALCOMP LIKE GRAPHICS INTERFACE WHICH       Evalplot
REQUIRES ONLY 3 SUBROUTINES...PLOTS, PLOT AND PEN (DESCRIBED IN        Evalplot
DETAIL BELOW). ALL CHARACTERS AND SYMBOLS ARE DRAWN USING TABLES       Evalplot
OF PEN STROKES (SUPPLIED WITH THIS PROGRAM). USING THIS METHOD         Evalplot
```

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THE PROGRAM SHOULD BE SIMPLE TO INTERFACE TO VIRTUALLY ANY PLOTTER Evalplot
OR GRAPHICS TERMINAL AND THE APPEARANCE AND LAYOUT OF THE PLOTS    Evalplot
SHOULD BE INDEPENDENT OF WHICH PLOTTER IS USED.                    Evalplot
                                                                   Evalplot
PROGRAM IDENTIFICATION                                             Evalplot
----------------------                                             Evalplot
AS DISTRIBUTED THE FIRST FRAME OF PLOTTED OUTPUT WILL DOCUMENT     Evalplot
THE PROGRAM NAME, VERSION AND INSTALLATION. THIS INFORMATION IS    Evalplot
STORED AS DATA IN THE ARRAY VERSES NEAR THE BEGINNING OF           Evalplot
SUBROUTINE FRAME1. IF YOU WISH TO CUSTOMIZE THE OUTPUT TO IDENTIFY Evalplot
YOUR INSTALLATION CHANGE THE LAST TWO LINES OF THE ARRAY VERSES.   Evalplot
                                                                   Evalplot
SIZE OF PLOTS                                                      Evalplot
-------------                                                      Evalplot
THE PROGRAM HAS A BUILT-IN DEFAULT SIZE TO MAKE EACH PLOT 13.50    Evalplot

BY 10.24 INCHES. THIS SIZE WAS SELECTED ASSUMING THAT THE          Evalplot
RESOLUTION OF THE PLOTTER IS 1024 RASTER POINTS PER INCH. THE      Evalplot
USER MAY CHANGE THE SIZE OF THE PLOT BY SPECIFYING ANY REQUIRED    Evalplot
SIZE ON THE FIRST INPUT LINE. IN PARTICULAR FOR USE ON ANY PLOTTER Evalplot
THAT USES CENTIMETERS INSTEAD OF INCHES THE USER MAY MERELY        Evalplot
SPECIFY THE REQUIRED SIZE OF THE PLOT IN CENTIMETERS (E.G., TO     Evalplot
OBTAIN A 13.50 BY 10.24 INCH PLOT, THE USER NEED ONLY SPECIFY      Evalplot
34.3 BY 26 ON THE FIRST INPUT LINE...ASSUMING 2.54 CENTIMETERS PER Evalplot
INCH, OR 343 BY 260 FOR MILLIMETERS..ASSUMING 25.4 MILLIMETERS     Evalplot
PER INCH).                                                         Evalplot
                                                                   Evalplot
CHARACTER SIZE                                                     Evalplot
--------------                                                     Evalplot
THE PLOT HAS A BUILT-IN CHARACTER SIZE WHICH HAS BEEN DEFINED FOR  Evalplot
COMPATIBILITY WITH THE BUILT-IN PLOT SIZE. IF THE USER SPECIFIES   Evalplot
BY INPUT A DIFFERENT PLOT SIZE, THE PROGRAM WILL AUOTMATICALLY     Evalplot
SCALE THE SIZE OF ALL CHARACTERS BY THE RATIO OF THE Y SIZE OF THE Evalplot
PLOT SPECIFIED BY THE USER TO THE BUILT-IN Y SIZE OF PLOTS (E.G.,  Evalplot
FOR PLOTS WHICH ARE ONLY 5.12 HIGH (Y DIRECTION) ALL CHARACTERS    Evalplot
WILL BE SCALED TO BE ONLY 1/2 THE CHARACTER SIZE ON PLOTS WHICH    Evalplot
ARE 10.24 HIGH (10.24 = THE BUILT-IN SIZE). NOTE, CHANGES IN THE   Evalplot
X SIZE OF THE PLOT WILL NOT HAVE ANY EFFECT ON THE CHARACTER SIZE  Evalplot
(E.G., FOR A LONG PLOT, 30 BY 10.24 THE CHARACTER SIZE WILL BE THE Evalplot
THE SAME AS ON A 13.50 BY 10.24 PLOT).                             Evalplot
                                                                   Evalplot
PLOT PER FRAME                                                     Evalplot
--------------                                                     Evalplot
BY INPUT THE USER CAN SPECIFY NOT ONLY THE ACTUAL SIZE OF THE      Evalplot
LOCAL PLOTTER, BUT ALSO HOW MANY PLOTS SHOULD APPEAR ON EACH       Evalplot
FRAME. THIS IS DONE BY SPECIFYING THE LAYOUT OF A FRAME IN TERMS   Evalplot
OF THE NUMBER OF PLOTS IN THE X AND Y DIRECTION. FOR EXAMPLE BY    Evalplot
SPECIFYING THAT EACH FRAME BE DIVIDED INTO 3 PLOTS IN THE X        Evalplot
DIRECTION AND 2 PLOTS IN THE Y DIRECTION, EACH FRAME WILL CONTAIN  Evalplot
UP TO 6 PLOTS (3 X 2). INTERNALLY EACH PLOT WILL BE GENERATED TO   Evalplot
STANDARD A4 SIZE, AS DESCRIBED ABOVE, AND THEN ON OUTPUT SCALED    Evalplot
TO THE NUMBER OF PLOTS PER FRAME SPECIFIED BY THE USER INPUT.      Evalplot
                                                                   Evalplot
ENDF/B FORMAT                                                      Evalplot
-------------                                                      Evalplot
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS     Evalplot
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION   Evalplot
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT). Evalplot
                                                                   Evalplot
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B       Evalplot
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS     Evalplot
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE  Evalplot
NUMBERS (COLUMNS 76-80) ARE IGNORED. FORMAT OF SECTION MT=452, 455 Evalplot
OF MF=1, AND ALL SECTIONS OF MF=3, 4 AND 5 MUST BE CORRECT. ALL    Evalplot
OTHER SECTION OF DATA ARE SKIPPED AND AS SUCH THE OPERATION OF     Evalplot
THIS PROGRAM IS INSENSITIVE TO THE CORRECTNESS OR INCORRECTNESS    Evalplot
OF ALL OTHER SECTIONS.                                             Evalplot
                                                                   Evalplot
```

```
INTERPOLATION LAW                                                    Evalplot
-----------------                                                    Evalplot
EACH TABLE OF DATA MAY USE EITHER COMPLETELY HISTOGRAM OR            Evalplot
COMPLETELY LINEAR INTERPOLATION LAW (THE TWO INTERPOLATION LAWS      Evalplot
CANNOT BE MIXED TOGETHER IN ONE TABLE). EITHER OF THESE TWO          Evalplot
REPRESENTATIONS WILL BE STORED IN CORE IN LINEARLY INTERPOLABLE      Evalplot
FORM. IF THIS PROGRAM FINDS ANY DATA THAT USES ANY OTHER             Evalplot
INTERPOLATION LAW IT WILL PRINT AN ERROR MESSAGE AND PLOT THE        Evalplot
TABLE AS IF IT WERE LINEARLY INTERPOLABLE. THE ONLY ERROR THAT       Evalplot
WILL RESULT IN THE PLOT WILL BE IN THE CURVE FOLLOWED BETWEEN        Evalplot
TABULATED POINTS. PROGRAM LINEAR (UCRL-50400, VOL. 17, PART A)       Evalplot
MAY BE USED TO CONVERT CROSS SECTIONS TO LINEARLY INTERPOLABLE       Evalplot
FORM. PROGRAM LEGEND CAN BE USED FOR ANGULAR DISTRIBUTIONS AND       Evalplot
PROGRAM ENERGY CAN BE USED FOR SECONDARY ENERGY DISTRIBUTIONS.       Evalplot
                                                                     Evalplot
REACTION INDEX                                                       Evalplot
--------------                                                       Evalplot
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN       Evalplot
SECTION MF=1, MT=451 OF EACH EVALUATION.                             Evalplot
                                                                     Evalplot
PAGE SIZE                                                            Evalplot
---------                                                            Evalplot
ONLY ONE PAGE OF DATA = 600000 DATA POINTS - IS KEPT IN CORE AT      Evalplot
ANY GIVEN TIME. IF THERE IS MORE THAN THIS MANY POINTS THEY WILL     Evalplot
BE KEPT ON A SCRATCH FILE AND LOADED INTO CORE AS NEEDED.            Evalplot
                                                                     Evalplot
TO CHANGE THE PAGE SIZE,                                             Evalplot
                                                                     Evalplot
1) CHANGE  600000 TO THE NEW PAGE SIZE                               Evalplot
2) CHANGE 1200000 TO TWO TIMES THE NEW PAGE SIZE                     Evalplot
                                                                     Evalplot
SECTION SIZE                                                         Evalplot
------------                                                         Evalplot
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT    Evalplot
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS        Evalplot
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                   Evalplot
                                                                     Evalplot
THE ONLY EXCEPTION TO THIS RULE IS THAT EACH TABLE OF DATA WHICH     Evalplot
USES A HISTOGRAM INTERPOLATION LAW CANNOT EXCEED HALF THE SIZE       Evalplot
OF THE IN CORE PAGE (PRESENTLY 600000/2=300000) WHICH IS ADEQUATE    Evalplot
FOR ALMOST ALL HISTOGRAM (E.G. MULTIGROUP) REPRESENTATIONS OF        Evalplot
A SINGLE TABLE (E.G. REACTION).                                      Evalplot
                                                                     Evalplot
WHAT DATA CAN BE PLOTTED                                             Evalplot
------------------------                                             Evalplot
THIS CODE CAN PLOT VIRTUALLY ANY NEUTRON OR PHOTON CROSS SECTIONS    Evalplot
(MF=3 OR 23) AND ANY TABULATED ANGULAR OR ENERGY DISTRIBUTIONS OR    Evalplot
LEGENDRE COEFFICIENTS. WHAT IS ACTUALLY PLOTTED DEPENDS ON WHAT      Evalplot
DATA IS SELECTED BY THE USER.                                        Evalplot
                                                                     Evalplot
SELECTION OF DATA                                                    Evalplot
-----------------                                                    Evalplot
DATA TO BE PLOTTED IS SPECIFIED BY INPUTTING UP TO 100 MAT/MF/MT     Evalplot
RANGES OR UP TO 100 ZA/MF/MT RANGES. IN ADDITION FOR EACH RANGE      Evalplot
THE USER MAY SPECIFY AN X RANGE (USUALLY ENERGY) AND THE TYPE OF     Evalplot
DATA TO BE PLOTTED (SEE: THE DESCRIPTION OF TYPES, BELOW).           Evalplot
                                                                     Evalplot
THE X RANGE FOR MF = 1, 3, 23 AND 27 AND MF = 4 LEGENDRE             Evalplot
COEFFICIENTS WILL BE USED AS THE X LIMITS OF THE PLOTS, E.G.,        Evalplot
PLOT ENERGY DEPENDENT CROSS SECTIONS BETWEEN 1 AND 20 MEV.           Evalplot
                                                                     Evalplot
THE X RANGE FOR MF = 4 AND 5 WILL BE USED TO ONLY SELECT ANGULAR     Evalplot
AND ENERGY DISTRIBUTION FOR WHICH THE INCIDENT NEUTRON ENERGY        Evalplot
IS IN THE X RANGE. E.G., ONLY PLOT ANGULAR DISTRIBUTIONS WHERE       Evalplot
THE INCIDENT NEUTRON ENERGY IS 1 TO 20 MEV.                          Evalplot
                                                                     Evalplot
INTERACTIVE VS. BATCH MODE                                           Evalplot
--------------------------                                           Evalplot
```

```
VERSION 92-1 AND LATER VERSIONS OF THIS CODE ONLY USE A BATCH      Evalplot
MODE WHERE ALL REQUESTS ARE READ AND PROCESSED. EARLIER VERSIONS   Evalplot
OF THIS CODE HAD BOTH AN INTERACTIVE MODE (WHERE REQUESTS WHERE    Evalplot
READ AND EXECUTED ONE AT A TIME) AND A BATCH MODE. INTERACTIVE     Evalplot
MODE HAS BEEN DROPPED AND WILL NOT TO REINTRODUCED UNLESS THE      Evalplot
AUTHOR IS INFORMED BY USERS THAT THEY WERE USING THE INTERACTIVE   Evalplot
MODE.                                                              Evalplot
                                                                   Evalplot
PLOT LAYOUT                                                        Evalplot
-----------                                                        Evalplot
VERSION 92-1 AND LATER VERSIONS OF THIS CODE WILL PLOT ALL         Evalplot
CURVES ON A SINGLE PLOT. EARLIER VERSIONS OF THIS CODE ALLOWED     Evalplot
THE OPTION TO HAVE,                                                Evalplot
MULTIPLE PLOTS - INDIVIDUAL SCALING                                Evalplot
MULTIPLE PLOTS - COMMON SCALING                                    Evalplot
SINGLE PLOT                                                        Evalplot
MULTILE PLOTS PER PLOT HAVE BEEN DROPPED AND WILL NOT BE           Evalplot
REINTRODUCED UNLESS IT IS DEMONSTRATED TO THE AUTHOR THAT THEY     Evalplot
ARE OF PRACTICAL USE IN SOME APPLICATION.                          Evalplot
                                                                   Evalplot
PROCESSING OF DATA                                                 Evalplot
------------------                                                 Evalplot
IN THE CASE OF NEUTRON AND PHOTON CROSS SECTIONS (MF=3 OR 23)      Evalplot
AND PARAMETERS (MF=1 OR 27) ALL DATA IN A FILE (MF) IS READ        Evalplot
GROUPED TOGETHER BY TYPE (AS EXPLAINED BELOW) AND PLOTTED.         Evalplot
                                                                   Evalplot
IN THE CASE OF ANGULAR AND ENERGY DISTRIBUTIONS (MF=4 OR 5) ONLY   Evalplot
ONE SECTION OF DATA AT A TIME IS READ AND PLOTTED.                 Evalplot
                                                                   Evalplot
TYPES OF DATA (MF=1, 3, 23 AND 27 ONLY)                            Evalplot
---------------------------------------                            Evalplot
THESE DATA ARE DIVIDED INTO UP TO 18 TYPES AND EACH TYPE OF        Evalplot
DATA IS GROUPED TOGETHER AND PLOTTED (IF THE DATA IS ACTUALLY      Evalplot
PRESENT).                                                          Evalplot
                                                                   Evalplot
WHAT TYPE OF DATA IS ACTUALLY PLOTTED CAN BE CONTROLLED BY USER    Evalplot
INPUT EITHER BASED ON SELECTED MAT/MF/MT OR ZA/MF/MT RANGES OR     Evalplot
BY EXPLICITLY SELECTING ONLY ONE TYPE OF DATA IS TO BE PLOTTED     Evalplot
(SEE THE DESCRIPTION OF INPUT BELOW).                              Evalplot
                                                                   Evalplot
SIMPLE REQUESTS                                                    Evalplot
---------------                                                    Evalplot
GENERALLY EACH MAT/MF/MT OR ZA/MF/MT REQUESTED IS TREATED          Evalplot
SEPERATELY AND THE SPECIFIED DATA IS GROUPED BY TYPE AND PLOTTED.  Evalplot
FOR EXAMPLE, THE USER MAY SPECIFY USING ONE REQUEST THAT ALL       Evalplot
TYPES OF DATA BE PLOTTED OVER THE ENTIRE ENERGY RANGE AND USE      Evalplot
A SECOND REQUEST TO SPECIFY THAT ONE PARTICULAR TYPE OF DATA       Evalplot
BE PLOTTED OVER A SPECIFIC ENERGY RANGE.                           Evalplot
                                                                   Evalplot
CHAINED REQUESTS                                                   Evalplot
----------------                                                   Evalplot
REQUESTS MAY ALSO BE CHAINED TOGETHER (SEE, THE DESCRIPTION OF     Evalplot
INPUT BELOW), WHERE A NUMBER OF REQUESTS MAY BE USED TO SELECT     Evalplot
DATA, BUT ONLY THE LAST REQUEST IN A CHAIN WILL CAUSE ALL SELECTED Evalplot
DATA TO BE PLOTTED. CHAINED REQUESTED ARE INDICATED ON INPUT BY    Evalplot
A SERIES OF REQUESTS FOR DATA TYPE = -1, EXCEPT FOR THE LAST       Evalplot
REQUEST OF THE CHAIN, WHICH MUST SPECIFY A TYPE DATA = 0 (ALL)     Evalplot
OR A POSITIVE NUMBER. UNLIKE SIMPLE REQUESTS, WHERE EACH WILL      Evalplot
PRODUCE ONE OR MORE PLOTS, WITH CHAINED REQUESTS THE ENTIRE        Evalplot
SERIES OF CHAINED REQUESTS WILL BE TREATED AS A SINGLE REQUEST     Evalplot
AND WILL PRODUCE ONE OR MORE PLOTS.                                Evalplot
                                                                   Evalplot
FOR EXAMPLE, DATA TYPE = 1 WILL NORMALLY INCLUDE,                  Evalplot
MT =   1 - TOTAL                                                  Evalplot
   =   2 - ELASTIC                                                 Evalplot
   =   4 - TOTAL INELASTIC                                         Evalplot
   =   5 - (N,REMAINDER)                                           Evalplot
   =  18 - FISSION                                                 Evalplot
```

```
   = 102 - CAPTURE                                                    Evalplot
IF YOU WISH TO EXCLUDE TOTAL INELASTIC FROM A PLOT YOU NEED ONLY      Evalplot
SPECIFY TWO CHAINED REQUESTS THE FIRST TO SELECT MT = 1 THROUGH       Evalplot
2 (TO INCLUDE TOTAL AND ELASTIC) AND A SECOND TO INCLUDE MT = 18      Evalplot
THROUGH 102. THE FIRST REQUEST SHOULD SPECIFY DATA TYPE = -1 AND      Evalplot
SECOND 1 (THIS WILL CHAIN THE 2 REQUESTS TOGETHER, SO THAT MT =1      Evalplot
THROUGH 2, AND MT = 18 THROUGH 102 ALL APPEAR ON THE SAME PLOT).      Evalplot
SINCE MT = 4 (TOTAL INELASTIC) IS NOT REQUESTED IT WILL NOT BE        Evalplot
PLOTTED.                                                              Evalplot
                                                                      Evalplot
DEFINITION OF 18 DATA TYPES                                           Evalplot
--------------------------------------------------------------------- Evalplot
NEUTRONS (MF = 3)                                                     Evalplot
-----------------                                                     Evalplot
(1) TOTAL, ELASTIC, CAPTURE, FISSION, TOTAL INELASTIC, REMAINDER      Evalplot
(2) (N,2N), (N,3N) AND (N,N' CHARGED PARTICLE)                        Evalplot
(3) (N,CHARGED PARTICLE)                                              Evalplot
(4) PARTICLE PRODUCTION (PROTON, DEUTERON, ETC.) AND DAMAGE           Evalplot
(5) TOTAL, FIRST, SECOND, ETC. CHANCE FISSION.                        Evalplot
(6) TOTAL INELASTIC, INELASTIC DISCRETE LEVELS AND CONTINUUM          Evalplot
(7) (N,P) TOTAL AND LEVELS (ONLY IF LEVELS ARE GIVEN)                 Evalplot
(8) (N,D) TOTAL AND LEVELS (ONLY IF LEVELS ARE GIVEN)                 Evalplot
(9) (N,T) TOTAL AND LEVELS (ONLY IF LEVELS ARE GIVEN)                 Evalplot
(10) (N,HE-3) TOTAL AND LEVELS (ONLY IF LEVELS ARE GIVEN)             Evalplot
(11) (N,ALPHA) TOTAL AND LEVELS (ONLY IF LEVELS ARE GIVEN)            Evalplot
(12) PARAMETERS MU-BAR, XI AND GAMMA                                  Evalplot
(13) NU-BAR - TOTAL, PROMPT AND DELAYED                               Evalplot
                                                                      Evalplot
PHOTONS  (MF=23 AND 27)                                               Evalplot
-----------------------                                               Evalplot
(14) TOTAL, COHERENT, INCOHERENT, TOTAL PHOTOELECTRIC, TOTAL          Evalplot
     PAIR PRODUCTION                                                  Evalplot
(15) TOTAL AND SUBSHELL PHOTOELECTRIC                                 Evalplot
(16) TOTAL, NUCLEAR AND ELECTRON PAIR PRODUCTION                      Evalplot
(17) COHERENT FORM FACTOR AND INCOHERENT SCATTERING FUNCTION          Evalplot
(18) REAL AND IMAGINARY SCATTERING FACTORS                            Evalplot
                                                                      Evalplot
IDENTIFICATION OF DATA                                                Evalplot
----------------------                                                Evalplot
ALL PLOTS IDENTIFY THE TARGET, E.G., U-238 AND UNITS OF THE X AND     Evalplot
Y AXIS, E.G., X = ENERGY (MEV) OR COSINE (LAB), ETC., Y = CROSS       Evalplot
SECTION (BARNS) OR PROBABILITY/COSINE, ETC.                           Evalplot
                                                                      Evalplot
FOR TYPES OF DATA (MF=1, 3, 23 AND 27) DIFFERENT REACTIONS (MT)       Evalplot
ARE GROUPED TOGETHER TO APPEAR ON THE SAME PLOT. THE TITLE AT         Evalplot
THE TOP OF THE PLOT WILL IDENTIFY THE TYPE OF DATA BEING PLOTTED      Evalplot
AND THE LEGEND BOX WITHIN THE PLOT WILL IDENTIFY EACH REACTION.       Evalplot
                                                                      Evalplot
FOR ANGULAR AND ENERGY DISTRIBUTIONS (MF=4 OR 5) EACH PLOT WILL       Evalplot
CONTAIN DATA FOR A SINGLE REACTION (MT) AND DIFFERENT INCIDENT        Evalplot
NEUTRON ENERGIES. THE TITLE AT THE TOP OF THE PLOT WILL IDENTIFY      Evalplot
THE REACTION AND THE LEGEND BOX WITHIN THE PLOT WILL IDENTIFY         Evalplot
THE INCIDENT ENERGY.                                                  Evalplot
                                                                      Evalplot
FOR LEGENDRE COEFFICIENT THE DATA IN ENDF/B FORMAT WILL BE            Evalplot
INVERTED IN ORDER TO PRESENT EACH LEGENDRE COEFFICIENT VERSUS         Evalplot
INCIDENT ENERGY. THE TITLE AT THE TOP OF THE PLOT WILL IDENTIFY       Evalplot
THE REACTION AND THE LEGEND BOX WITHIN THE PLOT WILL IDENTIFY         Evalplot
THE LEGENDRE ORDER.                                                   Evalplot
                                                                      Evalplot
INPUT FILES                                                           Evalplot
-----------                                                           Evalplot
UNIT  DESCRIPTION                                                     Evalplot
----  -----------                                                     Evalplot
   2   INPUT LINES (BCD - 80 CHARACTERS/RECORD)                       Evalplot
   9   MT DEFINITIONS (BCD - 80 CHARACTERS/RECORD)                    Evalplot
  10   ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)                       Evalplot
```

```
  12   SOFTWARE CHARACTERS (BCD - 80 CHARACTERS/RECORD)           Evalplot

                                                                  Evalplot
OUTPUT FILES                                                      Evalplot
------------                                                      Evalplot
UNIT  DESCRIPTION                                                 Evalplot
----  -----------                                                 Evalplot
   3   OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                Evalplot
  16   PLOTTING UNIT                                              Evalplot
                                                                  Evalplot
SCRATCH FILES                                                     Evalplot
-------------                                                     Evalplot
UNIT  DESCRIPTION                                                 Evalplot
----  -----------                                                 Evalplot
  11  SCRATCH FILE (BINARY - 960000 WORDS/RECORD = 2*PAGE SIZE)   Evalplot
                                                                  Evalplot
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)   Evalplot
---------------------------------------------------------------   Evalplot
UNIT  FILE NAME                                                   Evalplot
----  ----------                                                  Evalplot
  2   EVALPLOT.INP                                               Evalplot
  3   EVALPLOT.LST                                               Evalplot
  9   MT.DAT                                                     Evalplot
 10   ENDFB.IN    (OR AS INPUT PARAMETER)                        Evalplot
 11   (SCRATCH)                                                  Evalplot
 12   PLOT.CHR                                                   Evalplot
 16   (PLOTTING UNIT...USUALLY A DUMMY)                          Evalplot
                                                                  Evalplot
INPUT PARAMETERS                                                  Evalplot
----------------                                                  Evalplot
LINE COLUMNS FORMAT  DESCRIPTION                                  Evalplot
---- ------- ------  -----------                                  Evalplot
   1   1-11   E11.4  LOWER X LIMIT OF PLOTTER                     Evalplot
      12-22   E11.4  UPPER X LIMIT OF PLOTTER                     Evalplot
      23-33   E11.4  LOWER Y LIMIT OF PLOTTER                     Evalplot
      34-44   E11.4  UPPER Y LIMIT OF PLOTTER                     Evalplot
      45-55    I11   NUMBER OF PLOTS PER FRAME IN X DIRECTION     Evalplot
      56-66    I11   NUMBER OF PLOTS PER FRAME IN Y DIRECTION     Evalplot
      67-70    F4.1  CHARACTER SIZE MULTIPLIER                    Evalplot
                     = 0 OR 1    - NORMAL CHARACTER SIZE         Evalplot
                     = OTHERWISE - CHARACTERS SCALED BY THIS     Evalplot
                                   FACTOR.                        Evalplot
   2   1-60    A60   ENDF/B DATA FILENAME                        Evalplot
                     (LEAVE BLANK FOR STANDARD = ENDFB.IN)       Evalplot
   3   1-11    I11   RETRIEVAL CRITERIA                          Evalplot
                     = 0 - MAT                                   Evalplot
                     = 1 - ZA                                    Evalplot
      12-22    I11   TYPE OF GRID                                Evalplot
                     = 0 - TICK MARKS ON BORDER                  Evalplot
                     = 1 - SOLID AT COARSE INTERVALS             Evalplot
                     = 2 - DASHED AT COARSE INTERVALS            Evalplot
                     = 3 - SOLID AT FINE INTERVALS               Evalplot
                     = 4 - DASHED AT FINE INTERVALS              Evalplot
                     = 5 - SOLID COARSE/DASHED FINE GRID         Evalplot
      23-33    I11   SHOULD BORDER BE PLOTTED ON EACH PLOT       Evalplot
                     = 0 - NO                                    Evalplot
                     = 1 - YES                                   Evalplot
      34-44    I11   LINE THICKNESS                              Evalplot
                     = 0 -  5 = BORDER/CURVES/CHARACTERS         Evalplot
                     =-1 - -5 = BORDER/CURVES (NOT CHARACTERS)   Evalplot
                                NOTE, THE GRID IS NEVER THICK.   Evalplot
      45-55    I11   SHOULD TEMPERATURE BE PLOTTED.              Evalplot
                     = 0 - YES                                   Evalplot
                     = 1 - NO                                    Evalplot
      56-66   E11.4  ALLOWABLE RATIO OF PLOT Y RANGE MAXIMUM TO  Evalplot
                     MINIMUM - IF THIS RATIO IS EXCEEDED THE Y   Evalplot
                     RANGE MINIMUM WILL BE CHANGED TO THE Y RANGE Evalplot
                     MAXIMUM TIMES THIS RATIO.                   Evalplot
```

```
                    IF THIS RATIO IS NOT POSITIVE, IT IS          Evalplot
                    INTERPRETED TO MEAN NO LIMIT ON Y RANGE.      Evalplot
     67-70    I4    BACKGROUND COLOR                              Evalplot
                    = 0         = BLACK                           Evalplot
                    = OTHERWISE = WHITE                           Evalplot
 4-N  1- 6    I6    LOWER MAT OR ZA LIMIT                         Evalplot
      7- 8    I2    LOWER MF LIMIT                                Evalplot
      9-11    I3    LOWER MT LIMIT                                Evalplot
     11-22   E11.4  LOWER X LIMIT (USUALLY ENERGY) - EV           Evalplot
     23-28    I6    UPPER MAT OR ZA LIMIT                         Evalplot
     29-30    I2    UPPER MF LIMIT                                Evalplot
     31-33    I3    UPPER MT LIMIT                                Evalplot
     34-44   E11.4  UPPER X LIMIT (USUALLY ENERGY) - EV           Evalplot
     45-55   I11    TYPE OF DATA TO RETRIEVE AND PLOT             Evalplot
                    =  -1  - CHAIN THIS REQUEST TO THE NEXT ONE   Evalplot
                    =   0  - ALL                                  Evalplot
                    = 1-18 - TYPE AS SPECIFIED ABOVE              Evalplot
                                                                  Evalplot
THERE MAY BE UP 100 MAT/MF/MT OR ZA/MF/MT REQUEST RANGES. INPUT   Evalplot
MUST BE TERMINATED BY A BLANK LINE.                               Evalplot
                                                                  Evalplot
IF X LIMITS ARE NOT SPECIFIED (I.E., LOWER AND UPPER X LIMIT = 0) Evalplot
THIS WILL BE INTERPRETED TO MEAN NO LIMIT AND ALL DATA WILL BE    Evalplot
PLOTTED OVER THEIR ENTIRE ENERGY RANGE, I.E., YOU NEED NOT        Evalplot
KNOW AND SPECIFY THE ACTUAL ENERGY LIMITS OF THE DATA.            Evalplot
                                                                  Evalplot
EXAMPLE DEFINITION OF PLOTTER                                     Evalplot
----------------------------                                      Evalplot
THE FIRST INPUT LINE DEFINES THE DIMENSIONS OF THE PLOTTER BEING  Evalplot
USED IN ANY UNITS (INCHES, CENTIMETERS, MILLIMETERS, ANYTHING)    Evalplot
WHICH APPLY TO THE PLOTTER. IN ADDITION THE FIRST LINE DEFINES    Evalplot
HOW MANY PLOTS SHOULD APPEAR ON EACH FRAME. THE PLOTTING AREA     Evalplot
DEFINED ON THE FIRST INPUT LINE MAY BE SUBDIVIDED INTO ANY NUMBER Evalplot
OF PLOTS IN THE X AND Y DIRECTION. FOR EXAMPLE, TO PRODUCE A      Evalplot
SERIES OF FRAMES EACH CONTAINING 3 PLOTS IN THE X DIRECTION AND   Evalplot
2 PLOTS IN THE Y DIRECTION (6 PLOTS PER FRAME) COLUMN 45-55 OF    Evalplot
THE FIRST INPUT LINE SHOULD BE 3 AND COLUMNS 56-66 SHOULD BE 2.   Evalplot
                                                                  Evalplot
IF THE LOCAL PLOTTER USES DIMENSIONS OF INCHES IN ORDER TO OBTAIN  Evalplot
10 X 10 INCH FRAMES WITH 3 X 2 PLOTS PER FRAME THE FIRST INPUT    Evalplot
LINE SHOULD BE,                                                   Evalplot
                                                                  Evalplot
  0.0       10.0      0.0     10.0              3          2      Evalplot
                                                                  Evalplot
IF THE LOCAL PLOTTER USES DIMENSION OF MILLIMETERS THE SAME       Evalplot
PHYSICAL SIZE PLOT MAY BE OBTAINED IF THE FIRST INPUT LINE IS,    Evalplot
                                                                  Evalplot
  0.0      254.0      0.0    254.0              3          2      Evalplot
                                                                  Evalplot
FOR SIMPLICITY THE FOLLOWING EXAMPLE INPUTS WILL NOT DISCUSS THE  Evalplot
PHYSICAL DIMENSIONS OF THE PLOTTER AND THE FIRST INPUT LINE WILL   Evalplot
IN ALL CASES INDICATE 10 X 10 INCH PLOTS WITH ONLY 1 PLOT PER     Evalplot
FRAME.                                                            Evalplot
                                                                  Evalplot
ALL OF THE FOLLOWING EXAMPLE WILL USE,                            Evalplot
1) A DASHED GRID          (SECOND LINE, COLS. 12-22 = 2)          Evalplot
2) NO BORDER              (SECOND LINE, COLS. 23-33 = 0)          Evalplot
3) LINE THICKNESS -2      (SECOND LINE, COLS. 34-44 =-2)          Evalplot
4) TEMPERATURE ON PLOTS   (SECOND LINE, COLS. 45-55 = 0)          Evalplot
5) NO Y RANGE LIMIT       (SECOND LINE, COLS. 56-66 = 0.0)        Evalplot
                                                                  Evalplot
EXAMPLE INPUT NO. 1                                               Evalplot
-------------------                                               Evalplot
FOR ALL THORIUM AND URANIUM ISOTOPES PLOT NEUTRON CROSS SECTIONS  Evalplot
ENTIRE ENERGY RANGE. IN ADDITION PLOT TYPE 1 DATA, MAJOR NEUTRON  Evalplot
CROSS SECTIONS OVER THE ENERGY RANGE 1 EV TO 1 KEV. USE THE       Evalplot
STANDARD FILENAME (ENDFB.IN) FOR THE ENDF/B DATA. THE FOLLOWING   Evalplot
6 INPUT LINES ARE REQUIRED,                                       Evalplot
```

```
                                                                        Evalplot
   0.0       10.0       0.0       10.0               3          2      Evalplot
ENDFB.IN                                                                Evalplot
          1          2         0         -2          0 0.0             Evalplot
 90000 3  0           90999 3999                    0                 Evalplot
 90000 3  0 1.00000+ 090999 3999 1.00000+ 3          1                 Evalplot
(BLANK LINE MUSE FOLLOW LAST REQUEST)                                   Evalplot
                                                                        Evalplot
    EXAMPLE INPUT NO. 2                                                 Evalplot
    -------------------                                                 Evalplot
    PLOT FE-56 ELASTIC AND INELASTIC ANGULAR DISTRIBUTIONS BETWEEN      Evalplot
    1 AND 20 MEV. THE FOLLOWING 6 INPUT LINES ARE REQUIRED,             Evalplot
                                                                        Evalplot
   0.0       10.0       0.0       10.0               3          2      Evalplot
ENDFB.IN                                                                Evalplot
          1          2         0         -2          0 0.0             Evalplot
 26056 4  2 1.00000+ 626056 4  2 2.00000+ 7          0                 Evalplot
 26056 4  4 1.00000+ 626056 4  4 2.00000+ 7          0                 Evalplot
(BLANK LINE MUSE FOLLOW LAST REQUEST)                                   Evalplot
                                                                        Evalplot
    EXAMPLE INPUT NO. 3 (CHAINED INPUT)                                 Evalplot
    -----------------------------------                                 Evalplot
    FOR ALL THORIUM AND URANIUM ISOTOPES PLOT TOTAL, ELASTIC ,CAPTURE   Evalplot
    AND FISSION, BUT NOT INELASTIC CROSS SECTIONS OVER THERE ENTIRE     Evalplot
    ENERGY RANGE AND FROM 1 KEV TO 1 MEV. THE FOLLOWING 8 INPUT         Evalplot
    LINES ARE REQUIRED,                                                 Evalplot
                                                                        Evalplot
   0.0       10.0       0.0       10.0               3          2      Evalplot
ENDFB.IN                                                                Evalplot
          1          2         0         -2          0 0.0             Evalplot
 90000 3  1            90999 3  2                   -1                 Evalplot
 90000 3 18            90999 3102                    1                 Evalplot
 90000 3  1 1.00000+ 390999 3  2 1.00000+ 6         -1                 Evalplot
 90000 3 18 1.00000+ 390999 3102 1.00000+ 6          1                 Evalplot
(BLANK LINE MUSE FOLLOW LAST REQUEST)                                   Evalplot
                                                                        Evalplot
    NOTE, THIS EXAMPLE INCLUDES 2 CHAINED REQUESTED - INPUT LINES 3     Evalplot
    AND 4 SELECTING DATA AND PRODUCING A PLOT OVER THE ENTIRE ENERGY    Evalplot
    RANGE AND INPUT LINES 5 AND 6 SELECTING THE SAME DATA AND           Evalplot
    PRODUCING A PLOT FROM 1 KEV TO 1 MEV.                               Evalplot
                                                                        Evalplot
    ANY NUMBER OF REQUEST LINES MAY TO CHAINED TOGETHER TO SELECT       Evalplot
    DATA. THE CHAIN ENDS WHERE THE TYPE OF DATA (COLS. 45-55) IS NOT    Evalplot
    NEGATIVE AND THEN THE SELECTED DATA WILL BE PLOTTED.                Evalplot
                                                                        Evalplot
    EXAMPLE INPUT NO. 4                                                 Evalplot
    -------------------                                                 Evalplot
    FOR THE SAME EXAMPLE AS ABOVE, EXCEPT USE A DIFFERENT FILENAME      Evalplot
    FOR THE ENDF/B DATA TO READ FROM A FILE TREE STRUCTURE. THE         Evalplot
    FOLLOWING 8 INPUT LINES ARE REQUIRED,                               Evalplot
                                                                        Evalplot
   0.0       10.0       0.0       10.0               3          2      Evalplot
EVALUATION/ENDFB6/THORIUM                                               Evalplot
          1          2         0         -2          0 0.0             Evalplot
 90000 3  1            90999 3  2                   -1                 Evalplot
 90000 3 18            90999 3102                    1                 Evalplot
 90000 3  1 1.00000+ 390999 3  2 1.00000+ 6         -1                 Evalplot
 90000 3 18 1.00000+ 390999 3102 1.00000+ 6          1                 Evalplot
(BLANK LINE MUST FOLLOW LAST REQUEST)                                   Evalplot
                                                                        Evalplot
===== PLOTTER/GRAPHICS TERMINAL INTERFACE ============================= Evalplot
                                                                        Evalplot
     THIS PROGRAM USES A SIMPLE CALCOMP LIKE INTERFACE INVOLVING        Evalplot
     ONLY 6 SUBROUTINES,                                                Evalplot
                                                                        Evalplot
     STARPLOT  - INITIALIZE PLOTTER                                     Evalplot
     NEXTPLOT  - CLEAR THE SCREEN FOR THE NEXT PLOT                     Evalplot
     ENDPLOTS  - TERMINATE PLOTTING                                     Evalplot
```

```
                                                                      Evalplot
 PLOT(X,Y,IPEN)        - DRAW OR MOVE FROM LAST LOCATION TO (X,Y),   Evalplot
                         END OF CURRENT PLOT OR END OF PLOTTING.     Evalplot
       IPEN =   2 - DRAW                                            Evalplot
            =   3 - MOVE                                            Evalplot
                                                                      Evalplot
 PEN(IPEN)             - SELECT COLOR.                                Evalplot
      IPEN- COLOR = 1 TO N (N = ANY POSITIVE INTEGER)                 Evalplot
                                                                      Evalplot
 BOXCOLOR(X,Y,IFILL,IBORDER) - FILL A RECTANGULAR BOX DEFINED         Evalplot
                               BY THE X AND Y CORNERS - X(1),         Evalplot
                               X(2), Y(1),Y(2)                        Evalplot
              IFILL          - COLOR TO FILL BOX WITH                 Evalplot
                    IBORDER  - COLOR OF BOX BORDER                    Evalplot
                                                                      Evalplot
IN ORDER TO INTERFACE THIS PROGRAM FOR USE ON ANY PLOTTER WHICH       Evalplot
DOES NOT USE THE ABOVE CONVENTIONS IT IS MERELY NECESSARY FOR THE     Evalplot
THE USER TO WRITE 6 SUBROUTINES WITH THE NAMES PLOTS, PLOT AND PEN    Evalplot
WITH THE SUBROUTINE ARGUMENTS DESCRIBED ABOVE AND TO THEN CALL THE    Evalplot
LOCAL EQUIVALENT ROUTINES.                                            Evalplot
                                                                      Evalplot
COLOR PLOTS                                                           Evalplot
--------------------------------------------------------------------- Evalplot
TO SELECT PLOTTING COLORS SUBROUTINE PEN (DESCRIBED ABOVE) IS USED    Evalplot
TO SELECT ONE OF THE AVAILABLE COLORS. IF YOU HAVE COLOR ON YOUR      Evalplot
PLOTTER YOU SHOULD PROVIDE A SUBROUTINE PEN TO SELECT COLORS.         Evalplot
                                                                      Evalplot
BLACK AND WHITE PLOTS                                                 Evalplot
--------------------------------------------------------------------- Evalplot
WHEN PRODUCING BLACK AND WHITE PLOTS SUBROUTINE PEN NEED MERELY       Evalplot
BE A DUMMY SUBROUTINE TO IGNORE ANY ATTEMPT TO CHANGE COLORS,         Evalplot
                                                                      Evalplot
SUBROUTINE PEN(IPEN)                                                  Evalplot
RETURN                                                                Evalplot
END                                                                   Evalplot
                                                                      Evalplot
SIMILAR BOXCOLOR CAN BE A DUMMY                                       Evalplot
                                                                      Evalplot
SUBROUTINE BOXCOLOR(X,Y,IFILL,IBORDER)                                Evalplot
RETURN                                                                Evalplot
END                                                                   Evalplot
                                                                      Evalplot
CHARACTER SET                                                         Evalplot
--------------------------------------------------------------------- Evalplot
THIS PROGRAM USES COMPUTER AND PLOTTER DEVICE INDEPENDENT SOFTWARE    Evalplot
CHARACTERS. THIS PROGRAM COMES WITH A FILE THAT DEFINES THE PEN       Evalplot
STROKES REQUIRED TO DRAW ALL CHARACTERS ON AN IBM KEYBOARD (UPPER     Evalplot
AND LOWER CASE CHARACTERS, NUMBERS, ETC.) PLUS AN ALTERNATE SET OF    Evalplot
ALL UPPER AND LOWER CASE GREEK CHARACTERS AND ADDITIONAL SPECIAL      Evalplot
SYMBOLS.                                                              Evalplot
                                                                      Evalplot
THE SOFTWARE CHARACTER TABLE CONTAINS X AND Y AND PEN POSITIONS TO    Evalplot
DRAW EACH CHARACTER. IF YOU WISH TO DRAW ANY ADDITIONAL CHARACTERS     Evalplot
OR TO MODIFY THE FONT OF THE EXISTING CHARACTERS YOU NEED ONLY        Evalplot

MODIFY THIS TABLE.                                                    Evalplot
                                                                      Evalplot
ADDITIONAL FONTS                                                      Evalplot
---------------                                                       Evalplot
THIS PROGRAM COMES WITH 3 COMPLETE SETS OF THE SAME CHARACTERS        Evalplot
USING DIFFERENT FONTS. FOR SPEED IN PLOTTING IT IS RECOMMENDED        Evalplot
THAT YOU USE THE SIMPLEX FONT. FOR FINISHED PLOTS SUITABLE FOR        Evalplot
PUBLICATION, BUT REQUIRING MORE TIME TO GENERATE A PLOT, IT IS        Evalplot
RECOMMENDED THAT YOU USE THE DUPLEX OR COMPLEX FONT - YOU CAN         Evalplot
EXPERIMENT WITH ANY OF THE 3 FONTS TO DETERMINE WHICH BEST MEETS      Evalplot
YOUR NEEDS.                                                           Evalplot
                                                                      Evalplot
TO USE ANY ONE OF THE FONTS MERELY BY SURE THAT IT IS DEFINED AS      Evalplot
```

```
UNIT 12 FOR INPUT (IF USING STANDARD FILENAMES IT SHOULD BE        Evalplot
NAMED PLOT.CHR). SO THAT SWITCHING FONTS CAN BE SIMPLY DONE        Evalplot
MERELY BY COPYING THE FONT THAT YOU WANT TO THE UNIT 12 THAT       Evalplot
YOU ARE USING FOR INPUT.                                           Evalplot
                                                                   Evalplot
CONTROL CHARACTERS                                                 Evalplot
------------------------------------------------------------------ Evalplot
IN THE SOFTWARE CHARACTER TABLE ALL CHARACTERS TO BE PLOTTED WILL   Evalplot
HAVE PEN POSITION = 2 (DRAW) OR = 3 (MOVE). IN ADDITION THE TABLE  Evalplot
CURRENTLY CONTAINS 4 CONTROL CHARACTERS,                           Evalplot
                                                                   Evalplot
PEN POSITION = 0                                                   Evalplot
----------------                                                   Evalplot
SHIFT THE NEXT PRINTED CHARACTER BY X AND Y. 3 CONTROL CHARACTERS  Evalplot
ARE PRESENTLY INCLUDED IN THE SOFTWARE CHARACTER TABLE TO ALLOW    Evalplot
SHIFTING.                                                          Evalplot
                                                                   Evalplot
{   = SHIFT UP (FOR SUPERSCRIPTS.............X= 0.0, Y= 0.5)       Evalplot
}   = SHIFT DOWN (FOR SUBSCRIPTS.............X= 0.0, Y=-0.5)       Evalplot
\   = SHIFT LEFT 1 CHARACTER (FOR BACKSPACE...X=-1.0, Y= 0.0)      Evalplot
                                                                   Evalplot
PEN POSITION =-1                                                   Evalplot
----------------                                                   Evalplot
SELECT THE NEXT PRINTED CHARACTER FROM THE ALTERNATE CHARACTER     Evalplot
SET. AT PRESENT THIS CONTROL CHARACTER IS,                         Evalplot
                                                                   Evalplot
|   = SWITCH TO ALTERNATE CHARACTER SET                            Evalplot
                                                                   Evalplot
THESE 4 CONTROL CHARACTERS ARE ONLY DEFINED BY THE VALUE OF THE    Evalplot
PEN POSITION IN THE SOFTWARE CHARACTER TABLE (I.E., THEY ARE NOT   Evalplot
HARD WIRED INTO THIS PROGRAM). AS SUCH BY MODIFYING THE SOFTWARE   Evalplot
CHARACTER TABLE THE USER HAS THE OPTION OF DEFINING ANY CONTROL    Evalplot
CHARACTERS TO MEET SPECIFIC NEEDS.                                 Evalplot
                                                                   Evalplot
THESE CHARACTERS MAY BE USED IN CHARACTER STRINGS TO PRODUCE       Evalplot
SPECIAL EFFECTS. FOR EXAMPLE, TO PLOT SUBSCRIPT 5, B, SUPERSCRIPT  Evalplot
10 USE THE STRING,                                                 Evalplot
                                                                   Evalplot
}5B{1{0                                                            Evalplot
                                                                   Evalplot
TO PLOT B, SUBSCRIPT 5 AND SUPERSCRIPT 10 WITH THE 5 DIRECTLY      Evalplot
BELOW THE 1 OF THE 10 WE CAN USE THE BACKSPACE CHARACTER TO        Evalplot
POSITION THE 1 DIRECTLY ABOVE THE 5 USING THE STRING,              Evalplot
                                                                   Evalplot
B}5\{1{0                                                           Evalplot
                                                                   Evalplot
TO PLOT UPPER CASE GREEK GAMMA FOLLOWED BY THE WORD TOTAL (I.E.,   Evalplot
RESONANCE TOTAL WIDTH) USE THE STRING.                             Evalplot
                                                                   Evalplot
|G TOTAL                                                          Evalplot
                                                                   Evalplot
NOTE, WHEN THESE CONTROL CHARACTERS ARE USED THEY ONLY EFFECT THE  Evalplot
NEXT 1 PRINTED CHARACTER (SEE, ABOVE EXAMPLE OF PLOTTING SUPER-    Evalplot
SCRIPT 10 WHERE THE SHIFT UP CONTROL CHARACTER WAS USED BEFORE THE Evalplot
1 AND THEN AGAIN BEFORE THE 0 AND THE BACKSPACE AND SHIFT UP       Evalplot
CONTROL CHARACTERS WERE USED IN COMBINATION).                      Evalplot
                                                                   Evalplot
IF THESE 4 CONTROL CHARACTERS ARE NOT AVAILABLE ON YOUR COMPUTER   Evalplot
YOU CAN MODIFY THE SOFTWARE CHARACTER TABLE TO USE ANY OTHER 4     Evalplot
CHARACTERS THAT YOU DO NOT NORMALLY USE IN CHARACTER STRINGS (FOR  Evalplot
DETAILS SEE THE SOFTWARE CHARACTER TABLE).                         Evalplot
                                                                   Evalplot
STANDARD/ALTERNATE CHARACTER SETS                                  Evalplot
------------------------------------------------------------------ Evalplot
THE SOFTWARE CHARACTER TABLE CONTAINS 2 SETS OF CHARACTERS WHICH   Evalplot
ARE A STANDARD SET (ALL CHARACTERS ON AN IBM KEYBOARD) AND AN      Evalplot
ALTERNATE SET (UPPER AND LOWER CASE GREEK CHARACTERS AND SPECIAL   Evalplot
CHARACTERS). TO DRAW A CHARACTER FROM THE ALTERNATE CHARACTER SET  Evalplot
```

```
     PUT A RIGHT BRACKET CHARACTER (|) BEFORE A CHARACTER (SEE THE      Evalplot
     ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS  Evalplot
     CONTROL CHARACTER WILL ONLY EFFECT THE NEXT 1 PLOTTED CHARACTER.   Evalplot
                                                                        Evalplot
     SUB AND SUPER SCRIPTS                                              Evalplot
     ------------------------------------------------------------------ Evalplot
     TO DRAW SUBSCRIPT PRECEED A CHARACTER BY }. TO DRAW SUPERSCRIPT    Evalplot
     PRECEED A CHARACTER BY { (SEE THE ABOVE EXAMPLE AND THE SOFTWARE   Evalplot
     CHARACTER TABLE FOR DETAILS). THESE CONTROL CHARACTER WILL ONLY    Evalplot
     EFFECT THE NEXT 1 PLOTTED CHARACTER.                               Evalplot
                                                                        Evalplot
     BACKSPACING                                                        Evalplot
     ------------------------------------------------------------------ Evalplot
     TO BACKSPACE ONE CHARACTER PRECEED A CHARACTER BY \ (SEE, THE      Evalplot
     ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS  Evalplot
     CONTROL CHARACTER WILL PERFORM A TRUE BACKSPACE AND WILL EFFECT    Evalplot
     ALL FOLLOWING CHARACTERS IN THE SAME CHARACTER STRING.             Evalplot
                                                                        Evalplot
     PLOT DIMENSIONS                                                    Evalplot
     ---------------                                                    Evalplot
     ARE DEFINED BY USER INPUT. INTERNALLY THE PROGRAM WILL CREATE A    Evalplot
     PLOT IN APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. DURING        Evalplot
     OUTPUT THE PLOT IS TRANSFORMED TO THE UNITS (INCHES, CENTIMETERS,  Evalplot
     MILLIMETERS, WHATEVER) OF THE PLOTTER BEING USED AND OUTPUT.       Evalplot
                                                                        Evalplot
===== PLOTTER/GRAPHICS TERMINAL INTERFACE ============================== Evalplot
======================================================================== Evalplot
```

```
====================================================================== Fixup
                                                                       Fixup
      PROGRAM FIXUP                                                    Fixup
      VERSION 84-1 (NOVEMBER 1984)                                     Fixup
      VERSION 86-1 (JANUARY 1986) *IMPROVED BASED ON USER COMMENTS      Fixup
                                  *FORTRAN-77/H VERSION                Fixup
      VERSION 86-2 (JUNE 1986)    *ALLOW CREATION OF SECTIONS OF CROSS  Fixup
                                   SECTIONS WHICH ARE NOT PRESENT IN   Fixup
                                   THE ORIGINAL EVALUATION             Fixup
      VERSION 88-1 (JULY 1988)    *OPTION...INTERNALLY DEFINE ALL I/O   Fixup
                                   FILE NAMES (SEE, SUBROUTINE FILEIO  Fixup
                                   FOR DETAILS).                       Fixup
                                  *IMPROVED BASED ON USER COMMENTS.     Fixup
      VERSION 89-1 (JANUARY 1989) *PSYCHOANALYZED BY PROGRAM FREUD TO   Fixup
                                   INSURE PROGRAM WILL NOT DO ANYTHING Fixup
                                   CRAZY.                              Fixup
                                  *UPDATED TO USE NEW PROGRAM CONVERT   Fixup
                                   KEYWORDS.                           Fixup
                                  *ADDED LIVERMORE CIVIC COMPILER       Fixup
                                   CONVENTIONS.                        Fixup
      VERSION 89-2 (MARCH 1989)   *ADDED ENDF/B-VI SUMMATION RULES AND  Fixup
                                   DEFINED MF AND MT NUMBERS. PROGRAM  Fixup
                                   WILL NOW USE MF=1, MT=451 TO DEFINE Fixup
                                   THE ENDF/B FORMAT OF THE DATA (E.G., Fixup
                                   ENDF/B-VI OR EARLIER) AND USE THE   Fixup
                                   CORRECT SUMMATION RULES FOR EACH    Fixup
                                   VERSION OF THE ENDF/B FORMAT. IF    Fixup
                                   MF=1, MT=451 IS NOT PRESENT PROGRAM Fixup
                                   WILL USE ENDF/B-VI SUMMATION        Fixup
                                   CONVENTIONS AS A DEFAULT.           Fixup
      VERSION 90-1 (JUNE 1990)    *UPDATED BASED ON USER COMMENTS       Fixup
                                  *ADDED PHOTON INTERACTION, MF=23      Fixup
      VERSION 91-1 (JUNE 1991)    *ADDED FORTRAN SAVE OPTION            Fixup
                                  *NEW MORE CONSISTENT ENERGY OUTPUT    Fixup
                                   ROUTINE                             Fixup
      VERSION 92-1 (JANUARY 1992) *ADDED OPTION TO CALCULATE RATIOS,    Fixup
                                   E.G., CAPTURE/FISSION AND PRODUCTS, Fixup
                                   NU-BAR*FISSION - AND OUTPUT THE     Fixup
                                   RESULTS IN THE ENDF/B FORMAT (SEE,  Fixup
                                   BELOW - CREATING RATIOS AND PRODUCTS) Fixup
                                  *ALLOW TOTAL NU-BAR (MF=1, MT=452) TO Fixup
                                   BE USED IN DEFINING RATIOS OR       Fixup
                                   PRODUCTS.                           Fixup
                                  *ALLOW ALL CROSS SECTIONS TO BE PUT   Fixup
                                   ON A UNIFORM ENERGY GRID.           Fixup
                                  *NOTE, CHANGE IN INPUT FORMAT FOR     Fixup
                                   RANGES OF MT NUMBERS                Fixup
                                  *COMPLETELY CONSISTENT I/O ROUTINES -  Fixup
                                   TO MINIMIZE COMPUTER DEPENDENCE.    Fixup
      VERSION 93-1 (JULY 1993)    *CORRECTED ALGORITHM TO CREATE UNIFORM Fixup
                                   ENERGY GRID.                        Fixup
      VERSION 94-1 (JANUARY 1993) *VARIABLE ENDF/B DATA FILENAMES       Fixup
                                   TO ALLOW ACCESS TO FILE STRUCTURES  Fixup
                                   (WARNING - INPUT PARAMETER FORMAT   Fixup
                                   HAS BEEN CHANGED)                   Fixup
                                  *INCREASED PAGE SIZE FROM 1002 TO     Fixup
                                   12000 DATA POINTS.                  Fixup
                                  *CLOSE ALL FILES BEFORE TERMINATING   Fixup
                                   (SEE, SUBROUTINE ENDIT)             Fixup
      VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                    Fixup
                                  *IMPROVED COMPUTER INDEPENDENCE       Fixup
                                  *ALL DOUBLE PRECISION                 Fixup
                                  *ON SCREEN OUTPUT                     Fixup
                                  *UNIFORM TREATMENT OF ENDF/B I/O      Fixup
                                  *IMPROVED OUTPUT PRECISION            Fixup
                                  *DEFINED SCRATCH FILE NAMES           Fixup
                                  *INCREASED PAGE SIZE FROM 12000 TO    Fixup
                                   36000 DATA POINTS.                  Fixup
```

```
VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING       Fixup
                             POINT READ FOR MORE DIGITS           Fixup
                            *UPDATED TEST FOR ENDF/B FORMAT       Fixup
                             VERSION BASED ON RECENT FORMAT CHANGE Fixup
                            *GENERAL IMPROVEMENTS BASED ON        Fixup
                             USER FEEDBACK                        Fixup
VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING  Fixup
                             MF=1, MT-451.                        Fixup
                            *FIXED CREATION OF SECTIONS           Fixup
VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON        Fixup
                             USER FEEDBACK                        Fixup
VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS            Fixup
                            *SUMMATION RULES ARE DEFINED BASED    Fixup
                             ON CONTENTS OF TABLES.               Fixup
VERS. 2004-1 (JAN. 2004)    *GENERAL UPDATE BASED ON USER FEEDBACK Fixup
                            *INCREASED PAGE SIZE FROM 36000 TO    Fixup
                             60000 DATA POINTS.                   Fixup
VERS. 2005-1 (JAN. 2005)    *UPDATED MT CREATION TO ALLOW MAT =0  Fixup
                             INDICATING CREATE FOR ALL MATS.      Fixup
VERS. 2007-1 (JAN. 2007)    *CHECKED AGAINST ALL ENDF/B-VII       Fixup
                            *INCREASED PAGE SIZE FROM 60,000 TO   Fixup
                             600,000 DATA POINTS.                 Fixup
                                                                  Fixup
OWNED, MAINTAINED AND DISTRIBUTED BY                              Fixup
-----------------------------------                               Fixup
THE NUCLEAR DATA SECTION                                          Fixup
INTERNATIONAL ATOMIC ENERGY AGENCY                                Fixup
P.O. BOX 100                                                      Fixup
A-1400, VIENNA, AUSTRIA                                           Fixup
EUROPE                                                            Fixup
                                                                  Fixup
ORIGINALLY WRITTEN BY                                             Fixup
-----------------------------------                               Fixup
DERMOTT E. CULLEN                                                 Fixup
UNIVERSITY OF CALIFORNIA                                          Fixup
LAWRENCE LIVERMORE NATIONAL LABORATORY                            Fixup
L-159                                                             Fixup
P.O. BOX 808                                                      Fixup
LIVERMORE, CA 94550                                               Fixup
U.S.A.                                                            Fixup
TELEPHONE  925-423-7359                                           Fixup
E. MAIL    CULLEN1@LLNL.GOV                                       Fixup
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                            Fixup
                                                                  Fixup
PURPOSE                                                           Fixup
=======                                                           Fixup
THIS PROGRAM IS DESIGNED TO READ EVALUATED DATA IN THE ENDF/B     Fixup
FORMAT, PERFORM CORRECTIONS AND OUTPUT THE RESULT IN THE ENDF/B    Fixup
FORMAT. TWO TYPES OF CORRECTIONS ARE POSSIBLE (1) AUTOMATIC AND   Fixup
(2) OPTIONAL (BASED ON USER INPUT) CORRECTIONS.                    Fixup
                                                                  Fixup
ONE OF THE MOST IMPORTANT FUNCTIONS OF THIS PROGRAM IS TO         Fixup
RE-DEFINE ALL REDUNDANT CROSS SECTIONS (E.G. TOTAL) TO BE EXACTLY Fixup
EQUAL TO THE SUM OF ITS PARTS. THIS PROCEDURE ELIMINATES THE      Fixup
PROBLEM WITH MANY ENDF/B EVALUATIONS, WHERE DUE TO THE USE OF     Fixup
NON-LINEAR INTERPOLATION LAWS THE TOTAL MAY BE EQUAL TO THE SUM   Fixup
OF ITS PARTS AT ALL TABULATED ENERGIES, BUT BASED ON THE          Fixup
INTERPOLATION LAWS IT CAN BE QUITE DIFFERENT AT ENERGIES BETWEEN  Fixup
TABULATED ENERGIES.                                               Fixup
                                                                  Fixup
AUTOMATIC CHECKS/CORRECTIONS                                      Fixup
============================                                      Fixup
(1) CHECK THAT MAT/MF/MT DOES NOT CHANGE UNLESS A MEND/FEND/SEND  Fixup
    LINE IS READ. IF MAT/MF/MT CHANGES A WARNING MESSAGE IS       Fixup
    PRINTED BUT NO CORRECTIVE ACTION IS TAKEN.                    Fixup
(2) ALL LINES WITHIN A GIVEN MAT WILL BE SEQUENTIALLY NUMBERED    Fixup
    ON OUTPUT.                                                    Fixup
                                                                  Fixup
```

```
OPTIONAL CHECKS/CORRECTIONS                                          Fixup
==========================                                           Fixup
THE FOLLOWING NUMBERS CORRESPOND TO THE INPUT DATA OPTION COLUMNS    Fixup
(SEE THE DESCRIPTION OF THE INPUT BELOW)                             Fixup
                                                                     Fixup
(1) CORRECT ZA AND AWR IN ALL SECTIONS. CHECK TO INSURE THAT THE     Fixup
    C1 AND C2 VALUES (ZA AND AWR) ARE THE SAME IN ALL SECTIONS.      Fixup
    THE C1 AND C2 OF THE FIRST SECTION READ ARE ASSUMED TO BE        Fixup
    CORRECT AND ARE USED FOR COMPARISON. IF THE C1 AND/OR C2 OF      Fixup
    THE FIRST SECTION ARE NOT POSITIVE AN ERROR MESSAGE IS OUTPUT    Fixup
    AND THE MATERIAL IS COPIED WITHOUT CHANGE.                       Fixup
    NOTE....TO CHANGE THE ZA AND/OR AWR OF ANY MATERIAL IT IS        Fixup
    MERELY NECESSARY TO CHANGE THE ZA AND/OR AWR IN THE FIRST        Fixup
    SECTION OF THE MATERIAL AND USE THIS OPTION TO AUTOMATICALLY     Fixup
    CHANGE ALL OTHER SECTIONS.                                       Fixup
(2) CORRECT CROSS SECTION (MF=3) THRESHOLDS. THE Q-VALUE AND AWR     Fixup
    ARE USED TO DERIVE THE REACTION THRESHOLD USING THE RELATION,    Fixup
                                                                     Fixup
    E-THRESHOLD = -(Q-VALUE)*(AWRE+1.0)/AWRE                         Fixup
                                                                     Fixup
    IF THE THRESHOLD IS POSITIVE THE CROSS SECTION IS CHECKED TO     Fixup
    INSURE THAT THE FIRST TABULATED POINT IS AT THE THRESHOLD AND    Fixup
    HAS A ZERO CROSS SECTION. IF NOT, THE CROSS SECTION WILL BE      Fixup
    CHANGED.                                                         Fixup
    (A) IF THE FIRST TABULATED POINT IS ABOVE THE THRESHOLD AND      Fixup
        HAS A ZERO CROSS SECTION, THE POINT IS DELETED AND A POINT   Fixup
        IS INSERTED AT THE THRESHOLD.                                Fixup
    (B) IF THE FIRST TABULATED POINT IS ABOVE THE THRESHOLD AND      Fixup
        HAS A NON-ZERO CROSS SECTION, A POINT WITH ZERO CROSS        Fixup
        SECTION IS INSERTED AT THE THRESHOLD.                        Fixup
    (C) IF THE FIRST TABULATED POINT IS BELOW THE THRESHOLD AND      Fixup
        HAS A NON-ZERO CROSS SECTION, ALL POINTS BELOW THE           Fixup
        THRESHOLD ARE DELETED AND A POINT WITH ZERO CROSS SECTION    Fixup
        IS INSERTED AT THE THRESHOLD.                                Fixup
(3) EXTEND ALL CROSS SECTIONS (MF=3) TO 20 MEV. IF THE TABULATED     Fixup
    CROSS SECTION ENDS BELOW 20 MEV IT WILL BE EXTENDED TO 20 MEV    Fixup
    AS EITHER ZERO (IMOPS(3)=1) OR CONSTANT (IMOPS(3)=2) EQUAL       Fixup
    TO THE LAST TABULATED VALUE.                                     Fixup
(4) ALLOW REACTION (MF=3, ANY MT) DELETION. ALL SPECIFIED            Fixup
    REACTIONS WILL BE DELETED WHEN THE DATA IS READ FROM THE         Fixup
    INPUT ENDF/B DATA FILE AND WILL NOT BE IN THE OUTPUT ENDF/B      Fixup
    DATA FILE. WARNING DELETED REACTIONS MAY NOT BE USED TO DEFINE   Fixup
    ANY RECONSTRUCTED REACTIONS (I.E. REACTIONS DEFINED BY SUMMING   Fixup
    OTHER REACTIONS). SINCE DELETED REACTIONS ARE DELETED DURING     Fixup
    READING IT IS AS IF THEY NEVER EXISTED AND IF ANY DELETED        Fixup
    REACTION IS REQUIRED LATER TO DEFINE ANY SUM AN ERROR WILL       Fixup
    RESULT. THE USER MAY SPECIFY THAT THE DELETION RULES ARE TO BE   Fixup
    READ FROM INPUT (IMOPS(4)=1) OR THAT THE BUILT IN SUMMATION      Fixup
    RULES ARE TO BE USED (MOPS(4)=2). AT THE PRESENT TIME THE        Fixup
    BUILT-IN DELETION RULES ARE THAT NO SECTIONS SHOULD BE DELETED   Fixup
    (THE USER MAY OVERRIDE THIS CONVENTION BY INPUT).                Fixup
(5) ALLOW REACTION (MF=3, ANY MT) RECONSTRUCTION BY SUMMING OTHER    Fixup
    REACTIONS. IN ORDER TO OPTIMIZE THE RUNNING TIME OF THIS         Fixup
    PROGRAM CARE SHOULD BE EXERCISED TO MINIMIZE THE NUMBER OF       Fixup
    TIMES THAT EACH CONTRIBUTING CROSS SECTION MUST BE USED.         Fixup
    THE USED MAY SPECIFY THAT THE SUMMATION RULES ARE TO BE READ     Fixup
    AS INPUT (IMOPS(5)=1) OR THAT THE BUILT IN SUMMATION RULES       Fixup
    ARE TO BE USED (IMOPS(5)=2). THE BUILT IN SUMMATION RULES ARE    Fixup
    DESIGNED TO USE ENDF/B CONVENTIONS AND TO MINIMIZE THE NUMBER    Fixup
    OF TIMES THAT EACH CROSS SECTION IS USED.                        Fixup
(6) INSURE THAT ALL CROSS SECTIONS ARE NON-NEGATIVE (I.E. ARE        Fixup
    ZERO OR POSITIVE). DURING READING ALL NEGATIVE CROSS SECTIONS    Fixup
    WILL BE SET EQUAL TO ZERO AND TREATED AS SUCH DURING ALL         Fixup
    SUBSEQUENT SUMMATIONS AND ENDF/B OUTPUT.                         Fixup
    NOTE...THIS OPTION SHOULD NEVER BE USED WITH DATA CONTAINING     Fixup
    BACKGROUND CROSS SECTIONS WHICH MAY BE NEGATIVE. ONLY AFTER      Fixup
    THE RESONANCE CONTRIBUTION HAS BEEN ADDED TO THE BACKGROUND      Fixup
    TO DEFINE THE ACTUAL CROSS SECTION IS IT VALID TO ELIMINATE      Fixup
```

```
     NEGATIVE CROSS SECTIONS.                                          Fixup
     NOTE...THIS OPTION MAY BE USED TO DELETE NEGATIVE ELASTIC         Fixup
     CROSS SECTIONS THAT MAY RESULT FROM RECONSTRUCTING CROSS          Fixup
     SECTIONS FROM SINGLE LEVEL BREIT-WIGNER PARAMETERS. IF THE        Fixup
     TOTAL CROSS SECTION IS THEN RECONSTRUCTED USING THE CORRECTED     Fixup
     ELASTIC CROSS SECTION THE TOTAL WILL BE POSITIVE DUE TO THE       Fixup
     CONTRIBUTIONS OF CAPTURE AND FISSION (THUS AVOIDING NUMERICAL     Fixup
     INSTABILITY PROBLEMS DURING SELF-SHIELDING CALCULATIONS).         Fixup
 (7) WITHIN EACH SECTION OF CROSS SECTIONS DELETE ENERGIES THAT        Fixup
     ARE NOT IN ASCENDING ENERGY ORDER (ENERGY REPETITION IS O.K.)     Fixup
 (8) WITHIN EACH SECTION OF CROSS SECTIONS ELIMINATE DUPLICATE         Fixup
     POINTS (SUCCESSIVE POINTS WITH THE SAME ENERGY-CROSS SECTION).    Fixup
 (9) TEST THAT ALL SECTIONS ARE IN ASCENDING MAT/MF/MT ORDER.          Fixup
     IF NOT, NO CORRECTIVE ACTION WILL BE TAKEN, ONLY AN ERROR         Fixup
     MESSAGE WILL BE OUTPUT.                                           Fixup

(10) CHECK MF/MT FOR EACH SECTION TO INSURE THAT THEY ARE DEFINED      Fixup
     IN THE ENDF/B FORMAR MANUAL. IF THEY ARE NOT DEFINED AN ERROR     Fixup
     MESSAGE IS PRINTED, BUT NO CORRECTIVE ACTION IS TAKEN.            Fixup
(11) ALLOW SECTIONS WHICH ARE NOT PRESENT IN THE ORIGINAL (INPUT)      Fixup
     EVALUATION TO BE CREATED. NORMALLY THIS PROGRAM WILL ONLY         Fixup
     RECONSTRUCT AND OUTPUT SECTIONS IF THE SECTION IS PRESENT         Fixup
     IN THE ORIGINAL EVALUATION. THIS PROCEDURE IS FOLLOWED BECAUSE    Fixup
     NORMALLY THE PROGRAM DOES NOT KNOW HOW TO DEFINE THE CONTENTS     Fixup
     OF THE FIRST TWO LINES OF THE SECTION (E.G., Q-VALUE,             Fixup
     TEMPERATURE, INITIAL AND FINAL STATES). THIS OPTION MAY BE        Fixup
     USED TO ALLOW THE PROGRAM TO READ AND SAVE A TABLE DEFINING       Fixup
     THE CONTENTS OF THE FIRST TWO LINES OF EACH SECTION TO BE         Fixup
     CREATED.                                                          Fixup
     NOTE...IF A SECTION IS PRESENT ANY COMMAND TO CREATE IT WILL      Fixup
     BE IGNORED.                                                       Fixup
 (12)ALLOW ENERGY POINTS TO BE INSERTED. THE PROGRAM CAN READ UP       Fixup
     TO 50, ENERGIES, MAT, MT AND USE LINEAR INTERPOLATION TO          Fixup
     INSERT ENERGY POINTS INTO TABLES AS THEY ARE READ, E.G.,          Fixup
     INSERT AN ENERGY POINT AT THERMAL ENERGY (0.0253 EV). IF          Fixup
     AN MAT AND/OR MT IS ZERO THIS IMPLIES = ALL - INSERT THE          Fixup
     ENERGY IN ALL TABLES.                                             Fixup
 (13)PUT ALLOW CROSS SECTIONS ON A UNIFORM ENERGY GRID = EACH          Fixup
     SECTION (MT) OF CROSS SECTIONS WILL INCLUDE ALL ENERGIES          Fixup
     WHICH APPEAR IN AT LEAST ONE SECTION OF DATA. PARAMETERS          Fixup
     (MT=251 THROUGH 255) ARE NOT INCLUDED IN THE UNIFORM ENERGY       Fixup
     GRID.                                                             Fixup
 (14)DELETE SECTION IF CROSS SECTION = 0 AT ALL ENERGIES. THIS         Fixup
     SOUNDS LIKE AN ABSURD OPTION, BUT IS REQUIRED BECAUSE SUCH        Fixup
     SECTIONS EXIST IN ENDF/B-VI.                                      Fixup
                                                                       Fixup
 CREATING RATIOS AND PRODUCTS                                          Fixup
 ============================                                          Fixup
 IN ORDER TO CREATE RATIOS AND PRODUCTS = NEW MT NUMBERS, YOU MUST     Fixup
 DO TWO THINGS,                                                        Fixup
                                                                       Fixup
 1) DEFINE EACH NEW MT NUMBER AS A RATIO OR PRODUCT OF TWO MT          Fixup
    NUMBERS.                                                           Fixup
                                                                       Fixup
 2) USE THE CREATE MT NUMBER OPTION AND INPUT THE FIRST TWO LINES      Fixup
    OF THE SECTION                                                     Fixup
                                                                       Fixup
 WARNING - UNLESS YOU DO BOTH OF THESE YOU WILL NOT OBTAIN OUTPUT      Fixup
 IN THE ENDF/B FORMAT.                                                 Fixup
                                                                       Fixup
 TWO SPECIAL MT NUMBERS HAVE BEEN DEFINED BY CSEWG INVOLVING           Fixup
 RATIOS AND PRODUCTS,                                                  Fixup
                                                                       Fixup
 ALPHA (MT=254)= CAPTURE (MT=102)/FISSION (MT=18)                      Fixup
                                                                       Fixup
 ETA (MT=255)  = NU-BAR (MT=452)*FISSION (MT=18)/ABSORPTION (MT=27)    Fixup
                                                                       Fixup
 ABSORPTION (MT=27) = FISSION (MT=18) + SUM (MT=102 THROUGH 116)       Fixup
```

```
                                                                      Fixup
AS YET THERE IS NO STANDARD DEFINITION OF MT NUMBERS FOR RATIO        Fixup
OR PRODUCT DATA. YOU ARE FREE TO USE ANY MT NUMBERS NORMALLY NOT      Fixup
USED IN THE ENDF/B. HOWEVER, IT WILL THEN BE YOUR RESPONSIBILITY      Fixup
TO PROPERLY INTERPRET THE RESULTS, I.E., NOBODY ELSE WILL HAVE        Fixup
ANY IDEA HOW TO INTERPRET A TABLE OF DATA ASSOCIATED WITH THE MT      Fixup
NUMBERS YOU HAVE USED.                                                Fixup
                                                                      Fixup
THIS PROGRAM CAN BE ONLY DIRECTLY DEFINE RATIOS AND PRODUCTS          Fixup
USING TWO MT NUMBERS = BINARY OPERATIONS, E.G., DEFINE THE CAPTURE    Fixup
TO FISSION RATIO, OR DEFINE THE PRODUCT NU-BAR*FISSION.               Fixup
                                                                      Fixup
THIS PROGRAM CANNOT DIRECTLY DEFINE RATIO OR PRODUCT OF A SUM OF      Fixup
SECTIONS TO THE SUM OF ANOTHER SET OF SECTIONS. HOWEVER, THIS CAN     Fixup
BE DONE INDIRECTLY BY FIRST DEFINING A DUMMY MT NUMBER (ANY MT        Fixup
NUMBER NOT NORMALLY USED IN ENDF/B) TO BE A SUM OF SECTIONS AND       Fixup
A SECOND DUMMY MT NUMBER TO BE A SECOND SUM OF SECTIONS. YOU CAN      Fixup
THEN DEFINE RATIO OR PRODUCT YOU REQUIRE TO BE THE RATIO OF THESE     Fixup
TWO DUMMY MT NUMBERS.                                                 Fixup
                                                                      Fixup
FOR EXAMPLE, TO DEFINE ETA,                                           Fixup
1) FIRST DEFINE (MT=27) = (MT=27) + (SUM OF MT=102 THROUGH 116)       Fixup
2) NEXT DEFINE (MT=333) = (MT=452)*(MT=18)                            Fixup
3) LAST DEFINE (MT=255) = (MT=333)/(MT=27)                            Fixup
DO NOT FORGET TO TURN ON THE CREATE SECTION OPTION (ON THE FIRST      Fixup
INPUT LINE) AND INPUT THE FIRST TWO LINES OF SECTION MT=255 -         Fixup
OTHERWISE YOU WILL NOT GET ANY ENDF/B FORMATTED OUTPUT.               Fixup
                                                                      Fixup
THE ONLY SPECIAL CONVENTIONS USED BY THIS PROGRAM IN CALCULATING      Fixup
RATIOS ARE WHEN THE DENOMINATOR OF THE RATIO IS ZERO. IN THIS         Fixup
CASE IF THE NUMERATOR IS ALSO ZERO THE RATIO IS DEFINED TO BE ONE.    Fixup
IN THIS CASE IF THE NUMERATOR IS NOT ZERO THE RATIO IS DEFINED        Fixup
TO BE ZERO.                                                           Fixup
                                                                      Fixup
ENDF/B FORMAT                                                         Fixup
=============                                                         Fixup
THIS PROGRAM MAY BE USED WITH DATA IN ANY VERSION OF THE ENDF/B       Fixup
FORMAT (I.E. ENDF/B-I, II, III, IV, V OR VI FORMAT). SINCE A          Fixup
PAGING SYSTEM IS USED STORE CROSS SECTION TABLES ON SCRATCH FILES     Fixup
THERE IS NO LIMIT TO THE SIZE OF TABLES (E.G. THE TOTAL CROSS         Fixup
SECTION MAY BE REPRESENTED BY 200,000 TABULATED POINTS).              Fixup
                                                                      Fixup
WARNING                                                               Fixup
=======                                                               Fixup
(1) FOR EACH SECTION OF CROSS SECTIONS (I.E. EACH MT, MF=3) IN        Fixup
    THE ORIGINAL EVALUATION (I.E. ENDF/B DATA READ) ONE SECTION       Fixup
    OF DATA WILL BE OUTPUT, UNLESS THE SECTION HAS BEEN DELETED.      Fixup
    THIS INCLUDES ANY SECTIONS WHICH ARE NOT PRESENT IN THE           Fixup
    ORIGINAL EVALUATION, BUT THE USER INDICATES (BY INPUT) SHOULD     Fixup
    BE CREATED.                                                       Fixup
                                                                      Fixup
    THE PROGRAM WILL NOT OUTPUT ANY SECTION RECONSTRUCTED BY          Fixup
    SUMMATION UNLESS THE CORRESPONDING SECTION (MT NUMBER) IS         Fixup
    PRESENT IN THE ORIGINAL EVALUATION OR USER INPUT INDICATES        Fixup
    SHOULD BE CREATED AND OUTPUT. THIS IS (A) BECAUSE THE             Fixup
    PROGRAM CANNOT DEFINE THE PARAMETERS TO APPEAR ON THE FIRST       Fixup
    TWO LINES OF THE SECTION, (B) TO AVOID OUTPUTTING TOO MUCH        Fixup
    DATA WHICH THE USER MAY NOT BE INTERESTED IN.                     Fixup
                                                                      Fixup
(2) FOR ANY SECTIONS THAT DO NOT APPEAR IN THE ORIGINAL DATA THE      Fixup
    USER MAY SPECIFY THAT THEY BE DEFINED BY SUMMATION. ANY SUCH      Fixup
    SECTION MAY BE USED BE DEFINE SUBSEQUENT SUMS, BUT THE SECTION    Fixup
    ITSELF WILL NOT BE OUTPUT (E.G. GENERALLY MT=27 AND 101 ARE       Fixup
    NOT PRESENT IN EVALUATIONS. HOWEVER, THE BUILT-IN SUMMATION       Fixup
    RULES OF THIS PROGRAM USES THE ENDF/B SUMMATION RULES TO          Fixup
    DEFINE MT=27 AND 101, WHICH IN TURN ARE USED TO DEFINE THE        Fixup
    NON-ELASTIC CROSS SECTION, MT=3. SECTIONS MT=27 AND 101 ARE       Fixup
    NOT OUTPUT).                                                      Fixup
```

```
                                                                      Fixup
(3) ALL DATA IN FILE 3 AND 23 MUST BE LINEARLY INTERPOLABLE. IF       Fixup
    THE DATA IS NOT LINEARLY INTERPOLABLE THIS PROGRAM WILL           Fixup
    TERMINATE.                                                        Fixup
                                                                      Fixup
PROGRAM OPERATION                                                     Fixup
=================                                                     Fixup
ALL MAT NUMBER ON AN ENDF/B TAPE ARE PROCESSED. EACH MAT IS           Fixup
TREATED SEPARATELY. WITHIN EACH MAT, EACH SECTION BEFORE MF=3         Fixup
IS READ, CHECKED/CORRECTED (BASED ON INPUT OPTIONS) AND OUTPUT.       Fixup
WHEN MF=3 IS LOCATED ALL CROSS SECTIONS ARE READ, SECTIONS TO BE      Fixup
DELETED ARE DELETED, SECTIONS WHICH ARE NOT PRESENTED AND USER        Fixup
INPUT INDICATES SHOULD BE CREATED ARE CREATE, SECTIONS TO BE KEPT     Fixup
ARE CHECKED/CORRECTED (BASED ON INPUT OPTIONS) AND WRITTEN TO A       Fixup
SCRATCH FILE. NEXT, IF THE USER SPECIFIES THAT THEY SHOULD,           Fixup
SECTIONS ARE RECONSTRUCTED. FINALLY ALL CROSS SECTIONS (OLD AND       Fixup
NEW) ARE OUTPUT. WITHIN THE SAME MAT, EACH SECTION AFTER MF=3 IS      Fixup
READ, CHECKED/CORRECTED (BASED ON INPUT OPTIONS) AND OUTPUT.          Fixup
                                                                      Fixup
MF=3                                                                  Fixup
====                                                                  Fixup
THE TREATMENT OF THE CROSS SECTIONS REQUIRES UP TO 4 PASSES FOR       Fixup
CROSS SECTIONS. IN THE PROGRAM THEY CORRESPOND TO SUBROUTINES         Fixup
PASS1, PASS2, PASS3 AND PASS4. THE ORIGINAL AND FINAL ENDF/B DATA     Fixup
FILES, 5 SCRATCH FILES AND 3 IN CORE ARRAYS ARE USED. OPERATIONS      Fixup
PERFORMED DURING EACH PASS ARE,                                       Fixup
                                                                      Fixup
PASS1                                                                 Fixup
=====                                                                 Fixup
READ ALL CROSS SECTIONS FROM ITAPE. DELETED ANY SECTIONS. CREATE      Fixup
ANY SECTIONS. CHECK/CORRECT THEM AND WRITE THEM TO SCRATCH FILE.      Fixup
DATA IS READ INTO ARRAY A, TRANSFERRED TO ARRAY C (AFTER EDITING)     Fixup
AND OUTPUT TO ISCRC FROM ARRAY C.                                     Fixup
ITAPE  - UNIT ORIGINAL ENDF/B DATA IS READ FROM.                      Fixup
ISCRC  - SCRATCH UNIT THAT EDITED DATA IS WRITTEN ON.                 Fixup
TABA   - ARRAY INTO WHICH ORIGINAL DATA IS READ.                      Fixup
TABC   - ARRAY INTO WHICH EDITED DATA IS TRANSFERRED TO AND           Fixup
         FROM WHICH IT IS WRITTEN TO ISCRC.                           Fixup
                                                                      Fixup
PASS2                                                                 Fixup
=====                                                                 Fixup
IF A UNIFORM ENERGY GRID IS REQUESTED IT IS CREATED DURING THIS       Fixup
PASS. FIRST ALL OF THE CROSS SECTIONS FROM PASS1 ARE READ AND A       Fixup
UNIFORM ENERGY GRID IS CREATED = ALL ENERGIES THAT ARE INCLUDED       Fixup
IN AT LEAST ONE SECTION (MT) OF CROSS SECTIONS.                       Fixup
ISCRA  - SCRATCH UNIT CONTAINING UNIFORM ENERGY GRID.                 Fixup
ISCRB  - SCRATCH UNIT CONTAINING UNIFORM ENERGY GRID.                 Fixup
ISCRC  - SCRATCH UNIT THAT EDITED DATA IS READ FROM.                  Fixup
TABA   - ARRAY CONTAINING UNIFORM ENERGY GRID.                        Fixup
TABB   - ARRAY CONTAINING UNIFORM ENERGY GRID.                        Fixup
TABC   - ARRAY CONTAINING EDITED DATA.                                Fixup
                                                                      Fixup
THE UNIFORM ENERGY GRID ENDS UP ON ISCRB. NEXT EACH SECTION OF        Fixup
CROSS SECTIONS FROM PASS1 IS READ FROM ISCRC, INTERPOLATED TO         Fixup
THE UNIFORM ENERGY GRID AND OUTPUT TO ISCRA. FINALLY ISCRA AND        Fixup
ISCRC ARE SWITCH, SO THAT AT THE END OF THIS PASS THE DATA WILL       Fixup
AGAIN BE ON ISCRC (EXACTLY AS AT THE END OF PASS1), WITH UPDATED      Fixup
POINT COUNTS.                                                         Fixup
ISCRA  - SCRATCH UNIT THAT UNIFORM ENERGY GRID DATA IS WRITTEN ON.    Fixup
ISCRB  - SCRATCH UNIT CONTAINING UNIFORM ENERGY GRID.                 Fixup
ISCRC  - SCRATCH UNIT THAT EDITED DATA IS READ FROM.                  Fixup
TABA   - ARRAY CONTAINING UNIFORM ENERGY GRID DATA.                   Fixup
TABB   - ARRAY CONTAINING UNIFORM ENERGY GRID.                        Fixup
TABC   - ARRAY CONTAINING EDITED DATA.                                Fixup
                                                                      Fixup
PASS3                                                                 Fixup
=====                                                                 Fixup
SUMMATION CROSS SECTIONS ARE DEFINED BY READING DATA FROM ISCRC       Fixup
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 AND MERGING THEM ONTO ISCRA. THE FIRST SECTION THAT CONTRIBUTES    Fixup
 TO A SUM IS MERELY COPIED FROM C TO A. IF MORE SECTIONS WILL       Fixup
 CONTRIBUTE TO THE SUM THE DATA IN A IS TRANSFERRED TO B, A         Fixup
 SECTION OF DATA FROM C IS ADDED TO THE DATA IN B AND STORED IN     Fixup
 A. THE CYLE OF ADDED C AND B TO A, FOLLOWED BY MOVING A TO B       Fixup
 IS CONTINUED UNTIL ALL CONTRIBUTING SECTIONS HAVE BEEN ADDED.      Fixup
 THE SUM IS THEN COPIED FROM A TO D. IF NEWLY CONSTRUCTED SECTION   Fixup
 IS REQUIRED FOR ANY LATER SUMMUATIONS IT IS ALSO COPIED TO E.      Fixup
 THE CYCLE OF ADDED SECTIONS FROM C AND B TO A IS REPEATED FOR      Fixup
 EACH REQUIRED SUMMATION REACTION. IN ADDITION TO SECTIONS FROM     Fixup
 C, AFTER THE FIRST SUMMATION SECTIONS MAY ALSO BE ADDED TO A       Fixup
 FROM E (THE CONTRIBUTION OF NEW RECONSTRUCTED CROSS SECTIONS).     Fixup
 WHEN ALL REQUIRED SECTIONS HAVE BEEN RECONSTRUCTED THE NEW         Fixup
 SECTIONS WILL BE ON E AND THE ORIGINAL SECTIONS ON C.              Fixup
 ISCRC  - SCRATCH FILE FROM WHICH ORIGINAL DATA IS READ.            Fixup
 ISCRA  - SCRATCH FILE ONTO WHICH SUM FOR ONE SECTION IS WRITTEN.   Fixup
 ISCRD  - SCRATCH FILE ONTO WHICH ALL SUM CROSS SECTIONS ARE        Fixup
          WRITTEN.                                                  Fixup
 ISCRE  - SCRATCH FILE ONTO WHICH ALL SUM CROSS SECTIONS WHICH      Fixup
          ARE REQUIRED FOR LATER SUMS ARE WRITTEN.                  Fixup
 ISCRB  - UTILITY SCRATCH FILE USED TO CREATE SUM CROSS SECTIONS.   Fixup
 TABA   - ARRAY INTO WHICH SUMS ARE WRITTEN.                        Fixup
 TABB   - ARRAY INTO WHICH PARTIAL SUMS ARE WRITTEN.                Fixup
 TABC   - ARRAY INTO WHICH ORIGINAL DATA IS READ.                   Fixup
                                                                    Fixup
 PASS4                                                              Fixup
 =====                                                              Fixup
 CROSS SECTIONS ARE READ FROM ISCRC (ORIGINAL) AND ISCRD (NEW)      Fixup
 AND ARE WRITTEN IN THE ENDF/B FORMAT ON OTAPE. THE BEGINNING OF    Fixup
 EACH SECTION OF ORIGINAL DATA IS READ FROM ISCRC (TO DEFINE        Fixup
 SECTION HEADER INFORMATION). IF THIS MT HAS NOT BEEN RECOSTRUCTED  Fixup
 ON ISCRD THE ORIGINAL SECTION IS OUTPUT. IF THE SECTION HAS BEEN   Fixup
 RECONSTRUCTED THE ORIGINAL SECTION IS SKIPPED AND THE NEW SECTION  Fixup
 IS OUTPUT.                                                         Fixup
 OTAPE  - OUTPUT DATA IN THE ENDF/B FORMAT.                         Fixup
 ISCRC  - SCRATCH FILE FROM WHICH ORIGINAL DATA IS READ.            Fixup
 ISCRD  - SCRATCH FILE FROM WHICH NEW DATA IS READ.                 Fixup
 TABC   - ARRAY INTO WHICH CROSS SECTIONS ARE READ FROM SCRATCH     Fixup
          AND WRITTEN TO OTAPE                                      Fixup
                                                                    Fixup
 I/O FILE DEFINITIONS                                               Fixup
 ====================                                               Fixup
 UNIT   DESCRIPTION                                                 Fixup
 ====   ===========                                                 Fixup
   2    INPUT PARAMETERS.                                           Fixup
   3    OUTPUT REPORT.                                              Fixup
  10    ORIGINAL DATA IN THE ENDF/B FORMAT.                         Fixup
  11    FINAL DATA IN THE ENDF/B FORMAT.                            Fixup
  12    SCRATCH FILE                                                Fixup
  14    SCRATCH FILE                                                Fixup
  15    SCRATCH FILE                                                Fixup
  16    SCRATCH FILE                                                Fixup
  17    SCRATCH FILE                                                Fixup
                                                                    Fixup
 OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)    Fixup
 ===============================================================    Fixup
 UNIT  FILE NAME   FORMAT                                           Fixup
 ====  ==========  ======                                           Fixup
   2   FIXUP.INP    BCD                                           Fixup
   3   FIXUP.LST    BCD                                           Fixup
  10   ENDFB.IN     BCD                                           Fixup
  11   ENDFB.OUT    BCD                                           Fixup
12-17  (SCRATCH)   BINARY                                         Fixup
                                                                    Fixup
 INPUT LINES                                                        Fixup
 ===========                                                        Fixup
 LINE  COLUMNS  FORMAT  DESCRIPTION                                 Fixup
```

====	=======	======	==========	Fixup
1	1-14	14I1	INPUT OPTIONS AS DESCRIBED ABOVE.	Fixup
			EACH COLUMN OF THE INPUT LINE CONTROLS	Fixup
			ONE OF THE TESTS/CORRECTIONS DESCRIBED	Fixup
			ABOVE. TESTS/CORRECTION 1-14 (NOT ALL	Fixup
			IMPLEMENTED YET) CORRESPOND TO COLUMNS	Fixup
			1-14 OF THIS INPUT LINE AND ARE TREATED	Fixup
			AS FOLLOWS,	Fixup
			= 0 - DO NOT PERFORM TEST/CORRECTION.	Fixup
			= 1 - PERFORM TEST/CORRECTION.	Fixup
			FOR MT EXCLUSION FROM THRESHOLD TESTS	Fixup
			(COLUMN 2), DELETION (COLUMN 4), OR	Fixup
			SUMMATION (COLUMN 5) THE INPUT OPTION	Fixup
			MAY BE,	Fixup
			= 1 - READ RULES FROM INPUT	Fixup
			= 2 - USE BUILT-IN RULES	Fixup
2	1-60	A60	ENDF/B INPUT DATA FILENAME	Fixup
			(STANDARD OPTION = ENDFB.IN)	Fixup
3	1-60	A60	ENDF/B OUTPUT DATA FILENAME	Fixup
			(STANDARD OPTION = ENDFB.OUT)	Fixup
4-M	1-5	FREE	CHARACTER (S,D,T,R,*) FOLLOWED BY BLANK OR	Fixup
		FORM	MT NUMBER	Fixup
			- THE ALLOWED CHARACTERS ARE,	Fixup
			- S OR BLANK = SUM (OR DIFFERENCES)	Fixup
			- D = DELETE	Fixup
			- T = NO THRESHOLD ENERGY CORRECTIONS	Fixup
			- R = RATIO	Fixup
			- * = PRODUCT	Fixup
	6-72	FREE	UP TO 10 LOWER AND UPPER MT RANGES WHICH	Fixup
		FORM	WILL BE USED TO DEFINE THE RECONSTRUCTED	Fixup
			CROSS SECTION OR TO DEFINE MT RANGES WHICH	Fixup
			ARE EXCLUDED FROM THRESHOLD TESTS.	Fixup
				Fixup
			EACH MT NUMBER IS DEFINED BY A CONTINUOUS	Fixup
			STRING OF DIGITS, POSSIBILITY PRECEEDED BY	Fixup
			A - (MINUS SIGN). EACH MT NUMBER MUST BE	Fixup
			BLANK OR OTHERWISE (NOT A DIGIT) DELIMITED.	Fixup
				Fixup
			COLUMNS 6-72 MAY CONTAIN STRINGS OF DIGITS	Fixup
			THE FIRST DIGIT STRING OF EACH PAIR MAY BE	Fixup
			PRECEEDED BY A - (MINUS SIGN).	Fixup
				Fixup
			EACH LINE WILL BE INTERPRETED AS FOLLOWS,	Fixup
				Fixup
			*SUMMATION (OR DIFFERENCES)	Fixup
			-------------------------	Fixup
			COLUMNS 1-5 = S OR BLANK FOLLOWED BY THE	Fixup
			MT NUMBER TO BE DEFINED BY SUMMATION	Fixup
				Fixup
			COLUMNS 6-72 = UP TO 10 MT RANGE (PAIRS OF	Fixup
			MT NUMBERS) TO BE USED TO DEFINED THE SUM.	Fixup
			IF THE FIRST MT NUMBER OF A PAIR IS	Fixup
			NEGATIVE THE RANGE OF MT NUMBERS IS	Fixup
			SUBTRACTED - AT LEAST ONE RANGE MUST BE	Fixup
			SPECIFIED.	Fixup
				Fixup
			*DELETIONS	Fixup
			---------	Fixup
			COLUMNS 1-5 = D FOLLOWED BY BLANKS	Fixup
				Fixup
			COLUMNS 6-72 CONTAIN UP TO 10 MT RANGE	Fixup
			(PAIRS OF MT NUMBERS), EACH RANGE DEFINING	Fixup
			A RANGE OF MT NUMBERS TO BE DELETED - AT	Fixup
			LEAST ONE RANGE MUST BE SPECIFIED.	Fixup
				Fixup
			*EXCLUSION FROM THRESHOLD TESTS	Fixup
			------------------------------	Fixup

			COLUMNS 1=5 = T FOLLOWED BY BLANKS	Fixup
				Fixup
			COLUMNS 6-72 CONTAIN UP TO 10 MT RANGE	Fixup
			(PAIRS OF MT NUMBERS), EACH RANGE DEFINING	Fixup
			A RANGE OF MT NUMBERS WHOSE THRESHOLD	Fixup
			ENERGY WILL NOT BE CHECKED - AT LEAST ONE	Fixup
			RANGE MUST BE SPECIFIED.	Fixup
				Fixup
			*RATIO	Fixup
			-----	Fixup
			COLUMNS 1-5 = R FOLLOWED BY THE MT NUMBER	Fixup
			TO BE DEFINED BY A RATIO	Fixup
				Fixup
			COLUMNS 6-72 CONTAINS 2 MT NUMBERS TO BE	Fixup
			USED TO DEFINE THE RATIO.	Fixup
				Fixup
			*PRODUCT	Fixup
			-----	Fixup
			COLUMNS 1-5 = * FOLLOWED BY THE MT NUMBER	Fixup
			TO BE DEFINED BY A PRODUCT	Fixup
				Fixup
			COLUMNS 6-72 CONTAINS 2 MT NUMBERS TO BE	Fixup
			USED TO DEFINE THE PRODUCT.	Fixup
				Fixup
			CONVENTIONS	Fixup
			----------	Fixup
			*UP TO 20 DELETIONS AND 20 SUMMATIONS OR	Fixup
			RATIOS OR PRODUCTS MAY BE SPECIFIED.	Fixup
			*ONLY 1 EXCLUSION FROM THRESHOLD TESTS	Fixup
			MAY BE SPECIFIED (THE 1 LINE MAY CONTAIN	Fixup
			UP TO 10 MT RANGES TO EXCLUDE FROM TESTS).	Fixup
			*INPUT IS TERMINATED BY INPUTTNG 0 OR	Fixup
			BLANK IN COLUMNS 1-72 (I.E. THE LAST	Fixup
			INPUT LINE MUST BE BLANK).	Fixup
			*THE UPPER LIMIT OF EACH RANGE MUST BE AT	Fixup
			LEAST AS BIG AS THE LOWER LIMIT (IN	Fixup
			ABSOLUTE VALUE).	Fixup
			*FOR RECONSTRUCTION POSITIVE MT RANGES WILL	Fixup
			BE ADDED TO THE SUM AND NEGATIVE MT RANGES	Fixup
			WILL BE SUBTRACTED.	Fixup
			*IF INPUT OPTION 2 (FIRST INPUT LINE) IS	Fixup
			0 THRESHOLD EXCLUSION IS NOT ALLOWED.	Fixup
			*IF INPUT OPTION 4 (FIRST INPUT LINE) IS	Fixup
			0 DELETIONS ARE NOT ALLOWED.	Fixup
			*IF INPUT OPTION 5 (FIRST INPUT LINE) IS	Fixup
			0 SUMMATIONS AND RATIOS ARE NOT ALLOWED.	Fixup
N-K			IF THE USER SPECIFIES THAT SECTIONS WHICH	Fixup
			ARE NOT PRESENT IN THE ORIGINAL EVALUATION	Fixup
			MAY BE CREATED, TWO LINES MUST BE INPUT FOR	Fixup
			EACH SECTION TO BE CREATED. THE TWO LINES	Fixup
			DEFINE (C1, C2, L1 AND L2) FOR EACH OF THE	Fixup
			FIRST TWO LINES OF THE SECTION TO BE	Fixup
			CREATED. THE FIRST LINE ALSO DEFINES (MAT	Fixup
			AND MT). (N1, N2) ARE ALWAYS ZERO ON THE	Fixup
			FIRST LINE AND WILL BE CALCULATED BY THE	Fixup
			PROGRAM FOR THE SECOND LINE.	Fixup
FIRST	1-11	E11.4	ZA OF SECTION TO BE CREATED	Fixup
LINE	12-22	E11.4	AWRE OF SECTION TO BE CREATED	Fixup
	23-33	I11	L1 OF SECTION TO BE CREATED	Fixup
	34-44	I11	L2 OF SECTION TO BE CREATED	Fixup
	45-48	I4	MAT OF SECTION TO BE CREATED	Fixup
	49-51	I3	MT OF SECTION TO BE CREATED	Fixup
SECOND	1-11	E11.4	C1 OF SECTION TO BE CREATED	Fixup
LINE	12-22	E11.4	C2 OF SECTION TO BE CREATED	Fixup
	23-33	I11	L1 OF SECTION TO BE CREATED	Fixup
	34-44	I11	L2 OF SECTION TO BE CREATED	Fixup
			*PAIRS OF LINES MAY BE IN ANY MAT/MT ORDER	Fixup
			(E.G., THEY NEED NOT BE IN ASCENDING	Fixup

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                      MAT/MT ORDER).                                  Fixup
                     *UP TO 50 PAIRS OF LINES MAY BE USED TO          Fixup
                      DEFINE SECTIONS TO BE CREATED. THE LIST         Fixup
                      IS TERMINATED WHEN THE FIRST LINE OF A          Fixup
                      PAIR CONTAINS A ZERO (OR BLANK) MAT AND/OR      Fixup
                      MT.                                             Fixup
M-N                   IF THE USER SPECIFIES THAT ENERGIES WHICH       Fixup
                      ARE NOT PRESENT IN THE ORIGINAL EVALUATION      Fixup
                      MAY BE INSERTED, ONE LINE MUST BE INPUT FOR     Fixup
                      EACH ENERGY TO BE INSERTED.                     Fixup
       1-11    E11.4  ENERGY TO BE INSERTED                           Fixup
      12-15     I4    MAT IN WHICH TO INSERT ENERGY = 0 = ALL         Fixup
      16-18     I3    MT IN WHICH TO INSERT ENERGY = 0 = ALL          Fixup
                     *UP TO 50 (ENERGY, MAT, MT) LINES MAY BE         Fixup
                      USED. THE LIST IS TERMINATED BY A BLANK         Fixup
                      LINE.                                           Fixup
                     *INPUT MAY BE IN ANY (ENERGY, MAT, MT)           Fixup
                      ORDER.                                          Fixup
                     *ENERGY POINTS CAN ONLY BE INSERTED WITHIN       Fixup
                      THE ORIGINAL ENERGY RANGE OF A SECTION -        Fixup
                      THIS OPTION CANNOT BE USED TO EXTEND THE        Fixup
                      CROSS SECTION EITHER BELOW OR ABOVE THE         Fixup
                      ORIGINAL TABULATED ENERGY RANGE.                Fixup
                                                                      Fixup
 EXAMPLE INPUT NO. 1                                                  Fixup
 ==================                                                   Fixup
 (1) USE OPTIONS 1-11 (ALL OPTIONS, EXCEPT INSERT ENERGY POINTS)      Fixup
 (2) DELETE MT=900 (FOR EXAMPLE PURPOSES ONLY)                        Fixup
 (3) DEFINE THE FOLLOWING MT NUMBERS TO BE RECONSTRUCTED,             Fixup
     (MT=  4) = THE SUM OF MT= 51 THROUGH  91                         Fixup
     (MT=103) = THE SUM OF MT=700 THROUGH 718 (NOT 719)               Fixup
     (MT=104) = THE SUM OF MT=720 THROUGH 738 (NOT 739)               Fixup
     (MT=105) = THE SUM OF MT=740 THROUGH 758 (NOT 759)               Fixup
     (MT=106) = THE SUM OF MT=760 THROUGH 778 (NOT 779)               Fixup
     (MT=107) = THE SUM OF MT=780 THROUGH 798 (NOT 799)               Fixup
     (MT=101) = THE SUM OF MT=102 THROUGH 114                         Fixup
     (MT= 18) = (MT=19) + (MT=20 AND 21) + (MT=38)                    Fixup
                (IF TOTAL FISSION, MT=18, IS NOT PRESENT, DEFINE      Fixup
                IT BY SUMMING FIRST, SECOND, ETC. CHANCE - NOTE       Fixup
                THAT THIS MUST BE DONE IN THIS ORDER, SINCE THE       Fixup
                NEXT SUM INVOLVES USING MT=18.                        Fixup
     (MT= 27) = THE SUM OF MT= 18 AND 101                             Fixup
                (MT=101 RECONSTRUCTED ABOVE USED IN SUM).             Fixup
     (MT=  3) = THE SUM OF (MT=4)+(MT=6-9)+(MT=16-17)+(MT=22-37)+     Fixup
                (MT=41-45)                                            Fixup
                (MT=4 AND 27 RECONSTRUCTED ABOVE USED IN SUM).        Fixup
     (MT= 19) = (MT=18) - (MT=20 AND 21) - (MT=38)                    Fixup
                (DEFINE FIRST CHANCE FISSION BY SUBTRACTION TO        Fixup
                ALLOW RESONANCE CONTRIBUTION FROM MT=18 TO BE         Fixup
                INCLUDED IN MT=19).                                   Fixup
     (MT=  1) = THE SUM OF MT=2 AND 3                                 Fixup
                (MT=3 RECONSTRUCTED ABOVE USED IN SUM).               Fixup
 (4) THRESHOLD ENERGIES OF THE FOLLOWING MT NUMBERS WILL NOT BE       Fixup
      TESTED OR CORRECTED.                                            Fixup
      MT=1, 4, 18, 19, 91, 103 THROUGH 114.                           Fixup
 (5) DEFINE MT=254 TO BE THE CAPTURE TO FISSION RATIO (MT=102/18)     Fixup
 (6) CREATE MAT=1300/MT=254 - NOTE, THIS IS NECESSARY IN ORDER TO     Fixup
     HAVE THE CAPTURE TO FISSION RATIO OUTPUT IN THE ENDF/B FORMAT    Fixup
                                                                      Fixup
 NOTE, ON THE FOLLOWING INPUT LINES THE CHARACTERS = ( ) + , HAVE     Fixup
 BEEN USED ONLY TO MAKE THE INPUT MORE READABLE - THESE CHARACTERS    Fixup
 WILL BE SKIPPED BY THE PROGRAM IN READING INPUT - THE RESULTS        Fixup
 WOULD BE THE SAME IF THESE CHARACTERS WERE OMITTED, AS LONG AS       Fixup
 ALL OF THE MT NUMBERS ARE DELIMITED, I.E., THERE IS AT LEAST ONE     Fixup
 NON-DIGITAL CHARACTER BETWEEN MT NUMBERS. NOTE, THAT - (MINUS        Fixup
 SIGN) IS IMPORTANT AND IS USED DURING INPUT TO DEFINE MT RANGES      Fixup
 WHICH SHOULD BE SUBTRACTED, E.,G., SEE THE DEFINITION OF MT=19.      Fixup
                                                                      Fixup
```

```
READ FILE /ENDFB6/K300/LEAD.IN AND WRITE /ENDFB6/K300/LEAD.OUT     Fixup
                                                                   Fixup
THE FOLLOWING 21 INPUT LINES ARE REQUIRED.                         Fixup
                                                                   Fixup
11111111111                                                        Fixup
/ENDFB6/K300/LEAD.IN                                               Fixup
/ENDFB6/K300/LEAD.OUT                                              Fixup
D900                                                               Fixup
   4=( 51, 91)                                                     Fixup
 103=(700,718)                                                     Fixup
 104=(720,738)                                                     Fixup
 105=(740,758)                                                     Fixup
 106=(760,778)                                                     Fixup
 107=(780,798)                                                     Fixup
 101=(102,114)                                                     Fixup
  18=( 19, 19)+( 20, 21)+( 38, 38)                                 Fixup
  27=( 18, 18)+(101,101)                                           Fixup
   3=(  4,  4)+(  6,  9)+( 16, 17)+( 22, 37)+( 41, 45)             Fixup
  19=( 18, 18)-( 20, 21)-( 38, 38)                                 Fixup
   1=(  2,  3)                                                     Fixup
T    (  1,  1) (  4,  4) ( 18, 19) ( 91, 91) (103,114)             Fixup
R254=(102/ 18)                                                     Fixup
            (BLANK LINE TO TERMINATE SUMMATION/DELETION RULES)     Fixup
 2.00400+ 3 0.00000+ 0          0          01300254                Fixup
 0.00000+ 0 0.00000+ 0          0          0                       Fixup
            (BLANK LINE TO TERMINATE SECTION CREATION RULES)       Fixup
                                                                   Fixup
NOTE, THE DELETION AND THRESHOLD EXCLUSION LINES MAY APPEAR IN     Fixup
IN ANY ORDER. HOWEVER, SUMMATION AND RATIO RULES MUST APPEAR IN    Fixup
THE ORDER IN WHICH YOU WANT THEM TO BE EXECUTED - E.G., THE        Fixup
ABOVE INPUT WILL FIRST RECONSTRUCT MT=4, WHICH CAN THEN BE USED    Fixup
TO CONTRIBUTE TO THE FOLLOWING SUM TO DEFINE MT=3, WHICH IN TURN   Fixup
CAN THEN BE USED TO CONTRIBUTE TO THE FOLLOWING SUM TO DEFINE      Fixup
MT=1. IF THE ORDER OF THE INPUT LINES IS CHANGED SUCH THAT MT=3    Fixup
IS RECONSTRUCTED BEFORE MT=4, THE ORIGINAL MT=4 WILL BE USED IN    Fixup
THE SUMMATION TO DEFINE MT=3. THE SAME RULES APPLY TO CALCULATING  Fixup
RATIOS, IF EITHER THE NUMERATOR OR DENOMINATOR IS TO BE DEFINED    Fixup
BY SUMMATION, THIS SHOULD BE DONE BEFORE DEFINING THE RATIO BY     Fixup
INPUT PARAMETERS.                                                  Fixup
                                                                   Fixup
EXAMPLE INPUT NO. 2                                                Fixup
==================                                                 Fixup
(1) USE OPTIONS 1-11 (ALL OPTIONS, EXCEPT INSERT ENERGY POINTS)    Fixup
(2) USE BUILT-IN TABLES FOR SUMMATION/DELETION/THRESHOLD EXCLUSION Fixup
    (THIS ONLY REQUIRES COLUMNS 2, 4 AND 5 TO BE SET =2 ON THE     Fixup
    FIRST INPUT LINE. THE BUILT-IN RULES EXACTLY CORRESPOND TO     Fixup
    THE INPUT ABOVE UNDER EXAMPLE NO. 1, EXCEPT THAT NO MT NUMBERS Fixup
    WILL BE DELETED.                                               Fixup
(3) IF NOT PRESENT, CREATE MAT=1300/MT=1                           Fixup
                                                                   Fixup
USE THE STANDARD FILE NAMES ENDFB.IN AND ENDFB.OUT (THIS CAN BE    Fixup
DONE BY LEAVING THE SECOND AND THIRD INPUT LINES BLANK).           Fixup
                                                                   Fixup
THE FOLLOWING 6 INPUT LINES ARE REQUIRED.                          Fixup

                                                                   Fixup
12122111111                                                        Fixup
                                                                   Fixup
                                                                   Fixup
 2.00400+ 3 0.00000+ 0          0          01300  1                Fixup
 0.00000+ 0 0.00000+ 0          0          0                       Fixup
            (BLANK LINE TO TERMINATE SECTION CREATION RULES)       Fixup
                                                                   Fixup
EXAMPLE INPUT NO. 3                                                Fixup
==================                                                 Fixup
(1) USE OPTIONS 1-10 (ALL OPTIONS PRESENTLY IMPLEMENTED, EXCEPT    Fixup
    DO NOT ALLOW SECTION CREATION AND INSERT ENERGY POINTS).       Fixup
(2) USE BUILT-IN TABLES FOR SUMMATION/DELETION/THRESHOLD EXCLUSION Fixup
```

```
    (THIS ONLY REQUIRES COLUMNS 2, 4 AND 5 TO BE SET =2 ON THE     Fixup
    FIRST INPUT LINE. THE BUILT-IN RULES EXACTLY CORRESPOND TO     Fixup
    THE INPUT ABOVE UNDER EXAMPLE NO. 1, EXCEPT THAT NO MT NUMBERS Fixup
    WILL BE DELETED.                                               Fixup
(3) DO NOT CREATE ANY SECTIONS.                                    Fixup
                                                                   Fixup
READ FILE /ENDFB6/K300/LEAD.IN AND WRITE /ENDFB6/K300/LEAD.OUT     Fixup
                                                                   Fixup
THE FOLLOWING 3 INPUT LINES ARE REQUIRED.                          Fixup
                                                                   Fixup
1212211111                                                         Fixup
/ENDFB6/K300/LEAD.IN                                               Fixup
/ENDFB6/K300/LEAD.OUT                                              Fixup
                                                                   Fixup
EXAMPLE INPUT NO. 4                                                Fixup
==================                                                 Fixup
SAME AS EXAMPLE NO. 3, ABOVE, EXCEPT INSERT AN ENERGY POINT AT     Fixup
THERMAL FOR ALL REACTIONS WHICH SPAN THE THERMAL ENERGY RANGE.     Fixup
                                                                   Fixup
USE THE STANDARD FILE NAMES ENDFB.IN AND ENDFB.OUT (THIS CAN BE    Fixup
DONE BY LEAVING THE SECOND AND THIRD INPUT LINES BLANK).           Fixup
                                                                   Fixup
THE FOLLOWING 5 INPUT LINES ARE REQUIRED.                          Fixup
                                                                   Fixup
121221111101                                                       Fixup
                                                                   Fixup
                                                                   Fixup
 2.53000- 2   0  0                                                Fixup
            (BLANK LINE TO TERMINATE ENERGY INSERTS)               Fixup
                                                                   Fixup
WARNING                                                            Fixup
=======                                                            Fixup
ALTHOUGH THIS PROGRAM IS DESIGNED TO ALLOW REACTIONS TO BE DEFINED Fixup
BY ADDING OR SUBTRACTING REACTIONS THE USER SHOULD ALWAYS TRY TO    Fixup
DEFINE REACTIONS BY SUMMING TO AVOID NEGATIVE CROSS SECTIONS. FOR  Fixup
EXAMPLE, IT IS POSSIBLE TO CALCULATE MT=3 AND DEFINE MT=1 AS THE   Fixup
SUM OF MT=2 AND 3 (THE RECOMMENDED APPROACH AS USED IN THE ABOVE   Fixup
INPUT). ALTERATIVELY IT IS POSSIBLE TO CALCULATE MT=1 AND DEFINE   Fixup
MT=3 AS MT=1 MINUS MT=2 (THIS APPROACH IS NOT RECOMMENDED).        Fixup
                                                                   Fixup
THE ONLY BUILT-IN SUMMATION RULE THAT USES SUBTRACTION IS THE      Fixup
CALCULATION OF THE FIRST CHANGE FISSION (MT=19) AS THE TOTAL       Fixup
FISSION (MT=18) MINUS THE SECOND, THIRD AND FOURTH CHANGE FISSION  Fixup
(MT=20, 21, 38). THIS HAS BEEN DONE TO ALLOW THE RESONANCE         Fixup
CONTRIBUTION, CALCULATED BY MANY CODES AND INCLUDED IN MT=18,      Fixup
TO BE CONSISTENTLY INCLUDED IN THE FIRST CHANCE FISSION.           Fixup
                                                                   Fixup
=================================================================== Fixup
```

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====================================================================== Groupie
                                                                       Groupie
      PROGRAM GROUPIE                                                  Groupie
      VERSION 76-1 (NOVEMBER 1976)                                     Groupie
      VERSION 79-1 (OCTOBER 1979) CDC-7600 AND CRAY-1 VERSION.         Groupie
      VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION                Groupie
      VERSION 81-1 (JANUARY 1981) EXTENSION TO 3000 GROUPS             Groupie
      VERSION 81-2 (MARCH 1981) IMPROVED SPEED                         Groupie
      VERSION 81-3 (AUGUST 1981) BUILT-IN 1/E WEIGHTING SPECTRUM       Groupie
      VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY      Groupie
      VERSION 83-1 (JANUARY 1983)*MAJOR RE-DESIGN.                     Groupie
                                 *ELIMINATED COMPUTER DEPENDENT CODING. Groupie
                                 *NEW, MORE COMPATIBLE I/O UNIT NUMBERS. Groupie
                                 *NEW MULTI-BAND LIBRARY BINARY FORMAT. Groupie
      VERSION 83-2 (OCTOBER 1983) ADDED OPTION TO ALLOW SIGMA-0 TO BE  Groupie
                                  DEFINED EITHER AS MULTIPLES OF       Groupie
                                  UNSHIELDED TOTAL CROSS SECTION IN EACH Groupie
                                  GROUP, OR POWERS OF 10 IN ALL GROUPS. Groupie
      VERSION 84-1 (APRIL 1984)   ADDED MORE BUILT IN MULTIGROUP ENERGY Groupie
                                  STRUCTURES.                          Groupie
      VERSION 85-1 (APRIL 1985)  *UPDATED FOR ENDF/B-VI FORMATS.       Groupie
                                 *SPECIAL I/O ROUTINES TO GUARANTEE    Groupie
                                  ACCURACY OF ENERGY.                  Groupie
                                 *DOUBLE PRECISION TREATMENT OF ENERGY  Groupie
                                  (REQUIRED FOR NARROW RESONANCES).    Groupie
                                 *MINIMUM TOTAL CROSS SECTION TREATMENT Groupie
      VERSION 85-2 (AUGUST 1985) *FORTRAN-77/H VERSION                 Groupie
      VERSION 86-1 (JANUARY 1986)*ENDF/B-VI FORMAT                     Groupie
      VERSION 86-2 (JUNE 1986)   *BUILT-IN MAXWELLIAN, 1/E AND FISSION  Groupie
                                  WEIGHTING SPECTRUM.                  Groupie
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O    Groupie
                                  FILE NAMES (SEE, SUBROUTINES FILIO1  Groupie
                                  FILIO2 FOR DETAILS).                 Groupie
                                 *IMPROVED BASED ON USER COMMENTS.     Groupie
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO   Groupie
                                  INSURE PROGRAM WILL NOT DO ANYTHING  Groupie
                                  CRAZY.                               Groupie
                                 *UPDATED TO USE NEW PROGRAM CONVERT   Groupie
                                  KEYWORDS.                            Groupie
                                 *ADDED LIVERMORE CIVIC COMPILER       Groupie
                                  CONVENTIONS.                         Groupie
      VERSION 91-1 (JUNE 1991)   *INCREASED PAGE SIZE FROM 1002 TO 5010 Groupie
                                  POINTS                               Groupie
                                 *UPDATED BASED ON USER COMMENTS       Groupie
                                 *ADDED FORTRAN SAVE OPTION            Groupie
                                 *COMPLETELY CONSISTENT ROUTINE TO READ Groupie
                                  FLOATING POINT NUMBERS.              Groupie
      VERSION 92-1 (JANUARY 1992)*ADDED RESONANCE INTEGRAL CALCULATION - Groupie
                                  UNSHIELDED AND/OR SHIELDED - FOR     Groupie
                                  DETAILS SEE BELOW                    Groupie
                                 *INCREASED NUMBER OF ENERGY POINTS    Groupie
                                  IN BUILT-IN SPECTRA - TO IMPROVE     Groupie
                                  ACCURACY.                            Groupie
                                 *ALLOW SELECTION OF ZA/MF/MT OR       Groupie
                                  MAT/MF/MT RANGES - ALL DATA NOT      Groupie
                                  SELECTED IS SKIPPED ON INPUT AND     Groupie
                                  NOT WRITTEN AS OUTPUT.               Groupie
                                 *COMPLETELY CONSISTENT I/O ROUTINES -  Groupie
                                  TO MINIMIZE COMPUTER DEPENDENCE.     Groupie
                                 *NOTE, CHANGES IN INPUT PARAMETER     Groupie
                                  FORMAT - FOR ZA/MF/MT OR MAT/MF/MT   Groupie
                                  RANGES.                              Groupie
      VERSION 92-2 (JUNE 1992)   *MULTIBAND PARAMETERS OUTOUT AS       Groupie
                                  CHARACTER (RATHER THAN BINARY) FILE. Groupie
      VERSION 93-1 (APRIL 1993)  *INCREASED PAGE SIZE FROM 5010 TO     Groupie
                                  30000 POINTS                         Groupie
                                 *ELIMINATED COMPUTER DEPENDENCE.      Groupie
      VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES       Groupie
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                          TO ALLOW ACCESS TO FILE STRUCTURES     Groupie
                          (WARNING - INPUT PARAMETER FORMAT      Groupie
                          HAS BEEN CHANGED)                      Groupie
                         *CLOSE ALL FILES BEFORE TERMINATING     Groupie
                          (SEE, SUBROUTINE ENDIT)                Groupie
VERSION 95-1 (JANUARY 1994)*CORRECTED MAXWELLIAN WEIGHTING       Groupie
                         *CHANGING WEIGHTING SPECTRUM FROM       Groupie
                          0.1 TO 0.001 % UNCERTAINTY             Groupie
VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                   Groupie
                          *IMPROVED COMPUTER INDEPENDENCE        Groupie
                          *ALL DOUBLE PRECISION                  Groupie
                          *ON SCREEN OUTPUT                      Groupie
                          *UNIFORM TREATMENT OF ENDF/B I/O       Groupie
                          *IMPROVED OUTPUT PRECISION             Groupie
                          *DEFINED SCRATCH FILE NAMES            Groupie
                          *UP TO 1000 GROUP MULTI-BAND           Groupie
                           CALCULATION (PREVIOUSLY 175)          Groupie
                          *MAXIMUM NUMBER OF GROUPS REDUCED      Groupie
                           FROM 3,000 TO 1,000                   Groupie
                          *UP TO 1000 MATERIALS                  Groupie
                           (PREVIOUSLY 100)                      Groupie
                          *CORRECTED USE OF MAXWELLIAN +         Groupie
                           1/E + FISSION SPECTRUM                Groupie
                          *ONLY 2 BAND VERSION DISTRIBUTED       Groupie
                           (CONTACT AUTHOR FOR DETAILS)          Groupie
                          *DEFINED SCRATCH FILE NAMES            Groupie
VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING     Groupie
                           POINT READ FOR MORE DIGITS            Groupie
                          *UPDATED TEST FOR ENDF/B FORMAT        Groupie
                           VERSION BASED ON RECENT FORMAT CHANGE Groupie
                          *GENERAL IMPROVEMENTS BASED ON         Groupie
                           USER FEEDBACK                         Groupie
VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING Groupie
                           MF=1, MT-451.                         Groupie
VERS. 2000-1 (FEBRUARY 2000)*ADDED MF=10, ACTIVATION CROSS SECTION Groupie
                           PROCESSING.                           Groupie
                          *GENERAL IMPROVEMENTS BASED ON         Groupie
                           USER FEEDBACK                         Groupie
VERS. 2002-1 (FEBRUARY 2002)*ADDED TART 700 GROUP STRUCTURE      Groupie
                          *ADDED VARIABLE SIGMA0 INPUT OPTION    Groupie
             (MAY 2002)     *OPTIONAL INPUT PARAMETERS           Groupie
             (NOV. 2002)    *ADDED SAND-II EXTENDED DOWN TO      Groupie
                           1.0E-5 EV.                            Groupie
             (JUNE 2003)    *CORRECTED SAND-II 620 AND 640 GROUP Groupie
                           ENERGY BOUNDARIES DEFINITIONS.        Groupie
VERS. 2004-1 (SEPT. 2004)  *INCREASED PAGE SIZE FROM 30000 TO    Groupie
                           120000 POINTS                         Groupie
                          *ADDED "OTHER" AS ADDITIONAL REACTION  Groupie
                           TO IMPROVE MULTI-BAND FITTING         Groupie
                          *ADDED ITERATION FOR "BEST" PARTIAL    Groupie
                           PARAMETERS.                           Groupie
                          *DO NOT SKIP LOW TOTAL ENERGY RANGES   Groupie
                           WHEN DEFINING AVERAGE CROSS SECTIONS - Groupie
                           THIS MAKES OUTPUT COMPATIBLE WITH     Groupie
                           ANY STANDARD AVERAGING PROCEDURE      Groupie
VERS. 2005-1 (JAN. 2005)   *ADDED OPTION TO CHANGE TEMPERATURE OF Groupie
                           BUILT-IN STANDARD SPECTRUM.           Groupie
VERS. 2007-1 (JAN. 2007)   *CHECKED AGAINST ALL ENDF/B-VII.    OF Groupie
                          *INCREASED PAGE SIZE FROM 120,000 TO   Groupie
                           600,000 POINTS                        Groupie
                                                                 Groupie
OWNED, MAINTAINED AND DISTRIBUTED BY                             Groupie
-----------------------------------                              Groupie
THE NUCLEAR DATA SECTION                                         Groupie
INTERNATIONAL ATOMIC ENERGY AGENCY                               Groupie
P.O. BOX 100                                                     Groupie
A-1400, VIENNA, AUSTRIA                                          Groupie
EUROPE                                                           Groupie
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AUTHORS MESSAGE

THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY THE COMMENTS CONCERNING MACHINE DEPENDENT CODING.

AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR COMPUTER.

PURPOSE

THIS PROGRAM IS DESIGNED TO CALCULATE ANY COMBINATION OF THE FOLLOWING QUANTITIES FROM LINEARLY INTERPOLABLE TABULATED CROSS SECTIONS IN THE ENDF/B FORMAT

(1) UNSHIELDED GROUP AVERAGED CROSS SECTIONS
(2) BONDARENKO SELF-SHIELDED GROUP AVERAGED CROSS SECTIONS
(3) MULTI-BAND PARAMETERS

IN THE FOLLOWING FOR SIMPLICITY THE ENDF/B TERMINOLOGY--ENDF/B TAPE--WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS, DISK OR ANY OTHER MEDIUM.

ENDF/B FORMAT

THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV OR V FORMAT).

IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS ASSUMED THAT THE MAT, MF AND MT ON EACH CARD IS CORRECT. SEQUENCE NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE CORRECTLY OUTPUT ON ALL CARDS. THE FORMAT OF SECTION MF=1, MT=451 AND ALL SECTIONS OF MF= 3 MUST BE CORRECT. THE PROGRAM COPIES ALL OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.

ALL FILE 3 CROSS SECTIONS THAT ARE USED BY THIS PROGRAM MUST BE LINEARLY INTERPOLABLE IN ENERGY AND CROSS SECTION (ENDF/B INTERPOLATION LAW 2). FILE 3 BACKGROUND CROSS SECTIONS MAY BE MADE LINEARLY INTERPOLABLE USING PROGRAM LINEAR (UCRL-50400, VOL. 17, PART A). THE RESONANCE CONTRIBUTION MAY BE ADDED TO THE BACKGROUND CROSS SECTIONS USING PROGRAM RECENT (UCRL-50400, VOL. 17, PART B). IF THIS PROGRAM FINDS THAT THE FILE 3 CROSS SECTIONS ARE NOT LINEARLY INTERPOLABLE THIS PROGRAM WILL TERMINATE EXECUTION.

```
                                                                      Groupie
CONTENTS OF OUTPUT                                                    Groupie
------------------                                                    Groupie
IF ENDF/B FORMATTED OUTPUT IS REQUESTED ENTIRE EVALUATIONS ARE        Groupie
OUTPUT, NOT JUST THE MULTI-GROUPED FILE 3 CROSS SECTIONS, E.G.        Groupie
ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO INCLUDED.                   Groupie
                                                                      Groupie
DOCUMENTATION                                                         Groupie
-------------                                                         Groupie
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED     Groupie
BY THE ADDITION OF THREE COMMENT CARDS AT THE END OF EACH             Groupie
HOLLERITH SECTION TO DESCRIBE THE GROUP STRUCTURE AND WEIGHTING       Groupie
SPECTRUM, E.G.                                                        Groupie
                                                                      Groupie
********************** PROGRAM GROUPIE (2007-1) ***************     Groupie

UNSHIELDED GROUP AVERAGES USING   69 GROUPS (WIMS)                   Groupie
MAXWELLIAN, 1/E AND FISSION WEIGHTING SPECTRUM                        Groupie
                                                                      Groupie
THE ORDER OF ALL SIMILAR COMMENTS (FROM LINEAR, RECENT AND SIGMA1)    Groupie
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON          Groupie
THE DATA.                                                             Groupie
                                                                      Groupie
THESE COMMENT CARDS ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,    Groupie
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT    Groupie
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF         Groupie
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451       Groupie
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF         Groupie
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF         Groupie
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO             Groupie
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND      Groupie
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT     Groupie
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                         Groupie
                                                                      Groupie
REACTION INDEX                                                        Groupie
--------------                                                        Groupie
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN        Groupie
SECTION MF=1, MT=451 OF EACH EVALUATION.                              Groupie
                                                                      Groupie
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.      Groupie
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT            Groupie
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS    Groupie
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING     Groupie
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE     Groupie
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM    Groupie
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.        Groupie
                                                                      Groupie
SECTION SIZE                                                          Groupie
------------                                                          Groupie
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT     Groupie
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS         Groupie
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                    Groupie
                                                                      Groupie
SELECTION OF DATA                                                     Groupie
-----------------                                                     Groupie
THE PROGRAM SELECTS MATERIALS TO BE PROCESSED BASED EITHER ON         Groupie
MAT (ENDF/B MAT NO.) OR ZA. THE PROGRAM ALLOWS UP TO 100 MAT OR       Groupie
ZA RANGES TO BE SPECIFIED. THE PROGRAM WILL ASSUME THAT THE           Groupie
ENDF/B TAPE IS IN EITHER MAT OR ZA ORDER, WHICHEVER CRITERIA IS       Groupie
USED TO SELECT MATERIALS, AND WILL TERMINATE WHEN A MAT OR ZA         Groupie
IS FOUND THAT IS ABOVE THE RANGE OF ALL REQUESTS.                     Groupie
                                                                      Groupie
ENERGY ORDER AND UNITS                                                Groupie
----------------------                                                Groupie
ALL ENERGIES (FOR CROSS SECTIONS, WEIGHTING SPECTRUM OR GROUP         Groupie
BOUNDARIES) MUST BE IN UNITS OF EV AND MUST BE IN ASCENDING           Groupie
NUMERICAL ORDER.                                                      Groupie
                                                                      Groupie
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ENERGY GRID                                                          Groupie
-----------                                                          Groupie
ALTHOUGH ALL REACTIONS MUST TO LINEARLY INTERPOLABLE, THEY DO NOT    Groupie
ALL HAVE TO USE THE SAME ENERGY GRID. EACH REACTION CAN BE GIVEN     Groupie
BY AN INDEPENDENT ENERGY GRID. THIS PROGRAM WILL PROCEED FROM        Groupie
THE LOWEST TO HIGHEST ENERGY SELECTING EACH ENERGY INTERVAL OVER     Groupie
WHICH ALL DATA, FOR ANY GIVEN CALCULATION, ARE ALL LINEARLY          Groupie
INTERPOLABLE.                                                        Groupie
                                                                     Groupie
GROUP STRUCTURE                                                      Groupie
---------------                                                      Groupie
THIS PROGRAM IS DESIGNED TO USE AN ARBITRARY ENERGY GROUP            Groupie
STRUCTURE WHERE THE ENERGIES ARE IN EV AND ARE IN INCREASING         Groupie
ENERGY ORDER. THE MAXIMUM NUMBER OF GROUPS IS 1000.                  Groupie
                                                                     Groupie
THE USER MAY INPUT AN ARBITRARY GROUP STRUCTURE OR THE USER MAY      Groupie
USE USE ONE OF THE SEVEN BUILT-IN GROUP STRUCTURES.                  Groupie
(0) 175 GROUP (TART STRUCTURE)                                       Groupie
(1)  50 GROUP (ORNL STRUCTURE)                                       Groupie
(2) 126 GROUP (ORNL STRUCTURE)                                       Groupie
(3) 171 GROUP (ORNL STRUCTURE)                                       Groupie
(4) 620 GROUP (SAND-II STRUCTURE, UP TO 18 MEV)                      Groupie
(5) 640 GROUP (SAND-II STRUCTURE, UP TO 20 MEV)                      Groupie
(6)  69 GROUP (WIMS STRUCTURE)                                       Groupie
(7)  68 GROUP (GAM-I STRUCTURE)                                      Groupie
(8)  99 GROUP (GAM-II STRUCTURE)                                     Groupie
(9)  54 GROUP (MUFT STRUCTURE)                                       Groupie
(10)  28 GROUP (ABBN STRUCTURE)                                      Groupie
(11) 650 GROUP (TART STRUCTURE)                                      Groupie
(12) 700 GROUP (TART STRUCTURE)                                      Groupie
(13) 665 GROUP (SAND-II STRUCTURE, 1.0e-5 eV, UP TO 18 MEV)          Groupie
(14) 685 GROUP (SAND-II STRUCTURE, 1.0e-5 eV, UP TO 20 MEV)          Groupie
                                                                     Groupie
GROUP AVERAGES                                                       Groupie
--------------                                                       Groupie
THIS PROGRAM DEFINES GROUP AVERAGED CROSS SECTIONS AS...             Groupie
                                                                     Groupie
          (INTEGRAL E1 TO E2) (SIGMA(E)*S(E)*WT(E)*DE)               Groupie
AVERAGE = ------------------------------------------                 Groupie
          (INTEGRAL E1 TO E2) (S(E)*WT(E)*DE)                        Groupie
WHERE...                                                             Groupie
                                                                     Groupie
AVERAGE  = GROUP AVERAGED CROSS SECTION                              Groupie
E1, E2   = ENERGY LIMITS OF THE GROUP                                Groupie
SIGMA(E) = ENERGY DEPENDENT CROSS SECTION FOR ANY GIVEN REACTION     Groupie
S(E)     = ENERGY DEPENDENT WEIGHTING SPECTRUM                       Groupie
WT(E)    = ENERGY DEPENDENT SELF-SHIELDING FACTOR.                   Groupie
                                                                     Groupie
ENERGY DEPENDENT WEIGHTING SPECTRUM                                  Groupie
-----------------------------------                                  Groupie
THE ENERGY DEPENDENT WEIGHTING SPECTRUM IS GIVEN BY AN ARBITRARY     Groupie
TABULATED LINERLY INTERPOLABLE FUNCTION WHICH CAN BE DESCRIBED       Groupie
BY AN ARBITRARY NUMBER OF POINTS. THIS ALLOWS THE USER TO            Groupie
SPECIFY ANY DESIRED WEIGHTING SPECTRUM TO ANY GIVEN DEGREE OF        Groupie
ACCURACY. REMEMBER THAT THE PROGRAM WILL ASSUME THAT THE SPECTRUM    Groupie
IS LINEARLY INTERPOLABLE BETWEEN TABULATED POINTS. THEREFORE THE     Groupie
USER SHOULD USE ENOUGH POINTS TO INSURE AN ADEQUATE REPRESENTATION   Groupie
OF THE SPECTRUM BETWEEN TABULATED DATA POINTS.                       Groupie
                                                                     Groupie
THE PRESENT VERSION OF THE CODE HAS THREE BULIT-IN WEIGHTING         Groupie
SPECTRA,                                                             Groupie
                                                                     Groupie
(1) CONSTANT                                                         Groupie
(2) 1/E                                                              Groupie
(3) MAXWELLIAN = E*EXP(-E/KT)/KT                (0.0 TO 4*KT)        Groupie
    1/E        = C1/E                           (4*KT TO 67 KEV)     Groupie
    FISSION    = C2*EXP(-E/WA)*SINH(SQRT(E*WB)) (ABOVE 67 KEV)       Groupie
                                                                     Groupie
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    KT     = 0.253 EV (293 KELVIN)                                  Groupie
    WA     = 9.65E+5                                                Groupie
    WB     = 2.29E-6                                                Groupie
    C1, C2 = DEFINED TO MAKE SPECTRUM CONTINUOUS                    Groupie
                                                                    Groupie
    FISSION SPECTRUM CONSTANTS FROM                                 Groupie
    A.F.HENRY, NUCLEAR REACTOR ANALYSIS, P. 11, MIT PRESS (1975)    Groupie
                                                                    Groupie
UNSHIELDED GROUP AVERAGES                                           Groupie
-------------------------                                           Groupie
FOR UNSHIELDED AVERAGES THE SELF-SHIELDING FACTOR (WT(E)) IS SET    Groupie
TO UNITY. THIS PROGRAM ALLOWS UP TO 1000 GROUPS.                    Groupie
                                                                    Groupie
SELF-SHIELDED GROUP AVERAGES                                        Groupie
----------------------------                                        Groupie
IF SELF-SHIELDED AVERAGES AND/OR MULTI-BAND PARAMETERS ARE          Groupie
CALCULATED THIS PROGRAM ALLOWS UP TO 1000 GROUPS. SELF-SHIELDED     Groupie
AVERAGES AND/OR MULTI-BAND PARAMETERS ARE CALCULATED FOR THE        Groupie
TOTAL, ELASTIC, CAPTURE AND FISSION.                                Groupie
                                                                    Groupie
FOR THE TOTAL, ELASTIC, CAPTURE AND FISSION THE PROGRAM USES A      Groupie
WEIGHTING FUNCTION THAT IS A PRODUCT OF THE ENERGY DEPENDENT        Groupie
WEIGHTING SPECTRUM TIMES A BONDERENKO TYPE SELF-SHIELDING FACTOR.   Groupie
                                                                    Groupie
WT(E) = S(E)/(TOTAL(E)+SIGMA0)**N                                   Groupie
                                                                    Groupie
WHERE...                                                            Groupie
                                                                    Groupie
S(E)     - ENERGY DEPENDENT WEIGHTING SPECTRUM (DEFINED BY          Groupie
           TABULATED VALUES AND LINEAR INTERPOLATION BETWEEN        Groupie
           TABULATED VALUES).                                       Groupie
TOTAL(E) - ENERGY DEPENDENT TOTAL CROSS SECTION FOR ONE MATERIAL    Groupie
           (DEFINED BY TABULATED VALUES AND LINEAR INTERPOLATION    Groupie
           BETWEEN TABULATED VALUES).                               Groupie
SIGMA0   - CROSS SECTION TO REPRESENT THE EFFECT OF ALL OTHER       Groupie
           MATERIALS AND LEAKAGE (DEFINED WITHIN EACH GROUP TO BE   Groupie
           A MULTIPLE OF THE UNSHIELDED TOTAL CROSS SECTION WITHIN  Groupie
           THAT GROUP OR POWERS OF 10 - INPUT OPTION).              Groupie
N        - A POSITIVE INTEGER (0, 1, 2 OR 3).                       Groupie
                                                                    Groupie
THE PROGRAM WILL USE ONE ENERGY DEPENDENT WEIGHTING SPECTRUM S(E)   Groupie
AND 25 DIFFERENT BONDERENKO TYPE SELF-SHIELDING FACTORS (25 SIGMA0  Groupie
AND N COMBINATIONS) TO DEFINE 25 DIFFERENT AVERAGE CROSS SECTIONS,  Groupie
FOR EACH REACTION, WITHIN EACH GROUP.                               Groupie
                                                                    Groupie
THE 25 WEIGHTING FUNCTIONS USED ARE....                             Groupie
(1)   - UNSHIELDED CROSS SECTIONS (N=0)                             Groupie
(2-22)- PARTIALLY SHIELDED CROSS SECTIONS (N=1 ,VARIOUS SIGMA0)     Groupie
        THE VALUES OF SIGMA0 USED WILL BE EITHER,                   Groupie
        (A) THE VALUES OF SIGMA0 THAT ARE USED VARY FROM 1024       Groupie
        TIMES THE UNSHIELDED TOTAL CROSS SECTIONS IN STEPS OF 1/2   Groupie
        DOWN TO 1/1024 TIMES THE UNSHIELDED TOTAL CROSS SECTION     Groupie
        (A RANGE OF OVER 1 MILLION, CENTERED ON THE UNSHIELDED      Groupie
        TOTAL CROSS SECTION WITHIN EACH GROUP).                     Groupie
        (B) THE SAME CONSTANT VALUES OF SIGMA0 IN EACH GROUP. THE   Groupie
        VALUES OF SIGMA0 USED INCLUDE 40000, 20000, 10000, 7000,    Groupie
        4000, 2000, 1000, 700, 400, 200, 100, 70, 40, 20, 10, 7,    Groupie
        4, 2, 1, 0.7, 0.4 (A RANGE OF 100,000 SPANNING MORE THAN    Groupie
        THE RANGE OF SIGMA0 VALUES THAT MAY BE ENCOUNTERED IN       Groupie
        ACTUAL APPLICATIONS)                                        Groupie
(23)  - TOTALLY SHIELDED FLUX WEIGHTED CROSS SECTION                Groupie
        (N=1, SIGMA0=0)                                             Groupie
(24)  - TOTALLY SHIELDED CURRENT WEIGHTED CROSS SECTION             Groupie
        (N=2, SIGMA0=0)                                             Groupie
(25)  - TOTALLY SHIELDED COSINE SQUARED WEIGHTED CROSS SECTION      Groupie
        (N=3, SIGMA0=0)                                             Groupie
                                                                    Groupie
FOR ALL OTHER REACTIONS (EXCEPT TOTAL, ELASTIC, CAPTURE AND         Groupie
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FISSION) THE PROGRAM WILL USE THE ENERGY DEPENDENT WEIGHTING       Groupie
SPECTRUM S(E) TO DEFINE THE UNSHIELDED (BONDERENKO N=0)            Groupie
AVERAGED CROSS SECTION WITHIN EACH GROUP.                          Groupie
                                                                   Groupie
CALCULATION OF RESONANCE INTEGRALS                                 Groupie
---------------------------------                                  Groupie
IN A PURE ELASTIC ISOTROPICALLY SCATTERING MATERIAL WITH A         Groupie
CONSTANT CROSS SECTION THE SPECTRUM WILL BE 1/E AND THERE WILL     Groupie
BE NO SELF-SHIELDING.                                              Groupie
                                                                   Groupie
IN THIS CASE IF THE CROSS SECTION VARIES WITH ENERGY THE           Groupie
SPECTRUM WILL STILL BE 1/E AND THE SELF-SHIELDING FACTOR WILL      Groupie
BE EXACTLY 1/SIG-TOT(E) - WHERE SIG-TOT(E) = SIG-EL(E), SINCE      Groupie
THERE IS ONLY SCATTERING.                                          Groupie
                                                                   Groupie
IF WE HAVE AN INFINITELY DILUTE AMOUNT OF A MATERIAL UNIFORMLY     Groupie
MIXED WITH A PURE ELASTIC ISOTROPICALLY SCATTERING MATERIAL WITH   Groupie
A CONSTANT CROSS SECTION THE STANDARD DEFINITION OF THE RESONANCE  Groupie
INTEGRAL CAN BE USED TO DEFINE REACTION RATES FOR EACH REACTION.   Groupie
                                                                   Groupie
THE RESONANCE INTEGRAL IS DEFINED AS,                              Groupie
                                                                   Groupie
RI      = (INTEGRAL E1 TO E2) (SIGMA(E)*S(E)*WT(E)*DE)             Groupie
                                                                   Groupie
WHERE NORMALLY,                                                    Groupie
S(E)    = 1/E                                                      Groupie
WT(E)   = 1    - NO SELF-SHIELDING                                 Groupie
                                                                   Groupie
FROM THE ABOVE DEFINITION OF GROUP AVERAGED CROSS SECTIONS THE     Groupie
RESONANCE INTEGRAL IS,                                             Groupie
                                                                   Groupie
RI      = AVERAGE * (INTEGRAL E1 TO E2) (S(E)*WT(E)*DE)            Groupie
                                                                   Groupie
FOR A 1/E SPECTRUM AND NO SELF-SHIELDING THIS REDUCES TO,          Groupie
                                                                   Groupie
RI      = AVERAGE* LOG(E2/E1)                                      Groupie
                                                                   Groupie
IN ANY OTHER SITUATION, INCLUDING ABSORPTION AND/OR ENERGY         Groupie
DEPENDENT CROSS SECTIONS, THE SPECTRUM WILL NOT BE 1/E -           Groupie
ABSORPTION WILL TEND TO DECREASE THE SPECTRUM PROGRESSIVELY        Groupie
MORE AT LOWER ENERGIES - ENERGY DEPENDENCE OF THE CROSS SECTION    Groupie
WILL LEAD TO SELF-SHIELDING.                                       Groupie
                                                                   Groupie
HERE WE WILL NOT ATTEMPT TO PERFORM A DETAILED SPECTRUM            Groupie
CALCULATION TO ACCOUNT FOR ABSORPTION.                             Groupie
                                                                   Groupie
HOWEVER, WE WILL EXTEND THE DEFINITION OF THE RESONANCE INTEGRAL   Groupie
TO ACCOUNT FOR SELF-SHIELDING EFFECTS BY ALLOWING FOR INCLUSION    Groupie
OF SELF-SHIELDING EFFECTS IN THE DEFINITION OF GROUP AVERAGES      Groupie
AND THEN DEFINING THE RESONANCE INTEGRAL AS,                       Groupie
                                                                   Groupie
RI      = AVERAGE* LOG(E2/E1)                                      Groupie
                                                                   Groupie
IN ORDER TO CALCULATE RESONANCE INTEGRALS YOU MUST FOLLOW THESE    Groupie
STEPS,                                                             Groupie
                                                                   Groupie
1) SELECT A 1/E SPECTRUM - ON FIRST LINE OF INPUT PARAMETERS.      Groupie
2) SELECT THE ENERGY BOUNDARIES - NORMALLY ONLY 1 GROUP FROM       Groupie
   0.5 EV UP TO 20 MEV - HOWEVER, YOU ARE FREE TO SELECT ANY       Groupie
   ENERGY RANGE THAT YOU WISH - YOU MAY EVEN SELECT MORE THAN      Groupie
   1 GROUP MERELY BY SPECIFYING MORE THAN 1 GROUP AS INPUT -       Groupie
   THIS CAN BE USED TO DEFINE THE CONTRIBUTIONS TO THE RESONANCE   Groupie
   INTEGRAL FROM INDIVIDUAL ENERGY RANGES.                         Groupie
3) SELECT THIS OPTION FOR THE UNSHIELDED AND/OR SHIELDED OUTPUT    Groupie
   LISTING - ON THE SECOND LINE OF INPUT PARAMETERS.               Groupie
                                                                   Groupie
WHEN THIS OPTION IS USED THE PROGRAM WILL CALCULATE GROUP AVERAGED Groupie
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CROSS SECTIONS - AS DEFINED ABOVE - PRIOR TO OUTPUT THE RESULTS    Groupie

WILL MERELY BE MULTIPLIED BY THE WIDTH OF THE GROUP ASSUMING YOU   Groupie
HAVE SELECTED A 1/E SPECTRUM - THERE IS NO CHECK ON THIS - THE     Groupie
PROGRAM MERELY MULTIPLIES THE GROUP AVERAGED CROSS SECTIONS BY,    Groupie
                                                                   Groupie
LOG(E2/E1) - WHERE E2 AND E1 ARE THE GROUP ENERGY BOUNDARIES.      Groupie
                                                                   Groupie
WARNING - IT IS UP TO YOU TO INSURE THAT YOU FOLLOW EXACTLY THE    Groupie
          STEPS OUTLINED ABOVE IF YOU WISH TO OBTAIN MEANINGFUL    Groupie
          RESULTS.                                                 Groupie
                                                                   Groupie
NOTE - OUTPUT IN THE ENDF/B FORMAT IS ALWAYS GROUP AVERAGED CROSS  Groupie
       SECTIONS, REGARDLESS OF WHETHER YOU ASK FOR AVERAGED CROSS  Groupie
       SECTIONS OR RESONANCE INTEGRALS - THIS IS BECAUSE DATA IN   Groupie
       THE ENDF/B FORMAT IS EXPLICITLY DEFINED TO BE CROSS         Groupie
       SECTIONS.                                                   Groupie
                                                                   Groupie
       RESONANCE INTEGRAL OUTPUT CAN ONLY BE OBTAINED IN THE       Groupie
       LISTING FORMATS.                                            Groupie
                                                                   Groupie
MINIMUM TOTAL CROSS SECTION TREATMENT                              Groupie
-------------------------------------                              Groupie
SINCE THE BONDARENKO SELF-SHIELDING DEPENDS ON 1/TOTAL CROSS       Groupie
SECTION, THE ALGORITHM WILL BECOME NUMERICALLY UNSTABLE IF THE     Groupie
TOTAL CROSS SECTION IS NEGATIVE (AS OCCURS IN MANY ENDF/B          Groupie
EVALUATIONS). IF THE TOTAL IS LESS THAN SOME MINIMUM ALLOWABLE     Groupie
VALUE (DEFINE BY OKMIN, PRESENTLY 1 MILLI-BARN) AN ERROR MESSAGE   Groupie
WILL BE PRINTED AND FOR THE SELF-SHIELDING CALCULATION ALL ENERGY  Groupie
INTERVALS IN WHICH THE TOTAL IS LESS THAN THE MINIMUM WILL BE      Groupie
IGNORED.                                                           Groupie
                                                                   Groupie
NOTE, FOR THE UNSHIELDED CALCULATIONS ALL CROSS SECTIONS WILL BE   Groupie
CONSIDERED WHETHER THEY ARE POSITIVE OR NEGATIVE. THEREFORE IF     Groupie
THE TOTAL CROSS SECTION IS NEGATIVE OR LESS THAN THE MINIMUM       Groupie
VALUE THERE MAY BE AN INCONSISTENCY BETWEEN THE UNSHIELDED AND     Groupie
THE SELF-SHIELDED CROSS SECTIONS. IF THE TOTAL CROSS SECTION IS    Groupie
NEGATIVE AND SELF-SHIELDED CROSS SECTIONS ARE CALCULATED THE       Groupie
PROGRAM WILL PRINT AN ERROR MESSAGE INDICATING THAT THE SELF-      Groupie
SHIELDED RESULTS ARE UNRELIABLE AND SHOULD NOT BE USED. THEREFORE  Groupie
IN THIS CASE THE PROGRAM WILL NOT ATTEMPT TO MODIFY THE UNSHIELDED Groupie
RESULTS TO ELIMINATE THE EFFECT OF NEGATIVE CROSS SECTIONS, SINCE  Groupie
THE UNSHIELDED RESULTS ARE THE ONLY ONES WHICH TRULY REFLECT THE   Groupie
ACTUAL INPUT.                                                      Groupie
                                                                   Groupie
RESOLVED RESONANCE REGION                                          Groupie
-------------------------                                          Groupie
IN THE RESOLVED RESONANCE REGION (ACTUALLY EVERYWHERE BUT IN THE   Groupie
UNRESOLVED RESONANCE REGION) THE CROSS SECTIONS OUTPUT BY LINEAR-  Groupie
RECENT-SIGMA1 WILL BE ACTUAL ENERGY DEPENDENT CROSS SECTIONS AND   Groupie
THE CALCULATIONS BY THIS PROGRAM WILL YIELD ACTUAL SHIELDED AND    Groupie
UNSHIELDED CROSS SECTIONS.                                         Groupie
                                                                   Groupie
UNRESOLVED RESONANCE REGION                                        Groupie
---------------------------                                        Groupie
IN THE UNRESOLVED RESONANCE REGION PROGRAM RECENT USES THE         Groupie
UNRESOLVED RESONANCE PARAMETERS TO CALCULATE INFINITELY DILUTE     Groupie
AVERAGE CROSS SECTIONS. THIS PROGRAM WILL MERELY READ THIS         Groupie
INFINITELY DILUTE DATA AS IF IT WERE ENERGY DEPENDENT DATA AND     Groupie
GROUP AVERAGE IT. AS SUCH THIS PROGRAM WILL PRODUCE THE CORRECT    Groupie
UNSHIELDED CROSS SECTION IN THE UNRESOLVED RESONANCE REGION, BUT   Groupie
IT WILL NOT PRODUCE THE CORRECT SELF-SHIELDING EFFECTS.            Groupie
                                                                   Groupie
ACCURACY OF RESULTS                                                Groupie
-------------------                                                Groupie
ALL INTEGRALS ARE PERFORMED ANALYTICALLY. THEREFORE NO ERROR IS    Groupie
INTRODUCED DUE TO THE USE OF TRAPAZOIDAL OR OTHER INTEGRATION      Groupie
SCHEME. THE TOTAL ERROR THAT CAN BE ASSIGNED TO THE RESULTING      Groupie
```

AVERAGES IS JUST THAT DUE TO THE ERROR IN THE CROSS SECTIONS Groupie
AND ENERGY DEPENDENT WEIGHTING SPECTRUM. GENERALLY SINCE THE Groupie
THE ENERGY DEPENDENT WEIGHTING SPECTRUM APPEARS IN BOTH THE Groupie
NUMERATOR AND THE DENOMINATOR THE AVERAGES RAPIDLY BECOME Groupie
INSENSITIVE TO THE WEIGHTING SPECTRUM AS MORE GROUPS ARE USED. Groupie
SINCE THE WEIGHTING SPECTRUM IS LOADED IN THE PAGING SYSTEM THE Groupie
USER CAN DESCRIBE THE SPECTRUM TO ANY REQUIRED ACCURACY USING Groupie
ANY NUMBER OF ENERGY VS. SPECTRUM PAIRS. Groupie
Groupie

MULTI-BAND PARAMETERS Groupie
--- Groupie
MULTI-BAND PARAMETERS ARE CALCULATED FOR THE TOTAL, ELASTIC, Groupie
CAPTURE AND FISSION REACTIONS. WITH THE NUMBER OF GROUPS THAT Groupie
ARE NORMALLY USED (SEE BUILT IN GROUP STRUCTURES) ALL OTHER Groupie
REACTIONS RESULT IN A NEGLIGABLE AMOUNT OF SELF-SHIELDING. AS Groupie
SUCH THEIR EQUIVALENT BAND CROSS SECTION WILL MERELY BE THEIR Groupie
UNSHIELDED VALUE WITHIN EACH BAND. Groupie
Groupie

FOR ANY GIVEN EVALUATION, WITHIN ANY GIVEN GROUP THIS PROGRAM Groupie
WILL GENERATE THE MINIMUM NUMBER OF BANDS REQUIRED WITHIN THAT Groupie
GROUP. AS OUTPUT TO THE COMPUTER READABLE DISK FILE THE BAND Groupie
PARAMETERS FOR EACH EVALUATION WILL BE FORMATTED TO HAVE THE Groupie
SAME NUMBER OF BANDS IN ALL GROUPS (WITH ZERO WEIGHT FOR SOME Groupie
BANDS WITHIN ANY GROUP). THE USER MAY DECIDE TO HAVE OUTPUT Groupie
EITHER WITH THE MINIMUM NUMBER OF BANDS REQUIRED FOR EACH Groupie
EVALUATION (E.G. 2 BANDS FOR HYDROGEN AND 4 BANDS FOR U-233) OR Groupie
THE SAME NUMBER OF BANDS FOR ALL EVALUATIONS (E.G. 4 BANDS FOR Groupie
BOTH HYDROGEN AND U-233). Groupie
Groupie

FOR 2 OR FEWER BANDS THE PROGRAM USES AN ANALYTIC EXPRESSION Groupie
TO DEFINE ALL MULTI-BAND PARAMETERS. FOR MORE THAN 2 BANDS THE Groupie
PROGRAM PERFORMS A NON-LINEAR FIT TO SELECT THE MULTI-BAND Groupie
PARAMETERS THAT MINIMIZE THE MAXIMUM FRACTIONAL ERROR AT ANY Groupie
POINT ALONG THE ENTIRE SELF-SHIELDING CURVE. THE NUMBER OF BANDS Groupie
REQUIRED WITHIN ANY GIVEN GROUP IS DEFINED BY INSURING THAT THE Groupie
MULTI-BAND PARAMETERS CAN BE USED TO ACCURATELY DEFINE SELF- Groupie
SHIELDED CROSS SECTIONS ALONG THE ENTIRE SELF-SHIELDING CURVE Groupie
FROM SIGMA0 = 0 TO INFINITY. THE USER MAY DEFINE THE ACCURACY Groupie
REQUIRED. Groupie
Groupie

ENDF/B FORMATTED UNSHIELDED AVERAGES Groupie
--- Groupie
UNSHIELDED MULTI-GROUP AVERAGED CROSS SECTIONS FOR ALL REACTIONS Groupie
MAY BE OBTAINED IN THE ENDF/B FORTRAN IN EITHER HISTOGRAM Groupie
(INTERPOLATION LAW 1) OR LINEARLY INTERPOLABLE (INTERPOLATION Groupie
LAW 2) FORM. SEE INPUT BELOW FOR DETAILS. Groupie
Groupie

MIXTURES OF MATERIALS AND RESONANCE OVERLAP Groupie
--- Groupie
THE SELF-SHIELDED CROSS SECTIONS FOR THE INDIVIDUAL CONSTITUENTS Groupie
OF ANY MIXTURE CAN BE CALCULATED BY THIS PROGRAM BY REALIZING THAT Groupie
THIS PROGRAM ESSENTIALLY ONLY USES THE TOTAL CROSS SECTION AS A Groupie
WEIGHTING FUNCTION TO ACCOUNT FOR SELF-SHIELDING EFFECTS. FOR A Groupie
MIXTURE IT IS THEREFORE ONLY NECESSARY TO USE THE TOTAL CROSS Groupie
SECTION FOR THE MIXTURE IN PLACE OF THE ACTUAL TOTAL CROSS SECTION Groupie
FOR EACH CONSTITUENT AND TO RUN THIS PROGRAM. THIS CAN BE DONE BY Groupie
FIRST RUNNING PROGRAM MIXER TO CALCULATE THE ENERGY DEPENDENT Groupie
TOTAL CROSS SECTION FOR ANY COMPOSITE MIXTURE. NEXT, SUBSTITUTE Groupie
THIS COMPOSITE TOTAL CROSS SECTION FOR THE ACTUAL TOTAL CROSS Groupie
SECTION OF EACH CONSTITUENT (IN EACH ENDF/B FORMATTED EVALUATION). Groupie
FINALLY, RUN THIS PROGRAM TO CALCULATE THE SELF-SHIELDED CROSS Groupie
SECTION FOR EACH CONSTITUENT, PROPERLY ACCOUNTING FOR RESONANCE Groupie
OVERLAP BETWEEN THE RESONANCES OF ALL OF THE CONSTITUENTS OF THE Groupie
MIXTURE. DURING THE SAME RUN THESE SELF-SHIELDED CROSS SECTIONS Groupie
CAN IN TURN BE USED TO CALCULATE FULLY CORRELATED MULT-BAND Groupie
Groupie

MULTI-BAND PARAMETER OUTPUT FORMAT Groupie
--- Groupie

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FOR VERSIONS 92-2 AND LATER VERSIONS THE MULTI-BAND PARAMETERS     Groupie
ARE OUTPUT IN A SIMPLE CHARACTER FORMAT, THAT CAN BE TRANSFERRED   Groupie
AND USED ON VIRTUALLY ANY COMPUTER.                                Groupie
                                                                   Groupie
THE BINARY FORMAT USED IN EARLIER VERSIONS OF THIS CODE IS NO      Groupie
LONGER USED.                                                       Groupie
                                                                   Groupie
CONTACT THE AUTHOR IF YOU WOULD LIKE TO RECEIVE A SIMPLE PROGRAM   Groupie
TO READ THE CHARACTER FORMATTED MULTI-BAND PARAMETER FILE AND       Groupie
CREATE A BINARY, RANDOM ACCESS FILE FOR USE ON VIRTUALLY ANY       Groupie
COMPUTER.                                                          Groupie
                                                                   Groupie
THE FORMAT OF THE CHARACTER FILE IS,                               Groupie
                                                                   Groupie
RECORD   COLUMNS   FORMAT   DESCRIPTION                           Groupie
   1       1-72     18A4    LIBRARY DESCRIPTION (AS READ)         Groupie
   2       1-11      I11    MATERIAL ZA                           Groupie
          12-22      I11    NUMBER GROUPS                         Groupie
          23-33      I11    NUMBER OF BANDS                       Groupie
          34-44     D11.4   TEMPERATURE (KELVIN)                  Groupie
          45-55    1X,10A1  HOLLERITH DESCRIPTION OF ZA           Groupie
   3       1-11     D11.4   ENERGY (EV) - GROUP BOUNDARY.         Groupie
          12-22     D11.4   TOTAL      (FIRST BAND)               Groupie
          23-33     D11.4   ELASTIC                               Groupie
          34-44     D11.4   CAPTURE                               Groupie
          35-55     D11.4   FISSION                               Groupie
   4       1-11     -----   BLANK                                 Groupie
          12-22     D11.4   TOTAL      (SECOND BAND)              Groupie
          23-33     D11.4   ELASTIC                               Groupie
          34-44     D11.4   CAPTURE                               Groupie
          35-55     D11.4   FISSION                               Groupie
                                                                   Groupie
LINES 3 AND 4 ARE REPEATED FOR EACH GROUP. THE LAST LINE FOR EACH  Groupie
MATERIAL (ZA) IS,                                                  Groupie
                                                                   Groupie
   N       1-11     D11.4   ENERGY (EV) - UPPER ENERGY LIMIT OF   Groupie
                                          LAST GROUP.              Groupie
                                                                   Groupie
FOR EXAMPLE, A 175 GROUP, 2 BAND FILE, FOR EACH MATERIAL WILL      Groupie
CONTAIN 352 LINES = 1 HEADER LINE, 175 * 2 LINES OF PARAMETERS,    Groupie
                    AND 1 FINAL LINE WITH THE UPPER ENERGY LIMIT   Groupie
                    OF THE LAST GROUP.                             Groupie
                                                                   Groupie
INPUT FILES                                                        Groupie
-----------                                                        Groupie
UNIT  DESCRIPTION                                                  Groupie
----  -----------                                                  Groupie
  2   INPUT DATA (BCD - 80 CHARACTERS/RECORD)                      Groupie
 10   ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)            Groupie
                                                                   Groupie
OUTPUT FILES                                                       Groupie
------------                                                       Groupie
UNIT  DESCRIPTION                                                  Groupie
----  -----------                                                  Groupie
 31   MULTI-BAND PARAMETERS CHARACTER FILE - OPTIONAL              Groupie
      (BCD - 80 CHARACTERS/RECORD)                                 Groupie
 32   SELF-SHIELDED CROSS SECTION LISTING - OPTIONAL               Groupie
      (BCD - 120 CHARACTERS/RECORD)                                Groupie
 33   MULTI-BAND PARAMETER LISTING - OPTIONAL                      Groupie
      (BCD - 120 CHARACTERS/RECORD)                                Groupie
 34   UNSHIELDED CROSS SECTION LISTING - OPTION                    Groupie
      (BCD - 120 CHARACTERS/RECORD)                                Groupie
  3   OUTPUT REPORT (BCD - 80 CHARACTERS/RECORD)                   Groupie
 11   MULTI-GROUP ENDF/B DATA - OPTIONAL                           Groupie
      (BCD - 80 CHARACTERS/RECORD)                                 Groupie
                                                                   Groupie
SCRATCH FILES                                                      Groupie
-------------                                                      Groupie
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UNIT  FILENAME  DESCRIPTION                                                Groupie
----  --------  -----------                                                Groupie
  8   ENERGY DEPENDENT WEIGHTING SPECTRUM                                  Groupie
      (BINARY - 40080 WORDS/BLOCK)                                         Groupie
  9   TOTAL CROSS SECTION                                                  Groupie
      (BINARY - 40080 WORDS/BLOCK)                                         Groupie
 12   ELASTIC CROSS SECTION - ONLY FOR SELF-SHIELDING CALCULATION          Groupie
      (BINARY - 40080 WORDS/BLOCK)                                         Groupie
 13   CAPTURE CROSS SECTION - ONLY FOR SELF-SHIELDING CALCULATION          Groupie
      (BINARY - 40080 WORDS/BLOCK)                                         Groupie
 14   FISSION CROSS SECTION - ONLY FOR SELF-SHIELDING CALCULATION          Groupie
      (BINARY - 40080 WORDS/BLOCK)                                         Groupie
                                                                           Groupie
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINES FILIO1 AND FILIO2)           Groupie
-------------------------------------------------------------------        Groupie
UNIT  FILE NAME                                                            Groupie
----  ----------                                                           Groupie
  2   GROUPIE.INP                                                          Groupie
  3   GROUPIE.LST                                                          Groupie
  8   (SCRATCH)                                                            Groupie
  9   (SCRATCH)                                                            Groupie
 10   ENDFB.IN                                                             Groupie
 11   ENDFB.OUT                                                            Groupie
 12   (SCRATCH)                                                            Groupie
 13   (SCRATCH)                                                            Groupie
 14   (SCRATCH)                                                            Groupie
 31   MULTBAND.TAB                                                         Groupie
 32   SHIELD.LST                                                           Groupie
 33   MULTBAND.LST                                                         Groupie
 34   UNSHIELD.LST                                                         Groupie
                                                                           Groupie
 I/O UNITS USED                                                            Groupie
 --------------                                                            Groupie
 UNITS 2, 3 8, 9 AND 10 WILL ALWAYS BE USED.                               Groupie
 UNITS 31 THROUGH 34 AND 11 ARE OPTIONALLY USED DEPENDING ON THE           Groupie
 OUTPUT REQUESTED.                                                         Groupie
 UNITS 12, 13 AND 14 WILL ONLY BE USED IF SELF-SHIELDED OR                 Groupie
 MULTIBAND OUTPUT IS REQUESTED.                                            Groupie
                                                                           Groupie
INPUT CARDS                                                                Groupie
-----------                                                                Groupie
CARD  COLS.  FORMAT  DESCRIPTION                                           Groupie
----  -----  ------  -----------                                           Groupie
  1    1-11    I11   SELECTION CRITERIA (0=MAT, 1=ZA)                      Groupie
  1   12-22    I11   NUMBER OF GROUPS.                                     Groupie
                     =.GT.0 - ARBITRARY GROUP BOUNDARIES ARE READ          Groupie
                              FROM INPUT FILE (N GROUPS REQUIRE            Groupie
                              N+1 GROUP BOUNDARIES). CURRENT               Groupie
                              PROGRAM MAXIMUM IS 1000 GROUPS.              Groupie
                              BUILT-IN OPTIONS INCLUDE....                 Groupie
                     =  0   - TART    175 GROUPS                           Groupie
                     = -1   - ORNL     50 GROUPS                           Groupie
                     = -2   - ORNL    126 GROUPS                           Groupie
                     = -3   - ORNL    171 GROUPS                           Groupie

                     = -4   - SAND-II 620 (665) GROUPS TO 18 MEV           Groupie
                     = -5   - SAND-II 640 (685) GROUPS TO 20 MEV           Groupie
                     = -6   - WIMS     69 GROUPS                           Groupie
                     = -7   - GAM-I    68 GROUPS                           Groupie
                     = -8   - GAM-II   99 GROUPS                           Groupie
                     = -9   - MUFT     54 GROUPS                           Groupie
                     =-10   - ABBN     28 GROUPS                           Groupie
                     =-11   - TART    650 GROUPS                           Groupie
                     =-12   - TART    700 GROUPS                           Groupie
                     =-13   - SAND-II 665 GROUPS TO 18 MEV                 Groupie
                     =-14   - SAND-II 685 GROUPS TO 20 MEV                 Groupie
  1   23-33    I11   MULTI-BAND SELECTOR                                   Groupie
                     =  0 - NO MULTI-BAND CALCULATIONS                     Groupie
```

```
                          =  1 - 2 BAND. CONSERVE AV(TOT), AV(1/TOT)    Groupie
                                 AND AV(1/TOT**2)                       Groupie
                          =  2 - 2 BAND. CONSERVE AV(TOT), AV(1/TOT)    Groupie
                                 AND AV(1/(TOT+SIGMA0)) WHERE           Groupie
                                 SIGMA0 = AV(TOT) IN EACH GROUP         Groupie
                          = 3-5- MULTI-BAND FIT. CONSERVE AV(TOT) AND   Groupie
                                 MINIMIZE FRACTIONAL ERROR FOR ENTIRE   Groupie
                                 SELF-SHIELDING CURVE (SIGMA0 = 0 TO    Groupie
                                 INFINITY)                              Groupie
                          IF THE SELECTOR IS POSITIVE (1 TO 5) THE      Groupie
                          MINIMUM NUMBER OF BANDS WILL BE OUTPUT FOR    Groupie
                          EACH ISOTOPE INDEPENDENTLY. IF THE SELECTOR   Groupie
                          IS NEGATIVE (-1 TO -5) THE SAME NUMBER OF     Groupie
                          BANDS (ABS(SELECTOR)) WILL BE OUTPUT FOR      Groupie
                          ALL ISOTOPES.                                 Groupie
      1   34-44    I11    NUMBER OF POINTS USED TO DESCRIBE ENERGY      Groupie
                          DEPENDENT WEIGHTING SPECTRUM S(E).            Groupie
                          = -2    - MAXWELLIAN - UP TO 0.1 EV           Groupie
                                    1/E        - 0.1 EV TO 67 KEV       Groupie
                                    FISSION    - ABOVE 67 KEV           Groupie
05/01/20------------------ADDED OPTION TO ALLOW TEMPERATURE OF THE      Groupie
                          MAXWELLIAN TO BE CHANGED - SEE INPUT LINE 4,  Groupie
                          COLUMNS 55 - 66.                              Groupie
                          = -1    - 1/E                                 Groupie
                          = 0 OR 1- ENERGY INDEPENDENT (SO CALLED FLAT  Groupie
                                    WEIGHTING SPECTRUM).                Groupie
                          = .GT.1 - READ THIS MANY POINTS FROM INPUT    Groupie
                                    TO DESCRIBE WEIGHTING SPECTRUM.     Groupie
                                    NO LIMIT TO THE NUMBER OF POINTS    Groupie
                                    USED TO DESCRIBE WEIGHTING.         Groupie
      1   45-55   D11.4  MULTI-BAND CONVERGENCE CRITERIA.               Groupie
                          ONLY USED FOR 3 OR MORE BANDS. THE NUMBER OF  Groupie
                          BANDS IN EACH GROUPS IS SELECTED TO INSURE    Groupie
                          THAT THE ENTIRE SELF-SHIELDING CURVE CAN BE   Groupie
                          REPRODUCED TO WITHIN THIS FRACTIONAL ERROR.    Groupie
                          = .LT. 0.0001 - USE STANDARD 0.001            Groupie
                                          (0.1 PER-CENT)                Groupie
                          = .GE. 0.0001 - USE AS CONVERGENCE CRITERIA   Groupie
      1   56-66    I11    SIGMA-0 DEFINITION SELECTOR.                  Groupie
                          < 0 - 21 VALUES OF SIGMA0 ARE READ INPUT AND  Groupie
                                INTERPRETED AS FIXED VALUES = SAME AS   Groupie
                                = 1 DESCRIPTION BELOW                   Groupie
                                INPUT VALUES MUST ALL BE,               Groupie
                                1) GREATER THAN 0                       Groupie
                                2) IN DESCENDING VALUE ORDER            Groupie
                          = 0 - SIGMA-0 WILL BE DEFINED AS A MULTIPLE   Groupie
                                OF THE UNSHIELDED TOTAL CROSS SECTION   Groupie
                                IN EACH GROUP (VALUES OF 1/1024 TO      Groupie
                                1024 IN STEPS OF A FACTOR OF 2 WILL     Groupie
                                BE USED AS THE MULTIPLIER).             Groupie
                          = 1 - SIGMA-0 WILL BE DEFINED AS THE SAME     Groupie
                                NUMBER OF BARNS IN EACH GROUP (VALUES   Groupie
                                40000 TO 0.4 BARNS WILL BE USED. WITHIN Groupie
                                EACH DECADE VALUES OF 10, 7, 4, 2, 1    Groupie
                                BARNS WILL BE USED).                    Groupie
    2-4    1-66 6D11.4   IF SIGMA-0 DEFINITION SELECTOR < 0, THE NEXT  Groupie
                          4 LINES OF INPUT ARE THE 22 VALUES OF SIGMA0, Groupie
                          6 PER LINE.                                   Groupie
      2    1-60    A60   ENDF/B INPUT DATA FILENAME                    Groupie
                          (STANDARD OPTION = ENDFB.IN)                  Groupie
      3    1-60    A60   ENDF/B OUTPUT DATA FILENAME                   Groupie
                          (STANDARD OPTION = ENDFB.OUT)                 Groupie
                                                                        Groupie
    THE FOURTH INPUT CARD IS USED TO SELECT ALL DESIRED OUTPUT MODES.   Groupie
    EACH OUTPUT DEVICE MAY BE TURNED OFF (0) OR ON (1). THEREFORE       Groupie
    THEREFORE EACH OF THE FOLLOWING INPUT PARAMETERS MAY BE EITHER      Groupie
    ZERO TO INDICATE NO OUTPUT OR NON-ZERO TO INDICATE OUTPUT.          Groupie
                                                                        Groupie
```

```
       4     1-11   I11   SELF-SHIELDED CROSS SECTION LISTING          Groupie
                          = 1 - CROSS SECTIONS                        Groupie
                          = 2 - RESONANCE INTEGRALS                   Groupie
       4    12-22   I11   MULTI-BAND PARAMETER LISTING                Groupie
       4    23-33   I11   MULTI-BAND PARAMETERS COMPUTER READABLE      Groupie
       4    34-44   I11   UNSHIELDED CROSS SECTIONS IN ENDF/B FORMAT   Groupie
                          = 1 - HISTOGRAM FORMAT (INTERPOLATION LAW 1) Groupie
                          = 2 - LINEAR-LINEAR (INTERPOLATION LAW 2)    Groupie
       4    45-55   I11   UNSHIELDED CROSS SECTIONS LISTING            Groupie
                          = 1 - CROSS SECTIONS                        Groupie
                          = 2 - RESONANCE INTEGRALS                   Groupie
05/01/20 - ADDED THE BELOW OPTION                                     Groupie
       4    56-66  D11.4 IF THE STANDARD BUILT-IN SPECTRA IS USED,    Groupie
                          INPUT LINE 1, COLUMNS 34-44 = 2, THIS FIELD Groupie
                          CAN BE USED TO OPTIONALLY CHANGE TEMPERATURE Groupie
                          OF THE MAXWELLIAN.                          Groupie
                          INPUT IS IN EV (0.0253 EV = ROOM TEMPERATURE) Groupie
                          = 0 - USE DEFAULT 0.0253 EV, ROOM TEMPERATURE Groupie
                          > 0 - USE THIS AS THE TEMPERATURE           Groupie
                          RESTRICTION - TEMPERATURE CANNOT EXCEED     Groupie
                          1000 EV.                                    Groupie
                                                                      Groupie
       5     1-80   18A4  LIBRARY IDENTIFICATION. ANY TEXT THAT THE   Groupie
                          USER WISHES TO IDENTIFY THE MULTI-BAND      Groupie
                          PARAMETERS. THIS LIBRARY IDENTIFICATION IS  Groupie
                          WRITTEN INTO THE COMPUTER READABLE MULTI-BAND Groupie
                          DATA FILE.                                  Groupie
                                                                      Groupie
     6-N     1- 6    I6   LOWER MAT OR ZA LIMIT                       Groupie
             7- 8    I2   LOWER MF LIMIT                             Groupie
             9-11    I3   LOWER MT LIMIT                             Groupie
            12-17   I11   UPPER MAT OR ZA LIMIT                       Groupie
            18-19    I2   UPPER MF LIMIT                             Groupie
            20-22    I3   UPPER MT LIMIT                             Groupie
                          UP TO 100 RANGES MAY BE SPECIFIED, ONE RANGE Groupie
                          PER LINE. THE LIST OF RANGES IS TERMINATED  Groupie
                          BY A BLANK CARD. IF THE UPPER MAT OR ZA     Groupie
                          LIMIT IS LESS THAN THE LOWER LIMIT THE UPPER Groupie
                          IS SET EQUAL TO THE LOWER LIMIT. IF THE UPPER Groupie
                          MF OR MT LIMIT IS ZERO IT WILL BE SET EQUAL Groupie
                          TO ITS MAXIMUM VALUE, 99 OR 999, RESPECTIVELY Groupie
                          IF THE FIRST REQUEST LINE IS BLANK IT WILL  Groupie
                          TERMINATE THE LIST OF REQUESTS AND CAUSE ALL Groupie
                          DATA TO BE RETRIEVED (SEE EXAMPLE INPUT).   Groupie
                                                                      Groupie
     VARY    1-66  6D11.4 ENERGY GROUP BOUNDARIES. ONLY REQUIRED IF   Groupie
                          THE NUMBER OF GROUPS INDICATED ON THE FIRST Groupie
                          INPUT CARD IS POSITIVE. ALL ENERGIES MUST   Groupie
                          BE IN ASCENDING ENERGY IN EV. THE PRESENT   Groupie
                          LIMITS ARE 1 TO 1000 GROUPS. FOR N GROUPS   Groupie
                          N+1 BOUNDARIES WILL BE READ FROM THE        Groupie
                          INPUT FILE, E.G. IF THE FIRST INPUT CARD    Groupie
                          INDICATES 20 GROUPS, 21 ENERGY BOUNDARIES   Groupie
                          WILL BE READ FROM THE INPUT FILE.           Groupie
                                                                      Groupie
     VARY    1-66  6D11.4 ENERGY DEPENDENT WEIGHTING SPECTRUM. ONLY   Groupie
                          REQUIRED IF THE NUMBER OF POINTS INDICATED  Groupie
                          ON FIRST CARD IS MORE THAN ONE. DATA IS     Groupie
                          GIVEN IN (ENERGY, WEIGHT) PAIRS, UP TO 3    Groupie
                          PAIRS PER CARD, USING ANY NUMBER OF CARDS   Groupie
                          REQUIRED. ENERGIES MUST BE IN ASCENDING     Groupie
                          ORDER IN EV. THE SPECTRUM VALUES MUST BE    Groupie
                          NON-NEGATIVE. THE ENERGY RANGE OF SPECTRUM  Groupie
                          MUST AT LEAST SPAN THE ENERGY RANGE OF THE  Groupie
                          ENERGY GROUPS. SINCE SPECTRUM IS STORED IN  Groupie
                          PAGING SYSTEM THERE IS NO LIMIT TO NUMBER   Groupie
                          OF POINTS THAT CAN BE USED TO DESCRIBE THE  Groupie
                          WEIGHTING SPECTRUM.                         Groupie
```

```
                                                                      Groupie
    EXAMPLE INPUT NO. 1                                               Groupie
    ------------------                                                Groupie
    REQUEST DATA BY MAT AND PROCESS ALL DATA (ALL MAT BETWEEN 1 AND   Groupie
    9999). USE THE TART 175 GROUP STRUCTURE, GENERATE 2 BAND          Groupie
    PARAMETERS (THE FOR ALL ISOTOPES) TO 0.1 PER-CENT ACCURACY        Groupie
    IN THE SELF-SHIELDING CURVE. OUTPUT ALL  LISTING, COMPUTER        Groupie
    READABLE AND ENDF/B FORMAT GROUP AVERAGES.                        Groupie
                                                                      Groupie
    EXPLICITLY SPECIFY THE STANDARD FILENAMES.                        Groupie
                                                                      Groupie
    THE FOLLOWING 7 INPUT LINES ARE REQUIRED.                         Groupie
                                                                      Groupie
         0          0         -2          0 1.00000-03          0     Groupie
ENDFB.IN                                                              Groupie
ENDFB.OUT                                                             Groupie
         1          1          1          1          1                Groupie
TART 175 GROUP, 2 BAND LIBRARY TO 0.1 PER-CENT ACCURACY               Groupie
    1 1  1  9999 0  0                                                 Groupie
                   (BLANK CARD TERMINATES REQUEST LIST)               Groupie
                                                                      Groupie
    EXAMPLE INPUT NO. 2                                               Groupie
    ------------------                                                Groupie
    THE SAME EXAMPLE 1, AS ABOVE, ONLY THE ENDF/B DATA WILL BE READ   Groupie
    FROM \ENDFB6\SIGMA1\K300\ZA092238 (U-238 AT 300 KELVIN) AND       Groupie
    WRITTEN TO \ENDFB6\GROUPIE\K300\ZA092238                          Groupie
                                                                      Groupie
    THE FOLLOWING 7 INPUT LINES ARE REQUIRED.                         Groupie
                                                                      Groupie
         0          0         -2          0 1.00000-03          0     Groupie
\ENDFB6\SIGMA1\K300\ZA092238                                          Groupie
\ENDFB6\GROUPIE\K300\ZA092238                                         Groupie
         1          1          1          1          1                Groupie
TART 175 GROUP, 2 BAND LIBRARY TO 0.1 PER-CENT ACCURACY               Groupie
    1 1  1  9999 0  0                                                 Groupie
                   (BLANK CARD TERMINATES REQUEST LIST)               Groupie
                                                                      Groupie
    EXAMPLE INPUT NO. 3                                               Groupie
    ------------------                                                Groupie
    PROCESS ALL DATA. USE 1/V WEIGHTING IN ORDER TO CALCULATE         Groupie
    UNSHIELDED ONE GROUP CROSS SECTIONS OVER THE ENERGY RANGE 0.5 EV  Groupie
    TO 1 MEV (NOTE THAT THE RESULTS ARE SIMPLY PROPORTIONAL TO THE    Groupie
    RESONANCE INTEGRAL FOR EACH REACTION). OUTPUT UNSHIELDED LISTING. Groupie
                                                                      Groupie
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL    Groupie
    THEN USE STANDARD FILENAMES.                                      Groupie
                                                                      Groupie
    THE FOLLOWING 7 INPUT CARDS ARE REQUIRED.                         Groupie
                                                                      Groupie
         0          0          1         -1                    0     Groupie
                   (USE STANDARD FILENAME = ENDFB.IN)                 Groupie
                   (USE STANDARD FILENAME = ENDFB.OUT)                Groupie
         0          0          0          0          1                Groupie
RESONANCE INTEGRAL CALCULATION (FROM 0.5 EV TO 1 MEV)                 Groupie
                   (RETRIEVE ALL DATA, TERMINATE REQUEST LIST)        Groupie
5.00000-01 1.00000+06                                                 Groupie
                                                                      Groupie
====================================================================== Groupie
```

```
========================================================================= Legend
                                                                          Legend
      PROGRAM LEGEND                                                      Legend
      VERSION 80-1 (SEPTEMBER 1980)                                       Legend
      VERSION 84-1 (NOVEMBER 1984)                                        Legend
      VERSION 86-1 (JANUARY 1986) *CORRECTED BASED ON USER COMMENTS       Legend
                                  *FORTRAN-77/H VERSION                   Legend
      VERSION 87-1 (JANUARY 1987) *CORRECTED BASED ON USER COMMENTS       Legend
      VERSION 88-1 (JULY 1988)    *OPTION...INTERNALLY DEFINE ALL I/O     Legend
                                   FILE NAMES (SEE, SUBROUTINE FILEIO     Legend
                                   FOR DETAILS).                          Legend
                                  *IMPROVED BASED ON USER COMMENTS.       Legend
      VERSION 89-1 (JANUARY 1989) *PSYCHOANALYZED BY PROGRAM FREUD TO     Legend
                                   INSURE PROGRAM WILL NOT DO ANYTHING    Legend
                                   CRAZY.                                 Legend
                                  *UPDATED TO USE NEW PROGRAM CONVERT     Legend
                                   KEYWORDS.                              Legend
                                  *ADDED LIVERMORE CIVIC COMPILER         Legend
                                   CONVENTIONS.                           Legend
      VERSION 92-1 (JANUARY 1992) *FOR ANGULAR DISTRIBUTIONS CALCULATED   Legend
                                   FROM LEGENDRE COEFFICIENTS, INTERVAL   Legend
                                   HALF TO CONVERGENCE.                   Legend
                                  *UPDATED BASED ON USER COMMENTS         Legend
                                  *ADDED FORTRAN SAVE OPTION              Legend
                                  *ADDED SELECTED OF DATA TO PROCESS      Legend
                                   BY MAT/MF/MT/ENERGY RANGES.            Legend
                                  *WARNING...THE INPUT PARAMETER FORMAT   Legend
                                   HAS BEEN CHANGED - FOR DETAILS SEE     Legend
                                   BELOW.                                 Legend
      VERSION 92-2 (SEPT. 1992)   *CORRECTED PROCESSING OF ISOTROPIC      Legend
                                   ANGULAR DISTRIBUTIONS                  Legend
      VERSION 94-1 (JANUARY 1994) *VARIABLE ENDF/B DATA FILENAMES         Legend
                                   TO ALLOW ACCESS TO FILE STRUCTURES     Legend
                                   (WARNING - INPUT PARAMETER FORMAT      Legend
                                   HAS BEEN CHANGED)                      Legend
                                  *CLOSE ALL FILES BEFORE TERMINATING     Legend
                                   (SEE, SUBROUTINE ENDIT)                Legend
      VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                      Legend
                                  *IMPROVED COMPUTER INDEPENDENCE         Legend
                                  *ALL DOUBLE PRECISION                   Legend
                                  *ON SCREEN OUTPUT                       Legend
                                  *UNIFORM TREATMENT OF ENDF/B I/O        Legend
                                  *IMPROVED OUTPUT PRECISION              Legend
                                  *INCREASED MAX. POINTS FROM 5,000       Legend
                                   TO 20,000.                             Legend
      VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING        Legend
                                   POINT READ FOR MORE DIGITS             Legend
                                  *UPDATED TEST FOR ENDF/B FORMAT         Legend
                                   VERSION BASED ON RECENT FORMAT CHANGE  Legend
                                  *GENERAL IMPROVEMENTS BASED ON          Legend
                                   USER FEEDBACK                          Legend
      VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON          Legend
                                   USER FEEDBACK                          Legend
      VERS. 2001-1 (MARCH 2001)   *UPDATED TO HANDLE COMBINATIONS OF      Legend
                                   LEGENDRE COEFFICIENTS AT LOW ENERGY    Legend
                                   AND TABULATED DATA AT HIGH ENERGY.     Legend
      VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS              Legend
      VERS. 2004-1 (MARCH 2004)   *ADDED INCLUDE FOR COMMON               Legend
                                  *ZERO ANGULAR DISTRIBUTIONS ARE O.K.    Legend
                                   (PREVIOUSLY ZERO OR NEGATIVE WAS       Legend
                                    TREATED AS AN ERROR - ZERO IS O.K.    Legend
                                    FOR SOME REACTIONS OVER SOME COSINE   Legend
                                    RANGES)                               Legend
      VERS. 2006-1 (MARCH 2006)   *INCREASED MAXIMUM NUMBER OF LEGENDRE   Legend
                                   COEFFICIENTS FROM 50 TO 500.           Legend
                                   WARNING - THE RECURSION RELATIONSHIP   Legend
                                   FOR LEGENDRE POLYNOMIALS BECOMES       Legend
                                   UNSTABLE IN HIGHER ORDER POLYTNOMIALS  Legend
```

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                            EVEN USING DOUBLE PRECISION.          Legend
VERS. 2007-1 (JAN.  2007)   *CHECKED AGAINST ALL ENDF/B=VII.      Legend
                            *INCREASED MAX. POINTS FROM 60,000    Legend
                             TO 240,000.                          Legend
                                                                  Legend
OWNED, MAINTAINED AND DISTRIBUTED BY                              Legend
-----------------------------------                               Legend
THE NUCLEAR DATA SECTION                                          Legend
INTERNATIONAL ATOMIC ENERGY AGENCY                                Legend
P.O. BOX 100                                                      Legend
A-1400, VIENNA, AUSTRIA                                           Legend
EUROPE                                                            Legend
                                                                  Legend
ORIGINALLY WRITTEN BY                                             Legend
-------------------------------------                             Legend
DERMOTT E. CULLEN                                                 Legend
CURRENT ADDRESS                                                   Legend
UNIVERSITY OF CALIFORNIA                                          Legend
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TELEPHONE  925-423-7359                                           Legend
E. MAIL    CULLEN1@LLNL.GOV                                       Legend
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                            Legend
                                                                  Legend
PURPOSE                                                           Legend
-------                                                           Legend
CALCULATE LINEARLY INTERPOLABLE TABULATED ANGULAR DISTRIBUTIONS    Legend
STARTING FROM DATA IN THE ENDF/B FORMAT. ANGULAR DISTRIBUTIONS     Legend
MAY BE DESCRIBED IN THE ENDF/B FORMAT IN ONE OF THREE WAYS.       Legend
FOR EACH OF THESE THREE FORMS THE USER MAY CHOOSE (SEE, INPUT     Legend
OPTIONS) TO EITHER COPY EACH TYPE OF DATA OR TO PROCESS IT AT      Legend
AS FOLLOWS,                                                       Legend
                                                                  Legend
(1) ANGULAR DISTRIBUTION IS ISOTROPIC AT ALL ENERGIES (LTT=0)     Legend
-------------------------------------------------------------     Legend
IN THIS CASE THE INPUT DATA DOES NOT INCLUDE ANY ANGULAR          Legend
DISTRIBUTIONS. A SECTION MERELY CONTAINS A FLAG TO INDICATE       Legend
THE ANGULAR DISTRIBUTION IS ISOTROPIC AT ALL ENERGIES. IN THIS    Legend
CASE THE SECTION IS OUTPUT IN EXACTLY THE SAME FORM IN WHICH IT   Legend
WAS READ FROM THE INPUT.                                          Legend
                                                                  Legend
(2) ANGULAR DISTRIBUTIONS GIVEN BY LEGENDRE COEFFICIENTS (LTT=1)  Legend
----------------------------------------------------------------  Legend
LEGENDRE COEFFICIENTS ARE GIVEN AT A SERIES OF ENERGIES. AN       Legend
INTERPOLATION LAW IS GIVEN BETWEEN ENERGIES. THE INTERPOLATION    Legend
LAW BETWEEN ENERGIES IS COPIED AS INPUT (I.E., NO ATTEMPT IS      Legend
MADE TO LINEARIZE THE VARIATION WITH ENERGY). FOR EACH ENERGY AT  Legend
WHICH LEGENDRE COEFFICIENTS ARE GIVEN A LINEARLY INTERPOLABLE     Legend
ANGULAR DISITRIBUTION IS RECONSTRUCTED IN THE SYSTEM IN WHICH THE  Legend
THE COEFFICIENTS ARE GIVEN (I.E., CM OR LAB - NO ATTEMPT IS MADE  Legend
TO CONVERT FROM ONE SYSTEM TO THE OTHER). A MAXIMUM OF 50 LEGENDRE Legend
COEFFICIENTS IS ALLOWED. REGARDLESS OF THE NUMBER OF COEFFICIENTS  Legend
INPUT THE PROGRAM WILL ONLY USE COEFFICIENTS UP TO THE LAST ORDER  Legend
AT WHICH THE COEFFICIENTS ARE NON-ZERO (E.G. IF COEFFICIENTS P1    Legend
THROUGH P12 ARE READ, BUT P9=P10=P11=P12=0.0, THE PROGRAM WILL     Legend
ONLY USE COEFFICIENTS UP TO P8). IF OVER 50 NON-ZERO COEFFICIENTS  Legend
ARE READ ONLY THE FIRST 50 WILL BE USED.                          Legend
                                                                  Legend
(2) ANGULAR DISTRIBUTIONS IS TABULATED (LTT=2)                    Legend
----------------------------------------------------------------  Legend
ANGULAR DISTRIBUTIONS ARE GIVEN AT A SERIES OF ENERGIES. AN       Legend
INTERPOLATION LAW IS GIVEN BETWEEN ENERGIES AND A SECOND          Legend
INTERPOLATION LAW IS GIVEN AT EACH ENERGY TO INTERPOLATE BETWEEN   Legend
THE POINTS IN EACH TABULATED DISTRIBUTION. AT EACH ENERGY THE      Legend
ANGULAR DISTRIBUTION WILL BE CONVERTED TO LINEARLY INTERPOLABLE    Legend
```

```
FORM. THE INTERPOLATION BETWEEN ENERGIES IS OUTPUT EXACTLY AS      Legend
INPUT. THE INTERPOLATION LAW AT EACH ENERGY IS OUTPUT TO INDICATE  Legend
THE NOW LINEARLY INTERPOLABLE ANGULAR DISTRIBUTION.                Legend
                                                                   Legend
(3) LEGENDRE COEFFICIENTS AND TABULATED (LTT=3)                    Legend
-----------------------------------------------------------------  Legend
ENDF-102 SAYS THIS SHOULD BE LTT=4, BUT ALL OF THE EVALUATIONS     Legend
IN ENDF/B-VI, RELEASE 7, USE LTT=3? THIS CODE WILL TREAT THESE     Legend
AS LTT=4 - SEE BELOW.                                              Legend
                                                                   Legend
(4) LEGENDRE COEFFICIENTS AND TABULATED (LTT=4)                    Legend
-----------------------------------------------------------------  Legend
THIS IS A COMBINATION OF (1) AND (2) DESCRIBED ABOVE. THE          Legend
LEGENDRE DATA IS ALWAYS GIVEN FIRST, FOR LOWER ENERGIES,           Legend
FOLLOWED BY TABULATED ANGULAR DISTRIBUTIONS, FOR HIGHER ENERGIES.  Legend
                                                                   Legend
THIS TYPE OF DATA CAN ONLY BE COPIED OR ALL CONVERTED TO           Legend
TABULATED (LTT=2).                                                 Legend
                                                                   Legend
POINT VALUES - NORMALIZED VS. UNNORMALIZED                         Legend
------------------------------------------------------------------ Legend
THE VALUE OF AN ANGULAR DISTRIBUTION AT ANY COSINE WILL BE         Legend
CORRECTLY CALCULATED BY THIS CODE, BASED EITHER DIRECTLY ON THE    Legend
ANGULAR DISTRIBUTION, OR ON THE SUM OF THE CONTRIBUTING LEGENDRE   Legend
MOMENTS.                                                           Legend
                                                                   Legend
ENDF/B ANGULAR DISTRIBUTIONS ARE BY DEFINITION NORMALIZED WHEN     Legend
INTEGRATED OVER COSINE. THEREFORE THIS CODE WILL NORMALIZE EACH    Legend
ANGULAR DISTRIBUTION BEFORE IT IS OUTPUT. THE OUTPUT REPORT FROM   Legend
THIS CODE WILL INDICATE THE NORMALIZATION FACTOR USED.             Legend
                                                                   Legend
THE REASON THAT AN ANGULAR DISTRIBUTION MAY NOT BE NORMALIZED IS   Legend
DUE TO THE APPROXIMATION OF CREATING LINEARLY INTERPOLABLE         Legend
TABULATED ANGULAR DISTRIBUTIONS - THE MORE ACCURATELY THIS IS      Legend
DONE THE CLOSER THE NORMALIZATION FACTOR WILL BE TO UNITY. AS YOU  Legend
DECREASE THE ALLOWABLE ERROR THE NORMALIZED VALUES WILL APPROACH   Legend
THE CORRECT POINT VALUES CALCULATED BY THE CODE.                   Legend
                                                                   Legend
SINCE THE DATA IS NORMALIZED PRIOR TO OUTPUT THE RESULTS IN THE    Legend
ENDF/B FORMAT MAY DIFFER SLIGHTLY FROM VALUES REFERRED TO BE ERROR Legend
MESSAGES, ETC. PRINTED BY THE CODE DURING EXECUTION. IN ALL CASES  Legend
THE VALUES PRINTED BY THE CODE IN ERROR MESSAGES, ETC. SHOULD BE   Legend
CONSIDERED TO BE THE CORRECT VALUES AND THE OUTPUT TABULATED       Legend
ANGULAR DISTRIBUTIONS APPROXIMATE DUE TO THE RE-NORMALIZATION -    Legend
TO RE-ITERATE, THE OUTPUT TABULATED VALUES ARE APPROXIMATE DUE     Legend
TO THE APPROXIMATIONS USED IN CONSTRUCTING LINEAR INTERPOLABLE     Legend
ANGULAR DISTRIBUTIONS TO WITHIN SOME ALLOWABLE TOLERANCE.          Legend
                                                                   Legend
ELIMINATION OF NEGATIVE VALUES                                     Legend
------------------------------                                     Legend
THE RECONSTRUCTED ANGULAR DISTRIBUTION WILL BE TESTED AND IF IT    Legend
IS NEGATIVE AT ONE OR MORE COSINES AN ERROR MESSAGE WILL BE OUTPUT Legend
AND BASED ON THE INPUT OPTION SELECTED ONE OF THE FOLLOWING        Legend
CORRECTIVE ACTIONS WILL BE TAKEN (SEE, INPUT OPTIONS),             Legend
(1) NO CORRECTION                                                  Legend
(2) CHANGE INDIVIDUAL LEGENDRE COEFFICIENTS (EACH BY LESS THAN     Legend
    1.0 PER-CENT) UNTIL THE RECONSTRUCTED ANGULAR DISTRIBUTION     Legend
    IS POSITIVE (MINIMUM MORE THAN 1 MILLI-BARN). THE ALLOWABLE    Legend
    PER-CENT CHANGE IN COEFFICIENTS AND MINIMUM CROSS SECTION CAN  Legend
    BE CHANGED BY INPUT.                                           Legend
(3) CHANGE ALL LEGENDRE COEFFICIENTS TO FORCE DISTRIBUTION TO BE   Legend
    POSITIVE (MINIMUM MORE THAN 1 MILLI-BARN). WITH THIS OPTION    Legend
    THERE IS NO RESTRICTION ON THE AMOUNT THAT EACH COEFFICIENT    Legend
    IS CHANGED AND AS SUCH THIS OPTION SHOULD BE USED WITH         Legend
    CAUTION AND ONLY AS A LAST RESORT IF NO OTHER APPROACH CAN     Legend
    BE USED TO MAKE THE DISTRIBUTION POSITIVE.                     Legend
                                                                   Legend
OUTPUT                                                             Legend
```

```
------                                                              Legend
THE USER MAY REQUEST OUTPUT OF EITHER,                              Legend
(1) TABULATED VALUES - POSSIBLY CORRECTED TO ELIMINATE NEGATIVE     Legend
    VALUES. THE TABULATED DISTRIBUTION WILL BE NORMALIZED BEFORE    Legend
    OUTPUT.                                                         Legend
(2) LEGENDRE COEFFICIENTS - POSSIBLY CORRECTED TO ELIMINATE         Legend
    NEGATIVE VALUES AND WITHOUT HIGHER ORDER ZERO COEFFICIENTS.     Legend
    BY DEFINITION DISTRIBUTIONS DEFINED BY LEGENDRE COEFFICIENTS    Legend
    ARE NORMALIZED TO UNITY.                                        Legend
                                                                    Legend
(3) ANGULAR DISTRIBUTIONS GIVEN BY A TABULATION (LTT=2)             Legend
    ------------------------------------------------------          Legend
TABULATED ANGULAR DISTRIBUTIONS ARE GIVEN AT A SERIES OF ENERGIES.  Legend
AN INTERPOLATION LAW IS GIVEN BETWEEN ENERGIES. THE INTERPOLATION   Legend
LAW BETWEEN ENERGIES IS COPIED AS INPUT (I.E., NO ATTEMPT IS        Legend

MADE TO LINEARIZE THE VARIATION WITH ENERGY). FOR EACH ENERGY AT    Legend
AT WHICH TABULATED DATA ARE GIVEN A LINEARLY INTERPOLABLE ANGULAR   Legend
DISTRIBUTION IS CONSTRUCTED IN THE SYSTEM IN WHICH THE TABULATED    Legend
DATA ARE GIVEN (I.E., CM OR LAB - NO ATTEMPT IS MADE TO CONVERT     Legend
FROM ONE SYSTEM TO THE OTHER). A MAXIMUM OF 60000 POINTS IS ALLOWE  Legend
TO REPRESENT THE ANGULAR DISTRIBUTION AT EACH ENERGY.               Legend
                                                                    Legend
ELIMINATION OF NEGATIVE VALUES                                      Legend
------------------------------                                      Legend
THE RECONSTRUCTED ANGULAR DISTRIBUTION WILL BE TESTED AND IF IT     Legend
IS NEGATIVE AT ONE OR MORE COSINES AN ERROR MESSAGE WILL BE OUTPUT  Legend
AND BASED ON THE INPUT OPTION SELECTED ONE OF THE FOLLOWING         Legend
CORRECTIVE ACTIONS WILL BE TAKEN (SEE, INPUT OPTIONS),              Legend
(1) NO CORRECTION                                                   Legend
(2) CHANGE ALL TABULATED VALUES TO FORCE DISTRIBUTION TO BE         Legend
    POSITIVE (MINIMUM MORE THAN 1 MILLI-BARN). THE MINIMUM VALUE    Legend
    MAY BE CHANGED BY INPUT. WITH THIS OPTION THERE IS NO           Legend
    RESTRICTION ON THE AMOUNT THAT EACH VALUE IS CHANGED AND AS     Legend
    SUCH THIS OPTION SHOULD BE USED WITH CAUTION AND ONLY AS A      Legend
    LAST RESORT IF NO OTHER APPROACH CAN BE USED TO MAKE THE        Legend
    DISTRIBUTION POSITIVE.                                          Legend
                                                                    Legend
OUTPUT                                                              Legend
------                                                              Legend
THE OUTPUT WILL BE THE LINEARIZED ANGULAR DISTRIBUTION. THE         Legend
TABULATED DISTRIBUTION WILL BE NORMALIZED TO UNITY BEFORE OUTPUT.   Legend
                                                                    Legend
CORRECTING NEGATIVE ANGULAR DISTRIBUTION                            Legend
----------------------------------------                            Legend
IF AN ANGULAR DISTRIBUTION IS NEGATIVE AN ERROR MESSAGE WILL BE     Legend
PRINTED AND THE USER MAY DECIDE (BASED ON INPUT OPTION) TO,         Legend
(1) NOT PERFORM ANY CORRECTIVE ACTION.                              Legend
(2) FOR TABULATED DISTRIBUTIONS - ADD THE SAME VALUE TO EACH POINT  Legend
    VALUE SUCH THAT WHEN THE DISTRIBUTION IS RE-NORMALIZED THE      Legend
    MINIMUM VALUE IS 0.001 (1 MILLI-BARN). THE MINIMUM VALUE CAN    Legend
    BE CHANGED BY INPUT. WARNING...EXCEPT FOR SELECTION OF THE      Legend
    MINIMUM VALUE (BY INPUT) THE USER HAS NO CONTROL OVER HOW       Legend
    MUCH THE DISTRIBUTION IS CHANGED. THEREFORE THIS OPTION SHOULD  Legend
    BE USED WITH CAUTION.                                           Legend
(3) FOR LEGENDRE COEFFICIENTS ONE OF TWO OPTIONS MAY BE SELECTED,   Legend
(A) CHANGE INDIVIDUAL COEFFICIENTS (NO ONE COEFFICIENT BY MORE      Legend
    THAN 1 PER-CENT) TO MAKE THE DISTRIBUTION POSITIVE WITH A       Legend
    MINIMUM VALUE OF 0.001 (1 MILLI-BARN). THE MAXIMUM PER-CENT     Legend
    CHANGE IN EACH COEFFICIENT AND MINIMUM VALUE MAY BE CHANGED     Legend
    BY INPUT. INPUT THE PROGRAM CANNOT MAKE THE DISTRIBUTION        Legend
    POSITIVE BY CHANGING EACH COEFFICIENT BY UP TO THE MAXIMUM      Legend
    ALLOWABLE AMOUNT, THE ORIGINAL ANGULAR DISTRIBUTION OR          Legend
    COEFFICIENTS WILL BE OUTPUT. ONLY IN THE LATTER CASE SHOULD     Legend
    ONE CONSIDER USING OPTION (B) DESCRIBED BELOW.                  Legend
(B) LOGICALLY ADD THE SAME VALUE TO EACH POINT VALUE SUCH THAT      Legend
    WHEN THE DISTRIBUTION IS RE-NORMALIZED THE MINIMUM VALUE IS     Legend
    0.001 (1 MILLI-BARN). THIS IS EQUIVALENT AT INCREASING P0       Legend
```

```
    BY A CERTAIN AMOUNT AND RE-NORMALIZATION IS EQUIVALENT TO THEN Legend
    DIVIDING EACH COEFFICIENT BY A CERTAIN AMOUNT. THEREFORE,      Legend
    WHAT IS PHYSICALLY DONE BY THE PROGRAM IS TO DIVIDE EACH       Legend
    COEFFICIENT BY THE SAME AMOUNT. WARNING..EXCEPT FOR SELECTION  Legend
    OF THE MINIMUM VALUE (BY INPUT) THE USER HAS NO CONTROL OVER   Legend
    HOW MUCH THE DISTRIBUTION IS CHANGED. THEREFORE THIS OPTION    Legend
    SHOULD BE USED WITH CAUTION.                                   Legend
                                                                   Legend
WARNING MESSAGES FROM PROGRAM                                      Legend
----------------------------                                       Legend
THE WARNING MESSAGES PRINTED BY THIS PROGRAM SHOULD ONLY BE        Legend
CONSIDERED TO BE EXACTLY THAT..WARNINGS..NOT AN ABSOLUTE JUDGEMENT Legend
BY THIS PROGRAM THAT THERE IS SOMETHING WRONG WITH THE DATA. WHEN  Legend
WARNING MESSAGES ARE PRINTED EXAMINE THE DATA AND EITHER TAKE NO   Legend
ACTION (IF YOU FEEL THAT THE DATA IS O.K.) OR CORRECT THE DATA     Legend
(IF YOU FEEL THAT THE DATA IS INCORRECT AND YOU CAN CORRECT IT).   Legend
                                                                   Legend
VALIDITY OF MODIFIED DATA                                          Legend
------------------------                                           Legend
BEFORE BELIEVING AND USING DATA WHICH HAS BEEN MODIFIED (EITHER    Legend
TABULATED ANGULAR DISTRIBUTIONS OR LEGENDRE COEFFICIENTS) THE USER Legend
SHOULD INSURE THAT THE MODIFIED DATA IS PHYSICALLY MORE ACCEPTABLE Legend
THAN THE ORIGINAL DATA. IN ORDER TO DO THIS ONE OR MORE OF THE     Legend
FOLLOWING METHODS SHOULD BE USED,                                  Legend
                                                                   Legend
(1) USE THE ENERGY VARIATION TESTS BUILT-IN TO THIS PROGRAM AND    Legend
    EVALPLOT TO PLOT THE ENERGY DEPENDENCE OF THE LEGENDRE         Legend
    COEFFICIENTS IN ORDER TO IDENTIFY AND CORRECT (BY HAND...NOT   Legend
    BY THIS PROGRAM) ANY COEFFICIENTS WHICH HAVE UNREALISTIC       Legend
    ENERGY AND L ORDER VARIATIONS. THIS SHOULD ALWAYS BE DONE      Legend
    FIRST TO ELIMINATE MAJOR PROBLEMS BEFORE USING THIS PROGRAM    Legend
    TO AUTOMATICALLY MAKE MINOR CORRECTIONS.                       Legend
(1) OUTPUT AND PLOT THE UNCORRECTED AND CORRECTED ANGULAR          Legend
    DISTRIBUTIONS. COMPARE THE PLOTS TO INSURE THAT THE CORRECTED  Legend
    DATA DOES NOT SERIOUSLY CHANGE THE ENERGY DEPENDENCE OF THE    Legend
    ANGULAR DISTRIBUTION.                                          Legend
(2) IF PLOTTING CAPABILITY IS NOT AVAIALABLE, USE THE PRINTED OUT  Legend
    OF THIS PROGRAM TO DETERMINE HOW MUCH THE TABULATED ANGULAR    Legend
    DISTRIBUTION OR LEGENDRE COEFFICIENTS HAVE BEEN MODIFIED.      Legend
    GENERALLY IF ONE COEFFICIENT HAS BEEN ONLY SLIGHTLY MODIFIED   Legend
    THE DISTRIBUTION WILL BE ACCEPTABLE. HOWEVER IF MANY           Legend
    COEFFICIENTS HAVE BEEN MODIFIED THE RESULT WILL NOT BE         Legend
    RELIABLE.                                                      Legend
                                                                   Legend
SEEING ANGULAR DISTRIBUTIONS AND LEGENDRE COEFFICIENTS             Legend
------------------------------------------------------             Legend
PROGRAM EVALPLOT CAN BE USED TO PLOT ANGULAR DISTRIBUTION AND      Legend
LEGENDRE COEFFICIENTS - WHEN IT COMES TO CHECKING THIS TYPE OF     Legend
DATA THERE IS NO SUBSTITUTE FOR PLOTS OF THE DATA TO MAKE THE      Legend
JOB EASY AND STRAIGHTFORWARD.                                      Legend
                                                                   Legend
FOR LEGENDRE COEFFICIENTS EVALPLOT CAN BE USED TO SEE THE ENERGY   Legend
DEPENDENCE OF EACH COEFFICIENT - THIS IS AN EXTREMELY EASY AND     Legend
USEFUL WAY TO CHECK FOR ERRORS IN THE BASIC DATA.                  Legend
                                                                   Legend
FOR ANGULAR DISTRIBUTION EVALPLOT CAN BE USED TO PLOT THEM AT      Legend
EACH ENERGY THAT THEY ARE TABULATED - THIS IS ALSO AN EASY AND     Legend
USEFUL WAY TO CHECK FOR ERRORS.                                    Legend
                                                                   Legend
I/O UNIT DEFINITIONS                                               Legend
--------------------                                               Legend
UNIT  DESCRIPTION                                                  Legend
----  -----------                                                  Legend
  2   INPUT CARDS                                                  Legend
  3   OUTPUT REPORT                                                Legend
 10   ORIGINAL DATA IN ENDF/B FORMAT                               Legend
 11   FINAL DATA IN ENDF/B FORMAT                                  Legend
                                                                   Legend
```

```
    OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)    Legend
    ---------------------------------------------------------------    Legend
    UNIT  FILE NAME                                                    Legend
    ----  ----------                                                   Legend
      2   LEGEND.INP                                                   Legend
      3   LEGEND.LST                                                   Legend
     10   ENDFB.IN                                                     Legend
     11   ENDFB.OUT                                                    Legend
                                                                       Legend
    INPUT CARD                                                         Legend
    ----------                                                         Legend
CARD COLS.  FORMAT  DESCRIPTION                                        Legend
---- -----  ------ -----------                                        Legend
 1    1-11   E11.4 FRACTIONAL THINNING CRITERIA                        Legend
     12-22   I11   MAXIMUM NUMBER OF POINTS IN ANGULAR DISTRIBUTION    Legend
                   RECONSTRUCTED FROM LEGENDRE COEFFICIENTS (PRESENT   Legend
                   LIMITS ARE 11 TO 60000 POINTS)                      Legend
                  *THIS OPTION CAN BE USED TO RUN QUICK, BUT NOT       Legend
                   NECESSARILY SO ACCURATE CALCULATIONS - TO ROUGHLY   Legend
                   SEE WHAT THE ANGULAR DISTRIBUTIONS LOOK LIKE.       Legend
                  *IT IS RECOMMENDED THAT YOU USE 0 AS INPUT - IN      Legend
                   WHICH CASE THE PROGRAM WILL USE THE MAXIMUM         Legend
                   ALLOWABLE NUMBER OF POINTS = 60000.                 Legend
     23-33   I11   TABULATED ANGULAR DISTRIBUTION TREATMENT            Legend
                   = 0 - COPY TABLES                                   Legend
                   = 1 - LINEARIZE TABLES (OUTPUT TABLES)              Legend
                   = 2 - LINEARIZE AND THIN TABLES (OUTPUT TABLES)     Legend
     34-44   I11   LEGENDRE COEFFICIENT TREATMENT                      Legend
                   = 0 - COPY LEGENDRE COEFFICIENTS                    Legend
                   = 1 - RECONSTRUCT TABULATED ANGULAR DISTRIBUTION.   Legend
                         (OUTPUT TABLES).                              Legend
                   = 2 - RECONSTRUCT TABULATED ANGULAR DISTRIBUTION.   Legend
                         (OUTPUT LEGENDRE COEFFICIENTS).               Legend
     45-55   I11   NEGATIVE ANGULAR DISTRIBUTION TREATMENT.            Legend
                   = 0 - NO CORRECTION                                 Legend
                   = 1 - TABULATE DATA - NO CORRECTION.                Legend
                       - LEGENDRE DATA - CHANGE COEFFICIENTS           Legend
                         (NONE BY MORE THAN 1.0 PER-CENT - CAN BE      Legend
                         CHANGED BY INPUT).                            Legend
                   = 2 - FORCE DISTRIBUTIONS TO BE POSITIVE            Legend
                         (TABULATED OR LEGENDRE DATA).                 Legend
     56-66   I11   LEGENDRE COEFFICIENT VARIATION TEST FLAG.           Legend
                   = 0 - TEST TESTS.                                   Legend
                   = 1 - PERFORM TESTS,                                Legend
                         (A) LEGENDRE ORDER INCREASES WITH ENERGY.     Legend
                         (C) MONOTONIC VARIATION OF COEFFICIENTS       Legend
                             AS A FUNCTION OF ENERGY.                  Legend
                         (C) COEFFICIENTS DECREASE AS A FUNCTION OF    Legend
                             LEGENDRE ORDER.                           Legend
  2   1-60   60A1  ENDF/B INPUT DATA FILENAME                          Legend
                   (STANDARD OPTION = ENDFB.IN)                        Legend
  3   1-60   60A1  ENDF/B OUTPUT DATA FILENAME                         Legend
                   (STANDARD OPTION = ENDFB.OUT)                       Legend
4-N   1- 6    I6   LOWER MAT LIMIT                                    Legend
      7- 8    I2   LOWER MF LIMIT                                     Legend
      9-11    I3   LOWER MT LIMIT                                     Legend
     12-17    I6   UPPER MAT LIMIT                                    Legend
     18-19    I2   UPPER MF LIMIT                                     Legend
     20-22    I3   UPPER MT LIMIT                                     Legend
     23-33  E11.4  LOWER ENERGY LIMIT                                  Legend
     34-44  E11.4  UPPER ENERGY LIMIT                                  Legend
     45-55  E11.4  MINIMUM ALLOWABLE VALUE OF ANGULAR DISTRIBUTION     Legend
     56-66  E11.4  ALLOWABLE FRACTION (NOT PER-CENT) CHANGE IN ANY     Legend
                   ONE LEGENDRE COEFFICIENT TO MAKE THE ANGULAR        Legend
                   DISTRIBUTION POSITIVE (AND AT LEAST EQUAL TO THE    Legend
                   INPUT MINIMUM ALLOWABLE VALUE).                     Legend
                                                                       Legend
    *UP TO 100 MAT/MT/E RANGES MAY BE INPUT, EACH SPECIFYING AN        Legend
```

```
     ALLOWABLE MINIMUM SIGMA AND MAXIMUM CHANGE IN COEFFICIENTS.       Legend
    *INPUT IS TERMINATED BY A BLANK CARD.                              Legend
    *ALL MAY/MT/E RANGES NOT SPECIFIED BY INPUT WILL BE TREATED BY     Legend
     ALLOWING A MINIMUM SIGMA OF 0.001 (1 MILLI-BARN) AND A CHANGE     Legend
     IN EACH COEFFICIENT BY UP TO 0.01 (1 PER-CENT).                   Legend
    *THESE MAT/MT/E RANGES ARE NOT USED TO CORRECT ALL ANGULAR         Legend
     DISTRIBUTIONS WHERE SIGMA IS LESS THAN THE MINIMUM. THEY ARE      Legend
     ONLY USED TO CORRECT DISTRIBUTION THAT ARE NEGATIVE AND TO        Legend
     INSURE THAT THE CROSS SECTION AT THE COSINES WHERE THE ANGULAR    Legend
     DISTRIBUTION ARE INITIALLY NEGATIVE ARE CORRECTED TO BE POSITIVE  Legend
     AND AT LEAST AS LARGE AS THE MINIMUM ALLOWABLE SIGMA (SPECIFIED   Legend
     BY INPUT).                                                        Legend
                                                                       Legend
    EXAMPLE INPUT NO. 1                                                Legend
    -------------------                                                Legend
    PROCESS BOTH LEGENDRE COEFFICIENTS AND TABULATED DATA TO OBTAIN    Legend
    ANGULAR DISTRIBUTION WHICH ARE ACCURATE TO WITHIN 0.1 PER-CENT     Legend
    AND OUTPUT UNCORRECTED TABULATED ANGULAR DISTRIBUTION USING        Legend
    A MAXIMUM OF 501 POINTS IN EACH TABULATED ANGULAR DISTRIBUTION.    Legend
    SINCE LEGENDRE COEFFICIENTS WILL NOT BE CORRECTED THE INPUT NEED   Legend
    NOT SPECIFY MAT/MT/E RANGES.                                       Legend
                                                                       Legend
    READ /ENDFB6/K300/LEAD.IN AND WRITE /ENDFB6/K300/LEAD.OUT          Legend
                                                                       Legend
    THE FOLLOWING 4 INPUT LINES ARE REQUIRED,                          Legend
                                                                       Legend
1.00000- 3        501          2          1          0                 Legend
/ENDFB6/K300/LEAD.IN                                                   Legend
/ENDFB6/K300/LEAD.OUT                                                  Legend
    (BLANK CARD TERMINATED INPUT)                                      Legend
                                                                       Legend
    EXAMPLE INPUT NO. 2                                                Legend
    -------------------                                                Legend
    PROCESS BOTH LEGENDRE COEFFICIENTS AND TABULATED DATA TO OBTAIN    Legend
    ANGULAR DISTRIBUTION WHICH ARE ACCURATE TO WITHIN 0.1 PER-CENT     Legend
    AND OUTPUT CORRECTED TABULATED ANGULAR DISTRIBUTION (ONLY THOSE    Legend
    RE-CONSTRUCTED FROM LEGENDRE COEFFICIENTS WILL BE CORRECTED).      Legend
    FOR ALL MAT/MT/E CORRECT NEGATIVE ANGULAR DISTRIBUTION TO A VALUE  Legend
    OF 0.01 (10 MILLI-BARNS) AND ALLOW LEGENDRE COEFFICIENTS TO BE     Legend
    CHANGED BY UP TO 0.02 (2 PER-CENT).                                Legend
                                                                       Legend
    USE THE DEFAULT FILENAMES ENDFB.IN AND ENDFB.OUT (THIS CAN BE      Legend
    DONE BY LEAVING THE SECOND AND THIRD INPUT LINES BLANK).           Legend
                                                                       Legend
    THE FOLLOWING 5 INPUT LINES ARE REQUIRED,                          Legend
                                                                       Legend
1.00000- 3        501          2          1          1                 Legend
                                                                       Legend
                                                                       Legend
    1 1  1  999999999 0.00000+ 0 3.00000+ 7 1.00000- 2 2.00000- 2      Legend
    (BLANK CARD TERMINATED INPUT)                                      Legend
                                                                       Legend
    EXAMPLE INPUT NO. 3                                                Legend
    -------------------                                                Legend
    PROCESS BOTH LEGENDRE COEFFICIENTS AND TABULATED DATA TO OBTAIN    Legend
    ANGULAR DISTRIBUTION WHICH ARE ACCURATE TO WITHIN 0.1 PER-CENT     Legend
    AND OUTPUT CORRECTED LEGENDRE COEFFICIENTS AND UNCORRECTED         Legend
    TABULATED ANGULAR DISTRIBUTIONS. FOR MAT=1800, MT=2 CORRECT        Legend
    NEGATIVE ANGULAR DISTRIBUTIONS TO INSURE THE MINIMUM IS 0.01       Legend
    (10 MILLI-BARNS) ALLOWING EACH LEGENDRE COEFFICIENT TO CHANGE BY   Legend
    UP TO 0.02 (2 PER-CENT). ALL OTHER MAT/MT/E WILL BE CORRECTED      Legend
    TO A MINIMUM OF 0.001 (1 MILLI-BARN) ALLOWING A 0.01 (1 PER-CENT)  Legend
    CHANGE (BUILT-IN OPTION).                                          Legend
                                                                       Legend
    READ /ENDFB6/K300/LEAD.IN AND WRITE /ENDFB6/K300/LEAD.OUT          Legend
                                                                       Legend
    THE FOLLOWING 5 INPUT LINES ARE REQUIRED,                          Legend
```

```
                                                                        Legend

 1.00000- 3        501          2          2          1                Legend
 /ENDFB6/K300/LEAD.IN                                                  Legend
 /ENDFB6/K300/LEAD.OUT                                                 Legend
  1800 4  2  1800 4  2 0.00000+ 0 3.00000+ 7 1.00000- 2 2.00000- 2     Legend
     (BLANK CARD TERMINATED INPUT)                                      Legend
                                                                        Legend
     EXAMPLE INPUT NO. 4                                                Legend
     -------------------                                                Legend
     TO COPY TABULATED ANGULAR DISTRIBUTION AND CONVERT LEGENDRE        Legend
     COEFFICIENTS TO UNCORRECTED TABULAR DISTRIBUTIONS.                 Legend
                                                                        Legend
     USE THE DEFAULT FILENAMES ENDFB.IN AND ENDFB.OUT (THIS CAN BE      Legend
     DONE BY LEAVING THE SECOND AND THIRD INPUT LINES BLANK).           Legend
                                                                        Legend
     THE FOLLOWING 4 INPUT LINES ARE REQUIRED,                          Legend
                                                                        Legend
 1.00000- 3        501          0          1          0                Legend
                                                                        Legend
                                                                        Legend
     (BLANK CARD TERMINATED INPUT)                                      Legend
                                                                        Legend
========================================================================= Legend
```

```
====================================================================== Linear
                                                                       Linear
      PROGRAM LINEAR                                                   Linear
      VERSION 74-1 (MAY 1974)                                          Linear
      VERSION 75-1 (APRIL 1975)                                        Linear
      VERSION 76-2 (OCTOBER 1976)                                      Linear
      VERSION 77-1 (JANUARY 1977)                                      Linear
      VERSION 78-1 (JULY 1978)                                         Linear
      VERSION 79-1 (JULY 1979) CDC-7600 AND CRAY-1 VERSION.            Linear
      VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION.               Linear
      VERSION 80-2 (DECEMBER 1980)                                     Linear
      VERSION 81-1 (MARCH 1981)                                        Linear
      VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY.     Linear
      VERSION 83-1 (JANUARY 1983) *MAJOR RE-DESIGN.                    Linear
                                  *PAGE SIZE INCREASED - 1002 TO 3006. Linear
                                  *ELIMINATED COMPUTER DEPENDENT CODING. Linear
                                  *NEW, MORE COMPATIBLE I/O UNIT NUMBER. Linear
                                  *ADDED OPTION TO KEEP ALL ORIGINAL   Linear
                                   ENERGY POINTS FROM EVALUATION.      Linear
                                  *ADDED STANDARD ALLOWABLE ERROR OPTION Linear
                                   (CURRENTLY 0.1 PER-CENT).           Linear
      VERSION 83-2 (OCTOBER 1983) IMPROVED BASED ON USER COMMENTS.     Linear
      VERSION 84-1 (APRIL 1984)   IMPROVED BASED ON USER COMMENTS.     Linear
      VERSION 84-2 (JUNE 1984)   *UPDATED FOR ENDF/B-VI FORMATS.      Linear
                                 *SPECIAL I/O ROUTINES TO GUARANTEE    Linear
                                  ACCURACY OF ENERGY.                  Linear
                                 *DOUBLE PRECISION TREATMENT OF ENERGY Linear
                                  (REQUIRED FOR NARROW RESONANCES).    Linear
      VERSION 85-1 (AUGUST 1985) *FORTRAN-77/H VERSION                 Linear
      VERSION 86-1 (JANUARY 1986)*ENDF/B-VI FORMAT                     Linear
      VERSION 87-1 (JANUARY 1987)*DOUBLE PRECISION TREATMENT OF CROSS  Linear
                                  SECTION                              Linear
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O   Linear
                                  FILE NAMES (SEE, SUBROUTINE FILEIO   Linear
                                  FOR DETAILS).                        Linear
                                 *IMPROVED BASED ON USER COMMENTS.     Linear
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO   Linear
                                  INSURE PROGRAM WILL NOT DO ANYTHING  Linear
                                  CRAZY.                               Linear
                                 *UPDATED TO USE NEW PROGRAM CONVERT   Linear
                                  KEYWORDS.                            Linear
                                 *ADDED LIVERMORE CIVIC COMPILER       Linear
                                  CONVENTIONS.                         Linear
      VERSION 90-1 (JUNE 1990)   *EXTENDED TO LINEARIZE PHOTON         Linear
                                  INTERACTION DATA, MF=23 AND 27       Linear
                                 *ADDED FORTRAN SAVE OPTION            Linear
                                 *UPDATED BASED ON USER COMMENTS.      Linear
                                 *NEW MORE CONSISTENT ENERGY OUTPUT    Linear
                                  ROUTINE.                             Linear
                                 *WARNING...INPUT PARAMETER FORMAT     Linear
                                  HAS BEEN CHANGED...SEE DESCRIPTION   Linear
                                  BELOW.                               Linear
      VERSION 91-1 (JULY 1991)   *ADDED INTERPOLATION LAW 6 - ONLY USED Linear
                                  FOR CHARGED PARTICLE CROSS SECTIONS  Linear
                                  FOR COULOMB PENETRABILITIES.         Linear
      VERSION 92-1 (JANUARY 1992)*ADDED NU-BAR (TOTAL, DELAYED, PROMPT) Linear
                                  POLYNOMIAL OR TABULATED ALL CONVERTED Linear
                                  TO LINEARLY INTERPOLABLE             Linear
                                 *INCREASED PAGE SIZE FROM 3006 TO 5010 Linear
                                  POINTS.                              Linear
                                 *ALL ENERGIES INTERNALLY ROUNDED PRIOR Linear
                                  TO CALCULATIONS.                     Linear
                                 *COMPLETELY CONSISTENT I/O AND ROUNDING Linear
                                  ROUTINES - TO MINIMIZE COMPUTER      Linear
                                  DEPENDENCE.                          Linear
      VERSION 92-2 (JULY 1992)   *CORRECTED CONVERSION OF NU-BAR FROM   Linear
                                  POLYNOMIAL TO TABULATED - COPY       Linear
                                  SPONTANEOUS NU-BAR (BY DEFINITION    Linear
```

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                           THE SPONTANEOUS NU-BAR IS NOT AN       Linear
                           ENERGY DEPENDENT QUANTITY).            Linear
VERSION 93-1 (MARCH 1993)  *UPDATED FOR USE WITH LAHEY COMPILER    Linear
                           ON IBM-PCS.                            Linear
                          *INCREASED PAGE SIZE FROM 5010 TO       Linear
                           30000 POINTS                           Linear
VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES        Linear
                           TO ALLOW ACCESS TO FILE STRUCTURES     Linear
                           (WARNING - INPUT PARAMETER FORMAT      Linear
                           HAS BEEN CHANGED)                      Linear
                          *CLOSE ALL FILES BEFORE TERMINATING     Linear
                           (SEE, SUBROUTINE ENDIT)                Linear
VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                     Linear
                           *IMPROVED COMPUTER INDEPENDENCE        Linear
                           *ALL DOUBLE PRECISION                  Linear
                           *ON SCREEN OUTPUT                      Linear
                           *UNIFORM TREATMENT OF ENDF/B I/O       Linear
                           *IMPROVED OUTPUT PRECISION             Linear
                           *DEFINED SCRATCH FILE NAMES            Linear
                           *ALWAYS INCLUDE THERMAL VALUE          Linear
                           *INCREASED PAGE SIZE FROM 30000 TO     Linear
                            60000 POINTS                          Linear
VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING       Linear
                            POINT READ FOR MORE DIGITS            Linear
                           *UPDATED TEST FOR ENDF/B FORMAT        Linear
                            VERSION BASED ON RECENT FORMAT CHANGE Linear
                           *GENERAL IMPROVEMENTS BASED ON         Linear
                            USER FEEDBACK                         Linear
VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING   Linear
                            MF=1, MT-451.                         Linear
VERS. 2000-1 (FEBRUARY 2000)*ADDED MF = 9 AND 10 LINEARIZATION     Linear
                           *GENERAL IMPROVEMENTS BASED ON         Linear
                            USER FEEDBACK                         Linear
VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS             Linear
VERS. 2004-1 (JAN. 2004)    *GENERAL UPDATE BASED ON USER FEEDBACK Linear
VERS. 2005-1 (JAN. 2005)    *ALWAYS KEEP ORIGINAL TABULATED        Linear
                            NU-BAR POINTS.                        Linear
VERS. 2006-1 (FEB. 2006)    *CORRECTED INT=6 NEAR THRESHOLD        Linear
                           *NO SUBDIVIDE BELOW MINIMUM XCMIN      Linear
VERS. 2007-1 (JAN. 2007)    *CHECKED AGAINST ALL ENDF/B-VII.       Linear
                           *INCREASED PAGE SIZE FROM 60,000 TO    Linear
                            600,000 POINTS                        Linear
                                                                  Linear
OWNED, MAINTAINED AND DISTRIBUTED BY                              Linear
-----------------------------------                               Linear
THE NUCLEAR DATA SECTION                                          Linear
INTERNATIONAL ATOMIC ENERGY AGENCY                                Linear
P.O. BOX 100                                                      Linear
A-1400, VIENNA, AUSTRIA                                           Linear
EUROPE                                                            Linear
                                                                  Linear
ORIGINALLY WRITTEN BY                                             Linear
---------------------------------                                 Linear
DERMOTT E. CULLEN                                                 Linear
UNIVERSITY OF CALIFORNIA                                          Linear
LAWRENCE LIVERMORE NATIONAL LABORATORY                            Linear
L-159                                                             Linear
P.O. BOX 808                                                      Linear
LIVERMORE, CA 94550                                               Linear
U.S.A.                                                            Linear
TELEPHONE  925-423-7359                                           Linear
E. MAIL    CULLEN1@LLNL.GOV                                       Linear
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                            Linear
                                                                  Linear
AUTHORS MESSAGE                                                   Linear
---------------                                                   Linear
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION   Linear
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED Linear
```

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THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE Linear
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION.                 Linear
                                                                  Linear
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER Linear
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE    Linear
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT Linear
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY      Linear
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO  Linear
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF   Linear
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR         Linear
COMPUTER.                                                         Linear
                                                                  Linear
PURPOSE                                                           Linear
-------                                                           Linear
THIS PROGRAM IS DESIGNED TO CONVERT ENDF/B FILE 3, 23 AND 27 DATA  Linear
TO LINEAR-LINEAR INTERPOLABLE FORM. ANY SECTION THAT IS ALREADY    Linear
LINEAR-LINEAR INTERPOLABLE WILL BE THINNED.                       Linear
                                                                  Linear
IN THE FOLLOWING DISCUSSION FOR SIMPLICITY THE ENDF/B TERMINOLOGY  Linear
---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE    Linear
TAPE, CARDS, DISK OR ANY OTHER MEDIUM.                            Linear
                                                                  Linear
ENDF/B FORMAT                                                     Linear
-------------                                                     Linear
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS     Linear
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION   Linear
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT). Linear
                                                                  Linear
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B       Linear
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS     Linear
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE  Linear
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE          Linear
CORRECTLY OUTPUT ON ALL LINES. THE FORMAT OF SECTION MF=1, MT=451  Linear
AND ALL SECTIONS OF MF=3 MUST BE CORRECT. THE PROGRAM COPIES ALL   Linear
OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO   Linear
THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.            Linear
                                                                  Linear
OUTPUT FORMAT                                                     Linear
-------------                                                     Linear
IN THIS VERSION OF LINEAR ALL ENERGIES WILL BE OUTPUT IN           Linear
F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN   Linear
WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN  Linear
OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS   Linear
OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS    Linear
TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE  Linear
TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA     Linear
DUE TO TRUNCATION OF ENERGIES TO 6 DIGITS DURING OUTPUT.          Linear
                                                                  Linear
CONTENTS OF OUTPUT                                                Linear
------------------                                                Linear
ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE LINEARIZED DATA        Linear
CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO     Linear
INCLUDED.                                                         Linear
                                                                  Linear
DOCUMENTATION                                                     Linear
-------------                                                     Linear
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED  Linear
BY THE ADDITION OF 3 COMMENT LINES AT THE END OF EACH HOLLERITH    Linear
SECTION IN THE FORM                                               Linear
                                                                  Linear
***************** PROGRAM LINEAR (2007-1) ****************        Linear
FOR ALL DATA GREATER THAN 1.00000-10 IN ABSOLUTE VALUE            Linear
DATA LINEARIZED TO WITHIN AN ACCURACY OF  0.1  PER-CENT           Linear
                                                                  Linear
THE ORDER OF SIMILAR COMMENTS (FROM RECENT, SIGMA1 AND GROUPIE)    Linear
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON       Linear
THE DATA BY THESE PROGRAMS.                                       Linear
                                                                  Linear
```

```
THESE COMMENT LINES ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS, Linear
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT Linear
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF      Linear
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451    Linear
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF      Linear
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF      Linear
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO          Linear
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND   Linear
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT  Linear
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                      Linear
                                                                   Linear
REACTION INDEX                                                     Linear
--------------                                                     Linear
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN     Linear
SECTION MF=1, MT=451 OF EACH EVALUATION.                           Linear

                                                                   Linear
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.   Linear
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT         Linear
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS Linear
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING  Linear
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE  Linear
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM Linear
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.     Linear
                                                                   Linear
SECTION SIZE                                                       Linear
------------                                                       Linear
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT  Linear
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS      Linear
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                 Linear
                                                                   Linear
FOR ANY LINEARIZED SECTION THAT CONTAINS 60000 OR FEWER POINTS     Linear
THE ENTIRE OPERATION WILL BE PERFORMED IN CORE AND THE LINEARIZED  Linear
DATA WILL BE OUTPUT DIRECTLY TO THE ENDF/B FORMAT. FOR ANY SECTION Linear
THAT CONTAINS MORE POINTS THE DATA WILL BE LINEARIZED A PAGE AT A  Linear
TIME (1 PAGE = 60000 POINTS) AND OUTPUT TO SCRATCH. AFTER THE      Linear
ENTIRE SECTION HAS BEEN LINEARIZED THE DATA WILL BE READ BACK FROM Linear
SCRATCH AND OUTPUT TO THE ENDF/B FORMAT.                           Linear
                                                                   Linear
SELECTION OF DATA                                                  Linear
-----------------                                                  Linear
THE PROGRAM SELECTS DATA TO BE LINEARIZED BASED EITHER ON EITHER   Linear
MAT (ENDF/B MAT NO.) OR ZA AS WELL AS MF AND MT NUMBERS. THIS      Linear
PROGRAM ALLOWS UP TO 100 MAT/MF/MT OR ZA/MF/MT RANGES TO BE        Linear
SPECIFIED BY INPUT PARAMETERS. THE PROGRAM WILL ASSUME THAT THE    Linear
ENDF/B TAPE IS IN MAT ORDER, REGARDLESS OF THE CRITERIA USED       Linear
TO RETRIEVE MATERIALS. IF RETRIEVAL IS BY MAT RANGE THE PROGRAM    Linear
WILL TERMINATE WHEN A MAT IS FOUND THAT IS ABOVE ALL REQUESTED     Linear
MAT RANGES. IF RETRIEVAL IS BY ZA RANGE THE PROGRAM WILL SEARCH    Linear
THE ENTIRE ENDF/B TAPE.                                            Linear
                                                                   Linear
PROGRAM OPERATION                                                  Linear
-----------------                                                  Linear
EACH SECTION OF DATA IS CONSIDERED SEPARATELY. EACH SECTION OF     Linear
ENDF/B DATA TO LINEARIZE IS REPRESENTED BY A TABLE OF ENERGY       Linear
VS. CROSS SECTION AND ANY ONE OF FIVE ALLOWABLE INTERPOLATION LAWS Linear
BETWEEN ANY TWO TABULATED POINTS. THIS PROGRAM WILL REPLACE EACH   Linear
SECTION OF DATA CROSS SECTIONS BY A NEW TABLE OF ENERGY VS.        Linear
CROSS SECTION IN WHICH THE INTERPOLATION LAW IS ALWAYS LINEAR IN   Linear
ENERGY AND CROSS SECTION BETWEEN ANY TWO TABULATED POINTS.         Linear
                                                                   Linear
DATA IS READ AND LINEARIZED A PAGE AT A TIME (ONE PAGE CONTAINS    Linear
60000 DATA POINTS). IF THE FINAL LINEARIZED SECTION CONTAINS TWO   Linear
PAGES OR LESS, DATA POINTS IT WILL BE ENTIRELY CORE RESIDENT       Linear
AFTER IT HAS BEEN LINEARIZED AND WILL BE WRITTEN DIRECTLY FROM     Linear
CORE TO THE OUTPUT TAPE. IF THE LINEARIZED SECTION IS LARGER THAN  Linear
TWO PAGES, AFTER EACH PAGE IS LINEARIZED IT WILL BE WRITTEN TO     Linear
SCRATCH. AFTER THE ENTIRE SECTION HAS BEEN LINEARIZED IT WILL      Linear
```

```
BE READ BACK FROM SCRATCH, TWO PAGES AT A TIME, AND WRITTEN TO     Linear
THE OUTPUT TAPE.                                                  Linear
                                                                  Linear
KEEP EVALUATED DATA POINTS                                        Linear
--------------------------                                        Linear
SOMETIMES IT IS CONVENIENT TO KEEP ALL ENERGY POINTS WHICH WERE   Linear
PRESENT IN THE ORIGINAL EVALUATION AND TO MERELY SUPPLEMENT THESE  Linear
POINTS WITH ADDITIONAL ENERGY POINTS IN ORDER TO LINEARIZE THE     Linear
CROSS SECTIONS. FOR EXAMPLE, IT IS OFTEN CONVENIENT TO KEEP THE   Linear
THERMAL VALUE (AT 0.0253 EV) OR THE VALUE AT 14.1 MEV.            Linear
                                                                  Linear
THE CURRENT VERSION OF THIS PROGRAM WILL ALLOW THE USER TO KEEP   Linear
ALL ORIGINAL EVALUATED DATA POINTS BY SPECIFYING 1 IN COLUMNS     Linear
34-44 OF THE FIRST INPUT LINE. THIS WILL TURN OFF THE BACKWARD    Linear
THINNING (SEE UCRL-50400, VOL. 17, PART A FOR EXPLANATION) AND    Linear
RESULT IN ALL ORIGINAL ENERGY POINTS BEING KEPT. CAUTION SHOULD   Linear
BE EXERCISED IN USING THIS OPTION SINCE IT CAN RESULT IN A        Linear
CONSIDERABLE INCREASE IN THE NUMBER OF DATA POINTS OUTPUT BY      Linear
THIS CODE.                                                        Linear
                                                                  Linear
FOR ALL USERS WHO ARE NOT INTERESTED IN THIS OPTIONS NO CHANGES   Linear
ARE REQUIRED IN THE INPUT TO THIS PROGRAM, I. E. IF COLUMNS       Linear
34-44 ARE BLANK (AS FOR ALL PREVIOUS VERSIONS OF THIS CODE) THE   Linear
PROGRAM WILL OPERATE EXACTLY AS IT DID BEFORE.                    Linear
                                                                  Linear
ALLOWABLE ERROR                                                   Linear
---------------                                                   Linear
ALLOWABLE ERROR MUST ALWAYS BE SPECIFIED IN THE INPUT TO THIS     Linear
PROGRAM AS A FRACTION, NOT A PER-CENT. FOR EXAMPLE, INPUT THE     Linear
ALLOWABLE FRACTIONAL ERROR 0.001 IN ORDER TO OBTAIN DATA THAT IS  Linear
ACCURATE TO WITHIN 0.1 PER-CENT.                                  Linear
                                                                  Linear
THE CONVERSION OF THE DATA FROM THE GENERAL INTERPOLATION FORM TO  Linear
LINARLY INTERPOLABLE FORM CANNOT BE PERFORMED EXACTLY. HOWEVER, IT Linear
CAN BE PERFORMED TO VIRTUALLY ANY REQUIRED ACCURACY AND MOST      Linear
IMPORTANTLY CAN BE PERFORMED TO A TOLERANCE THAT IS SMALL COMPARED Linear
TO THE UNCERTAINTY IN THE CROSS SECTIONS THEMSELVES. AS SUCH THE  Linear
CONVERSION OF CROSS SECTIONS TO LINEARLY INTERPOLABLE FORM CAN BE  Linear
PERFORMED WITH ESSENTIALLY NO LOSE OF INFORMATION.                Linear
                                                                  Linear
THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY Linear
DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED        Linear
FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION Linear
BETWEEN TABULATED POINTS. IF ONLY ONE TABULATED POINT IS GIVEN THE Linear
ERROR WILL BE CONSIDERED CONSTANT OVER THE ENTIRE ENERGY RANGE.    Linear
WITH THIS ENERGY DEPENDENT ERROR ONE MAY OPTIMIZE THE OUTPUT FOR   Linear
ANY GIVEN APPLICATION BY USING A SMALL ERROR IN THE ENERGY RANGE   Linear
OF INTEREST AND A LESS STRINGENT ERROR IN OTHER ENERGY RANGES.     Linear
                                                                  Linear
DEFAULT ALLOWABLE ERROR                                           Linear
-----------------------                                           Linear
IN ORDER TO INSURE CONVERGENCE OF THE LINEARIZING ALGORITHM THE    Linear
ALLOWABLE ERROR MUST BE POSITIVE. IF THE USER INPUTS AN ERROR      Linear
THAT IS NOT POSITIVE IT WILL AUTOMATICALLY BE SET TO THE DEFAULT   Linear
VALUE (CURRENTLY 0.001, CORRESPONDING TO 0.1 PER-CENT) AND        Linear
INDICATED AS SUCH IN THE OUTPUT LISTING.                          Linear
                                                                  Linear
COULOMB PENETRABILITY (INTERPOLATION LAW = 6)                     Linear
---------------------------------------------                     Linear
INTRODUCED FOR ENDF/B-VI. THIS IS DEFINED AS,                     Linear
                                                                  Linear
SIG(E) = C1*EXP(-C2/SQRT(E - T))                                  Linear
                                                                  Linear
THIS PROGRAM ONLY CONSIDERS EXOTHERMIC REACTIONS - T = 0          Linear
                                                                  Linear
SIG(E) = C1*EXP(-C2/SQRT(E))                                      Linear
                                                                  Linear
WARNING...THIS INTERPOLATION LAW SHOULD ONLY BE USED FOR REACTIONS Linear
```

```
          WHICH HAVE A POSITIVE Q-VALUE (EXOTHERMIC REACTIONS),    Linear
          SINCE HERE WE ONLY CONSIDER T = 0.0 IN THE FORMALISM.    Linear
          IN ALL OTHER CASES A WARNING MESSAGE WILL BE PRINTED.    Linear
                                                                   Linear
INPUT FILES                                                        Linear
-----------                                                        Linear
UNIT  DESCRIPTION                                                  Linear
----  -----------                                                  Linear
   2  INPUT LINES (BCD - 80 CHARACTERS/RECORD)                     Linear
  10  ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)            Linear
                                                                   Linear
OUTPUT FILES                                                       Linear
------------                                                       Linear
UNIT  DESCRIPTION                                                  Linear
----  -----------                                                  Linear
   3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                  Linear
  11  FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)               Linear
                                                                   Linear
SCRATCH FILES                                                      Linear
-------------                                                      Linear
UNIT  DESCRIPTION                                                  Linear
----  -----------                                                  Linear
  12  SCRATCH FILE (BINARY - 180000 WORDS/RECORD                   Linear
                                                                   Linear
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)               Linear
----------------------------------------------------               Linear
UNIT  FILE NAME                                                    Linear
----  ----------                                                   Linear
  2   LINEAR.INP                                                   Linear
  3   LINEAR.LST                                                   Linear
 10   ENDFB.IN                                                     Linear
 11   ENDFB.OUT                                                    Linear
 12   (SCRATCH)                                                    Linear
                                                                   Linear
                                                                   Linear
INPUT PARAMETERS                                                   Linear
----------------                                                   Linear
FOR VERSIONS EARLIER THAN 90-1 THIS PROGRAM ONLY ALLOWED THE USER  Linear
TO SPECIFY BY INPUT PARAMETERS WHICH MATERIALS (MAT) TO PROCESS.    Linear
FOR EACH REQUESTED MATERIAL NEUTRON INTERACTION CROSS SECTIONS     Linear
(MF=3) WOULD BE LINEARIZED AND THE REMAINDER OF THE MATERIAL       Linear
WOULD BE COPIED.                                                   Linear
                                                                   Linear
FOR VERSIONS 90-1 AND LATER THIS PROGRAM WILL ALLOW THE USER TO    Linear
TO SPECIFY BY INPUT PARAMETERS EXACTLY WHAT SECTIONS OF DATA        Linear
TO PROCESS. FOR EACH SECTION OF DATA, SPECIFIED BY MAT, MF, MT      Linear
RANGES, SECTIONS OF MF=3, 23 AND 27 WILL BE LINEARIZED AND ALL     Linear
OTHER REQUESTED SECTIONS WILL BE COPIED. ALL SECTIONS WHICH ARE    Linear
NOT EXPLICITLY REQUESTED WILL BE SKIPPED AND WILL NOT APPEAR ON    Linear
ENDF/B FILE OUTPUT BY THIS PROGRAM.                                Linear
                                                                   Linear
WITH THIS NEW PROCEDURE YOU CAN MINIMIZE THE SIZE OF THE ENDF/B    Linear
FILE OUTPUT BY THIS PROGRAM, E.G., IF YOU ONLY WANT NEUTRON        Linear
CROSS SECTIONS FOR SUBSEQUENT PROCESSING YOU NEED ONLY REQUEST     Linear
ONLY MF=3 DATA.                                                    Linear
                                                                   Linear
HOWEVER, YOU MUST UNDERSTAND THAT ONLY THOSE SECTIONS WHICH YOU    Linear
EXPLICITLY REQUEST WILL APPEAR ON THE ENDF/B FILE OUTPUT BY        Linear
THIS PROGRAM. FOR EXAMPLE, IF YOU WISH TO DOCUMENT EXACTLY         Linear
HOW YOU LINEARIZED THE DATA BY INCLUDING COMMENTS IN MF=1, MT=451  Linear
THEN YOU MUST EXPLICITLY REQUEST THAT MF=1, MT=451 BE PROCESSED    Linear
FOR EACH MATERIAL THAT YOU REQUEST. SIMILAR IF YOU WANT THE        Linear
ENTIRE EVALUATION YOU MUST REQUEST ALL MF AND MT TO BE OUTPUT.     Linear
                                                                   Linear
LINE  COLS.  DESCRIPTION                                           Linear
----  -----  -----------                                           Linear
   1   1-11  SELECTION CRITERIA (0=MAT, 1=ZA)                      Linear
      12-22  MONITOR MODE SELECTOR                                 Linear
```

```
                = 0 - NORMAL OPERATION                                  Linear
                = 1 - MONITOR PROGRESS OF LINEARIZING OF THE DATA.      Linear
                      EACH TIME A PAGE OF DATA POINTS IS WRITTEN TO     Linear
                      THE SCRATCH FILE PRINT OUT THE TOTAL NUMBER OF    Linear
                      POINTS ON SCRATCH AND THE LOWER AND UPPER         Linear
                      ENERGY LIMITS OF THE PAGE (THIS OPTION MAY BE     Linear
                      USED IN ORDER TO MONITOR THE EXECUTION SPEED      Linear
                      OF LONG RUNNING JOBS).                            Linear
          23-33  MINIMUM CROSS SECTION OF INTEREST (BARNS).             Linear
                 (IF 0.0 OR LESS IS INPUT THE PROGRAM WILL              Linear
                 USE 1.0E-10). ENERGY INTERVALS WILL NOT BE             Linear
                 SUB-DIVIDED IF THE ABSOLUTE VALUE OF THE CROSS         Linear
                 SECTION WITHIN THE INTERVAL IS LESS THAN THIS VALUE.   Linear
                 AN EXCEPTION TO THIS RULE IS NEAR THRESHOLDS ENERGY    Linear
                 INTERVALS WILL BE SUB-DIVIDED UNTIL CONVERGENCE        Linear
                 REGARDLESS OF THE MAGNITUDE OF THE CROSS SECTION.      Linear
          34-44  KEEP ORIGINAL EVALUATED DATA POINTS.                   Linear
                 = 0 - NO.                                              Linear
                 = 1 - YES - ADDITIONAL POINTS MAY BE ADDED IN ORDER    Linear
                             TO LINEARIZE DATA, BUT ALL ORIGINAL        Linear
                             DATA POINTS WILL BE INCLUDED IN THE        Linear
                             RESULTS.                                   Linear
    2     1-60  ENDF/B INPUT DATA FILENAME                              Linear
                (STANDARD OPTION = ENDFB.IN)                            Linear
    3     1-60  ENDF/B OUTPUT DATA FILENAME                             Linear
                (STANDARD OPTION = ENDFB.OUT)                           Linear
  4-N     1- 6  LOWER MAT OR ZA LIMIT                                   Linear
          7- 8  LOWER MF LIMIT                                          Linear
         9-11   LOWER MT LIMIT                                         Linear
        12-17   UPPER MAT OR ZA LIMIT                                   Linear
        18-19   UPPER MF LIMIT                                          Linear
        20-22   UPPER MT LIMIT                                          Linear
                UP TO 100 RANGES MAY BE SPECIFIED, ONLY ONE RANGE       Linear
                PER LINE. THE LIST OF RANGES IS TERMINATED BY A         Linear
                BLANK LINE. IF THE UPPER MAT LIMIT OF ANY REQUEST       Linear
                IS LESS THAN THE LOW LIMIT IT WILL BE SET EQUAL TO      Linear
                THE LOWER LIMIT. IF THE UPPER LIMIT IS STILL ZERO       Linear
                IT WILL BE SET EQUAL TO 999999. IF THE UPPER MF OR      Linear
                MT LIMIT IS ZERO IT WILL BE SET TO 99 OR 999            Linear
                RESPECTIVELY.                                           Linear
 VARY    1-11   ENERGY FOR ERROR LAW                                   Linear
        12-22   ALLOWABLE FRACTIONAL ERROR FOR ERROR LAW.               Linear
                THE ACCEPTABLE LINEARIZING ERROR MAY BE SPECIFIED TO    Linear
                BE EITHER ENERGY INDEPENDENT (DEFINED BY A SINGLE       Linear
                ERROR), OR ENERGY DEPENDENT (DEFINED BY UP TO 20        Linear
                ENERGY, ERROR PAIRS). FOR THE ENERGY DEPENDENT CASE     Linear
                LINEAR INTERPOLATION WILL BE USED TO DEFINE THE ERROR   Linear
                AT ENERGIES BETWEEN THOSE AT WHICH IT IS TABULATED.     Linear
                IN ALL CASES THE ERROR LAW IS TERMINATED BY A BLANK     Linear
                LINE. IF ONLY ONE ENERGY, ERROR PAIR IS GIVEN THE       Linear
                THE LAW WILL BE CONSIDERED TO BE ENERGY INDEPENDENT.    Linear
                IF MORE THAN ONE PAIR IS GIVEN IT WILL BE CONSIDERED    Linear
                TO BE ENERGY DEPENDENT (NOTE, ENERGY INDEPENDENT        Linear
                FORM WILL RUN FASTER THAN THE EQUIVALENT ENERGY         Linear
                DEPENDENT FORM). FOR AN ENERGY DEPENDENT ERROR LAW      Linear
                ALL ENERGIES MUST BE ASCENDING ENERGY ORDER. FOR        Linear
                CONVERGENCE OF THE LINEARIZING ALGORITHM ALL ERRORS     Linear
                MUST BE POSITIVE. IF AN ALLOWABLE ERROR IS NOT          Linear
                POSITIVE IT WILL BE SET EQUAL TO THE STANDARD OPTION    Linear
                (CURRENTLY 0.001, CORRESPONDING TO 0.1 PER-CENT).       Linear
                IF THE FIRST ERROR LINE IS BLANK IT WILL TERMINATE      Linear
                THE ERROR LAW AND THE ERROR WILL BE TREATED AS          Linear
                ENERGY INDEPENDENT, EQUAL TO THE STANDARD OPTION        Linear
                (CURRENTLY 0.1 PER-CENT). (SEE EXAMPLE INPUT 4).        Linear
                                                                        Linear
EXAMPLE INPUT NO. 1                                                     Linear
------------------                                                      Linear
```

```
    RETRIEVE DATA BY ZA IN ORDER TO FIND ALL URANIUM ISOTOPES AND      Linear

    THORIUM 232. RETRIEVE ALL NEUTRON INTERACTION CROSS SECTIONS       Linear
    (MF=3). ALL ENERGY INTERVALS IN WHICH THE CROSS SECTION IS         Linear
    AT LEAST 1 MICRO-BARN (1.0E-06 BARNS) WILL BE SUBDIVIDED.          Linear
    BACKWARD THINNING WILL BE PERFORMED. FROM 0 TO 100 EV LINEARIZE    Linear
    TO WITHIN 0.1 PER-CENT ACCURACY. FROM 100 EV TO 1 KEV VARY         Linear
    ACCURACY BETWEEN 0.1 AND 1.0 PER-CENT. ABOVE 1 KEV USE 1           Linear
    PER-CENT ACCURACY.                                                 Linear
                                                                       Linear
    EXPLICITLY SPECIFY THE STANDARD FILENAMES.                         Linear
                                                                       Linear
    IN THIS CASE THE FOLLOWING 11 INPUT LINES ARE REQUIRED             Linear
                                                                       Linear
         1          0 1.00000- 6          0                          Linear
ENDFB.IN                                                               Linear
ENDFB.OUT                                                              Linear
92000 3  0 92999 3999                                                  Linear
90232 3  0     0 3  0    (UPPER LIMIT AUTOMATICALLY SET TO 90232 3999) Linear
                         (END OF REQUEST LIST)                         Linear
0.00000+ 0 1.00000-03                                                  Linear
1.00000+ 2 1.00000-03                                                  Linear
1.00000+ 3 1.00000-02                                                  Linear
1.00000+ 9 1.00000-02                                                  Linear
                         (END OF ERROR LAW)                            Linear
                                                                       Linear
    EXAMPLE INPUT NO. 2                                                Linear
    ------------------                                                 Linear
    SAME AS THE ABOVE CASE, EXCEPT LINEARIZE ALL DATA TO WITHIN THE    Linear
    STANDARD ACCURACY (CURRENTLY 0.1 PER-CENT). IN ORDER TO USE THE    Linear
    STANDARD ACCURACY YOU NEED NOT SPECIFY ANY ERROR LAW AT ALL. IN    Linear
    THIS CASE INCLUDE THE HOLLERITH SECTION, MF=1, MT=451, FOR EACH    Linear
    MATERIAL.                                                          Linear
                                                                       Linear
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL     Linear
    THEN USE STANDARD FILENAMES.                                       Linear
                                                                       Linear
    IN THIS CASE THE FOLLOWING 9 INPUT LINES ARE REQUIRED              Linear
                                                                       Linear
         1          0 1.00000- 6          0                          Linear
                         (USE DEFAULT FILENAME = ENDFB.IN)             Linear
                         (USE DEFAULT FILENAME = ENDFB.OUT)            Linear
92000 1451 92999 1451                                                  Linear
92000 3  0 92999 3999                                                  Linear
90232 1451     0 1451                                                  Linear
90232 3  0     0 3  0    (UPPER LIMIT AUTOMATICALLY SET TO 90232 3999) Linear
                         (END OF REQUEST LIST)                         Linear
                         (0.1 PER-CENT ERROR, END OF ERROR LAW)        Linear
                                                                       Linear
    EXAMPLE INPUT NO. 3                                                Linear
    ------------------                                                 Linear
    LINEARIZE ALL MATERIALS ON AN ENDF/B TAPE TO WITHIN AN ACCURACY    Linear
    OF 0.5 PER-CENT (0.005 AS A FRACTION). IN THIS CASE YOU NEED NOT   Linear
    SPECIFY THE MAT, MF, MT RANGES.                                    Linear
                                                                       Linear
    READ THE ENDF/B DATA FROM \ENDFB6\ZA092238 AND WRITE THE ENDF/B    Linear
    DATA TO \ENDFB6\LINEAR\ZA092238.                                   Linear
                                                                       Linear
    IN THIS CASE THE FOLLOWING 6 INPUT LINES ARE REQUIRED              Linear
                                                                       Linear
                                          (MAT, 1.0E-10 BARNS, THIN)   Linear
\ENDFB6\ZA092238                                                       Linear
\ENDFB6\LINEAR\ZA092238                                                Linear
                         (RETRIEVE ALL DATA, END REQUEST LIST)         Linear
           5.00000-03                                                  Linear
                         (END OF ERROR LAW)                            Linear
                                                                       Linear
    NOTE THAT IN THIS CASE IF THE INPUT HAD SPECIFIED AN EQUIVALENT    Linear
```

```
     ENERGY DEPENDENT ERROR LAW BY GIVING A NUMBER OF ENERGY POINTS     Linear
     AT EACH OF WHICH THE ERROR IS 0.5 PER-CENT THE PROGRAM WOULD TAKE  Linear
     LONGER TO RUN (I.E., ONLY USE AN ENERGY DEPENDENT ERROR LAW WHEN   Linear
     IT IS NECESSARY).                                                  Linear
                                                                        Linear
     EXAMPLE INPUT NO. 4                                                Linear
     -------------------                                                Linear
     IN ORDER TO LINEARIZE ALL MATERIALS ON AN ENDF/B TAPE TO THE       Linear
     STANDARD OPTION OF 0.1 PER-CENT IT IS ADEQUATE TO INPUT A SET      Linear
     OF COMPLETELY BLANK LINES WHICH WILL AUTOMATICALLY INVOKE ALL      Linear
     OF THE STANDARD OPTIONS.                                           Linear
                                                                        Linear
     LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL     Linear
     THEN USE STANDARD FILENAMES.                                       Linear
                                                                        Linear
     IN THIS CASE THE FOLLOWING THREE INPUT LINES ARE REQUIRED          Linear
                                                                        Linear
                                          (MAT, 1.0E-10 BARNS, THIN)    Linear
                          (USE DEFAULT FILENAME = ENDFB.IN)             Linear
                          (USE DEFAULT FILENAME = ENDFB.OUT)            Linear
                          (RETRIEVE ALL DATA, END REQUEST LIST)         Linear
                          (0.1 PER-CENT ERROR, END OF ERROR LAW)        Linear
                                                                        Linear
=========================================================================== Linear
```

```
====================================================================== Merger
                                                                        Merger
      PROGRAM MERGER                                                    Merger
      VERSION 80-1 (JANUARY 1980)                                       Merger
      VERSION 80-2 (DECEMBER 1980)                                      Merger
      VERSION 82-1 (JANUARY 1982)                                       Merger
      VERSION 83-1 (JANUARY 1983)*NEW, MORE COMPATIBLE I/O UNIT NUMBERS. Merger
      VERSION 85-1 (AUGUST 1985) *FORTRAN-77/H VERSION                  Merger
      VERSION 86-1 (JANUARY 1986)*ENDF/B-VI FORMATS                     Merger
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O     Merger
                                  FILE NAMES (SEE, SUBROUTINES FILIO1   Merger
                                  AND FILIO2 FOR DETAILS).              Merger
                                 *IMPROVED BASED ON USER COMMENTS.      Merger
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO     Merger
                                  INSURE PROGRAM WILL NOT DO ANYTHING   Merger
                                  CRAZY.                                Merger
                                 *UPDATED TO USE NEW PROGRAM CONVERT    Merger
                                  KEYWORDS.                             Merger
                                 *ADDED LIVERMORE CIVIC COMPILER        Merger
                                  CONVENTIONS.                          Merger
      VERSION 92-1 (JANUARY 1992)*UPDATED BASED ON USER COMMENTS        Merger
                                 *ADDED FORTRAN SAVE OPTION             Merger
      VERSION 92-2 (JULY 1992)   *ALLOW UP TO 99 ENDF/B DATA FILES.     Merger
                                  (TO ALLOW MANAGEMENT OF THE ENTIRE    Merger
                                   ENDF/B SYSTEM).                      Merger
      VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES        Merger
                                  TO ALLOW ACCESS TO FILE STRUCTURES    Merger
                                  (WARNING - INPUT PARAMETER FORMAT     Merger
                                  HAS BEEN CHANGED)                     Merger
                                 *ONLY SPECIFY FILENAMES - NO UNIT      Merger
                                  NUMBERS ON INPUT (WARNING - INPUT     Merger
                                  PARAMETERS FORMAT HAS BEEN CHANGED)   Merger
                                 *CLOSE ALL FILES BEFORE TERMINATING    Merger
                                  (SEE, SUBROUTINE ENDIT)               Merger
                                 *REQUEST LOG DELETED                   Merger
      VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                    Merger
                                  *IMPROVED COMPUTER INDEPENDENCE       Merger
                                  *ALL DOUBLE PRECISION                 Merger
                                  *ON SCREEN OUTPUT                     Merger
                                  *UNIFORM TREATMENT OF ENDF/B I/O      Merger
                                  *IMPROVED OUTPUT PRECISION            Merger
      VERSION 99-1 (MARCH 1999)   *GENERAL IMPROVEMENTS BASED ON        Merger
                                   USER FEEDBACK                        Merger
      VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON        Merger
                                   USER FEEDBACK                        Merger
      VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS            Merger
      VERS. 2004-1 (MARCH 2004)   *ADDED INCLUDE TO DEFINE COMMON       Merger
                                  *ADDED TEND LINE IF NO DATA RETRIEVED Merger
      VERS. 2007-1 (JAN.  2007)   *CHECKED AGAINST ALL ENDF/B-VII.      Merger
                                                                        Merger
      OWNED, MAINTAINED AND DISTRIBUTED BY                              Merger
      -----------------------------------                               Merger
      THE NUCLEAR DATA SECTION                                          Merger
      INTERNATIONAL ATOMIC ENERGY AGENCY                                Merger
      P.O. BOX 100                                                      Merger
      A-1400, VIENNA, AUSTRIA                                           Merger
      EUROPE                                                            Merger
                                                                        Merger
      ORIGINALLY WRITTEN BY                                             Merger
      ---------------------------------                                 Merger
      DERMOTT E. CULLEN                                                 Merger
      UNIVERSITY OF CALIFORNIA                                          Merger
      LAWRENCE LIVERMORE NATIONAL LABORATORY                            Merger
      L-159                                                             Merger
      P.O. BOX 808                                                      Merger
      LIVERMORE, CA 94550                                               Merger
      U.S.A.                                                            Merger
      TELEPHONE  925-423-7359                                           Merger
```

```
E. MAIL    CULLEN1@LLNL.GOV                                          Merger
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                               Merger
                                                                     Merger
AUTHORS MESSAGE                                                      Merger
---------------                                                      Merger
THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENTATION     Merger
FOR THIS PROGRAM INCLUDING ALL RECENT IMPROVEMENTS. PLEASE READ      Merger
ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY THE        Merger
COMMENTS CONCERNING MACHINE DEPENDENT CODING.                        Merger
                                                                     Merger
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER   Merger
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE       Merger
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT   Merger
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY         Merger
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO    Merger
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF      Merger
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR           Merger
COMPUTER.                                                            Merger
                                                                     Merger
PURPOSE                                                              Merger
-------                                                              Merger
THIS PROGRAM IS DESIGNED TO SELECTIVELY RETRIEVE DATA OFF OF FROM    Merger
1 TO 10 ENDF/B DATA TAPES AND TO MERGE THE SELECTED DATA INTO A      Merger
SINGLE MAT/MF/MT ORDERED FINAL OUTPUT FILE.                          Merger
                                                                     Merger
IN THE DISCUSSION THAT FOLLOWS FOR SIMPLICITY THE ENDF/B             Merger
TERMINOLOGY---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL         Merger
MEDIUM USED MAY BE TAPE, CARD, DISK OR ANY OTHER MEDIUM.             Merger
                                                                     Merger
ENDF/B FORMAT                                                        Merger
-------------                                                        Merger
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS       Merger
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION     Merger
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV OR V FORMAT).       Merger
                                                                     Merger
THE ONLY NUMERICAL DATA THAT THIS PROGRAM READS IS THE ZA FROM THE   Merger
FIRST CARD OF EACH SECTION AND THE MAT/MF/MT FROM EACH CARD.         Merger
SEQUENCE NUMBERS ARE IGNORED ON INPUT AND ALL OTHER FIELDS ARE       Merger
READ AS HOLLERITH. AS SUCH THIS PROGRAM NEED NOT DISTINGUISH         Merger
BETWEEN DIFFERENT VERSIONS OF THE ENDF/B FORMAT.                     Merger
                                                                     Merger
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B         Merger
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS       Merger
ASSUMED THAT THE MAT, MF AND MT ON EACH CARD IS CORRECT. SEQUENCE    Merger
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE            Merger
CORRECTLY OUTPUT ON ALL CARDS.                                       Merger
                                                                     Merger
SECTION SIZE                                                         Merger
------------                                                         Merger
SINCE THIS PROGRAM ONLY READS THE DATA ONE CARD AT A TIME THERE      Merger
IS NO LIMIT TO THE SIZE OF ANY GIVEN SECTION, E.G. THE TOTAL         Merger
CROSS SECTION MAY BE DESCRIBED BY 200,000 DATA POINTS.               Merger
                                                                     Merger
SELECTION OF DATA                                                    Merger
-----------------                                                    Merger
THE USER MAY CHOOSE TO MERGE ALL DATA OR THE USER MAY SPECIFY        Merger
THAT ONLY CERTAIN DATA SHOULD BE SELECTED. THE DATA TO BE            Merger
SELECTED IS DEFINED BY SPECIFYING UP TO 100 MAT/MF/MT OR             Merger
ZA/MF/MT RANGES. EACH RANGE IS DEFINED BY LOWER AND UPPER LIMITS     Merger
OF MAT/MF/MT OR ZA/MF/MT.                                            Merger
                                                                     Merger
REQUEST LIMITS                                                       Merger
--------------                                                       Merger
IN ORDER TO SIMPLIFY THE INPUT OF SELECTION REQUESTS THE FOLLOWING   Merger
CONVENTIONS HAVE BEEN INTRODUCED IN ORDER TO DEFINE THE UPPER        Merger
LIMITS OF REQUESTS IF THEY ARE NOT DEFINED BY INPUT (I.E., IF THEY   Merger
ARE ZERO).                                                           Merger
                                                                     Merger
```

(1) MAT OR ZA - IF THE UPPER LIMIT IS ZERO IT IS SET EQUAL TO THE LOWER LIMIT.
(2) MF OR MT - IF THE UPPER LIMIT IS ZERO IT IS SET EQUAL TO THE MAXIMUM POSSIBLE VALUE, 99 OR 999 RESPECTIVELY.

WITH THESE CONVENTIONS AN ENTIRE EVALUATION MAY BE SELECTED BY MERELY SPECIFYING THE LOWER LIMIT OF MAT OR ZA. THE UPPER MAT OR ZA LIMIT WILL BE SET EQUAL TO THE LOWER LIMIT, THE LOWER LIMITS OF MF/MT WILL BE 0/0 AND THE UPPER LIMITS OF MF/MT WILL BE SET TO 99/999. THIS WILL CAUSE ALL SECTIONS OF A SINGLE EVALUATION TO BE SELECTED.

SATISFYING SELECTION CRITERIA

IN ORDER FOR A SECTION TO MEET THE SELECTION CRITERIA SPECIFIED BY ONE OF THE RETRIEVAL REQUESTS, EACH OF THE THREE FIELDS (MAT/MF/MT OR ZA/MF/MT) MUST INDIVIDUALLY SATISFY THE CORRESPONDING LIMITS OF THE REQUEST. IT IS NOT SUFFICIENT THAT THE MAT OF A SECTION LIE BETWEEN THE MINIMUM AND MAXIMUM MATS OF A REQUEST. THE MF AND MT WILL ALSO BE INDIVIDUALLY COMPARED TO THE MF AND MT LIMITS OF THE REQUEST. FOR EXAMPLE, A SECTION WITH MAT/MF/MT= 2500/3/2 DOES NOT SATISFY A REQUEST THAT SPECIFIES A REQUEST USING THE RANGE 2000/3/1 THROUGH 3000/3/1. THIS REQUEST SPECIFIES ALL MATERIALS WITH MAT BETWEEN 2000 AND 3000, BUT ONLY THOSE SECTIONS WITH MF/MT=3/1. SIMILARLY A REQUEST FOR 2000/3/1 THROUGH 3000/99/ 999 WILL NOT SELECT ANY SECTIONS WITH MF=1 OR 2, SINCE THE REQUEST SPECIFIES ALL MATERIALS WITH MAT BETWEEN 2000 AND 3000, BUT ONLY THOSE SECTIONS WITH MF= 3, OR MORE.

DUPLICATE SECTIONS

IF TWO OR MORE SECTIONS WITH THE SAME MAT/MF/MT ARE FOUND EITHER ON THE SAME OR DIFFERENT TAPES, THE SECTION FROM THE TAPE DEFINED EARLIEST IN THE INPUT CARDS WILL BE COPIED TO THE FINAL TAPE AND ALL OTHER SECTIONS WITH THE SAME MAT/MF/MT WILL BE SKIPPED. THE OUTPUT REPORT WILL INDICATE WHICH SECTIONS WERE COPIED FROM WHICH TAPES, AS WELL AS WHICH SECTIONS ARE DUPLICATE AND WERE SKIPPED.

REACTION INDEX

THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451. FOR EACH MATERIAL THE PROGRAM WILL FOLLOW THE CONVENTIONS DEFINED ABOVE AND ONLY COPY ONE SECTION MF=1, MT=451 AND SKIP ALL OTHERS (IF MORE THAN ONE). THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT REQUIRE A CORRECT REACTION INDEX FOR THERE APPLICATIONS AND IT WAS NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE A REACTION INDEX FOR YOUR APPLICATION AFTER RUNNING THIS PROGRAM YOU MAY USE PROGRAM DICTIN TO CREATE ONE.

RETRIEVAL STATISTICS

THERE WILL ALWAYS BE AN OUTPUT REPORT LISTING INDICATING WHICH SECTIONS WHERE SELECTED, WHICH DUPLICATE SECTIONS WERE SKIPPED, WHICH TAPE THE SECTION WAS ON, WHICH REQUEST (MAT/MF/MT OR ZA/MF/MT RANGE) CAUSED THE SECTION TO BE SELECTED AND HOW MANY CARDS WERE IN THE SECTION. IN ADDITION THE USER MAY OPTIONALLY OBTAIN A FILE CONTAINING THE SAME INFORMATION. THIS FILE MAY BE COMBINED WITH OTHER SIMILAR FILES OUTPUT BY THIS PROGRAM IN ORDER TO ACCUMULATE RETRIEVAL STATISTICS OVER A PERIOD OF TIME. IF SPECIFIED THIS FILE WILL CONTAIN THE FOLLOWING INFORMATION IN 6I7 FORMAT.

(1) ZA
(2) MAT
(3) MF
(4) MT

```
(5) NUMBER OF CARDS IN SECTION                                          Merger
(6) REQUEST NUMBER THAT CAUSED SECTION TO BE SELECTED                   Merger
                                                                        Merger
INPUT FILES                                                             Merger
-----------                                                             Merger
UNIT  DESCRIPTION                                                       Merger
----  -----------                                                       Merger
  2   INPUT CARDS (BCD - 80 CHARACTERS/RECORD)                          Merger
VARY  FROM 1 TO 99 ENDF/B DATA FILES (BCD - 80 CHARACTERS/RECORD)       Merger
                                                                        Merger
OUTPUT FILES                                                            Merger
------------                                                            Merger
UNIT  DESCRIPTION                                                       Merger
----  -----------                                                       Merger
  3   OUTPUT REPORT LISTING (BCD - 120 CHARACTERS/RECORD)               Merger

 10   MERGED ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)                   Merger
                                                                        Merger
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINES FILIO1 AND FILIO2)        Merger
-------------------------------------------------------------------     Merger
UNIT  FILE NAME   DESCRIPTION                                           Merger
----  ----------  -----------                                           Merger
  2   MERGER.INP  INPUT PARAMETERS                                      Merger
  3   MERGER.LST  OUTPUT LISTING                                        Merger
 11   ENDFB.OUT   RETRIEVED ENDF/B DATA                                 Merger
 12   ENDFB.IN1   ENDF/B DATA TO READ...FILENAMES WILL BE DEFINED       Merger
 13   ENDFB.IN2   IN THE ORDER ENDFB.IN1, ENDFB.IN2,...ENDFB.I99        Merger
 14   ENDFB.IN3   CORRESPONDING TO THE FIRST, SECOND,...99-TH           Merger
 15   ENDFB.IN4   ENDF/B DATA FILE TO READ.                             Merger
 16   ENDFB.IN5                                                         Merger
 17   ENDFB.IN6                                                         Merger
 18   ENDFB.IN7                                                         Merger
        .                                                               Merger
        .                                                               Merger
110   ENDFB.I99                                                         Merger
                                                                        Merger
 INPUT CARDS                                                            Merger
 -----------                                                            Merger
 CARD  COLUMNS  FORMAT  DESCRIPTION                                     Merger
 ----  -------  ------  -----------                                     Merger
   1     1-60    A60    FILENAME FOR MERGED OUTPUT.                     Merger
                        (LEAVE BLANK FOR STANDARD = ENDFB.OUT)          Merger
   2     1-66  16A4,A2  MERGED FILE LABEL                               Merger
                        IF BLANK - LABEL FROM FIRST FILE READ WILL      Merger
                        BE OUTPUT                                       Merger
        67-70    I4     MERGED FILE ENDF/B NUMBER                       Merger
                        IF ZERO - NUMBER OF FIRST FILE READ WILL        Merger
                        BE OUTPUT.                                      Merger
        71-72    I2     RETRIEVAL CRITERIA                              Merger
                        = 0 - MAT/MF/MT RANGES                          Merger
                        = 1 - ZA/MF/MT RANGES                           Merger
 3-N     1-60    A60    FILENAME FOR FILE TO RETRIEVE DATA FROM         Merger
                        (LEAVE BLANK FOR STANDARD..ENDFB.IN1,ETC.)      Merger
                        TERMINATE LIST OF FILES WITH A LINE THAT        Merger
                        SAYS END OR end                                 Merger
 VARY    1- 6    I6     LOWER PRIMARY LIMIT (MAT OR ZA)                 Merger
         7- 8    I2     LOWER MF LIMIT                                  Merger
         9-11    I3     LOWER MT LIMIT                                  Merger
        12-17    I6     UPPER PRIMARY LIMIT (MAT OR ZA)                 Merger
        18-19    I2     UPPER MF LIMIT                                  Merger
        20-22    I3     UPPER MT LIMIT                                  Merger
                        RANGES OF MAT/MF/MT OR ZA/MF/MT TO BE           Merger
                        RETRIEVED ARE SPECIFIED BY DEFINING             Merger
                        ONE RANGE (LOWER AND UPPER LIMITS) PER          Merger
                        CARD. THE USER MAY SPECIFY 0 TO 100             Merger
                        RANGES AND THE LIST OF REQUEST RANGES           Merger
                        IS TERMINATED BY A BLANK CARD. IF               Merger
                        THE FIRST CARD IS BLANK (0 REQUESTS)            Merger
```

```
                          ALL DATA WILL BE RETRIEVED. IF THE UPPER   Merger
                          PRIMARY CRITERIA (MAT OR ZA) IS LESS THAN  Merger
                          THE LOWER PRIMARY CRITERIA, THE UPPER      Merger
                          PRIMARY CRITERIA WILL BE SET EQUAL TO      Merger
                          THE LOWER PRIMARY CRITERIA. IF THE UPPER   Merger
                          MF OR MT LIMIT IS ZERO, OR BLANK, IT       Merger
                          WILL BE SET TO THE MAXIMUM POSSIBLE        Merger
                          VALUE, I.E. MF=99 OR MT=999 (SEE           Merger
                          EXAMPLE INPUT).                            Merger
                                                                     Merger
     EXAMPLE INPUT NO. 1                                             Merger
     -------------------                                             Merger
     MERGE ENDF/B DATA ONTO UNIT 10 FROM UNITS 11, 12, 13 AND 14.    Merger
     RETRIEVE DATA BY MAT NUMBER. RETRIEVE MATS 1103, 1106, ALL MATS Merger
     BETWEEN 1204 AND 1215, MF=1, 3, 4 AND 5 OF MAT 1219 AND MF=3,   Merger
     MT=1 OF MAT 1304. USE STANDARD FILENAMES.                       Merger
                                                                     Merger
     THE FOLLOWING 13 INPUT CARDS ARE REQUIRED.                      Merger
                                                                     Merger
    ENDFB.OUT                                                        Merger
    EXAMPLE FILE LABEL FOR MERGER                              0 0 Merger
    ENDFB.IN1                                                        Merger
    ENDFB.IN2                                                        Merger
    ENDFB.IN3                                                        Merger
    ENDFB.IN4                                                        Merger
    END                                                              Merger
      1103                    4317  (UPPER LIMIT SET TO 1103/99/999) Merger
      1106                    4317  (UPPER LIMIT SET TO 1106/99/999) Merger
      1204       1215         4317  (UPPER LIMIT SET TO 1215/99/999) Merger
      1219 1     1219 1       4317  (UPPER LIMIT SET TO 1219/ 1/999) Merger
      1219 3     1219 5       4317  (UPPER LIMIT SET TO 1219/ 5/999) Merger
      1304 3  1  1304 3  1    4317  (UPPER LIMIT COMPLETELY DEFINED) Merger
                                    (BLANK CARD TERMINATES REQUESTS) Merger
                                                                     Merger
     EXAMPLE INPUT NO. 2                                             Merger
     -------------------                                             Merger
     THE SAME AS EXAMPLE 1, EXCEPT SPECIFY FILENAMES                 Merger
                                                                     Merger
    \ENDFB6\MERGED.LIB                                               Merger
    EXAMPLE FILE LABEL FOR MERGER                              0 0 Merger
    ENDFB6.PART1                                                     Merger
    ENDFB6.PART2                                                     Merger
    ENDFB6.PART3                                                     Merger
    ENDFB6.PART4                                                     Merger
    END                                                              Merger
      1103                    4317  (UPPER LIMIT SET TO 1103/99/999) Merger
      1106                    4317  (UPPER LIMIT SET TO 1106/99/999) Merger
      1204       1215         4317  (UPPER LIMIT SET TO 1215/99/999) Merger
      1219 1     1219 1       4317  (UPPER LIMIT SET TO 1219/ 1/999) Merger
      1219 3     1219 5       4317  (UPPER LIMIT SET TO 1219/ 5/999) Merger
      1304 3  1  1304 3  1    4317  (UPPER LIMIT COMPLETELY DEFINED) Merger
                                    (BLANK CARD TERMINATES REQUESTS) Merger
                                                                     Merger
=========================================================================== Merger
```

```
====================================================================== Mixer
                                                                        Mixer
      PROGRAM MIXER                                                     Mixer
                                                                        Mixer
      VERSION 76-1 (NOVEMBER 1976)                                      Mixer
      VERSION 81-1 (APRIL 1981)  *IBM VERSION                           Mixer
      VERSION 82-1 (AUGUST 1982) *COMPUTER INDEPENDENT VERSION          Mixer
      VERSION 84-1 (JUNE 1984)   *SPECIAL I/O ROUTINES TO GUARANTEE     Mixer
                                  ACCURACY OF ENERGY.                   Mixer
                                 *DOUBLE PRECISION TREATMENT OF ENERGY   Mixer
                                  (REQUIRED FOR NARROW RESONANCES).     Mixer
      VERSION 86-1 (JANUARY 1986)*FORTRAN-77/H VERSION                  Mixer
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O    Mixer
                                  FILE NAMES (SEE, SUBROUTINE FILIO1    Mixer
                                  AND FILIO2 FOR DETAILS).              Mixer
                                 *IMPROVED BASED ON USER COMMENTS.      Mixer
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO    Mixer
                                  INSURE PROGRAM WILL NOT DO ANYTHING   Mixer
                                  CRAZY.                                Mixer
                                 *UPDATED TO USE NEW PROGRAM CONVERT    Mixer
                                  KEYWORDS.                             Mixer
                                 *ADDED LIVERMORE CIVIC COMPILER        Mixer
                                  CONVENTIONS.                          Mixer
      VERSION 92-1 (JANUARY 1992)*UPDATED BASED ON USER COMMENTS        Mixer
                                 *ADDED PHOTON CROSS SECTIONS           Mixer
                                 *ADDED FORTRAN SAVE OPTION             Mixer
                                 *OUTPUT IN ENDF/B-VI FORMAT            Mixer
                                 *COMPLETELY CONSISTENT I/O ROUTINES -  Mixer
                                  TO MINIMIZE COMPUTER DEPENDENCE.      Mixer
                                 *NOTE, CHANGE IN INPUT PARAMETER       Mixer
                                  FORMAT.                               Mixer
      VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES        Mixer
                                  TO ALLOW ACCESS TO FILE STRUCTURES    Mixer
                                  (WARNING - INPUT PARAMETER FORMAT     Mixer
                                  HAS BEEN CHANGED)                     Mixer
                                 *CLOSE ALL FILES BEFORE TERMINATING    Mixer
                                  (SEE, SUBROUTINE ENDIT)               Mixer
                                 *INCREASED INCORE PAGE SIZE FROM       Mixer
                                  1002 TO 4008.                         Mixer
      VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                    Mixer
                                  *IMPROVED COMPUTER INDEPENDENCE       Mixer
                                  *ALL DOUBLE PRECISION                 Mixer
                                  *ON SCREEN OUTPUT                     Mixer
                                  *UNIFORM TREATMENT OF ENDF/B I/O      Mixer
                                  *IMPROVED OUTPUT PRECISION            Mixer
                                  *DEFINED SCRATCH FILE NAMES           Mixer
                                  *INCREASED INCORE PAGE SIZE FROM      Mixer
                                   4008 TO 12000.                       Mixer
      VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING      Mixer
                                   POINT READ FOR MORE DIGITS           Mixer
                                  *UPDATED TEST FOR ENDF/B FORMAT       Mixer
                                   VERSION BASED ON RECENT FORMAT CHANGE Mixer
                                  *GENERAL IMPROVEMENTS BASED ON        Mixer
                                   USER FEEDBACK                        Mixer
      VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING  Mixer
                                   MF=1, MT-451.                        Mixer
      VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON        Mixer
                                   USER FEEDBACK                        Mixer
      VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS            Mixer
      VERS. 2004-1 (MARCH 2004)   *ADDED INCLUDE FOR COMMON            Mixer
                                  *INCREASED INCORE PAGE SIZE FROM      Mixer
                                   12000 TO 60000.                      Mixer
      VERS. 2005-1 (OCT. 2005)    *CORRECTED MERGE ERROR                Mixer
      VERS. 2007-1 (JAN. 2007)    *CHECKED AGAINST ALL ENDF/B-VII       Mixer
                                  *INCREASED INCORE PAGE SIZE FROM      Mixer
                                   60,000 TO 240,000.                   Mixer
                                                                        Mixer
      OWNED, MAINTAINED AND DISTRIBUTED BY                              Mixer
```

```
------------------------------------                                    Mixer
THE NUCLEAR DATA SECTION                                                Mixer
INTERNATIONAL ATOMIC ENERGY AGENCY                                      Mixer
P.O. BOX 100                                                            Mixer
A-1400, VIENNA, AUSTRIA                                                 Mixer
EUROPE                                                                  Mixer
                                                                        Mixer
ORIGINALLY WRITTEN BY                                                   Mixer
------------------------------------                                    Mixer
DERMOTT E. CULLEN                                                       Mixer
UNIVERSITY OF CALIFORNIA                                                Mixer
LAWRENCE LIVERMORE NATIONAL LABORATORY                                  Mixer
L-159                                                                   Mixer
P.O. BOX 808                                                            Mixer
LIVERMORE, CA 94550                                                     Mixer
U.S.A.                                                                  Mixer
TELEPHONE  925-423-7359                                                 Mixer
E. MAIL    CULLEN1@LLNL.GOV                                             Mixer
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                  Mixer
                                                                        Mixer
PURPOSE                                                                 Mixer
-------                                                                 Mixer
THIS PROGRAM IS DESIGNED TO CALCULATE THE ENERGY DEPENDENT CROSS        Mixer
SECTION FOR A COMPOSITE MIXTURE OF UP TO 10 DIFFERENT MATERIALS.        Mixer
                                                                        Mixer
THE PRESENT VERSION WILL ONLY CALCULATE THE CROSS SECTION FOR ONE       Mixer
FINAL REACTION (ENDF/B SECTION), E.G. TOTAL CROSS SECTION, BUT NOT      Mixer
ANY OTHER REACTION.                                                     Mixer
                                                                        Mixer
NOTE, THIS PROGRAM WILL NOT COMBINE ALL REACTIONS FOR A MIXTURE         Mixer
OF MATERIALS DURING A SINGLE RUN - ONLY ONE REACTION WILL BE            Mixer
CREATED PER RUN.                                                        Mixer
                                                                        Mixer
EVALUATED DATA FORMAT                                                   Mixer
---------------------                                                   Mixer
THE CROSS SECTIONS ARE READ FROM THE ENDF/B FORMAT AND THE              Mixer
COMPOSITE CROSS SECTION IS CONVERTED TO AN EQUIVALENT BARNS/ATOM        Mixer
FORM AND OUTPUT IN THE ENDF/B FORMAT WITH AN EQUIVALENT ATOMIC          Mixer
WEIGHT. THE USER MUST SPECIFY THE COMPOSITION BY GIVING THE ZA,         Mixer
MT AND GRAMS/CC OF EACH CONSTITUENT. IN ADDITION THE USER MUST          Mixer
IDENTIFY THE COMPOSITE CROSS SECTION BY SPECIFYING THE ZA, MAT          Mixer
AND MT TO BE USED IN THE ENDF/B FORMATTED OUTPUT.                       Mixer
                                                                        Mixer
SINCE ONLY THE CROSS SECTIONS IN FILE 3 AND 23 ARE USED, AND THE        Mixer
FORMAT FOR FILE 3/23 IS THE SAME IN ALL VERSIONS ON ENDF/B, THIS        Mixer
PROGRAM MAY BE USED WITH ANY VERSION OF ENDF/B DATA (I.E.,              Mixer
ENDF/B-I, II, III, IV, V OR VI). DURING A SINGLE RUN IT MAY EVEN        Mixer
BE USED TO READ AND COMBINE EVALUATIONS WHICH ARE IN DIFFERENT          Mixer
VERSIONS OF THE ENDF/B FORMAT.                                          Mixer
                                                                        Mixer
ENDF/B FORMATTED OUTPUT WILL BE IN THE ENDF/B-VI FORMAT REGARDLESS      Mixer
OF THE FORMAT OF THE INPUT ENDF/B DATA. THIS WILL ONLY EFFECT THE       Mixer
HOLLERITH SECTION (MF=1, MT=451). THE FORMAT OF CROSS SECTIONS          Mixer
(MF=3) IS THE SAME IN ALL VERSION OF THE ENDF/B FORMAT.                 Mixer
                                                                        Mixer
IN ORDER TO GUARANTEE PROPER OPERATION OF THIS PROGRAM THE DATA         Mixer
MUST BE PROPERLY CODED IN THE ENDF/B FORMAT. NO ERROR CHECKING IS       Mixer
PERFORMED. IT IS PARTICULARLY IMPORTANT THAT THE FOLLOWING DATA         Mixer
BE CORRECT                                                              Mixer
                                                                        Mixer
(1) ZA, MF, MT - MUST BE CORRECT IN ORDER TO ALLOW PROGRAM TO           Mixer
    SELECT THE APPROPRIATE SECTIONS TO BE COMBINED.                     Mixer
(2) AWRE - ATOMIC WEIGHT RATIO MUST BE CORRECT TO ALLOW PROGRAM         Mixer
    TO CONVERT THE USER SPECIFIED GRAMS/CC INTO ATOMS/CC FOR            Mixer
    PROPER ATOM RATIO MIXING.                                           Mixer
(3) (ENERGIES, CROSS SECTIONS) - MUST BE CORRECT, LINEARLY              Mixer
                                                  ========              Mixer
    INTERPOLABLE, IN ASCENDING ENERGY ORDER OF (E, BARNS).              Mixer
```

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    ============                                                    Mixer
                                                                    Mixer
    TO CONVERT ENDF/B FORMATTED DATA TO THE REQUIRED INPUT FORM     Mixer
    THE FOLLOWING PROGRAMS MAY BE USED,                             Mixer
    LINEAR - CONVERT TABULATED CROSS SECTIONS TO LINEARLY           Mixer
             INTERPOLABLE FORM.                                     Mixer
    RECENT - RECONSTRUCT RESONANCE CONTRIBUTION, ADD TO BACKGROUND  Mixer
             CROSS SECTION AND OUTPUT THE COMBINATION IN LINEARLY   Mixer
             INTERPOLABLE FORM.                                     Mixer
    SIGMA1 - DOPPLER BROADEN CROSS SECTIONS TO ANY TEMPERATURE AND  Mixer
             OUTPUT THE RESULT IN LINEARLY INTERPOLABLE FORM.       Mixer
                                                                    Mixer
DOCUMENTATION                                                       Mixer
-------------                                                       Mixer
THE FACT THAT THIS PROGRAM HAS COMBINED THE DATA IS DOCUMENTED      Mixer
IN THE OUTPUT ENDF/B FORMAT IN THE HOLLERITH SECTION BY FIRST       Mixer
IDENTIFYING THE VERSION OF THIS PROGRAM THAT WAS USED, IN THE FORM  Mixer
                                                                    Mixer
********************( PROGRAM MIXER 2007-1) **********************  Mixer
                                                                    Mixer
THIS IS FOLLOWED BY THE TWO LINE IDENTIFICATION INPUT BY THE USER.  Mixer
THIS IS FOLLOWED BY COMPOSITION INPUT BY THE USER.                  Mixer
                                                                    Mixer
NEUTRON OR PHOTON DATA                                              Mixer
----------------------                                              Mixer
THIS PROGRAM WILL ALLOW YOU TO PROCESS EITHER NEUTRON OR PHOTON     Mixer
CROSS SECTIONS - BUT YOU CANNOT MIX THE TWO TYPES TOGETHER. BY      Mixer
INPUT YOU CAN SPECIFY THE OUTPUT MF = 3 (NEUTRONS) OR 23 (PHOTONS)  Mixer
WHATEVER TYPE YOU SPECIFIED FOR OUTPUT IS THE ONLY TYPE OF DATA     Mixer
WHICH WILL BE PROCESSED BY THIS PROGRAM.                            Mixer
                                                                    Mixer
DEFINING THE COMPOSITION                                            Mixer
------------------------                                            Mixer
THE USER MAY SPECIFY UP TO 10 DIFFERENT SECTIONS OF DATA TO BE      Mixer
COMBINED, EACH SECTION IDENTIFIED BY ZA AND MT NUMBER. THE          Mixer
AMOUNT OF EACH MATERIAL IS SPECIFIED BY DEFINING THE NUMBER OF      Mixer
GRAMS/CC OF EACH MATERIAL IN THE COMPOSITE MIXTURE. THIS CAN BE     Mixer
DERIVED FROM THE VOLUME FRACTION SIMPLY BY MULTIPLYING THE STP      Mixer
DENSITY OF EACH MATERIAL BY ITS VOLUME FRACTION. NOTE, DO NOT       Mixer
INPUT ATOM FRACTIONS.                                               Mixer
                                                                    Mixer
THE LIST OF SECTIONS TO BE COMBINED MAY BE SPECIFIED IN ANY         Mixer
ORDER, I.E. THEY NEED NOT BE IN ZA ORDER OR THE ORDER THAT THE      Mixer
EVALUATED DATA APPEARS ON THE ENDF/B FORMATTED TAPE.                Mixer
                                                                    Mixer
IF ANY REQUESTED SECTION OF DATA IS NOT FOUND ON THE ORIGINAL       Mixer
ENDF/B FORMATTED FILE, THE PROGRAM WILL PRINT A LIST OF THE         Mixer
MISSING SECTIONS AND TERMINATE. IF ALL REQUESTED SECTIONS ARE       Mixer
FOUND THE PROGRAM WILL PRODUCE A COMPOSITE SECTION USING THE        Mixer
UNION OF ALL ENERGIES FOUND IN ANY SECTION. THE COMPOSITE SECTION   Mixer
WILL NOT BE THINNED.                                                Mixer
                                                                    Mixer
PRIOR TO LATER USE IN ANY APPLICATION THE NUMBER OF ENERGY POINTS   Mixer
IN THE COMPOSITE CROSS SECTION MAY BE MINIMIZED BY USING PROGRAM    Mixer
LINEAR, UCRL-50400, VOL. 17, PART B TO THIN THE DATA.               Mixer
                                                                    Mixer
ONLY LINEARLY INTERPOLABLE DATA                                     Mixer
-------------------------------                                     Mixer
THE CROSS SECTIONS TO BE COMBINED MUST BE IN LINEARLY INTERPOLABLE  Mixer
TABULATED FORM (I. E., FILE 3 OR 23, INTERPOLATION LAW 2).          Mixer
                                                                    Mixer
TO CONVERT TABULATED CROSS SECTIONS TO LINEARLY INTERPOLABLE FORM   Mixer
SEE, PROGRAM LINEAR, UCRL-50400, VOL. 17, PART A.                   Mixer
                                                                    Mixer
TO CONVERT RESONANCE PARAMETERS TO LINEARLY INTERPOLABLE FORM SEE,  Mixer
PROGRAM RECENT, UCRL-50400, VOL. 17, PART C.                        Mixer
                                                                    Mixer
TO DOPPLER BROADEN LINEARLY INTERPOLABLE DATA TO ANY TEMPERATURE    Mixer
```

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SEE PROGRAM SIGMA1, UCRL-50400, VOL. 17, PART B.                  Mixer
                                                                  Mixer
PAGING SYSTEM                                                     Mixer
-------------                                                     Mixer
THERE IS NO LIMIT TO THE THE NUMBER OF DATA POINTS IN EACH OF THE Mixer
SECTIONS TO BE COMBINED, NOR IS THERE A LIMIT TO THE NUMBER OF    Mixer
DATA POINTS IN THE COMPOSITE MIXTURE CROSS SECTION.               Mixer
                                                                  Mixer
ALL REQUIRED SECTIONS OF DATA ARE READ FROM THE ORIGINAL ENDF/B   Mixer
FORMATTED FILE. ANY SECTION OF 60000 OR FEWER POINTS WILL BE      Mixer
TOTALLY CORE RESIDENT. LARGER SECTIONS ARE LOADED INTO A PAGING   Mixer
SYSTEM USING A SCRATCH FILE WITH ONLY 60000 POINTS PER SECTION    Mixer
CORE RESIDENT AT ANY ONE TIME. SIMILARLY THE COMPOSITE SECTION    Mixer
WILL BE TOTALLY CORE RESIDENT IF IT CONTAINS 60000 OR FEWER POINTS Mixer
AND LARGER COMPOSITE SECTIONS WILL BE LOADED INTO A PAGING        Mixer

SYSTEM WHERE ONLY 60000 POINTS ARE CORE RESIDENT AT ANY TIME. SINC Mixer
A PAGING SYSTEM MAY BE USED BY ANY SECTION OF DATA THERE IS NO    Mixer
LIMIT TO THE SIZE OF EITHER THE ORIGINAL SECTIONS, NOR TO THE     Mixer
COMPOSITE SECTION, E.G. A SECTION MAY CONTAIN 100,000 ENERGIES    Mixer
AND CROSS SECTIONS TO DESCRIBE A GIVEN REACTION.                  Mixer
                                                                  Mixer
PAGE SIZE                                                         Mixer
---------                                                         Mixer
THE PAGE SIZE USED IN THIS PROGRAM IS DEFINED BY THE PARAMETER    Mixer
NPAGE AND THE DIMENSIONS OF THE ARRAYS XTAB AND YTAB. IN ORDER    Mixer
TO ADAPT THIS PROGRAM FOR USE ON ANY COMPUTER THE PAGE SIZE MAY   Mixer
BE INCREASED OR DECREASED BUT THE FOLLOWING RULES MUST BE FOLLOWED Mixer
                                                  ====            Mixer
                                                                  Mixer
(1) NPAGE - MUST BE A MULTIPLE OF 3 IN ORDER TO ALLOW THE PROGRAM Mixer
    TO READ FULL CARDS OF ENDF/B DATA (3 POINTS PER LINE). FAILURE Mixer
    TO FOLLOW THIS RULE CAN LEAD TO LOSS OF DATA AND/OR PROGRAM   Mixer
    ERRORS DURING EXECUTION.                                      Mixer
(3) YTAB  - THE DIMENSION OF YTAB MUST BE (NPAGE,11).             Mixer
(4) XTAB  - THE DIMENSION OF XTAB MUST BE (NPAGE,11).             Mixer
                                                                  Mixer
DOPPLER BROADENING                                                Mixer
------------------                                                Mixer
THE COMPOSITE CROSS SECTION OUTPUT FROM THIS PROGRAM SHOULD NOT   Mixer
BE DOPPLER BROADENED USING PROGRAM SIGMA1, OR THE EQUIVALENT. THE Mixer
ATOMIC WEIGHT USED TO IDENTIFY THE COMPOSITE MIXTURE IS BASED ON  Mixer
THE ATOM FRACTION OF EACH CONSTITUENT AND CANNOT BE USED TO       Mixer
CHARACTERIZE THE BROADENING OF ANY GIVEN RESONANCE IN THE MIXTURE Mixer
DUE TO THE CONTRIBUTION OF ONE CONSTITUENT. IN ORDER TO CONSIDER  Mixer
DOPPLER BROADENING FIRST USE PROGRAM SIGMA1 TO BROADEN THE CROSS  Mixer
SECTION FOR EACH OF THE CONSTITUENTS AND THEN COMBINE THE         Mixer
BROADENED DATA USING PROGRAM MIXER.                               Mixer
                                                                  Mixer
EXAMPLE USE                                                       Mixer
-----------                                                       Mixer
THE OUTPUT FROM THIS PROGRAM HAS BEEN FOUND TO BE EXTREMELY       Mixer
USEFUL IN THE FOLLOWING APPLICATIONS...                           Mixer
                                                                  Mixer
(1) CALCULATE A COMPOSITE TOTAL CROSS SECTON FOR LATER USE AS     Mixer
    A WEIGHTING FUNCTION IN SELF-SHIELDING THE CROSS SECTIONS     Mixer
    OF EACH CONSTITUENT OF THE MIXTURE SEPARATELY.                Mixer
                                                                  Mixer
    PROGRAM GROUPIE CAN USE THE CALCULATED COMPOSITE TOTAL CROSS  Mixer
    SECTION AS THE TOTAL CROSS SECTION FOR EACH CONSTITUENT OF    Mixer
    THE MIXTURE IN ORDER TO CALCULATE  SELF-SHIELDED CROSS SECTION Mixer
    FOR EACH CONSTITUENT OF THE MIXTURE.                          Mixer
                                                                  Mixer
(2) CALCULATE COMPOSITE TOTAL AND FISSION CROSS SECTIONS IN       Mixer
    ORDER TO CALCULATE THE TRANSMISSION AND SELF-INDICATION       Mixer
    THROUGH COMPOSITE MATERIALS. GENERALLY IN THIS CASE THE       Mixer
    TOTAL CROSS SECTION WILL BE CALCULATED FOR THE COMPOSITION    Mixer
    OF THE SAMPLE AND THE FISSION CROSS SECTION WILL BE           Mixer
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    CALCULATED FOR THE COMPOSITION OF THE FISSION CHAMBER          Mixer
    (WHICH GENERALLY WILL HAVE A DIFFERENT COMPOSITION THAN THE    Mixer
    SAMPLE).                                                       Mixer
                                                                   Mixer
    PROGRAM VIRGIN CAN USE THE OUTPUT FROM THIS PROGRAM TO         Mixer
    PERFORM TRANSMISSION AND SELF-INDICATION CALCULATIONS.         Mixer
    PROGRAM VIRGIN WILL ANALYTICALLY CALCULATE THE UNCOLLIDED      Mixer
    (I.E. VIRGIN) FLUX TRANSMITTED AND REACTION RATE DUE TO ANY    Mixer
    TABULATED LINEARLY INTERPOLABLE INCIDENT SPECTRUM. RESULTS     Mixer
    WILL BE PRESENTLY FOR UP TO 10 DIFFERENT SAMPLE THICKNESSES    Mixer
    AND BINNED INTO ENERGY GROUPS IN ORDER TO SIMULATE AN          Mixer
    EXPERIMENTAL MEASUREMENT.                                      Mixer
                                                                   Mixer
(3) THE OUTPUT FROM THIS PROGRAM IS VERY USEFUL TO PLOT IN ORDER   Mixer
    TO SEE THE IMPORTANCE OF SPECIFIC CROSS SECTION FEATURES IN    Mixer
    THE COMPOSITE CROSS SECTION.                                   Mixer
                                                                   Mixer
    PROGRAM COMPLOT CAN BE USED TO PLOT THE OUTPUT FROM THIS       Mixer
    PROGRAM AND IF REQUIRED EXAMINE ANY PARTICULAR ENERGY RANGE    Mixer
    IN DETAIL. IN ORDER TO DO THIS THE (ZA, MT) EQUIVALENCE OPTION Mixer
    OF PROGRAM COMPLOT SHOULD BE USED. TO COMPARE ANY CONSTITUENT  Mixer
    CROSS SECTION TO THE COMPOSITE CROSS SECTION THE INPUT TO      Mixer
    COMPLOT SHOULD EQUATE THE (ZA,MT) OF THE COMPOSITE TO THE      Mixer
    (ZA,MT) OF ONE CONSTITUENT AND THE MULTIPLIER INPUT TO         Mixer
    COMPLOT SHOULD BE THE ATOM FRACTION FOR THE CONSTITUENT (THE   Mixer
    ATOM FRACTIONS ARE DEFINED IN THE OUTPUT LISTING FROM PROGRAM  Mixer
    MIXER).                                                        Mixer
                                                                   Mixer
INPUT FILES                                                        Mixer
-----------                                                        Mixer
UNIT  DESCRIPTION                                                  Mixer
----  -----------                                                  Mixer
  2   INPUT CARDS (BCD - 80 CHARACTERS/RECORD)                     Mixer
 10   ORIGINAL EVALUATED DATA IN ENDF/B FORMAT                     Mixer
                 (BCD - 80 CHARACTERS/RECORD)                      Mixer
                                                                   Mixer
OUTPUT FILES                                                       Mixer
------------                                                       Mixer
UNIT  DESCRIPTION                                                  Mixer
----  -----------                                                  Mixer
  3   OUTPUT LISTING (BCD - 120 CHARACTERS/RECORD)                 Mixer
 11   COMPOSITE EVALUATED DATA IN ENDF/B FORMAT                    Mixer
              (BCD - 80 CHARACTERS/RECORD)                         Mixer
                                                                   Mixer
SCRATCH FILES                                                      Mixer
-------------                                                      Mixer
UNIT  DESCRIPTION                                                  Mixer
----  -----------                                                  Mixer
 12   SCRATCH FILE FOR EACH OF THE 10 SECTIONS WHICH               Mixer
 13   WILL BE ADDED TOGETHER TO DEFINE THE FINAL                   Mixer
  .   SECTION (BINARY - 60000 AND 480000 WORDS/RECORD)            Mixer
  . .                                                              Mixer
  . .                                                              Mixer
 20 .                                                              Mixer
 21 .                                                              Mixer
 22   SCRATCH FILE FOR COMBINED SECTION.                           Mixer
      (BINARY - 2004 WORDS/RECORD)                                 Mixer
                                                                   Mixer
STANDARD FILE NAMES (SEE SUBROUTINES FILIO1 AND FILIO2)            Mixer
-------------------------------------------------------------      Mixer
UNIT  FILE NAME                                                    Mixer
----  ----------                                                   Mixer
  2   MIXER.INP                                                    Mixer
  3   MIXER.LST                                                    Mixer
 10   ENDFB.IN                                                     Mixer
 11   ENDFB.OUT                                                    Mixer
12-22 (SCRATCH)                                                    Mixer
                                                                   Mixer
```

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INPUT CARDS                                                          Mixer
-----------                                                          Mixer
LINE  COLS.  FORMAT  NAME    DESCRIPTION                             Mixer
----  -----  ------  ------- ----------                              Mixer
 1-2   1-66 16A4,A2  TITLE   TWO LINE TITLE DESCRIBING PROBLEM      Mixer
                             (THIS TITLE IS USED TO IDENTIFY THE    Mixer
                             OUTPUT LISTING AND IS ALSO WRITTEN     Mixer
                             IN MF=1, MT=451 (HOLLERITH SECTION)    Mixer
                             OF THE ENDF/B FORMATTED OUTPUT TO      Mixer
                             IDENTIFY THE COMPOSITE MIXTURE).       Mixer
   3   1-60                  ENDF/B INPUT DATA FILENAME             Mixer
                             (STANDARD OPTION = ENDFB.IN)           Mixer
   4   1-60                  ENDF/B OUTPUT DATA FILENAME            Mixer
                             (STANDARD OPTION = ENDFB.OUT)          Mixer
   5   1-11    I11   IZAOUT  ZA IDENTIFICATION FOR COMBINATION      Mixer
   5  12-17    I6    MATOUT  MAT IDENTIFICATION FOR COMBINATION     Mixer
   5  18-19    I2    MFOUT   MF IDENTIFICATION FOR COMBINATION      Mixer
   5  20-22    I3    MTOUT   MT IDENTIFICATION FOR COMBINATION      Mixer
 6-N   1-11    I11   IZAGET  ZA (1000*Z+A) OF MATERIAL               Mixer
 6-N  12-22    I11   MTGET   MT OF REACTION                         Mixer
 6-N  23-33  E11.4   DENSE   DENSITY OF MATERIAL (GRAMS/CC)         Mixer
                                                                     Mixer
THE SIXTH LINE IS REPEATED FOR EACH SECTION (FROM 2 TO 10).          Mixer
SINCE THE ENDF/B FORMATTED OUTPUT IS IN BARNS/ATOM FORM A MINIMUM     Mixer
OF TWO SECTIONS MUST BE COMBINED (I.E., IF ONLY ONE SECTION IS       Mixer
SPECIFIED THE OUTPUT WOULD BE IDENTICAL TO THE INPUT AND AS SUCH     Mixer
THE PROGRAM WILL CONSIDER THIS TO BE AN ERROR AND NOT PERFORM THE    Mixer
CALCULATION). THE LIST OF SECTIONS IS TERMINATED BY A BLANK LINE.    Mixer
                                                                     Mixer
THE LIST OF SECTIONS TO BE COMBINED MAY BE SPECIFIED IN ANY          Mixer
ORDER, I.E. THEY NEED NOT BE IN ZA ORDER OR THE ORDER THAT THE       Mixer
EVALUATED DATA APPEARS ON THE ENDF/B FORMATTED TAPE.                 Mixer
                                                                     Mixer
EXAMPLE INPUT NO. 1                                                  Mixer
-------------------                                                  Mixer
CREATE THE TOTAL CROSS SECTION (MT=1) FOR STAINLESS STEEL AND        Mixer
IDENTIFY THE COMBINED MATERIAL WITH ZA=26800 AND MAT=4000,           Mixer
THE COMPOSITION BY VOLUME OF THE STEEL WILL BE...                    Mixer
                                                                     Mixer
THE DATA FROM \ENDFB6\K300\LIBRARY.DAT AND WRITE DATA TO             Mixer
\MIXER\STEEL.DAT                                                     Mixer
                                                                     Mixer
IRON      - 74.8 PER-CENT                                            Mixer
CHROMIUM  - 16.0                                                     Mixer
NICKEL    -  6.0                                                     Mixer
MANGANESE -  2.0                                                     Mixer
SILICON   -  1.0                                                     Mixer
CARBON    -  0.2                                                     Mixer
                                                                     Mixer
THE INPUT MUST SPECIFY THE COMPOSITION BY GRAMS/CC. THIS IS          Mixer
DEFINED AS THE PRODUCT OF THE STANDARD DENSITY (GRAMS/CC)            Mixer
TIMES THE VOLUME FRACTION. NOTE, DO NOT USE ATOM FRACTIONS.          Mixer
FOR THIS EXAMPLE THE FOLLOWING 12 INPUT CARDS ARE REQUIRED....       Mixer
                                                                     Mixer
STAINLESS STEEL. COMPOSITION BY PER-CENT VOLUME IS 74.8-IRON,        Mixer
16-CHROME, 6-NICKEL, 2-MANGANESE, 1-SILICON, 0.2-CARBON              Mixer
\ENDFB6\K300\LIBRARY.DAT                                             Mixer
\MIXER\STEEL.DAT                                                     Mixer
     26800  4000 3  1                                               Mixer
     26000          1 5.88676    (NOTE, GRAMS/CC INPUT FOR EACH     Mixer
     24000          1 1.150448    CONSTITUENT, E.G. FOR IRON THE    Mixer
     28000          1 0.533928    STP DENSITY IS 7.87 GRAMS/CC.     Mixer
     25055          1 0.1486      THE INPUT VALUE OF 5.88676 IS     Mixer
     14000          1 0.0233      0.748 X 7.87,I.E.  VOLUME         Mixer
      6012          1 0.0044958   FRACTION TIMES STP DENSITY).      Mixer
                                (BLANK LINE TERMINATES INPUT LIST)   Mixer
                                                                     Mixer
EXAMPLE INPUT NO. 2                                                  Mixer
```

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     -------------------                                                Mixer
     THE SAME EXAMPLE AS THE ABOVE PROBLEM, ONLY USE THE STANDARD       Mixer
     ENDF/B DATA FILENAMES - ENDFB.IN AND ENDFB.OUT (THIS CAN BE        Mixer
     DONE BY LEAVING THE THIRD AND FOURTH INPUT LINES BLANK).           Mixer
     FOR THIS EXAMPLE THE FOLLOWING 12 INPUT CARDS ARE REQUIRED....     Mixer
                                                                        Mixer
     STAINLESS STEEL. COMPOSITION BY PER-CENT VOLUME IS 74.8-IRON,      Mixer
     16-CHROME, 6-NICKEL, 2-MANGANESE, 1-SILICON, 0.2-CARBON            Mixer
     (NOTE - THIS LINE IS REALLY BLANK)                                 Mixer
     (NOTE - THIS LINE IS REALLY BLANK)                                 Mixer
          26800  4000 3  1                                             Mixer
          26000          1 5.88676    (NOTE, GRAMS/CC INPUT FOR EACH    Mixer
          24000          1 1.150448    CONSTITUENT, E.G. FOR IRON THE   Mixer
          28000          1 0.533928    STP DENSITY IS 7.87 GRAMS/CC.    Mixer
          25055          1 0.1486      THE INPUT VALUE OF 5.88676 IS    Mixer
          14000          1 0.0233      0.748 X 7.87,I.E.  VOLUME        Mixer
           6012          1 0.0044958   FRACTION TIMES STP DENSITY).     Mixer
                                     (BLANK LINE TERMINATES INPUT LIST) Mixer
                                                                        Mixer
=========================================================================== Mixer
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======================================================================== Recent
                                                                         Recent
      PROGRAM RECENT                                                     Recent
      VERSION 79-1 (OCTOBER 1979)  CDC-7600                              Recent
      VERSION 80-1 (MAY 1980)      IBM, CDC AND CRAY VERSION             Recent
      VERSION 80-2 (DECEMBER 1980) IMPROVED TREATMENT OF UNRESOLVED      Recent
                                    REGION TO COMPUTE ALL REACTIONS AT   Recent
                                    THE SAME TIME.                       Recent
      VERSION 81-1 (MARCH 1981)  IMPROVED BASED ON USER COMMENTS.        Recent
      VERSION 81-2 (AUGUST 1981) ADDED MONITOR MODE. ADDED SPEED OPTION  Recent
                                 TO BYPASS BACKWARDS THINNING IF FILE 3  Recent
                                 ALLOWABLE ERROR = 0.0 (NOTE THIS OPTION Recent
                                 WILL RESULT IN ALL TABULATED POINTS     Recent
                                 FROM THE EVALUATION BEING KEPT IN THE   Recent
                                 OUTPUT FROM THIS PROGRAM).              Recent
      VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY.       Recent
      VERSION 83-1 (JANUARY 1983)*MAJOR RE-DESIGN.                       Recent
                                 *PAGE SIZES INCREASED.                  Recent
                                 *ELIMINATED COMPUTER DEPENDENT CODING.  Recent
                                 *NEW, MORE COMPATIBLE I/O UNIT NUMBERS. Recent
                                 *ADDED OPTION TO KEEP ALL RECONSTRUCTED Recent
                                  AND BACKGROUND ENERGY POINTS.          Recent
                                 *ADDED STANDARD ALLOWABLE ERROR OPTIONS Recent
                                  (CURRENTLY 0.1 PER-CENT RECONSTRUCTION Recent
                                  AND 0.0 PER-CENT THINNING).            Recent
      VERSION 83-2 (OCTOBER 1983) IMPROVED BASED ON USER COMMENTS.       Recent
      VERSION 84-1 (JANUARY 1984) IMPROVED INTERVAL HALFING CONVERGENCE. Recent
      VERSION 85-1 (APRIL 1985)  *A BRAND NEW PROGRAM WHICH COMPLETELY   Recent
                                  SUPERCEDES ALL PREVIOUS VERSIONS OF    Recent
                                  THIS PROGRAM.                          Recent
                                 *UPDATED FOR ENDF/B-VI FORMATS.         Recent
                                 *ADDED GENERAL REICH-MOORE FORMALISM    Recent
                                  (WITH TWO FISSION CHANNELS).           Recent
                                 *DECREASED RUNNING TIME.                Recent
                                 *SPECIAL I/O ROUTINES TO GUARANTEE      Recent
                                  ACCURACY OF ENERGY.                    Recent
                                 *DOUBLE PRECISION TREATMENT OF ENERGY   Recent
                                  (REQUIRED FOR NARROW RESONANCES).      Recent
      VERSION 85-2 (AUGUST 1985) *FORTRAN-77/H VERSION                   Recent
      VERSION 86-1 (JANUARY 1986)*ENERGY DEPENDENT SCATTERING RADIUS     Recent
      VERSION 86-2 (JUNE 1986)   *IF FIRST CHANCE FISSION (MT=19)        Recent
                                  BACKGROUND IS PRESENT ADD RESONANCE    Recent
                                  CONTRIBUTION OF FISSION TO IT.         Recent
      VERSION 86-3 (OCTOBER 1986)*MULTI-LEVEL OR REICH-MOORE..CORRECT    Recent
                                  POTENTIAL SCATTERING CROSS SECTION FOR Recent
                                  MISSING AND/OR FICTICIOUS (L,J)        Recent
                                  SEQUENCES.                             Recent
      VERSION 87-1 (JANUARY 1987)*IMPROVED COMBINING FILE 2+3            Recent
      VERSION 87-2 (MARCH 1987)  *CORRECTED ADLER-ADLER CALCULATIONS.    Recent
      VERSION 88-1 (JULY 1988)   *UPDATED REICH-MOORE ENDF/B-VI FORMAT   Recent
                                  TO BE THE SAME AS REICH-MOORE FORMAT   Recent
                                  IN EARLIER VERSIONS OF ENDF/B FORMAT.  Recent
                                 *CHECK FOR PRELIMINARY ENDF/B-VI        Recent
                                  REICH-MOORE FORMAT (NOW ABANDONED)     Recent
                                  AND TERMINATE EXECUTION IF DATA IS     Recent
                                  IN THIS FORMAT.                        Recent
                                 *CALCULATE CHANNEL RADIUS OR SET IT     Recent
                                  EQUAL TO THE SCATTERING RADIUS.        Recent
                                 *IMPLEMENTED HYBRID R-FUNCTION WITH THE Recent
                                  FOLLOWING RESTRICTIONS                 Recent
                                  - ONLY INELASTIC COMPETITION (NO       Recent
                                    CHARGED PARTICLES)                   Recent
                                  - NO TABULATED FILE 2 BACKGROUND       Recent
                                  - NO TABULATED OPTICAL MODEL PHASE     Recent
                                    SHIFT                                Recent
                                 *PROGRAM EXIT IF GENERAL R-MATRIX IN    Recent
                                  THE EVALUATION (THIS FORMALISM WILL    Recent
                                  BE IMPLEMENTED ONLY AFTER THE AUTHOR   Recent
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                          RECEIVES REAL EVALUATIONS WHICH USE    Recent
                          THIS FORMALISM...UNTIL THEN IT IS      Recent
                          IMPOSSIBLE TO ADEQUATELY TEST THAT     Recent
                          THE CODING FOR THIS FORMALISM IS       Recent
                          CORRECT).                              Recent
                         *INCREASED MAXIMUM NUMBER OF RESONANCES Recent
                          FROM 1002 TO 4008.                     Recent
                         *DOUBLE PRECISION RESONANCE REGION      Recent
                          LIMITS.                                Recent
                         *FILE 2 AND FILE 3 ENERGIES WHICH ARE   Recent
                          NEARLY EQUAL ARE TREATED AS EQUAL      Recent
                          (I.E., SAME TO ABOUT 9 DIGITS).        Recent
                         *CHECK FILE 3 BACKGROUND CROSS SECTIONS Recent
                          IN EDIT MODE.                          Recent
                         *OPTION...INTERNALLY DEFINE FILENAMES   Recent
                          (SEE SUBROUTINE FILEIO FOR DETAILS).   Recent
VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO   Recent
                          INSURE PROGRAM WILL NOT DO ANYTHING    Recent
                          CRAZY.                                 Recent
                         *UPDATED TO USE NEW PROGRAM CONVERT     Recent
                          KEYWORDS.                              Recent
                         *CORRECTED MULTILEVEL, REICH-MOORE AND  Recent
                          HYBRID R-FUNCTION POTENTIAL SCATTER    Recent
                          TO ACCOUNT FOR REPEATED J-VALUES FOR   Recent
                          THE SAME TARGET SPIN AND L-VALUE.      Recent
                         *ADDED LIVERMORE CIVIC COMPILER         Recent
                          CONVENTIONS.                           Recent
                         *UPDATED TO USE NEW ENDF/B-VI           Recent
                          CONVENTION TO ALLOW UNRESOLVED         Recent
                          RESONANCE CONTRIBUTION TO ALREADY      Recent
                          BE INCLUDED IN THE FILE 3 CROSS        Recent
                          SECTIONS (INFINITELY DIULUTE           Recent
                          CONTRIBUTION).                         Recent
VERSION 90-1 (JUNE 1990)  *UPDATED BASED ON USER COMMENTS        Recent
                         *ADDED FORTRAN SAVE OPTION              Recent
                         *NEW MORE CONSISTENT ENERGY OUTPUT      Recent
                          ROUTINE                                Recent
VERSION 91-1 (JULY 1991)  *NEW UNIFORM TREATMENT OF ALL RESONANCE Recent
                          FORMALISMS (SEE, COMMENTS BELOW)       Recent
                         *NEW REICH-MOORE ALGORITHM              Recent
                         *MORE EXTENSIVE ERROR CHECKING AND      Recent
                          ERROR MESSAGE EXPLANATIONS             Recent
VERSION 92-1 (JANUARY 1992)*MAJOR RESTRUCTING TO IMPROVE ACCURACY Recent
                          AND COMPUTER INDEPENDENCE.             Recent
                         *INCREASED ENERGY POINT PAGE SIZE FROM  Recent
                          1002 TO 4008.                          Recent
                         *NO MORE THAN 2 ENERGY POINTS WHERE     Recent
                          CROSS SECTION IS ZERO AT BEGINNING     Recent
                          OF A SECTION FOR EACH REACTION,E.G.,   Recent
                          THRESHOLD FISSION.                     Recent
                         *PROCESS ONLY A PORTION OF RESONANCE    Recent
                          REGION - SEE EXPLANATION BELOW         Recent
                         *ALL ENERGIES INTERNALLY ROUNDED PRIOR  Recent
                          TO CALCULATIONS.                       Recent
                         *COMPLETELY CONSISTENT I/O AND ROUNDING Recent
                          ROUTINES - TO MINIMIZE COMPUTER        Recent
                          DEPENDENCE.                            Recent
VERSION 93-1 (MARCH 1993)  *UPDATED REICH-MOORE TREATMENT TO USE  Recent
                          L DEPENDENT SCATTERING RADIUS (APL)    Recent
                          RATHER THAN SCATTERING RADIUS (AP)     Recent
                          (SEE, ENDF/B-VI FORMATS AND            Recent
                           PROCEDURES MANUAL, PAGE 2.6)          Recent
                         *INCREASED PAGE SIZE FROM 4008 TO       Recent
                          20040 DATA POINTS.                     Recent
                         *INCREASED MAXIMUM NUMBER OF RESONANCES Recent
                          FROM 4008 TO 20040.                    Recent
VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES       Recent
                          TO ALLOW ACCESS TO FILE STRUCTURES     Recent
```

```
                          (WARNING - INPUT PARAMETER FORMAT      Recent
                          HAS BEEN CHANGED).                     Recent
                         *CLOSE ALL FILES BEFORE TERMINATING     Recent
                          (SEE, SUBROUTINE ENDIT)                Recent
VERSION 94-2 (AUGUST 1994) *CORRECTED ADDJ FOR ENERGY DEPENDENT  Recent
                          (TABULATED) SCATTERING RADIUS CASE.    Recent
VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                   Recent
                          *IMPROVED COMPUTER INDEPENDENCE        Recent
                          *ALL DOUBLE PRECISION                  Recent
                          *ON SCREEN OUTPUT                      Recent
                          *UNIFORM TREATMENT OF ENDF/B I/O       Recent
                          *IMPROVED OUTPUT PRECISION             Recent
                          *ALWAYS INCLUDE THERMAL VALUE          Recent
                          *DEFINED SCRATCH FILE NAMES            Recent
VERSION 97-1 (APRIL 1997)  *OPTIONAL MAKE NEGATIVE CROSS         Recent
                           SECTION = 0 FOR OUTPUT                Recent
                         *INCREASED PAGE SIZE FROM 20040 TO      Recent
                          120000 DATA POINTS.                    Recent
                         *INCREASED MAXIMUM NUMBER OF RESONANCES Recent
                          FROM 20040 TO 120000.                  Recent
VERSION 99-1 (MARCH 1999)  *CORRECTED CHARACTER TO FLOATING      Recent
                           POINT READ FOR MORE DIGITS            Recent
                          *UPDATED TEST FOR ENDF/B FORMAT        Recent
                           VERSION BASED ON RECENT FORMAT CHANGE Recent
                          *UPDATED CONSTANTS BASED ON CSEWG      Recent
                           SUBCOMMITTEE RECOMMENDATIONS          Recent
                          *GENERAL IMPROVEMENTS BASED ON         Recent
                           USER FEEDBACK                         Recent
VERSION 99-2 (JUNE 1999)   *IMPLEMENTED NEW REICH-MOORE FORMALISM Recent
                           TO ALLOW DEFINITION OF (L,J,S) FOR    Recent
                           EACH SEQUENCE.                        Recent
                          *ASSUME ENDF/B-VI, NOT V, IF MISSING   Recent
                           MF=1, MT-451.                         Recent
VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON       Recent
                           USER FEEDBACK                         Recent
VERS. 2002-1 (MAY 2002)    *OPTIONAL INPUT PARAMETERS            Recent
             (SEPT. 2002)  *OUTPUT RESONANCE WITH 9 DIGITS       Recent
                          *TO BE C AND C++ COMPATIBLE OUTPUT     Recent
VERS. 2004-1 (JAN. 2004)   *ADDED INCLUDE 'recent.h'             Recent
                          *MADE ENDF/B-VII READY                 Recent
                          *UPDATED FOR NEW REICH-MOORE LRF=7     Recent
                           PARAMETERS WITH COMPETITION           Recent
                          *ADDED COULOMB PENETRATION FACTORS FOR Recent
                           LRF=7 COMPETITIVE CHANNELS.           Recent
                          *EXTENDED DEFINITIONS OF PENETRATION   Recent
                           FACTOR, LEVEL SHIFT FACTOR, AND       Recent
                           POTENTIAL SCATTERING PHASE SHIFT      Recent
                           ABOVE L = 5 TO INFINITY.              Recent
                          *ADDED QUICK CALCULATION - IF THE      Recent
                           INPUT ALLOWABLE ERROR IS 1.0 OR MORE  Recent
                           (100 % OR MORE) THERE IS NO ITERATION Recent
                           TO CONVERGENCE - CROSS SECTION ARE    Recent
                           QUICKLY CALCULATED ONLY AT A FIXED    Recent
                           SET OF ENERGY POINTS, BASED ON THE    Recent
                           ENERGY AND WIDTH OF ALL RESONANCES.   Recent
                           THIS CAN BE USED TO QUICKLY "SEE"     Recent
                           NEW EVALUATIONS THAT MAY CONTAIN      Recent
                           ERRORS, THAT WOULD OTHERWISE CAUSE    Recent
                           THIS CODE TO RUN FOR AN EXCESSIVELY   Recent
                           LONG TIME.                            Recent
VERS. 2005-1 (JUNE 2005)   *ADDED ENERGY DEPENDENT SCATTERING     Recent
                           RADIUS FOR ALL RESONANCE TYPES        Recent
                           (EARLIER ONLY BREIT-WIGNER ALLOWED).  Recent
VERS. 2007-1 (JAN. 2007)   *CHECKED AGAINST ALL ENDF/B-VII.       Recent
                          *DECOUPLED PAGE SIZE FROM MAX. # OF    Recent
                           RESONANCES.                           Recent
                          *INCREASED PAGE SIZE FROM 120,000 TO   Recent
                           750,000 DATA POINTS.                  Recent
```

```
                              *KEPT MAX. # OF RESONANCE AT 120,000.  Recent
                              *CORRECTED ALL BACKGROUND = 0 CASE     Recent
                                                                     Recent
OWNED, MAINTAINED AND DISTRIBUTED BY                                 Recent
-----------------------------------                                  Recent
THE NUCLEAR DATA SECTION                                             Recent
INTERNATIONAL ATOMIC ENERGY AGENCY                                   Recent
P.O. BOX 100                                                         Recent
A-1400, VIENNA, AUSTRIA                                              Recent
EUROPE                                                               Recent
                                                                     Recent
ORIGINALLY WRITTEN BY                                                Recent
-----------------------------------                                  Recent
DERMOTT E. CULLEN                                                    Recent
UNIVERSITY OF CALIFORNIA                                             Recent

LAWRENCE LIVERMORE NATIONAL LABORATORY                               Recent
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LIVERMORE, CA 94550                                                  Recent
U.S.A.                                                               Recent
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E. MAIL    CULLEN1@LLNL.GOV                                          Recent
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                               Recent
                                                                     Recent
Acknowledgement (Version 2004-1)                                     Recent
==================================================================== Recent
The author thanks Nancy Larson, ORNL, for providing her SAMRML       Recent
code for comparison to RECENT output for Reich-Moore evaluations,    Recent
in particular to verify results for the new LFR=7 evaluations. I     Recent
also thank her for providing guidance to help me understand and      Recent
implement this new teatment for Reich-Moore parameters.              Recent
                                                                     Recent
ACKNOWLEDGEMENT (VERSION 92-1)                                       Recent
==================================================================== Recent
THE AUTHOR THANKS SOL PEARLSTEIN (BROOKHAVEN NATIONAL LAB) FOR       Recent
SIGNIFICANTLY CONTRIBUTING TOWARD IMPROVING THE ACCURACY AND         Recent
COMPUTER INDEPENDENCE OF THIS CODE - THANKS, SOL                     Recent
==================================================================== Recent
                                                                     Recent
AUTHORS MESSAGE                                                      Recent
==================================================================== Recent
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION     Recent
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED   Recent
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE   Recent
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY       Recent
THE COMMENTS CONCERNING MACHINE DEPENDENT CODING.                    Recent
                                                                     Recent
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER   Recent
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE       Recent
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT   Recent
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY         Recent
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO    Recent
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF      Recent
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR           Recent
COMPUTER.                                                            Recent
                                                                     Recent
PURPOSE                                                              Recent
==================================================================== Recent
THIS PROGRAM IS DESIGNED TO RECONSTRUCT THE RESONANCE CONTRIBUTION   Recent
TO THE CROSS SECTION IN LINEARLY INTERPOLABLE FORM, ADD IN ANY       Recent
LINEARLY INTERPOLABLE BACKGROUND CROSS SECTION AND OUTPUT THE        Recent
RESULT IN THE ENDF/B FORMAT. THE CROSS SECTIONS OUTPUT BY THIS       Recent
PROGRAM WILL BE LINEARLY INTERPOLABLE OVER THE ENTIRE ENERGY RANGE   Recent
                                                                     Recent
THE RESONANCE CONTRIBUTION IS CALCULATED FOR TOTAL (MT=1),           Recent
ELASTIC (MT=2), CAPTURE (MT=102) AND FISSION (MT=18), ADDED          Recent
TO THE BACKGROUND (IF ANY) AND OUTPUT. IN ADDITION, IF THERE         Recent
```

```
IS A FIRST CHANCE FISSION (MT=19) BACKGROUND PRESENT THE RESONANCE Recent
CONTRIBUTION OF FISSION WILL BE ADDED TO THE BACKGROUND AND        Recent
OUTPUT. IF THERE IS NO FIRST CHANCE FISSION (MT=19) BACKGROUND     Recent
PRESENT THE PROGRAM WILL NOT OUTPUT MT=19.                         Recent
                                                                   Recent
IN THE FOLLOWING FOR SIMPLICITY THE ENDF/B TERMINOLOGY--ENDF/B     Recent
TAPE--WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS,  Recent
DISK OR ANY OTHER MEDIUM.                                          Recent
                                                                   Recent
PROCESSING DATA IN THE ENDF/B-VI FORMAT                            Recent
================================================================== Recent
IT HAS NOW BEEN CONFIRMED (PRIVATE COMMUNICATION, CHARLES DUNFORD, Recent
APRIL, 1991) THAT THE PROPER PROCEDURE TO FOLLOW WHEN THERE ARE    Recent
MISSING OR DUPLICATE J VALUES IS TO IN ALL CASES ADD A SEQUENCE    Recent
WITH NO RESONANCES TO ACCOUNT FOR THE CONTRIBUTION OF THE SEQUENCE Recent
TO THE POTENTIAL SCATTERING CROSS SECTION.                         Recent
                                                                   Recent
THIS IS THE PROCEDURE WHICH WAS FOLLOWED BY ALL VERSIONS OF RECENT Recent
SINCE 86-3 AND WILL CONTINUE TO BE THE PROCEDURE.                  Recent
                                                                   Recent
INPUT ENDF/B FORMAT AND CONVENTIONS                                Recent
================================================================== Recent
ENDF/B FORMAT                                                      Recent
-------------                                                      Recent
THIS PROGRAM ONLY USES THE ENDF/B BCD OR LINE IMAGE FORMAT (AS     Recent
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION   Recent
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT). Recent
                                                                   Recent
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B       Recent
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS     Recent
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE  Recent
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE          Recent
CORRECTLY OUTPUT ON ALL CARDS. THE FORMAT OF SECTION MF=1, MT=451  Recent
AND ALL SECTIONS OF MF=2 AND 3 MUST BE CORRECT. THE PROGRAM COPIES Recent
ALL OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE  Recent
TO THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.          Recent
                                                                   Recent
ENDF/B FORMAT VERSION                                              Recent
---------------------                                              Recent
THE FORMATS AND CONVENTIONS FOR READING AND INTERPRETING THE DATA  Recent
VARIES FROM ONE VERSION OF ENDF/B TO THE NEXT. HOWEVER, IF THE     Recent
HOLLERITH SECTION (MF=1, MT=451) IS PRESENT IT IS POSSIBLE FOR     Recent
THIS PROGRAM TO DISTINGUISH BETWEEN DATA IN THE ENDF/B-IV, V AND   Recent
VI FORMATS AND TO USE THE APPROPRIATE CONVENTIONS FOR EACH         Recent
ENDF/B VERSION (SEE, SUBROUTINE FILE1 FOR A DESCRIPTION OF HOW     Recent
THIS IS DONE). IF THE HOLLERITH SECTION IS NOT PRESENT THE         Recent
PROGRAM WILL ASSUME THE DATA IS IN THE ENDF/B-VI FORMAT AND USE    Recent
ALL CONVENTIONS APPROPRIATE TO ENDF/B-V. USERS ARE ENCOURAGED TO   Recent
INSURE THAT THE HOLLERITH SECTION (MF=1, MT=451) IS PRESENT IN     Recent
ALL EVALUATIONS.                                                   Recent
                                                                   Recent
INPUT OF ENERGIES                                                  Recent
-----------------                                                  Recent
ALL ENERGIES ARE READ IN DOUBLE PRECISION (BY SPECIAL FORTRAN I/O  Recent
ROUTINES) AND ARE TREATED IN DOUBLE PRECISION IN ALL CALCULATIONS.  Recent
                                                                   Recent
OUTPUT ENDF/B FORMAT AND CONVENTIONS                               Recent
================================================================== Recent
CONTENTS OF OUTPUT                                                 Recent
------------------                                                 Recent
ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE RECONSTRUCTED FILE     Recent
3 CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE        Recent
ALSO INCLUDED.                                                     Recent
                                                                   Recent
DOCUMENTATION                                                      Recent
-------------                                                      Recent
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED  Recent
BY THE ADDITION OF COMMENT CARDS AT THE END OF EACH HOLLERITH      Recent
```

```
SECTION IN THE FORM                                                    Recent
                                                                       Recent
***************** RECENT (VERSION 2007-1) ***************              Recent
RESONANCE CONTRIBUTION RECONSTRUCTED TO WITHIN   0.100 PER-CENT       Recent
COMBINED DATA NOT THINNED (ALL RESONANCE + BACKGROUND DATA KEPT)       Recent
                                                                       Recent
THE ORDER OF ALL SIMILAR COMMENTS (FROM LINEAR, SIGMA1 AND GROUPY)     Recent
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON           Recent
THE DATA, INCLUDING WHICH VERSION OF EACH PROGRAM WAS USED.            Recent
                                                                       Recent
THESE COMMENT CARDS ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,     Recent
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT     Recent
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF          Recent
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451        Recent
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF          Recent
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF          Recent
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO              Recent
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND       Recent
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT      Recent
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                          Recent
                                                                       Recent
REACTION INDEX                                                         Recent
--------------                                                         Recent
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN         Recent
SECTION MF=1, MT=451 OF EACH EVALUATION.                               Recent
                                                                       Recent
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.       Recent
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT             Recent
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS     Recent
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING      Recent
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE      Recent
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM     Recent
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.         Recent
                                                                       Recent
OUTPUT FORMAT OF ENERGIES                                              Recent
-------------------------                                              Recent
IN THIS VERSION OF RECENT ALL FILE 3 ENERGIES WILL BE OUTPUT IN        Recent
F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN       Recent
WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN      Recent
OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS       Recent
OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS        Recent
TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE      Recent
TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA         Recent
JUST DUE TO TRANSLATION OF ENERGIES FROM THEIR INTERNAL (BINARY)       Recent
REPRESENTATION TO THE ENDF/B FORMAT.                                   Recent
                                                                       Recent
ACCURACY OF ENERGY                                                     Recent
------------------                                                     Recent
IN ORDER TO ALLOW ENERGIES TO BE ACCURATELY OUTPUT TO 9 DIGITS         Recent
ON SHORT WORD LENGTH COMPUTERS (E.G. IBM) ALL ENERGIES AND             Recent
ENERGY DEPENDENT TERMS ARE READ AND TREATED IN DOUBLE PRECISION.       Recent
                                                                       Recent
OUTPUT OF RESONANCE PARAMETERS                                         Recent
------------------------------                                         Recent
A SPECIAL CONVENTION HAS BEEN INTRODUCED REGARDING RESONANCE           Recent
PARAMETERS. IN ORDER TO ALLOW THE USER TO DOPPLER BROADEN AND/OR       Recent
SELF-SHIELD CROSS SECTIONS THE RESONANCE PARAMETERS ARE ALSO           Recent
INCLUDED IN THE OUTPUT WITH THE EVALUATION. IN ORDER TO AVOID THE      Recent
POSSIBILITY OF ADDING THE RESONANCE CONTRIBUTION A SECOND TIME         Recent
TWO CONVENTIONS HAVE BEEN ADOPTED TO INDICATE THAT THE RESONANCE       Recent
CONTRIBUTION HAS ALREADY BEEN ADDED TO THE FILE 3 CROSS SECTIONS,      Recent
                                                                       Recent
(1) WHEN THE DATA IS PROCESSED BY THIS PROGRAM LRP (IN MF=1,           Recent
MT=451) IS SET EQUAL TO 2. THIS IS A CONVENTION WHICH HAS BEEN         Recent
ADOPTED AS A STANDARD CONVENTION IN ENDF/B-VI, BUT IS ONLY TO BE       Recent
USED FOR PROCESSED DATA, AS OPPOSED TO THE ORIGINAL EVALUATIONS.       Recent
IN EVALUATIONS WHICH CONTAIN MF=1, MT=451 LRP CAN BE USED TO           Recent
DETERMINE IF THE MATERIAL HAS BEEN PROCESSED.                          Recent
```

(2) THE LRU FLAG IN EACH SECTION OF FILE 2 DATA IS CHANGED TO LRU=LRU+3. FOR EXAMPLE WHEN READING AN ENDF/B EVALUATION LRU=0 (NO RESONANCES), =1 (RESOLVED) OR =2 (UNRESOLVED) INDICATES THAT THE DATA IS IN THE ORIGINAL ENDF/B FORM. LRU=3 (NO RESONANCES), =4 (RESOLVED) OR =5 (UNRESOLVED) INDICATES THAT THE RESONANCE CONTRIBUTION HAS ALREADY BEEN ADDED TO THE FILE 3 DATA. THIS SECOND CONVENTION HAS BEEN ADOPTED AS INSURANCE THAT THE RESONANCE CONTRIBUTION WILL NOT BE ADDED TWICE, EVEN FOR EVALUATIONS WHICH DO NOT CONTAIN MF=1, MT=451 (EVALUATIONS WHICH CONTAIN MF=1, MT=451 ARE COVERED BY CONVENTION (1), DESCRIBED ABOVE).

UNIFORM TREATMENT OF RESONANCE FORMALISMS

NORMALIZATION

ALL OF THE RESONANCE FORMALISMS INCLUDE A FACTOR OF,

PI*(FRACTIONAL ABUNDANCE)/(K**2)

THIS FACTOR HAS BEEN REMOVED FROM THE CALCULATION OF EACH TYPE OF RESONANCE FORMALISM AND IS APPLIED AS A FINAL NORMALIZATION AFTER THE CALCULATION, ONLY ONE PLACE IN THIS PROGRAM.

FOR SIMPLICITY THIS TERM IS NOT INCLUDED IN THE FOLLOWING DERIVATIONS - IN ALL CASES THE ACTUAL CROSS SECTION IS A PRODUCT OF THE ABOVE FACTOR TIMES THE RESULTS PRESENTED BELOW.

SIMILARITIES

FOR THE RESOLVED RESONANCE REGION, EXCEPT FOR SINGLE LEVEL BREIT WIGNER, PARAMETERS ALL OF THE FORMALISMS DEFINE THE CROSS SECTIONS IN AN EQUIVALENT FORM,

```
TOTAL    = 2*GJ*REAL(1 - U)
         = 2*GJ*(1 - REAL(U))
ELASTIC  =   GJ*(1 - U)**2
         =   GJ*((1 - 2*REAL(U)) + (REAL(U)**2 + IM(U)**2))
         = 2*GJ*(1 - REAL(U)) - GJ*(1 - (REAL(U)**2 + IM(U)**2))
```

SINCE THE FIRST TERM IS THE TOTAL, THE SECOND TERM MUST BE ABSORPTION. SO WE FIND,

```
ABSORPTION = GJ*(1 - (REAL(U)**2 + IM(U)**2))
```

IN ALL CASES U IS DEFINED IN THE FORM,

```
U        = EXP(-I*2*PS)*((1-X) - I*Y)
```

WHERE (X) AND (Y) ARE RELATED TO THE SYMMETRIC AND ANTI-SYMMETRIC CONTRIBUTIONS OF THE RESONANCES, RESPECTIVELY. ONLY THE DEFINITION OF (X) AND (Y) WILL BE DIFFERENT FOR EACH RESONANCE FORMALISM. BELOW WE WILL SHOW THAT WHAT MIGHT APPEAR TO BE A STRANGE CHOICE OF DEFINITION OF THE SIGN OF (X) AND(Y) HAS BEEN SELECTED SO THAT FOR BREIT-WIGNER PARAMETERS (X) AND (Y) CORRESPOND EXACTLY TO THE SYMMETRIC AND ANTI-SYMMETRIC CONTRIBUTION OF THE RESONANCES.

```
U        = (COS(2*PS) - I*SIN(2*PS))*((1-X) - I*Y)
         =   ((1-X)*COS(2*PS) - Y*SIN(2*PS))
         =-I*((1-X)*SIN(2*PS) + Y*COS(2*PS))

REAL(U)  = ((1-X)*COS(2*PS) - Y*SIN(2*PS))
IM(U)    =-((1-X)*SIN(2*PS) + Y*COS(2*PS))

R(U)**2  =((1-X)*COS(2*PS))**2 + (Y*SIN(2*PS))**2
          -2*(1-X)*Y*COS(2*PS)*SIN(2*PS)
I(U)**2  =((1-X)*SIN(2*PS))**2 + (Y*COS(2*PS))**2
```

```
          +2*(1-X)*Y*COS(2*PS)*SIN(2*PS)                              Recent

                                                                      Recent
THE TERMS 2*(1-X)*Y*COS(2*PS)*SIN(2*PS) CANCEL AND UPON USING         Recent
THE IDENTITY COS(2*PS)**2 + SIN(2*PS)**2 = 1,                         Recent
                                                                      Recent
SUM      = (1-X)**2 + (Y)**2                                          Recent
                                                                      Recent
WE NOW HAVE ALL THE QUANTITIES THAT WE NEED TO DEFINE THE CROSS       Recent
SECTIONS,                                                             Recent
                                                                      Recent
ELASTIC                                                               Recent
=======                                                               Recent
ELASTIC  =GJ*(1 - 2*REAL(U) + (REAL(U)**2 + IM(U)**2))                Recent
         =GJ*(1 - 2*((1-X)*COS(2*PS)-Y*SIN(2*PS))+(1-X)**2+(Y)**2)    Recent
                                                                      Recent
THIS CAN BE WRITTEN AS A SUM OF 2 SQUARES,                            Recent
                                                                      Recent
ELASTIC  =GJ*(COS(2*PS) - (1-X))**2 + (SIN(2*PS) + Y)**2)             Recent
                                                                      Recent
         =GJ*((COS(2*PS))**2 - 2*(1-X)*COS(2*PS) + (1-X)**2) +        Recent
              (SIN(2*PS))**2 + 2*Y*SIN(2*PS)    + (Y)**2)             Recent
                                                                      Recent
AGAIN USING THE IDENTITY COS(2*PS)**2 + SIN(2*PS)**2 = 1, WE CAN      Recent
SEE THAT THE DEFINITION AS THE SUM OF 2 SQUARES IS IDENTICAL TO       Recent
THE PRECEDING DEFINITION OF THE ELASTIC.                              Recent
                                                                      Recent
ELASTIC  =GJ*(COS(2*PS) - (1-X))**2 + (SIN(2*PS) + Y)**2)             Recent
         =GJ*((COS(2*PS)-1) + X)**2 + (SIN(2*PS) + Y)**2)             Recent
                                                                      Recent
USING THE IDENTITY (1 - COS(2*PS))) = 2*SIN(PS)**2, WE OBTAIN         Recent
THE FINAL FORM FOR THE ELASTIC,                                       Recent
                                                                      Recent
ELASTIC =GJ*(2*SIN(PS)**2 - X)**2 + (SIN(2*PS) + Y)**2)               Recent
                                                                      Recent
ABSORPTION                                                            Recent
==========                                                            Recent
ABSORPTION = GJ*(1 - (REAL(U)**2 + IM(U)**2))                         Recent
           = GJ*(1 - ((1-X)**2   + (Y)**2)                            Recent
           = GJ*(1 - (1 - 2*X + (X)**2 + (Y)**2)                      Recent
           = GJ*(2*X - (X)**2 + (Y)**2)                               Recent
                                                                      Recent
SINCE PHYSICALLY THE ABSORPTION CANNOT BE NEGATIVE WE CAN SEE         Recent
THAT (X) MUST BE POSITIVE AND 2*X MUST BE GREATER THAN                Recent
(X)**2 + (Y)**2, FOR ALL OF THE FORMALISMS.                           Recent
                                                                      Recent
TOTAL                                                                 Recent
=====                                                                 Recent
IN THIS PROGRAM THE TOTAL CROSS SECTION IS ALWAYS DEFINED TO BE       Recent
THE SUM OF ITS PARTS - SO THE ABOVE DEFINITION IS NEVER EXPLICITLY    Recent
USED. HOWEVER, WE CAN LEARN SOMETHING BY EXAMINING THE DEFINITION,    Recent
                                                                      Recent
TOTAL    = 2*GJ*REAL(1 - U)                                           Recent
         = 2*GJ*(1 - (((1-X)*COS(2*PS) - Y*SIN(2*PS)))                Recent
         = 2*GJ*((1 - COS(2*PS))*(1-X) - (1-X) + Y*SIN(2*PS))         Recent
         = 2*GJ*(2*SIN(PS)**2*(1-X)    - (1-X) + Y*SIN(2*PS))         Recent
                                                                      Recent
         = 4*GJ*SIN(PS)**2 +                                          Recent
           2*GJ*((X-1) - 2*X*SIN(PS)**2 +  Y*SIN(2*PS))               Recent
                                                                      Recent
THE IMPORTANT POINT TO NOTE IS THAT THE DEFINITION OF THE TOTAL       Recent
DOES NOT EXPLICITLY CONTAIN ANY DEPENDENCE ON X**2 AND Y**2 -         Recent
THE LEVEL-LEVEL INTERFERENCE TERMS.                                   Recent
                                                                      Recent
THIS IMPLIES THAT IF A GIVEN SET OF RESONANCE PARAMETERS ARE USED     Recent
WITH THIS DEFINITION THEY WILL PRODUCE EXACTLY THE SAME TOTAL         Recent
CROSS SECTION - WHETHER WE CLAIM THE PARAMETERS HAVE BEEN             Recent
PRODUCED USING A SINGLE OR MULTI-LEVEL FIT. THIS RESULT COULD         Recent
```

```
BE VERY MISLEADING, IF THIS RESULT FOR THE TOTAL IS IMPLIED TO     Recent
MEAN THAT ONE INTERPRETATION OR THE OTHER WILL NOT HAVE ANY        Recent
EFFECT ON THE INDIVIDUAL CROSS SECTIONS.                           Recent
                                                                   Recent
STARTING FROM EXACTLY THE SAME RESONANCE PARAMETERS, RELATIVE TO   Recent
THE RESULTS OBTAINED USING THE SINGLE LEVEL FORMULA, MULTI-LEVEL   Recent
RESULTS WILL TEND TO ALWAYS DECREASE THE ABSORPTION AND INCREASE   Recent
THE ELASTIC. THIS CAN BE IMMEDIATELY SEEN FROM OUR GENERAL         Recent
MULTI-LEVEL DEFINITION OF ABSORPTION,                              Recent
                                                                   Recent
ABSORPTION =GJ*(2*X - ((X)**2 + (Y)**2))                           Recent
                                                                   Recent
THE SINGLE LEVEL ABSORPTION IS,                                    Recent
                                                                   Recent
ABSORPTION =GJ*(2*X)                                               Recent
                                                                   Recent
THE DIFFERENCE BETWEEN THE TWO IS -2*GJ*(X**2 + Y**2), SO THAT     Recent
REGARDLESS OF HOW WE DEFINE (X) AND (Y) THE INCLUSION OF THIS      Recent
TERM WILL ALWAYS DECREASE ABSORPTION. SINCE THE TOTAL CROSS        Recent
SECTION IS THE SAME IN BOTH CASE, THIS MEANS THAT THE ELASTIC      Recent
HAS BEEN INCREASED BY THIS AMOUNT.                                 Recent
                                                                   Recent
AGAIN, THESE RESULTS ARE BASED ON STARTING FROM EXACTLY THE SAME   Recent
PARAMETERS - IN ANY ACTUAL CASE THE PARAMETERS BASED ON A SINGLE   Recent
OR MULTI-LEVEL FIT WILL BE QUITE DIFFERENT - THE POINT THAT WE     Recent
WANT TO STRESS HERE IS THAT YOU SHOULD NEVER USE PARAMETERS        Recent
WHICH HAVE BEEN DEFINED BY A FIT USING ONE FORMALISM - IN THE      Recent
EQUATIONS FOR A DIFFERENT FORMALISM - AND ASSUME THAT THE RESULTS  Recent
WILL BE CONSISTENT - AND NEVER USE THE TOTAL CROSS SECTION TO      Recent
SEE WHETHER OR NOT A SET OF SINGLE LEVEL PARAMETERS CAN BE USED    Recent
WITH A MULTI-LEVEL FORMALISM.                                      Recent
                                                                   Recent
POTENTIAL CROSS SECTION                                            Recent
======================                                             Recent
FAR FROM RESONANCES (X) AND (Y) WILL BE SMALL AND THE ELASTIC      Recent
CROSS SECTION REDUCES TO,                                          Recent
                                                                   Recent
ELASTIC =GJ*(2*SIN(PS)**2)**2     + (SIN(2*PS))**2                 Recent
        =GJ*4*(SIN(PS)**4         + SIN(2*PS)**2                   Recent
                                                                   Recent
USING THE IDENTITY SIN(2*PS) = 2*SIN(PS)*COS(PS)                   Recent
                                                                   Recent
        =4*GJ*(SIN(PS)**4         + (SIN(PS)*COS(PS))**2)          Recent
        =4*GJ*SIN(PS)**2*(SIN(PS)**2 + COS(PS)**2)                 Recent
        =4*GJ*SIN(PS)**2                                           Recent
                                                                   Recent
WHICH IS THE POTENTIAL CROSS SECTION. NOTE THAT THIS RESULT IS     Recent
INDEPENDENT OF THE FORMALISM USED, AS IT MUST PHYSICALLY BE,       Recent
AND AS SUCH ALTHOUGH AS YET WE HAVE NOT DEFINED IT, WE CAN         Recent
NOW SEE THAT IN ALL CASES (PS) MUST BE THE PHASE SHIFT AND FOR     Recent
CONSISTENCY IT MUST BE DEFINED USING EXACTLY THE SAME DEFINITION   Recent
IN ALL CASES.                                                      Recent
                                                                   Recent
IN ADDITION SINCE PHYSICALLY FOR EACH L VALUE WE EXPECT TO OBTAIN  Recent
A POTENTIAL CROSS SECTION,                                         Recent
                                                                   Recent
4*(2*L+1)*SIN(PS)**2                                               Recent
                                                                   Recent
OBVIOUSLY FOR CONSISTENCY WE MUST HAVE,                            Recent
                                                                   Recent
(2*L+1) = (SUM OVER J) GJ                                          Recent
                                                                   Recent
ONLY IN THIS CASE WILL THE RESULTS BE CONSISTENT - THIS POINT WILL Recent
BE DISCUSSED IN DETAIL BELOW.                                      Recent
                                                                   Recent
WHAT ARE THIS TERMS (X) AND (Y)                                    Recent
==============================                                     Recent
(X) AND (Y) CAN BE EASILY IDENTIFIED BY CONSIDERING THE SINGLE     Recent
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AND MULTI-LEVEL BREIT WIGNER FORMALISMS. IN THESE CASES WE WILL    Recent
FIND THAT,                                                         Recent
                                                                   Recent
X        = GAM(N)*GAM(T)/2/DEN                                     Recent
Y        = GAM(N)*(E-ER)/DEN                                       Recent
DEN      = ((E-ER)**2 + (GAM(T)/2)**2)                             Recent
                                                                   Recent
EXTREME CARE HAS TO BE USED TO PROPERLY DEFINE (Y) SUCH THAT IT    Recent
IS NEGATIVE FOR E LESS THAN ER AND POSITIVE FOR E GREATER THAN     Recent
ER. I WILL MERELY MENTION THAT THE EQUATIONS FOR ALL FORMALISMS    Recent
IN ENDF-102 DO NOT CONSISTENTLY USE (E - ER) - IN SOME CASES       Recent
THIS IS WRITTEN AS (ER - E), WHICH CAN LEAD TO AN INCORRECT        Recent
SIGN IN THE DEFINITION OF THE (Y) THAT WE REQUIRE.                 Recent
                                                                   Recent
THE INTERFERENCE TERMS CAN BE WRITTEN IN TERMS OF,                 Recent
1) LEVEL-SELF INTERFERENCE  = THE CONTRIBUTION OF EACH LEVEL       Recent
                              INTERFERRING WITH ITSELF             Recent
2) LEVEL-LEVEL INTERFERENCE = THE CONTRIBUTION OF EACH LEVEL       Recent
                              INTERFERRRING WITH ALL OTHER LEVELS  Recent
                                                                   Recent
WE WILL REFER TO THESE TWO AS (L-S) AND (L-L),                     Recent
                                                                   Recent
X**2     = (GAM(N)*(GAM(T)/2)**2/(DEN)**2      + (L-L)             Recent
         = (GAM(N)**2*((GAM(T)/2)**2)/(DEN)**2 + (L-L)             Recent
Y**2     = (GAM(N))**2*((E-ER))**2/(DEN)**2    + (L-L)             Recent
                                                                   Recent
X**2+Y**2= GAM(N)**2*DEN/(DEN)**2 = GAM(N)**2/DEN + (L-L)          Recent
                                                                   Recent
TO SEE THE EFFECT OF INCLUDING MULTI-LEVEL INTERFERENCE WE CAN     Recent
CONSIDER OUR GENERAL EXPRESSION FOR ABSORPTION,                    Recent
                                                                   Recent
ABSORPTION =GJ*(2*X - ((X)**2 + (Y)**2))                           Recent
                                                                   Recent
AND NOTE THAT FOR BOTH SINGLE AND MULTI-LEVEL BREIT WIGNER THE     Recent
ENDF-102 SAYS TO TREAT ABSORPTION IN A SINGLE LEVEL APPROXIMATION  Recent
I.E., IGNORE LEVEL-LEVEL INTERFERENCE. IF ALL INTERFERENCE IS      Recent
IGNORED THIS IS EQUIVALENT TO COMPLETELY IGNORING X**2 + Y**2 AND  Recent
DEFINING,                                                          Recent
                                                                   Recent
ABSORPTION =GJ*2*X                                                 Recent
           =2*GJ*GAM(N)*GAM(T)/DEN                                 Recent
                                                                   Recent
WHICH IS INCORRECT - SINCE THIS SEEMS TO INDICATE EVERYTHING IS    Recent
ABSORBED. IN ORDER TO OBTAIN THE CORRECT EXPRESSION WE CANNOT      Recent
COMPLETELY IGNORE INTERFERENCE - WE CAN IGNORE LEVEL-LEVEL         Recent
INTERFERENCE, BUT WE MUST INCLUDE LEVEL-SELF INTERFERENCE,         Recent
                                                                   Recent
X**2+Y**2= GAM(N)**2/DEN                                           Recent
                                                                   Recent
ABSORPTION =GJ*(2*X - ((X)**2 + (Y)**2))                           Recent
           =GJ*GAM(N)*(GAM(T)-GAM(N))/DEN                          Recent
           =GJ*GAM(N)*GAM(A)/DEN                                   Recent
                                                                   Recent
SUMMARY                                                            Recent
=======                                                            Recent
AN IMPORTANT POINT TO NOTE IS THE DEFINITION OF (X) AND (Y)        Recent
WHICH IN ALL CASES WILL CORRESPOND TO THE SYMMETRIC AND            Recent
ANTI-SYMMETRIC CONTRIBUTION OF THE RESONANCES. IN PARTICULAR       Recent
DEFINING (U) IN TERMS OF (1-X) INSTEAD OF (X) IS EXTREMELY         Recent
IMPORTANT. NOTE, THAT THE DEFINITION OF THE ELASTIC AND            Recent
ABSORPTION ONLY INVOLVE (X), NOT (1-X). FAR FROM RESONANCES        Recent
(X) CAN BE EXTREMELY SMALL, THEREFORE (1-X) WILL BE VERY CLOSE     Recent
TO (1). IF THE CALCULATION PROCEEDS BY FIRST CALCULATING (1-X)     Recent
AND THEN DEFINING (X) BY SUBTRACTING (1), EXTREME ROUND-OFF        Recent
PROBLEMS CAN RESULT. THESE PROBLEMS CAN BE AVOIDED BY IN ALL       Recent
CASES DEFINING (X) DIRECTLY, WITHOUT ANY DIFFERENCES.              Recent
                                                                   Recent
IN EACH FORMALISM THE DEFINITION OF (X) AND (Y) MAY BE DIFFERENT   Recent
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BUT ONCE WE HAVE DEFINED (X) AND (Y) WE CAN IMMEDIATELY WRITE      Recent
THE CROSS SECTIONS USING A UNIFORM DEFINITION,                     Recent
                                                                   Recent
ELASTIC =GJ*(2*SIN(PS)**2 - X)**2 + (SIN(2*PS) + Y)**2)            Recent
                                                                   Recent
ABSORPTION =-GJ*(2*X + (X)**2 + (Y)**2)                            Recent
                                                                   Recent
AND DEFINE THE TOTAL AS THE SUM OF THESE 2 PARTS.                  Recent
                                                                   Recent
RELATIONSHIP TO SINGLE LEVEL                                       Recent
============================                                       Recent
HOW DO THE SINGLE AND MULTI-LEVEL FORMALISMS COMPARE. TO SEE,      Recent
STARTING FROM OUR GENERAL DEFINITION OF THE ELASTIC IN THE FORM,   Recent
                                                                   Recent
ELASTIC =GJ*(2*SIN(PS)**2 + X)**2 + (SIN(2*PS) + Y)**2)            Recent
        =GJ*(4*SIN(PS)**4 - 4*X*SIN(PS)**2 + X**2                  Recent
           + SIN(2*PS)**2 + 2*Y*SIN(2*PS)  + Y**2)                 Recent
                                                                   Recent
        =4*GJ*SIN(PS)**2 +                                         Recent
           GJ*(X**2 + Y**2                                         Recent
              -4*X*SIN(PS)**2                                      Recent
              +2*Y*SIN(2*PS))                                      Recent
                                                                   Recent
AND OUR SPECIFIC DEFINITIONS OF (X) AND (Y) FOR MULTI-LEVEL BREIT- Recent
WIGNER PARAMETERS,                                                 Recent
                                                                   Recent
X        = GAM(N)*GAM(T)/2/DEN                                     Recent
Y        = GAM(N)*(E-ER)/DEN                                       Recent
DEN      = ((E-ER)**2 + (GAM(T)/2)**2)                             Recent
                                                                   Recent
X**2+Y**2= GAM(N)**2/DEN + (L-L)                                   Recent
                                                                   Recent
WE CAN RECOGNIZE X**2 AND Y**2 AS THE INTERFERENCE - (L-S) + (L-L) Recent
TERMS IN THE MULTI-LEVEL FORMALISM. IN ORDER TO OBTAIN THE SINGLE  Recent
LEVEL EQUATION WE CAN ASSUME THAT EACH LEVEL DOES NOT INTERFERE    Recent
WITH ANY OTHER LEVEL - THEREFORE THE (L-L) CONTRIBUTION IS ZERO.   Recent
                                                                   Recent
ELASTIC =4*GJ*SIN(PS)**2 +                                         Recent
          GJ*GAM(N)*(GAM(N)                                        Recent
                     -2*GAM(T)*SIN(PS)**2                          Recent
                     +2*(E-ER)*SIN(2*PS))/DEN                      Recent
                                                                   Recent
WHICH IS THE FORM THAT IT APPEARS IN ENDF-102, EXCEPT FOR TWO      Recent
TYPOGRAPHICAL ERRORS IN THE SECOND TERM,                           Recent
                                                                   Recent
-2*GAM(T)*SIN(PS)**2                                               Recent
                                                                   Recent
WHICH IN ENDF-102 IS WRITTEN,                                      Recent
                                                                   Recent
-2*(GAM(T)-GAM(N))*SIN(2*PS)**2                                    Recent
                                                                   Recent
PROGRAM CONVENTIONS                                                Recent
================================================================== Recent
MINIMUM INPUT DATA                                                 Recent

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FOR EACH MATERIAL TO BE PROCESSED THE MINIMUM INPUT DATA ARE THE   Recent
RESONANCE PARAMETERS IN FILE 2. IF THERE ARE NO FILE 2 PARAMETERS  Recent
IN A GIVEN MATERIAL THE ENTIRE MATERIAL WILL SIMPLY BE COPIED.     Recent
NEITHER THE HOLLERITH SECTION (MF=1, MT=451) NOR THE BACKGROUND    Recent
CROSS SECTION (SECTIONS OF MF=3) NEED BE PRESENT FOR THIS PROGRAM  Recent
TO EXECUTE PROPERLY. HOWEVER, SINCE THE CONVENTIONS USED IN        Recent
INTERPRETING THE RESONANCE PARAMETERS DEPENDS ON ENDF/B VERSION    Recent
USERS ARE STRONGLY RECOMMENDED TO INSURE THAT MF=1, MT=451 IS      Recent
PRESENT IN EACH MATERIAL TO ALLOW THE PROGRAM TO DETERMINE THE     Recent
ENDF/B FORMAT VERSION.                                             Recent
                                                                   Recent
RESONANCE PARAMETERS                                               Recent
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RESONANCE PARAMETERS MAY BE REPRESENTED USING ANY COMBINATION         Recent
OF THE REPRESENTATIONS ALLOWED IN ENDF/B,                             Recent
(1) RESOLVED DATA                                                     Recent
    (A) SINGLE LEVEL BREIT-WIGNER                                     Recent
    (B) MULTI-LEVEL BREIT-WIGNER                                      Recent
    (C) ADLER-ADLER                                                   Recent
    (D) REICH-MOORE                                                   Recent
    (E) HYBRID R-FUNCTION                                             Recent
(2) UNRESOLVED DATA                                                   Recent
    (A) ALL PARAMETERS ENERGY INDEPENDENT                             Recent
    (B) FISSION PARAMETERS ENERGY DEPENDENT                           Recent
    (C) ALL PARAMETERS ENERGY DEPENDENT                               Recent
                                                                      Recent
THE FOLLOWING RESOLVED DATA FORMALISMS ARE NOT TREATED BY THIS        Recent
VERSION OF THE CODE AND WILL ONLY BE IMPLEMENTED AFTER EVALUATIONS     Recent
USING THESE FORMALISMS ARE AVAILABLE TO THE AUTHOR OF THIS CODE       Recent
FOR TESTING IN ORDER TO INSURE THAT THEY CAN BE HANDLED PROPERLY      Recent
    (A) GENERAL R-MATRIX                                              Recent
                                                                      Recent
CALCULATED CROSS SECTIONS                                             Recent
-------------------------                                             Recent
THIS PROGRAM WILL USE THE RESONANCE PARAMETERS TO CALCULATE THE       Recent
TOTAL, ELASTIC, CAPTURE AND POSSIBLY FISSION CROSS SECTIONS. THE      Recent
COMPETITIVE WIDTH WILL BE USED IN THESE CALCULATIONS, BUT THE         Recent
COMPETITIVE CROSS SECTION ITSELF WILL NOT BE CALCULATED. THE          Recent
ENDF/B CONVENTION IS THAT ALTHOUGH A COMPETITIVE WIDTH MAY BE         Recent
GIVEN, THE COMPETITIVE CROSS SECTION MUST BE SEPARATELY TABULATED     Recent
AS A SECTION OF FILE 3 DATA.                                          Recent
                                                                      Recent
RESOLVED REGION                                                       Recent
---------------                                                       Recent
IN THE RESOLVED REGION THE RESOLVED PARAMETERS ARE USED TO            Recent
CALCULATE COLD (0 KELVIN), LINEARLY INTERPOLABLE, ENERGY DEPENDENT    Recent
CROSS SECTIONS.                                                       Recent
                                                                      Recent
SCATTERING RADIUS                                                     Recent
-----------------                                                     Recent
FOR SINGLE OR MULTI LEVEL BREIT-WIGNER PARAMETERS THE SCATTERING      Recent
RADIUS MAY BE SPECIFIED IN EITHER ENERGY INDEPENDENT (CONSTANT)       Recent
OR ENERGY DEPENDENT FORM (A TABLE OF ENERGY VS. RADIUS AND AN         Recent
ASSOCIATED INTERPOLATION LAW). IN ALL OTHER CASE ONLY AN ENERGY       Recent
INDEPENDENT SCATTERING RADIUS IS ALLOWED.                             Recent
                                                                      Recent
FOR ANY ONE MATERIAL (I.E. MAT) IF ENERGY DEPENDENT SCATTERING        Recent
RADII ARE GIVEN THE TOTAL NUMBER OF INTERPOLATION REGIONS AND         Recent
TABULATED VALUES FOR THE ENTIRE MATERIAL CANNOT EXCEED,               Recent
200 - INTERPOLATION REGIONS                                           Recent
500 - TABULATED VALUES                                                Recent
IF THESE LIMITS ARE EXCEEDED THE PROGRAM WILL PRINT AN ERROR          Recent
MESSAGE AND TERMINATE.                                                Recent
                                                                      Recent
IF YOU REQUIRE A LARGER NUMBER OF INTERPOLATION REGION AND/OR         Recent
TABULATED VALUES,                                                     Recent
(1) INTERPOLATION REGIONS - INCREASE THE DIMENSION OF NBTRHO AND      Recent
INTRHO IN COMMON/TABRHO/ THROUGHOUT THE PROGRAM AND CHANGE MAXSEC     Recent
IN SUBROUTINE RDAP (MAXSEC = MAXIMUM NUMBER OF INTERPOLATION          Recent
REGIONS).                                                             Recent
(2) TABULATED VALUES - INCREASE THE DIMENSION OF ERHOTB, RHOTAB       Recent
AND APTAB IN COMMON/TABRHO/ THROUGHOUT THE PROGRAM AND CHANGE         Recent
MAXRHO IN SUBROUTINE RDAP (MAXRHO = MAXIMUM NUMBER OF TABULATED       Recent
VALUES).                                                              Recent
                                                                      Recent
RESOLVED REICH-MOORE AND MULTI-LEVEL BREIT-WIGNER PARAMETERS          Recent
-----------------------------------------------------------           Recent
CROSS SECTIONS FOR REICH-MOORE PARAMETERS ARE CALCULATED ACCORDING     Recent
TO THE EQUATION (1) - (8) OF SECTION D.1.3 OF ENDF-102. IN ORDER      Recent
TO CALCULATE CROSS SECTIONS FROM MULTI-LEVEL PARAMETERS IN A          Recent
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REASONABLE AMOUNT OF TIME THIS PROGRAM EXPRESSES THE CROSS SECTION Recent
IN TERMS OF A SINGLE SUM OVER RESONANCES (SEE, ENDF-102, SECTION   Recent
D.1.2, EQUATIONS 6-7), RATHER THAN AS A DOUBLE SUM (SEE, ENDF-102  Recent
SECTION D.1.2, EQUATION 1-2). IN ORDER FOR THE ENDF-102 EQUATIONS  Recent
TO BE CORRECT THE PARAMETERS MUST MEET THE FOLLOWING CONDITIONS,   Recent
                                                                   Recent
(1) FOR EACH L STATE ALL PHYSICALLY POSSIBLE J SEQUENCES MUST BE   Recent
    PRESENT. ONLY IN THIS CASE WILL THE CONTRIBUTIONS OF THE       Recent
    INDIVIDUAL J SEQUENCES ADD UP TO PRODUCE THE CORRECT POTENTIAL Recent
    SCATTERING CONTRIBUTION FOR THE L STATE (SEE, ENDF-102,        Recent
    SECTION D.1.2, EQUATIONS 6-7). IF ANY J SEQUENCE IS MISSING    Recent
    THE PROGRAM WILL PRINT A WARNING AND ADD THE J SEQUENCE WITH   Recent
    NO RESONANCE PARAMETERS IN ORDER TO ALLOW THE POTENTIAL        Recent
    SCATTERING TO BE CALCULATED CORRECTLY (THIS IS EQUIVALENT TO   Recent
    ASSUMING THAT THE EVALUATOR REALIZES THAT ALL J SEQUENCES MUST Recent
    BE AND ARE PRESENT AND THAT THE EVALUATION STATES THAT THERE   Recent
    ARE NO RESONANCES WITH CERTAIN PHYSICALLY POSSIBLE J VALUES... Recent
    IN THIS CASE POTENTIAL CONTRIBUTION MUST STILL BE CONSIDERED). Recent
                                                                   Recent
    EXAMPLE                                                        Recent
    =======                                                        Recent
    AN EXAMPLE OF WHERE THIS OCCURS AND IS IMPORTANT TO CONSIDER   Recent
    IS U-238 IN ENDF/B-IV AND V LIBRARIES WHERE FOR L=1 THERE IS   Recent
    ONLY A J=1/2 SEQUENCE. NOT INCLUDING THE J=3/2 SEQUENCE LEADS  Recent
    TO UNDERESTIMATING THE POTENTIAL SCATTERING AND PRODUCES        Recent
    MINIMA IN THE ELASTIC CROSS SECTION WHICH ARE AN ORDER OF      Recent
    MAGNITUDE LOWER THAN THE CROSS SECTIONS OBTAINED BE INCLUDING  Recent
    THE J=3/2 SEQUENCE.                                            Recent
                                                                   Recent
(2) FOR A GIVEN TARGET SPIN AND L VALUE THERE MAY BE 2 POSSIBLE    Recent
    MEANS OF OBTAINING THE SAME J VALUE. WHEN THIS OCCURS IN       Recent
    ORDER TO CALCULATE THE CORRECT POTENTIAL SCATTERING CROSS       Recent
    SECTION IT IS IMPORTANT TO INCLUDE THE EFFECT OF BOTH          Recent
    POSSIBLE J SEQUENCES, EVEN THOUGH FROM THE ENDF/B DATA IT IS   Recent
    NOT POSSIBLE TO DETERMINE WHICH OF THE 2 POSSIBLE SEQUENCES    Recent
    ANY GIVEN RESONANCE BELONGS TO. IN THIS CASE THIS PROGRAM      Recent
    TREAT ALL RESONANCES WITH THE SAME J VALUE AS BELONGING TO     Recent
    THE SAME J SEQUENCE (TO ALLOW INTERFERENCE) AND WILL ADD AN    Recent
    ADDITIONAL J SEQUENCE WITH NO RESONANCES IN ORDER TO ALLOW     Recent
    THE POTENTIAL CROSS SECTION TO BE CALCULATED CORRECTLY. WHEN   Recent
    THIS OCCURS A WARNING MESSAGE IS PRINTED, BUT BASED ON THE     Recent
    ENDF/B DATA THERE IS NOTHING WRONG WITH THE DATA AND THERE IS  Recent
    NOTHING THAT THE USER CAN DO TO CORRECT OR IN ANY WAY MODIFY    Recent
    THE DATA TO ELIMINATE THE PROBLEM.                             Recent
                                                                   Recent
    EXAMPLE                                                        Recent
    =======                                                        Recent
    FOR A TARGET SPIN =1 AND L=1 THE 2 RANGES OF PHYSICALLY        Recent
    POSSIBLE J ARE 1/2, 3/2, 5/2 AND 1/2, 3/2. BY CHECKING THE     Recent
    ENDF/B DATA IT IS POSSIBLE TO INSURE THAT THE 3 POSSIBLE       Recent
    J VALUES (1/2, 3/2, 5/2) ARE PRESENT AND TO INCLUDE ALL 3      Recent
    J SEQUENCES IN THE CALCULATIONS. HOWEVER, UNLESS ALL 5         Recent
    POSSIBLE J SEQUENCES ARE INCLUDED THE STATISTICAL WEIGHTS      Recent
    OF THE J SEQUENCES WILL NOT SUM UP TO 2*L+1 AND THE            Recent
    POTENTIAL CROSS SECTION WILL BE UNDERESTIMATED. IN THIS        Recent
    EXAMPLE THE SUM OF THE 3 J SEQUENCES 1/2, 3/2, 5/2 IS 2,       Recent
    RATHER THAN 3 AS IT SHOULD BE FOR L=1, AND THE CONTRIBUTION    Recent
    OF THE L=1 RESONANCES TO THE POTENTIAL SCATTERING CROSS         Recent
    SECTION WILL ONLY BE 2/3 OF WHAT IT SHOULD BE, UNLESS THE      Recent
    OTHER 2 J SEQUENCES (WITH DUPLICATE J VALUES) ARE INCLUDED     Recent
    IN THE CALCULATION.                                            Recent
                                                                   Recent
(3) EACH RESONANCE MUST HAVE AN ASSIGNED, PHYSICALLY POSSIBLE      Recent
    J VALUE. PHYSICALLY IMPOSSIBLE OR AVERAGE J VALUES CANNOT BE   Recent
    UNIQUELY INTERPRETED USING THE EQUATIONS IN ENDF-102 AND        Recent
    THEIR USE WILL USUALLY RESULT IN PHYSICALLY UNRELIABLE CROSS   Recent
    SECTIONS. THIS PROGRAM WILL CHECK ALL J VALUES AND IF ANY ARE  Recent
    ARE FOUND TO BE PHYSICALLY IMPOSSIBLE (BASED ON TARGET SPIN    Recent
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    AND L VALUE) AN ERROR MESSAGE WILL BE PRINTED TO INDICATE THAT Recent
    THE RECONSTRUCTED CROSS SECTIONS WILL BE UNRELIABLE AND THE    Recent
    PROGRAM WILL CONTINUE. IN AN ATTEMPT TO CALCULATE THE CORRECT  Recent
    POTENTIAL SCATTERING CROSS SECTION THIS PROGRAM WILL SUBTRACT  Recent
    THE POTENTIAL SCATTERING CONTRIBUTION DUE TO ALL FICTICIOUS J  Recent
    SEQUENCES AND ADD THE CONTRIBUTION OF ALL PHYSICALLY POSSIBLE  Recent
    J SEQUENCES (AS DESCRIBED ABOVE).                              Recent
                                                                   Recent
    WARNING (LET THE USER BEWARE)                                  Recent
    =============================                                  Recent
    (A) IT CANNOT BE STRESSED ENOUGH THAT CROSS SECTIONS OBTAINED  Recent
        USING PHYSICALLY IMPOSSIBLE J VALUES FOR REICH-MOORE AND   Recent
        MULTI-LEVEL BREIT-WIGNER RESONANCE PARAMETERS WILL RESULT  Recent
        IN UNRELIABLE CROSS SECTIONS. THE DECISION TO HAVE THIS    Recent
        PROGRAM CONTINUE TO PROCESS WHEN THIS CONDITION IS FOUND   Recent
        IS BASED ON AN ATTEMPT TO ALLOW THE USER TO AT LEAST HAVE  Recent
        SOME RESULTS (HOWEVER BAD THEY MAY BE) IF THERE IS NO      Recent
        OTHER EVALUATED DATA AVAILABLE.                            Recent
    (B) EVEN THOUGH THE REICH-MOORE AND MULTI-LEVEL EQUATIONS ARE  Recent
        DEFINED AS ABSOLUTE OR SQUARED CONTRIBUTIONS WHICH MUST    Recent
        ALL BE PHYSICALLY POSSIBLE, ATTEMPTING TO CORRECT THE      Recent
        POTENTIAL CROSS SECTION (AS DESCRIBED ABOVE) CAN LEAD TO   Recent
        NEGATIVE ELASTIC CROSS SECTIONS. THIS IS BECAUSE BASED ON  Recent
        THE INFORMATION AVAILABLE IN THE EVALUATION IT IS NOT      Recent
        NOT POSSIBLE TO CORRECTLY ACCOUNT FOR THE INTERFERENCE     Recent
        BETWEEN THE RESONANCE AND POTENTIAL CONTRIBUTIONS FOR EACH Recent
        J SEQUENCE.                                                Recent
                                                                   Recent
UNRESOLVED RESONANCE REGION                                        Recent
---------------------------                                        Recent
IN THE UNRESOLVED RESONANCE REGION THE UNRESOLVED PARAMETERS       Recent
ARE USED TO CALCULATE INFINITELY DILUTE AVERAGE CROSS SECTIONS.    Recent
NOTE, IT IS IMPORTANT TO UNDERSTAND THAT FROM THE DEFINITION OF    Recent
THE UNRESOLVED PARAMETERS IT IS NOT POSSIBLE TO UNIQUELY CALCULATE Recent
ENERGY DEPENDENT CROSS SECTIONS. ONLY AVERAGES OR DISTRIBUTIONS    Recent
MAY BE CALCULATED.                                                 Recent
                                                                   Recent
UNRESOLVED INTERPOLATION                                           Recent
------------------------                                           Recent
IN THE UNRESOLVED RESONANCE REGION CROSS SECTIONS AT EACH ENERGY   Recent
ARE CALCULATED BY INTERPOLATING PARAMETERS. THIS IS THE CONVENTION Recent
USED IN ENDF/B-IV AND EARLIER VERSIONS OF ENDF/B. THE ENDF/B-V     Recent
CONVENTION OF INTERPOLATING CROSS SECTIONS, NOT PARAMETERS, HAS    Recent
BEEN ABANDONED AS IMPRACTICAL SINCE IT CAN LEAD TO THE SITUATION   Recent
WHERE EXACTLY THE SAME PHYSICAL DATA CAN LEAD TO DIFFERENT RESULTS Recent
DEPENDING ON WHICH OF THE THREE ENDF/B UNRESOLVED PARAMTER FORMATS Recent
IS USED. FOR EXAMPLE, GIVEN A SET OF ENERGY INDEPENDENT UNRESOLVED Recent
PARAMETERS IT IS POSSIBLE TO CODE THESE PARAMETERS IN EACH OF THE  Recent
THREE ENDF/B UNRESOLVED PARAMETER FORMATS. SINCE PHYSICALLY WE     Recent
ONLY HAVE ONE SET OF PARAMETERS WE WOULD EXPECT THE RESULTS TO BE  Recent
INDEPENDENT OF HOW THEY ARE REPRESENTED IN ENDF/B. UNFORTUNATELY   Recent
USING THE ENDF/B-V CONVENTION TO INTERPOLATE CROSS SECTIONS CAN    Recent
LEAD TO THREE COMPLETELY DIFFERENT RESULTS. IN CONTRAST USING THE  Recent
ENDF/B-IV AND EARLIER CONVENTION OF INTERPOLATING PARAMETERS LEADS Recent
TO COMPLETELY CONSISTENT RESULTS.                                  Recent
                                                                   Recent
INTERNAL REPRESENTATION OF UNRESOLVED PARAMETERS                   Recent
-----------------------------------------------                    Recent
ANY OF THE THREE POSSIBLE REPRESENTATIONS OF UNRESOLVED PARAMETERS Recent
CAN BE UNIQUELY REPRESENTED IN THE ALL PARAMETERS ENERGY DEPENDENT Recent
REPRESENTATIONS WITH THE APPROPRIATE (ENDF/B VERSION DEPENDENT)    Recent
INTERPOLATION LAW. THIS IS DONE BY THE PROGRAM WHILE READING THE   Recent
UNRESOLVED PARAMETERS AND ALL SUBSEQUENT CALCULATIONS NEED ONLY    Recent
CONSIDER THE ALL PARAMETERS ENERGY DEPENDENT REPRESENTATION.       Recent
                                                                   Recent
RESONANCE RECONSTRUCTION STARTING ENERGY GRID                      Recent
---------------------------------------------                      Recent
AS IN ANY ITERATIVE METHOD THE WAY TO SPEED CONVERGENCE IS TO TRY  Recent
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TO START CLOSE TO THE ANSWER. THIS PROGRAM ATTEMPTS TO DO THIS BY  Recent
STARTING FROM AN ENERGY GRID WHICH IS A GOOD APPROXIMATION TO A    Recent
SIMPLE BREIT-WIGNER LINE SHAPE,                                    Recent
                                                                   Recent
SIGMA(X)=1.0/(1.0+X*X)                                             Recent
                                                                   Recent
WHERE X IS THE DISTANCE FROM THE PEAK IN HALF-WIDTHS               Recent
                                                                   Recent
SUBROUTINE SUBINT HAS A BUILT-IN TABLE OF NODES WHICH ARE THE      Recent
HALF-WIDTH MULTIPLES TO APPROXIMATE THE SIMPLE BREIT-LINE SHAPE    Recent
TO WITHIN 1 PER-CENT OVER THE ENTIRE INTERVAL 0 TO 500 HALF-WIDTHS Recent
                                                                   Recent
BETWEEN ANY TWO RESOLVED RESONANCES THE STARTING GRID IS BASED ON  Recent
THE HALF-WIDTHS OF THE TWO RESONANCES. FROM THE LOWER ENERGY       Recent
RESONANCE UP TO THE MID-POINT BETWEEN THE RESONANCES (MID-POINT    Recent
IS DEFINED HERE AS AN EQUAL NUMBER OF HALF-WIDTHS FROM EACH        Recent
RESONANCE) THE HALF-WIDTH OF THE LOWER ENERGY RESONANCE IS USED.   Recent
FROM THE MID-POINT UP TO THE HIGHER ENERGY RESONANCE THE HALF-     Recent
WIDTH OF THE UPPER ENERGY RESONANCE IS USED.                       Recent
                                                                   Recent
WITH THIS ALOGORITHM CLOSELY SPACED RESONANCES WILL HAVE ONLY      Recent
A FEW STARTING NODES PER RESONANCE (E.G. U-235). WIDELY SPACED     Recent
RESONANCES WILL HAVE MORE NODES PER RESONANCE (E.G. U-238). FOR    Recent
A MIX OF S, P, D ETC. RESONANCES THIS ALOGORITHM GUARANTEES AN     Recent
ADEQUTE DESCRIPTION OF THE PROFILE OF EVEN EXTREMELY NARROW        Recent
RESONANCES (WHICH MAY IMMEDIATELY CONVERGENCE TO THE ACCURACY      Recent
REQUESTED, THUS MINIMIZING ITERATION).                             Recent
                                                                   Recent
BACKGROUND CROSS SECTIONS                                          Recent
-------------------------                                          Recent
THE PROGRAM WILL SEARCH FOR BACKGROUND CROSS SECTIONS FOR TOTAL    Recent
(MT=1), ELASTIC (MT=2), FISSION (MT=18), FIRST CHANCE FISSION      Recent
(MT=19) AND CAPTURE (MT=102).                                      Recent
                                                                   Recent
(1) THE BACKGROUND CROSS SECTIONS (FILE 3) CAN BE PRESENT OR NOT   Recent
    PRESENT FOR EACH REACTION.                                     Recent
(2) IF FOR A GIVEN REACTION THE BACKGROUND CROSS SECTION IS        Recent
    PRESENT, IT WILL BE ADDED TO THE RESONANCE CONTRIBUTION AND    Recent
    THE RESULT WILL BE OUTPUT.                                     Recent

(3) IF FOR A GIVEN REACTION THE BACKGROUND IS NOT PRESENT THE      Recent
    PROGRAM WILL,                                                  Recent
    (A) IF THE INPUT TO THE PROGRAM SPECIFIES NO OUTPUT FOR        Recent
        REACTIONS WITH NO BACKGROUND THERE WILL BE NO OUTPUT.      Recent
    (B) IF THE INPUT TO THE PROGRAM SPECIFIES OUTPUT FOR REACTIONS Recent
        WITH NO BACKGROUND,                                        Recent
        (I) THE RESONANCE CONTRIBUTION TO TOTAL, ELASTIC OR        Recent
            CAPTURE WILL BE OUTPUT.                                Recent
        (II) IF ALL FISSION RESONANCE PARAMETERS ARE ZERO THE      Recent
             FISSION CROSS SECTION (MT=18) WILL NOT BE OUTPUT.     Recent
             OTHERWISE THE RESONANCE CONTRIBUTION OF THE FISSION   Recent
             (MT=18) WILL BE OUTPUT.                               Recent
        (III) THERE WILL BE NO OUTPUT FOR FIRST CHANCE FISSION     Recent
              (MT=19).                                             Recent
                                                                   Recent
COMBINING RESONANCES AND BACKGROUND CROSS SECTIONS                 Recent
--------------------------------------------------                 Recent
IN ORDER TO BE COMBINED WITH THE RESONANCE CONTRIBUTION THE        Recent
BACKGROUND CROSS SECTIONS MUST BE GIVEN AT 0 KELVIN TEMPERATURE    Recent
AND MUST BE LINEARLY INTERPOLABLE. IF THESE CONDITIONS ARE MET     Recent
THE RESONANCE AND BACKGROUND CONTRIBUTIONS WILL BE ADDED TOGETHER  Recent
AND OUTPUT. IF THESE CONDITIONS ARE NOT MET THE BACKGROUND CROSS   Recent
SECTION WILL BE IGNORED AND ONLY THE RESONANCE CONTRIBUTION WILL   Recent
BE OUTPUT. IF THE BACKGROUND HAS NOT BEEN ADDED TO THE RESONANCE   Recent
CONTRIBUTION AFTER THIS PROGRAM FINISHES THE USER CAN MAKE THE     Recent
RESONANCE AND BACKGROUND CONTRIBUTIONS COMPATIBLE BY,              Recent
                                                                   Recent
(1) IF THE BACKGROUND IS NOT LINEARLY INTERPOABLE, LINEARIZE THE   Recent
```

```
    BACKGROUND (E.G., USE PROGRAM LINEAR).                              Recent
(2) IF THE BACKGROUND IS NOT GIVEN AT 0 KELVIN, DOPPLER BROADEN         Recent
    THE RESONANCE (NOT BACKGROUND) CONTRIBUTION TO THE SAME             Recent
    TEMPERATURE AS THE BACKGROUND (E.G., USE PROGRAM SIGMA1).           Recent
                                                                        Recent
ONCE THE RESONANCE AND BACKGROUND CONTRIBUTIONS HAVE BEEN MADE          Recent
COMPATIBLE THEY CAN BE ADDED TOGETHER (E.G., USE PROGRAM MIXER).        Recent
                                                                        Recent
THE RECONSTRUCTION OF THE RESONANCE CONTRIBUTION TO THE CROSS           Recent
SECTION CAN BE QUITE EXPENSIVE (IN TERMS OF COMPUTER TIME). SINCE       Recent
THE RECONSTRUCTION IS PERFORMED BEFORE THE BACKGROUND CROSS             Recent
SECTIONS ARE READ, THE ABOVE CONVENTIONS HAVE BEEN ADOPTED IN           Recent
ORDER TO AVOID LOSE OF COMPUTER TIME INVOLVED IN RECONSTRUCTING         Recent
THE RESONANCE CONTRIBUTION.                                             Recent
                                                                        Recent
COMMON ENERGY GRID                                                      Recent
------------------                                                      Recent
THIS PROGRAM WILL RECONSTRUCT THE RESONANCE CONTRIBUTION TO THE         Recent
TOTAL, ELASTIC, FISSION AND CAPTURE CROSS SECTIONS ALL ON THE           Recent
SAME ENERGY GRID. EACH REACTION WILL THEN BE COMBINED WITH ITS          Recent
BACKGROUND CROSS SECTION (IF ANY) AND OUTPUT WITHOUT ANY FURTHER        Recent
THINNING. IF THERE ARE NO BACKGROUND CROSS SECTIONS, OR IF THE          Recent
BACKGROUND CROSS SECTION FOR ALL FOUR REACTIONS ARE GIVEN ON A          Recent
COMMON ENERGY GRID, THE OUTPUT FROM THIS PROGRAM WILL BE ON A           Recent
COMMON ENERGY GRID FOR ALL FOUR REACTIONS.                              Recent
                                                                        Recent
THERMAL ENERGY                                                          Recent
--------------                                                          Recent
IF THE RESONANCE REGION SPANS THERMAL ENERGY (0.0253 EV) THIS           Recent
POINT IS ALWAYS INCLUDED IN THE COMMON ENERGY GRID USED FOR ALL         Recent
REACTIONS AND WILL ALWAYS APPEAR IN THE OUTPUT DATA.                    Recent
                                                                        Recent
SECTION SIZE                                                            Recent
------------                                                            Recent
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT       Recent
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS           Recent
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                      Recent
                                                                        Recent
SELECTION OF DATA                                                       Recent
-----------------                                                       Recent
THE PROGRAM SELECTS MATERIALS TO BE PROCESSED BASED EITHER ON           Recent
MAT (ENDF/B MAT NO.) OR ZA. THE PROGRAM ALLOWS UP TO 100 MAT OR         Recent
ZA RANGES TO BE SPECIFIED. THE PROGRAM WILL ASSUME THAT THE             Recent
ENDF/B TAPE IS IN EITHER MAT OR ZA ORDER, WHICHEVER CRITERIA IS         Recent
USED TO SELECT MATERIALS, AND WILL TERMINATE WHEN A MAT OR ZA           Recent
IS FOUND THAT IS ABOVE THE RANGE OF ALL REQUESTS.                       Recent
                                                                        Recent
ALLOWABLE ERROR                                                         Recent
---------------                                                         Recent
THE RECONSTRUCTION OF LINEARLY INTERPOLABLE CROSS SECTIONS FROM         Recent
RESONANCE PARAMETERS CANNOT BE PERFORMED EXACTLY. HOWEVER IT CAN        Recent
BE PERFORMED TO VIRTUALLY ANY REQUIRED ACCURACY AND MOST                Recent
IMPORTANTLY CAN BE PERFORMED TO A TOLERANCE THAT IS SMALL COMPARED      Recent
TO THE UNCERTAINTY IN THE CROSS SECTIONS THEMSELVES. AS SUCH THE        Recent
CONVERSION OF CROSS SECTIONS TO LINEARLY INTERPOLABLE FORM CAN BE       Recent
PERFORMED WITH ESSENTIALLY NO LOSS OF INFORMATION.                      Recent
                                                                        Recent
THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY      Recent
DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED              Recent
FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION      Recent
BETWEEN TABULATED POINTS. IF ONLY ONE TABULATED POINT IS GIVEN THE      Recent
ERROR WILL BE CONSIDERED CONSTANT OVER THE ENTIRE ENERGY RANGE.         Recent
WITH THIS ENERGY DEPENDENT ERROR ONE MAY OPTIMIZE THE OUTPUT FOR        Recent
ANY GIVEN APPLICATION BY USING A SMALL ERROR IN THE ENERGY RANGE        Recent
OF INTEREST AND A LESS STRINGENT ERROR IN OTHER ENERGY RANGES,          Recent
E.G., 0.1 PER-CENT FROM 0 UP TO THE LOW EV RANGE AND A LESS             Recent
STRINGENT TOLERANCE AT HIGHER ENERGIES.                                 Recent
                                                                        Recent
```

```
DEFAULT ALLOWABLE ERROR                                                 Recent
----------------------                                                  Recent
IN ORDER TO INSURE CONVERENCE OF THE RESONANCE RECONSTRUCTION THE       Recent
ALLOWABLE ERROR MUST BE POSITIVE. IF THE USER INPUTS AN ERROR FOR       Recent
RESONANCE RECONSTRUCTION THAT IS NOT POSITIVE IT WILL BE SET TO         Recent
THE DEFAULT VALUE (CURRENTLY 0.1 PER-CENT) AND INDICATED AS SUCH        Recent
IN THE OUTPUT LISTING.                                                  Recent
                                                                        Recent
INTERVAL HALVING ALGORITHM                                              Recent
-------------------------                                               Recent
THIS PROGRAM WILL START BY CALCULATING THE CROSS SECTIONS AT THE        Recent
ENERGIES CORRESPONDING TO THE PEAK OF EACH RESONANCE, AS WELL AS        Recent
A FIXED NUMBER OF HALF-WIDTHS ON EACH SIDE OF EACH RESONANCE.           Recent
STARTING FROM THIS BASIC GRID OF POINTS THE PROGRAM WILL CONTINUE       Recent
TO HALF EACH INTERVAL UNTIL THE CROSS SECTIONS FOR ALL REACTIONS        Recent
AT THE CENTER OF THE INTERVAL CAN BE DEFINED BY LINEAR                  Recent
INTERPOLATION FROM THE ENDS OF THE INTERVAL TO WITHIN THE USER          Recent
SPECIFIED ACCURACY CRITERIA.                                            Recent
                                                                        Recent
DISTANT RESONANCE TREATMENT                                             Recent
---------------------------                                             Recent
THE OPTION TO TREAT DISTANT RESONANCES, WHICH WAS AVAILABLE IN          Recent
EARLIER VERSIONS OF THIS PROGRAM, IS NO LONGER AVAILABLE, BECAUSE       Recent
IT WAS FOUND TO PRODUCE UNRELIABLE RESULTS. IN THIS VERSION OF          Recent
THE PROGRAM ALL RESONANCES ARE TREATED EXACTLY.                         Recent
                                                                        Recent
PROGRAM OPERATION                                                       Recent
================================================================        Recent
EDIT MODE                                                               Recent
---------                                                               Recent
IT IS SUGGESTED THAT BEFORE RUNNING THIS PROGRAM TO RECONSTRUCT         Recent
CROSS SECTIONS FROM RESONANCE PARAMETERS (WHICH CAN BE QUITE            Recent
EXPENSIVE) THE USER FIRST RUN THE PROGRAM IN THE EDIT MODE (SEE,        Recent
DESCRIPTION OF INPUT PARAMETERS BELOW). IN THE EDIT MODE THE            Recent
PROGRAM WILL READ, LIST AND EXTENSIVELY CHECK THE CONSISTENCY OF        Recent
ALL RESONANCE PARAMETERS AND ENDF/B DEFINED RESONANCE FLAGS. THIS       Recent
IS A VERY INEXPENSIVE MEANS OF CHECKING ALL DATA BEFORE INVESTING       Recent
A LARGE AMOUNT OF MONEY IN RECONSTRUCTING CROSS SECTIONS. ANY AND       Recent
ALL DIGNOSTICS RECEIVED FROM THE EDIT WILL SUGGEST HOW TO CORRECT       Recent
THE EVALUATED DATA TO MAKE IT CONSISTENT BEFORE RECONSTRUCTING          Recent
CROSS SECTIONS. IN ORDER TO OBTAIN MEANINGFUL RESULTS FROM THE          Recent
RECONSTRUCTION ALL SUGGESTED CHANGES TO THE EVALUATION SHOULD BE        Recent
PERFORMED BEFORE TRYING RECONSTRUCTION (OTHERWISE THE RESULT OF         Recent
RECONSTRUCTION WILL NOT BE RELIABLE).                                   Recent
                                                                        Recent
RECONSTRUCTION MODE                                                     Recent
-------------------                                                     Recent
FOR EACH REQUESTED MATERIAL                                             Recent
---------------------------                                             Recent
IF SECTION MF=1, MT=451 IS PRESENT COMMENTS WILL BE ADD TO              Recent
DOCUMENT THAT THE MATERIAL HAS BEEN PROCESSED. MF=1, MT=451 WILL        Recent
ALSO BE USED TO DETERMINE THE VERSION OF THE ENDF/B FORMAT WHICH        Recent
WILL ALLOW THE PROGRAM TO USE THE APPROPRIATE CONVENTIONS.              Recent
                                                                        Recent
ALL OF THE FILE 2 RESONANCE PARAMETERS ARE FIRST READ AND THE           Recent
LINEARLY INTERPOLABLE CONTRIBUTION OF THE RESONANCE PARAMETERS          Recent
TO THE TOTAL, ELASTIC, CAPTURE AND FISSION CROSS SECTIONS IS            Recent
CALCULATED SIMULTANEOUSLY USING A COMMON ENERGY GRID FOR ALL            Recent
FOUR REACTIONS.                                                         Recent
                                                                        Recent
AFTER THE RESONANCE CONTRIBUTION HAS BEEN RECONSTRUCTED EACH OF         Recent
THE FIVE REACTIONS (MT=1, 2, 18, 19, 102) IS CONSIDERED SEPARATELY      Recent
FOR COMBINATION WILL THE BACKGROUND CROSS SECTION, IF ANY, AS           Recent
DESCRIBED ABOVE.                                                        Recent
                                                                        Recent
OUTPUT WILL INCLUDE THE ENTIRE EVALUATION, INCLUDING RESONANCES         Recent
PARAMETERS WITH LRU MODIFIED (AS DESCRIBED ABOVE) TO INDICATE           Recent
THAT THE RESONANCE CONTRIBUTION HAS ALREADY BEEN ADDED TO THE           Recent
```

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FILE 3 CROSS SECTIONS.                                                  Recent
                                                                        Recent
THE CYCLE OF RECONSTRUCTING THE RESONANCE CONTRIBUTION AND ADDING       Recent
THE BACKGROUND WILL BE REPEATED FOR EACH MATERIAL REQUESTED.            Recent
                                                                        Recent
PROCESS ONLY A PORTION OF RESONANCE REGION                              Recent
======================================================================= Recent
MODERN EVALUATIONS MAY BE EXTREMELY LARGE AND IT MAY NOT BE             Recent
POSSIBLE TO PROCESS AN ENTIRE EVALUATION (I.E., ADD THE RESONANCE       Recent
CONTRIBUTION) DURING A SINGLE COMPUTER RUN.                             Recent
                                                                        Recent
ALSO IN THE CASE WHERE YOU ARE ONLY INTERESTED IN THE CROSS             Recent
SECTIONS OVER A SMALL ENERGY RANGE, YOU MAY NOT WANT TO PROCESS         Recent
AN ENTIRE EVALUATION, E.G., IF YOU ONLY WANT TO KNOW WHAT THE           Recent
CROSS SECTIONS ARE NEAR THERMAL ENERGY, 0.0253 EV.                      Recent
                                                                        Recent
IN ORDER TO ALLOW AN EVALUATION TO BE PROCESSED USING A NUMBER OF       Recent
SHORTER COMPUTER RUNS AN OPTION HAS BEEN ADDED TO THIS PROGRAM TO       Recent
ALLOW THE USER TO SPECIFY THE ENERGY RANGE TO BE PROCESSED.             Recent
                                                                        Recent
USING THIS OPTION YOU MAY START AT THE LOWEST ENERGY (ZERO UP TO        Recent
SOME ENERGY) AND USE THE RESULTS OF THIS RUN AS INPUT TO THE            Recent
NEXT RUN, WHERE YOU CAN SPECIFY THE NEXT ENERGY RANGE. THIS             Recent
CYCLE CAN BE REPEATED UNTIL YOU HAVE PROCESSED THE ENTIRE               Recent
EVALUATION.                                                             Recent
                                                                        Recent
WARNING - THIS OPTION SHOULD BE USED WITH EXTREME CARE - THIS           Recent
OPTION HAS BEEN RELUCTANTLY ADDED - RELUCTANTLY BECAUSE IT CAN          Recent
BE EXTREMELY DANGEROUS TO USE THIS OPTION UNLESS YOU CAREFULLY          Recent
CHECKED WHAT YOU ARE DOING.                                             Recent
                                                                        Recent
THE OPTION SHOULD ONLY BE USED AS FOLLOWS,                              Recent
1) YOU MUST PROCESS USING ENERGY RANGES STARTING AT LOW ENERGY          Recent
   AND WORKING YOUR WAY TOWARD HIGH ENERGY, E.G.,                       Recent
    0.0   TO  3.0+3                                                    Recent
    3.0+3 TO 10.0+3                                                    Recent
   10.0+3 TO 80.0+3, ETC.                                               Recent
2) FOR THE LAST ENERGY RANGE THE LOWER ENERGY LIMIT MUST BE             Recent
   NON-ZERO (WHERE TO START) AND THE UPPER ENERGY LIMIT MUST            Recent
   BE ZERO (NO LIMIT)                                                   Recent
   80.0+3 TO  0.0                                                       Recent
                                                                        Recent
IF YOU ARE ONLY INTERESTED IN THE CROSS SECTION OVER A NARROW           Recent
ENERGY INTERVAL AND DO NOT INTENT TO MAKE ANY OTHER USE OF THE          Recent
RESULTS, YOU CAN IGNORE THESE WARNINGS AND MERELY SPECIFY ANY           Recent
ENERGY INTERVAL OVER WHICH YOU WISH CALCULATIONS TO BE                  Recent
PERFORMED.                                                              Recent
                                                                        Recent
NORMALLY WHEN THIS PROGRAM PROCESSES AN EVALUATION IT WILL SET          Recent
FLAGS IN THE EVALUATION TO PREVENT THE SAME RESONANCE                   Recent
CONTRIBUTION FROM BEING ADDED TO THE CROSS SECTION MORE THAN            Recent
ONCE, SHOULD YOU USE THE OUTPUT FROM THIS PROGRAM AS INPUT TO           Recent
THE PROGRAM.                                                            Recent
                                                                        Recent
WHEN PROCESSING ONLY PORTIONS OF THE RESONANCE REGION THIS              Recent
PROGRAM CANNOT SET THESE FLAGS TO PROTECT AGAINST ADDING THE            Recent
RESONANCE CONTRIBUTION MORE THAN ONCE - WHICH MAKES USE OF              Recent
THIS OPTION EXTREMELY DANGEROUS.                                        Recent
                                                                        Recent
ONLY YOU CAN CHECK TO MAKE SURE THAT YOU HAVE CORRECTLY                 Recent
INCLUDED EACH ENERGY RANGE ONLY ONCE - SEE THE COMMENT LINES            Recent
AT THE END OF SECTION, MF=1, MT=451, FOR A COMPLETE RECORD              Recent
OF EACH RUN USING THIS PROGRAM. THIS SECTION WILL CONTAIN               Recent
LINES OF THE FORM                                                       Recent
                                                                        Recent
***************** PROGRAM RECENT (VERSION 2007-1) *************        Recent
ONLY PROCESS  0.00000+ 0 TO  3.00000+ 3 EV                              Recent
***************** PROGRAM RECENT (VERSION 2007-1) *************        Recent
```

```
ONLY PROCESS  3.00000+ 3 TO  1.00000+ 4 EV                          Recent
***************** PROGRAM RECENT (VERSION 2007-1) *************    Recent
ONLY PROCESS  1.00000+ 4 TO  8.00000+ 4 EV                          Recent
***************** PROGRAM RECENT (VERSION 2007-1) *************    Recent
ONLY PROCESS  8.00000+ 4 TO  2.00000+ 7 EV                          Recent
                                                                    Recent
YOU SHOULD CHECK TO INSURE THAT THERE ARE NO OVERLAPPING ENERGY      Recent
RANGES OR MISSING ENERGY RANGES.                                    Recent
                                                                    Recent
WHEN YOU INDICATE BY INPUT THAT YOU ARE ABOUT TO PROCESS THE        Recent
LAST ENERGY RANGE (SEE ABOVE, LOWER ENERGY LIMIT = NON-ZERO,        Recent
UPPER ENERGY LIMIT = ZERO), THIS PROGRAM WILL ASSUME THAT           Recent
YOU HAVE NOW COMPLETED ALL PROCESSING - AND ONLY THEN WILL          Recent
IT SET FLAGS IN THE EVALUATION TO PREVENT THE RESONANCE             Recent
CONTRIBUTION FROM BEING ADDED MORE THAN ONCE. FOR THIS REASON       Recent
YOU CANNOT PROCESS STARTING WITH ENERGY INTERVALS AT HIGH           Recent
ENERGY AND WORKING TOWARD LOW ENERGY - YOU MUST START AT LOW        Recent
ENERGY AND WORK TOWARD HIGH ENERGY.                                 Recent
                                                                    Recent
I/O FILES                                                           Recent
================================================================== Recent
INPUT FILES                                                         Recent
-----------                                                         Recent
UNIT  DESCRIPTION                                                   Recent

----  -----------                                                   Recent
  2   INPUT LINE (BCD - 80 CHARACTERS/RECORD)                       Recent
 10   ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)             Recent
                                                                    Recent
OUTPUT FILES                                                        Recent
------------                                                        Recent
UNIT  DESCRIPTION                                                   Recent
----  -----------                                                   Recent
  3   OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                   Recent
 11   FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)                Recent
                                                                    Recent
SCRATCH FILES                                                       Recent
-------------                                                       Recent
UNIT  DESCRIPTION                                                   Recent
----  -----------                                                   Recent
 12   SCRATCH FILE FOR DATA RECONSTRUCTED FROM RESONANCE            Recent
      PARAMETERS (BINARY - 100200 WORDS/RECORD)                     Recent
 14   SCRATCH FILE FOR COMBINED FILE 2 AND 3 DATA                   Recent
      (BINARY - 40080 WORDS/RECORD)                                 Recent
                                                                    Recent
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)                Recent
================================================================== Recent
UNIT  FILE NAME                                                     Recent
----  ----------                                                    Recent
  2   RECENT.INP                                                    Recent
  3   RECENT.LST                                                    Recent
 10   ENDFB.IN                                                      Recent
 11   ENDFB.OUT                                                     Recent
 12   (SCRATCH)                                                     Recent
 14   (SCRATCH)                                                     Recent
                                                                    Recent
INPUT CARDS                                                         Recent
================================================================== Recent
LINE  COLS.  FORMAT  DESCRIPTION                                    Recent
----  -----  ------  -----------                                    Recent
  1    1-11    I11   RETRIEVAL CRITERIA (0=MAT, 1=ZA)              Recent
                     THIS OPTION DEFINED WHETHER COLUMNS 1-22 OF    Recent
                     SUBSEQUENT INPUT CARDS SHOULD BE INTERPRETED   Recent
                     TO BE MAT OR ZA RANGES.                        Recent
      12-22   E11.4  FILE 2 MINIMUM ABSOLUTE CROSS SECTION          Recent
                     (IF 1.0E-10 OR LESS IS INPUT THE PROGRAM       Recent
                     WILL USE 1.0E-10)                              Recent
      23-33    I11   TREATMENT OF REACTIONS FOR WHICH BACKGROUND    Recent
```

			CROSS SECTION IS NOT GIVEN.	Recent
			= 0 - IGNOR (I.E. NO OUTPUT)	Recent
			= 1 - OUTPUT RESONANCE CONTRIBUTION.	Recent
			THIS OPTION IS USEFUL WITH PARTIAL EVALUATION	Recent
			(E.G. ENDF/B-V DOSIMETRY LIBRARY) WHERE ONLY	Recent
			ONE OR MORE OF THE REACTIONS ARE OF ACTUAL	Recent
			INTEREST.	Recent
			WARNING...THE USE OF THIS FIELD HAS BEEN	Recent
			CHANGED. THIS FIELD WAS PREVIOUSLY USED TO	Recent
			DEFINE THE PRECISION OF THE CALCULATION AND	Recent
			OUTPUT. THE FORMER DEFINITION OF THIS FIELD	Recent
			WAS...	Recent
			MINIMUM ENERGY SPACING FLAG	Recent
			= 0 - 6 DIGIT MINIMUM ENERGY SPACING.	Recent
			STANDARD 6 DIGIT E11.4 OUTPUT.	Recent
			= 1 - 9 DIGIT MINIMUM ENERGY SPACING.	Recent
			STANDARD 6 DIGIT E11.4 OUTPUT.	Recent
			= 2 - 9 DIGIT MINIMUM ENERGY SPACING.	Recent
			VARIABLE 9 DIGIT F FORMAT OUTPUT.	Recent
			FROM EXPERIENCE IT HAS BEEN FOUND THAT	Recent
			FAILURE TO SET THIS OPTION TO 2 CAN RESULT	Recent
			IN LARGE ERRORS IN THE FINAL DATA. THEREFORE	Recent
			INTERNALLY THIS OPTION IS SET TO 2.	Recent
	34-44	I11	OPERATING MODE	Recent
			= 0 - CACULATE. MINIMUM OUTPUT LISTING	Recent
			= 1 - CACULATE. LIST ALL RESONANCE PARAMETERS	Recent
			= 2 - EDIT MODE. NO CALCULATION. LIST ALL	Recent
			RESONANCE PARAMETERS.	Recent
			NOTE, THE EDIT MODE (=2) IS THE SUGGESTED	Recent
			MODE TO FIRST TEST THE CONSISTENCY OF THE	Recent
			EVALUATED DATA, BEFORE RECONSTRUCTING CROSS	Recent
			SECTIONS (SEE, COMMENTS ABOVE).	Recent
	45-55	I11	NEGATIVE CROSS SECTIOIN TREATMENT	Recent
			= 0 - O.K. - NO CHANGE	Recent
			= 1 - SET = 0	Recent
	56-66	I11	MONITOR MODE SELECTOR	Recent
			= 0 - NORMAL OPERATION	Recent
			= 1 - MONITOR PROGRESS OF RECONSTRUCTION OF	Recent
			FILE 2 DATA AND COMBINING FILE 2 AND	Recent
			FILE 3 DATA. EACH TIME A PAGE OF DATA	Recent
			POINTS IS WRITTEN TO A SCRATCH FILE	Recent
			PRINT OUT THE TOTAL NUMBER OF POINTS	Recent
			ON SCRATCH AND THE LOWER AND UPPER	Recent
			ENERGY LIMITS OF THE PAGE (THIS OPTION	Recent
			MAY BE USED IN ORDER TO MONITOR THE	Recent
			EXECUTION SPEED OF LONG RUNNING JOBS).	Recent
2	1-60	A60	ENDF/B INPUT DATA FILENAME	Recent
			(STANDARD OPTION = ENDFB.IN)	Recent
3	1-60	A60	ENDF/B OUTPUT DATA FILENAME	Recent
			(STANDARD OPTION = ENDFB.OUT)	Recent
4-N	1-11	I11	MINIMUM MAT OR ZA (SEE COLS. 1-11, LINE 1)	Recent
	12-22	I11	MAXIMUM MAT OR ZA (SEE COLS. 1-11, LINE 1)	Recent
			UP TO 100 MAT OR ZA RANGES MAY BE SPECIFIED,	Recent
			ONE RANGE PER LINE. THE LIST IS TERMINATED	Recent
			BY A BLANK LINE. IF THE THE UPPER LIMIT OF	Recent
			ANY REQUEST IS LESS THAN THE LOWER LIMIT THE	Recent
			UPPER LIMIT WILL BE SET EQUAL TO THE LOWER	Recent
			LIMIT. IF THE FIRST REQUEST LINE IS BLANK IT	Recent
			WILL TERMINATE THE REQUEST LIST AND CAUSE ALL	Recent
			DATA TO BE RETRIEVED (SEE EXAMPLE INPUT).	Recent
	23-33	E11.4	LOWER ENERGY LIMIT FOR PROCESSING.	Recent
	34-44	E11.4	UPPER ENERGY LIMIT FOR PROCESSING.	Recent
			*THE LOWER AND UPPER ENERGY LIMITS MUST BE	Recent
			ZERO, OR BLANK, UNLESS YOU WISH TO ONLY	Recent
			PROCESS A PORTION OF RESONANCE REGIONS.	Recent
			*THESE ENERGY LIMITS ARE ONLY READ FROM THE	Recent
			FIRST MAT/ZA REQUEST LINE	Recent
			*IF BOTH ARE ZERO (OR BLANK) THE ENTIRE	Recent

```
                        RESONANCE REGION FOR EACH MATERIAL WILL BE    Recent
                        PROCESSED                                     Recent
                       *IF LIMITS ARE INPUT ONLY THAT PORTION OF THE  Recent
                        RESONANCE REGION FOR EACH MATERIAL WHICH      Recent
                        LIES BETWEEN THESE LIMITS WILL BE PROCESSED   Recent
                       *SEE INSTRUCTIONS ABOVE BEFORE USING THIS      Recent
                        OPTION.                                       Recent
    VARY   1-11   E11.4  ENERGY FOR FILE 2 ERROR LAW     (  SEE   )    Recent
          12-22   E11.4  ERROR FOR FILE 2 ERROR LAW      (COMMENTS)    Recent
                                                         ( BELOW  )    Recent
                                                                       Recent
    NOTE, THIS VERSION OF THE PROGRAM DOES NOT THIN THE COMBINED FILE  Recent
    FILE 2 + 3 DATA. AS SUCH THE ERROR LAW FOR COMBINING FILE 2 + 3    Recent
    WHICH WAS REQUIRED IN EARLIER VERSIONS OF THIS CODE ARE NO LONGER  Recent
    REQUIRED.                                                          Recent
                                                                       Recent
    THE FILE 2 ERROR LAW MAY BE ENERGY INDEPENDENT (DEFINED BY A       Recent
    SINGLE ERROR) OR ENERGY DEPENDENT (DEFINED BY UP TO 20 ENERGY,     Recent
    ERROR PAIRS). FOR THE ENERGY DEPENDENT CASE LINEAR INTERPOLATION   Recent
    WILL BE USED TO DEFINE THE ERROR AT ENERGIES BETWEEN THOSE AT      Recent
    WHICH THE ERROR IS TABULATED. THE ERROR LAW IS TERMINATED BY A      Recent
    BLANK LINE. IF ONLY ONE ENERGY, ERROR PAIR IS GIVEN THE LAW WILL   Recent
    BE CONSIDERED TO BE ENERGY INDEPENDENT. IF MORE THAN ONE PAIR      Recent
    IS GIVEN IT BE CONSIDERED TO BE ENERGY DEPENDENT (NOTE, THAT       Recent
    FOR A CONSTANT ERROR THE ENERGY INDEPENDENT FORM WILL RUN FASTER.  Recent
    HOWEVER, FOR SPECIFIC APPLICATIONS AN ENERGY DEPENDENT ERROR MAY   Recent
    BY USED TO MAKE THE PROGRAM RUN CONSIDERABLE FASTER).              Recent
                                                                       Recent
    ALL ENERGIES MUST BE IN ASCENDING ENERGY ORDER. FOR CONVERGENCE    Recent
    OF THE FILE 2 RECONSTRUCTION ALGORITHM ALL THE ERRORS MUST BE      Recent
    POSITIVE. IF ERROR IS NOT POSITIVE IT WILL BE SET EQUAL TO THE     Recent
    STANDARD OPTION (CURRENTLY 0.001, CORRRESPONDING TO 0.1 PER-CENT). Recent
    IF THE FIRST LINE OF THE ERROR LAW IS BLANK IT WILL TERMINATE THE   Recent
    ERROR LAW AND THE ERROR WILL BE TREATED AS ENERGY INDEPENDENT,      Recent
    EQUAL TO THE STANDARD OPTION (CURRENTLY, 0.1 PER-CENT). SEE,       Recent
    EXAMPLE INPUT 4.                                                   Recent
                                                                       Recent
    EXAMPLE INPUT NO. 1                                                Recent
    -------------------                                                Recent
    CONSIDER ALL URANIUM ISOTOPES AND TH-232. CONSIDER CROSS SECTIONS  Recent
    WHICH ARE LARGER THAN 1.0E-8 BARNS IN ABSOLUTE VALUE. ONLY OUTPUT  Recent
    REACTIONS FOR WHICH A BACKGROUND IS GIVEN. LIST ALL PARAMETERS AND Recent
    CALCULATE CROSS SECTIONS. MONITOR THE EXECUTION PROGRESS OF THE    Recent
    PROGRAM. BETWEEN 0 AND 100 EV USE 0.1 PER-CENT ACCURACY. BETWEEN   Recent
    100 EV AND 1 KEV VARY THE ACCURACY FROM 0.1 TO 1 PER-CENT. ABOVE   Recent
    1 KEV USE 1 PER-CENT ACCURACY.                                     Recent
                                                                       Recent
    EXPLICITLY SPECIFY THE STANDARD FILENAMES.                         Recent
                                                                       Recent
    THE FOLLOWING 11 INPUT CARDS ARE REQUIRED.                         Recent
                                                                       Recent
        1 1.00000-08         0          1          0         1        Recent
ENDFB.IN                                                               Recent
ENDFB.OUT                                                              Recent
     92000      92999                                                  Recent
     90232                 (UPPER LIMIT AUTOMATICALLY SET TO 90232)    Recent
                           (END REQUEST LIST)                          Recent
0.00000+ 0 1.00000-03                                                  Recent
1.00000+02 1.00000-03                                                  Recent
1.00000+03 1.00000-02                                                  Recent
1.00000+09 1.00000-02                                                  Recent
                           (END FILE 2 ERROR LAW)                      Recent
                                                                       Recent
    EXAMPLE INPUT NO. 2                                                Recent
    -------------------                                                Recent
    CONSIDER ALL URANIUM ISOTOPES AND TH-232. CONSIDER CROSS SECTIONS  Recent
    WHICH ARE LARGER THAN 1.0E-8 BARNS IN ABSOLUTE VALUE. ONLY OUTPUT  Recent
    REACTIONS FOR WHICH A BACKGROUND IS GIVEN. CROSS SECTIONS WILL BE  Recent
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    CALCULATED, BUT PARAMETERS WILL NOT BE LISTED. THE PROGRESS OF THE Recent
    PROGRAM WILL NOT BE MONITORED. USE 0.1 PER-CENT ACCURACY FOR ALL   Recent
    ENERGIES. SINCE 0.1 PER-CENT IS THE STANDARD OPTION FOR THE ERROR  Recent
    LAW THE FIRST ERROR LAW LINE MAY BE LEFT BLANK.                    Recent
                                                                       Recent
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL     Recent
    THEN USE THE STANDARD FILENAMES.                                   Recent
                                                                       Recent
    THE FOLLOWING 7 INPUT CARDS ARE REQUIRED.                          Recent
                                                                       Recent
         1 1.00000-08          0          0          0         0       Recent
                                                                       Recent
                                                                       Recent
     92000      92999                                                  Recent
     90232                 (UPPER LIMIT AUTOMATICALLY SET TO 90232)   Recent
                           (END REQUEST LIST)                          Recent
                           (USE STANDARD OPTION FOR ERROR LAW)         Recent
                                                                       Recent
    EXAMPLE INPUT NO. 3                                                Recent
    -------------------                                                Recent
    THE SAME AS EXAMPLE INPUT NO. 2, ONLY IN THIS CASE ONLY CALCULATE  Recent
    CROSS SECTIONS OVER THE ENERGY RANGE 0.01 TO 0.1 EV - ACROSS THE   Recent
    THERMAL ENERGY RANGE. NOTE, THE ONLY DIFFERENCE BETWEEN THE INPUT  Recent
    PARAMETERS IN THIS CASE AND IN EXAMPLE NO. 2, IS THAT ON THE       Recent
    SECOND INPUT LINE WE HAVE ADDED THE ENERGY RANGE 0.01 TO 0.1 EV.   Recent
    USE \PREPRO94\LINEAR\ENDFB.OUT AS INPUT AND ENDFB.OUT AS OUTPUT -  Recent
    SINCE ENDFB.OUT IS THE STANDARD OUTPUT FILENAME THE NAME CAN BE    Recent
    EITHER INCLUDED IN THE INPUT OR LEFT BLANK.                        Recent
                                                                       Recent
    THE FOLLOWING 7 INPUT CARDS ARE REQUIRED.                          Recent
                                                                       Recent
         1 1.00000-08          0          0          0         0       Recent
\PREPRO94\LINEAR\ENDFB.OUT                                             Recent
ENDFB.OUT                                                              Recent
     92000      92999 1.00000- 2 1.00000- 1                            Recent
     90232                 (UPPER LIMIT AUTOMATICALLY SET TO 90232)   Recent
                           (END REQUEST LIST)                          Recent
                           (USE STANDARD OPTION FOR ERROR LAW)         Recent
                                                                       Recent
    EXAMPLE INPUT NO. 4                                                Recent
    -------------------                                                Recent
    RECONSTRUCT ALL DATA. OUTPUT ALL REACTIONS, REGARDING OF WHETHER   Recent
    OR NOT THERE IS A BACKGROUND CROSS SECTION. DO NOT MONITOR THE     Recent
    PROGRESS OF THE PROGRAM. RECONSTRUCT CROSS SECTIONS TO 1 PER-CENT  Recent
    ACCURACY. USE \ENDFB6\LINEAR\ZA092238 AS INPUT AND                 Recent
    \ENDFB6\RECENT\ZA092238 AS OUTPUT.                                 Recent
                                                                       Recent
    THE FOLLOWING 6 INPUT CARDS ARE REQUIRED.                          Recent
                                                                       Recent
         0 0.0                 1          0          0         0       Recent
\ENDFB6\ZA092238                                                       Recent
\ENDFB6\RECENT\ZA092238                                                Recent
                      (RETRIEVE ALL DATA, END REQUEST LIST)            Recent
           1.00000- 2                                                  Recent
                      (END FILE 2 ERROR LAW)                           Recent
                                                                       Recent
    EXAMPLE INPUT NO. 5                                                Recent
    -------------------                                                Recent
    RECONSTRUCT ALL DATA. ONLY OUTPUT REACTIONS FOR WHICH A BACKGROUND Recent
    CROSS SECTION IS GIVEN. DO NOT MONITOR THE PROGRESS OF THE PROGRAM Recent
    RECONSTRUCT CROSS SECTIONS TO 0.1 PER-CENT ACCURACY. USE ENDFB.IN  Recent
    AS INPUT AND ENDFB.OUT AS OUTPUT.                                  Recent
                                                                       Recent
    THIS CORRESPONDS TO USING ALL OF THE STANDARD OPTONS BUILT-IN TO   Recent
    THE PROGRAM AND ALL INPUT CARDS MAY BE BLANK.                      Recent
                                                                       Recent
    IN THIS CASE THE FOLLOWING 5 INPUT CARDS ARE REQUIRED.             Recent
    (ZEROES ARE INDICATED ON THE FIRST LINE, BELOW, ONLY TO INDICATE   Recent
```

```
     WHERE THE LINE IS. THE ACTUAL INPUT LINE CAN BE COMPLETELY BLANK). Recent
                                                                        Recent
          0 0.0                0          0          0         0       Recent
                       (USE STANDARD INPUT FILENAME = ENDFB.IN)         Recent
                       (USE STANDARD OUTPUT FILENAME = ENDFB.OUT)       Recent
                       (RETRIEVE ALL DATA, END REQUEST LIST)            Recent
                       (0.1 ERROR, END FILE 2 ERROR LAW)                Recent
                                                                        Recent
=========================================================================== Recent
```

```
====================================================================== Relabel
                                                                       Relabel
      PROGRAM RELABEL                                                  Relabel
      VERSION 69-1 (APRIL 1969)                                        Relabel
      VERSION 73-1 (JUNE 1973)                                         Relabel
      VERSION 77-1 (SEPTEMBER 1977)                                    Relabel
      VERSION 80-1 (AUGUST 1980) IBM VERSION                           Relabel
      VERSION 83-1 (JANUARY 1983) COMBINED STATEMENT NUMBER SEQUENCE   Relabel
                                  AND LINE I.D. INTO ONE PROGRAM.      Relabel
      VERSION 86-1 (JANUARY 1986) FORTRAN-77/H VERSION                 Relabel
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O    Relabel
                                  FILE NAMES (SEE, SUBROUTINES FILIO1  Relabel
                                  AND FILIO2 FOR DETAILS).             Relabel
                                 *IMPROVED BASED ON USER COMMENTS.     Relabel
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO   Relabel
                                  INSURE PROGRAM WILL NOT DO ANYTHING  Relabel
                                  CRAZY.                               Relabel
                                 *UPDATED TO USE NEW PROGRAM CONVERT   Relabel
                                  KEYWORDS.                            Relabel
                                 *ADDED LIVERMORE CIVIC COMPILER       Relabel
                                  CONVENTIONS.                         Relabel
      VERSION 92-1 (JANUARY 1992)*ADDED FORTRAN SAVE OPTION            Relabel
      VERSION 94-1 (JANUARY 1994)*COMPLETE RE-WRITE                    Relabel
                                 *OUTPUT MINIMUM NON-BLANK LENGTH FOR  Relabel
                                  EACH LINE - NO SEQUENCE NUMBERS.     Relabel
                                 *INCREASED MAXIMUM NUMBER OF LABELS   Relabel
                                  PER ROUTINE FROM 1000 TO 50,000      Relabel
                                 *CAN NOW PROCESS UPPER OR LOWER CASE  Relabel
                                  CODING.                              Relabel
                                 *SKIP IMBEDDED BLANKS IN KEYWORDS.    Relabel
                                 *ADDED WRITE(XX,XX,ERR=YYY,END=ZZZ)   Relabel
                                 *ADDED OPEN(XX,ERR=YYY,END=ZZZ)       Relabel
                                 *ADDED CLOSE(XX,ERR=YYY,END=ZZZ)      Relabel
                                 *INTEGER INSTEAD OF CHARACTERS IS NO  Relabel
                                  LONGER SUPPORTED - ALL CHARACTERS    Relabel
                                  MUST BE IDENTIFIED AS CHARACTERS.    Relabel
                                 *VARIABLE FILENAMES TO ALLOW ACCESS   Relabel
                                  FILE STRUCTURES                      Relabel
                                  (WARNING - INPUT PARAMETER FORMAT    Relabel
                                  HAS BEEN CHANGED)                    Relabel
                                 *CLOSE ALL FILES BEFORE TERMINATING   Relabel
                                  (SEE, SUBROUTINE ENDIT)              Relabel
      VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                   Relabel
                                  *IMPROVED COMPUTER INDEPENDENCE      Relabel
                                  *ALL DOUBLE PRECISION                Relabel
                                  *ON SCREEN OUTPUT                    Relabel
                                  *IMPROVED OUTPUT PRECISION           Relabel
                                  *DEFINED SCRATCH FILE NAMES          Relabel
                                  *INCREASED THE NUMBER OF LABELS      Relabel
                                   IN A ROUTINE FOR 5,000 TO 50,000    Relabel
      VERSION 99-1 (MARCH 1999)   *GENERAL IMPROVEMENTS BASED ON       Relabel
                                   USER FEEDBACK                       Relabel
      VERS. 2000-1 (FEBRUARY 2000)*UPDATED TO IGNORE ( AND ) IN QUOTES Relabel
                                  *GENERAL IMPROVEMENTS BASED ON       Relabel
                                   USER FEEDBACK                       Relabel
      VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS           Relabel
                                  *CORRECTED END=, ERR=, WHEN I/O UNIT Relabel
                                   NUMBER IS DIMENSIONED               Relabel
      VERS. 2004-1 (MARCH 2004)   *ADDED INCLUDE FOR COMMON           Relabel
                                  *INCREASED THE NUMBER OF LABELS IN   Relabel
                                   A ROUTINE FOR 50,000 TO 100,000     Relabel
                                                                       Relabel
      OWNED, MAINTAINED AND DISTRIBUTED BY                             Relabel
      -----------------------------------                              Relabel
      THE NUCLEAR DATA SECTION                                         Relabel
      INTERNATIONAL ATOMIC ENERGY AGENCY                               Relabel
      P.O. BOX 100                                                     Relabel
      A-1400, VIENNA, AUSTRIA                                          Relabel
```

```
EUROPE                                                                  Relabel
                                                                        Relabel
ORIGINALLY WRITTEN BY                                                   Relabel
-----------------------------------                                     Relabel
DERMOTT E. CULLEN                                                       Relabel
UNIVERSITY OF CALIFORNIA                                                Relabel
LAWRENCE LIVERMORE NATIONAL LABORATORY                                  Relabel
L-159                                                                   Relabel
P.O. BOX 808                                                            Relabel
LIVERMORE, CA 94550                                                     Relabel
U.S.A.                                                                  Relabel
TELEPHONE  925-423-7359                                                 Relabel
E. MAIL    CULLEN1@LLNL.GOV                                             Relabel
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                  Relabel
                                                                        Relabel
PURPOSE                                                                 Relabel
-------                                                                 Relabel
THIS PROGRAM IS DESIGNED TO RE-LABEL A FORTRAN PROGRAM SO THAT          Relabel
STATEMENT LABELS ARE IN INCREASING ORDER IN INCREMENTS OF 10            Relabel
WITHIN EACH ROUTINE.                                                    Relabel
                                                                        Relabel
THE FOLLOWING TYPES OF FORTRAN STATEMENTS ARE CONSIDERED,               Relabel
                                                                        Relabel
GO TO NN                                                                Relabel
GO TO (NN,MM,.....,JJ,KK),LL (MULTI LINE O.K.)                          Relabel
DO NN                                                                   Relabel
IF(......) NN,MM,...JJ,KK                                               Relabel
IF(......) GO TO NN                                                     Relabel
IF(......) GO TO (NN,MM,.....,JJ,KK),LL (MULTI LINE O.K.)               Relabel
IF(......) READ(.....,END=NN,ERR=MM)                                    Relabel
IF(......) WRITE(.....,END=NN,ERR=MM)                                   Relabel
READ(......,END=NN,ERR=MM)                                              Relabel
OPEN(......,END=NN,ERR=MM)                                              Relabel
                                                                        Relabel
GO TO STATEMENTS MAY APPEAR IN THE FORM 'GO TO' OR 'GOTO'. IF           Relabel
THERE IS ROOM ON THE LINE 'GOTO' WILL BE CONVERTED TO 'GO TO'.          Relabel
WHETHER OR NOT 'GOTO' IS CONVERTED TO 'GO TO' IT WILL BE TREATED        Relabel
AS IDENTICAL TO 'GO TO' FOR SUBSEQUENT PROCESSING AND RELACEMENT        Relabel
OF STATEMENT NUMBERS.                                                   Relabel
                                                                        Relabel
ALL OTHER STATEMENT TYPES ARE NOT CHANGED. IN PARTICULAR ALL I/O        Relabel
STATEMENTS AND ASSOCIATED FORMAT STATEMENTS ARE NOT CONVERTED.          Relabel
                                                                        Relabel
WARNING                                                                 Relabel
-------                                                                 Relabel
THIS PROGRAM IS ONLY DESIGNED TO MAINTAIN ENDF/B PRE-PROCESSING         Relabel
PROGRAMS, WHICH ONLY USE A RESTRICTED SET OF FORTRAN STATEMENT          Relabel
TYPES THAT CAN BE USED ON A VARIETY OF DIFFERENT TYPES OF               Relabel
COMPUTERS. THIS PROGRAM IS NOT DESIGNED TO HANDLE ALL POSSIBLE          Relabel
TYPES OF FORTRAN STATEMENTS.                                            Relabel
                                                                        Relabel
THE FORTRAN STATEMENTS DESCRIBED ABOVE AND TREATED BY THIS PROGRAM      Relabel
DO NOT INCLUDE ALL POSSIBLE FORTRAN STATEMENTS. AS SUCH THIS            Relabel
PROGRAM IS NOT COMPLETELY GENERAL AND SHOULD ONLY BE USED WITH          Relabel
PROGRAMS THAT ONLY USE THE FORTRAN STATEMENTS DESCRIBED ABOVE.          Relabel
                                                                        Relabel
FAILURE TO FOLLOW THESE INSTRUCTIONS CAN LEAD TO ERROR IN PROGRAMS      Relabel
                                                                        Relabel
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINES FILIO1 AND FILIO2)        Relabel
-------------------------------------------------------------------     Relabel
UNIT  FILE NAME    DESCRIPTION                                          Relabel
----  ----------   -----------                                          Relabel
  2   RELABEL.INP  INPUT PARAMETERS                                     Relabel
  3   RELABEL.LST  OUTPUT REPORT                                        Relabel
 10   RELABEL.IN   PROGRAM TO READ                                      Relabel
 11   RELABEL.OUT  PROGRAM TO WRITE                                     Relabel
 12   (SCRATCH)                                                         Relabel
                                                                        Relabel
```

```
     INPUT CARDS                                                          Relabel
     -----------                                                          Relabel
     LINE  COLUMNS  DEFINITION                                            Relabel
     ----  -------  ----------                                            Relabel
        1   1-60    INPUT PROGRAM FILENAME                                Relabel
                    (STANDARD OPTION = RELABEL.IN)                        Relabel
        2   1-60    OUTPUT PROGRAM FILENAME                               Relabel
                    (STANDARD OPTION = RELABEL.OUT)                       Relabel
                                                                          Relabel
     LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL       Relabel
     THEN USE STANDARD FILENAMES.                                         Relabel
                                                                          Relabel
     EXAMPLE INPUT NO. 1                                                  Relabel
     -------------------                                                  Relabel
     TO READ \PREPRO94\RECENT\RECENT.FOR AND                              Relabel
     WRITE   \PREPRO94\RECENT\RECENT.NEW THE FOLLOWING 2 INPUT LINES      Relabel
     ARE REQUIRED,                                                        Relabel
                                                                          Relabel
     \PREPRO94\RECENT\RECENT.FOR                                          Relabel
                                                                          Relabel
     EXAMPLE INPUT NO. 2                                                  Relabel
     -------------------                                                  Relabel
     TO READ RELABEL.IN AND WRITE RELABEL.OUT THE FOLOWING 2 INPUT        Relabel
     LINES ARE REQUIRED,                                                  Relabel
                                                                          Relabel
     RELABEL.IN                                                           Relabel
     RELABEL.OUT                                                          Relabel
                                                                          Relabel
     EXAMPLE INPUT NO. 3                                                  Relabel
     -------------------                                                  Relabel
     TO READ RELABEL.IN AND WRITE RELABEL.OUT, SINCE THESE ARE THE        Relabel
     STANDARD OPTIONS THE 2 INPUT LINES CAN BE COMPLETELY BLANK.          Relabel
                                                                          Relabel
==================================================================================== Relabel
```

```
====================================================================== Sigma1
                                                                       Sigma1
      PROGRAM SIGMA1                                                   Sigma1
      ==============                                                   Sigma1
      VERSION 73-1 (MARCH 1973)                                        Sigma1
      VERSION 76-1 (FEBRUARY 1976)                                     Sigma1
      VERSION 76-2 (OCTOBER 1976)                                      Sigma1
      VERSION 77-1 (JANUARY 1977)                                      Sigma1
      VERSION 78-1 (JULY 1978)                                         Sigma1
      VERSION 79-1 (JULY 1979)    CDC-7600 AND CRAY-1 VERSION.         Sigma1
      VERSION 80-1 (MAY 1980)     IBM, CDC AND CRAY VERSION            Sigma1
      VERSION 80-2 (DECEMBER 1980)IMPROVED BASED ON USER COMMENTS.     Sigma1
      VERSION 81-1 (MARCH 1981)   DOUBLE PRECISION IBM VERSION         Sigma1
      VERSION 81-2 (AUGUST 1981)  IMPROVED IBM SPEED AND STABILITY     Sigma1
      VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY      Sigma1
      VERSION 83-1 (JANUARY 1983)*MAJOR RE-DESIGN.                     Sigma1
                                 *PAGE SIZE INCREASED - 1002 TO 2004.  Sigma1
                                 *ELIMINATED COMPUTER DEPENDENT CODING.Sigma1
                                 *NEW, MORE COMPATIBLE I/O UNIT NUMBER.Sigma1
                                 *ADDED STANDARD ALLOWABLE ERROR OPTION Sigma1
                                  (CURRENTLY 0.1 PER-CENT).           Sigma1
                                 *UNRESOLVED RESONANCE REGION COPIED.  Sigma1
                                 *1/V EXTENSION OF CROSS SECTIONS      Sigma1
                                  OUTSIDE OF TABULATED ENERGY RANGE AND Sigma1
                                  INTO UNRESOLVED ENERGY RANGE.        Sigma1
      VERSION 83-2 (OCTOBER 1983)*IMPROVED BASED ON USER COMMENTS.     Sigma1
      VERSION 84-1 (APRIL 1984)  *IMPROVED NUMERICAL STABILITY.        Sigma1
                                 *PARTIAL EVALUATION TREATMENT.        Sigma1
      VERSION 85-1 (APRIL 1985)  *ITERATE TO CONVERGENCE (USING THE SAME Sigma1
                                  ENERGY GRID FOR HOT CROSS SECTION AS Sigma1
                                  COLD CROSS SECTIONS WAS FOUND TO BE  Sigma1
                                  INACCURATE).                         Sigma1
                                 *NEW FASTER HIGH ENERGY BROADENING.   Sigma1
                                 *UPDATED FOR ENDF/B-VI FORMATS.       Sigma1
                                 *SPECIAL I/O ROUTINES TO GUARANTEE    Sigma1
                                  ACCURACY OF ENERGY.                  Sigma1
                                 *DOUBLE PRECISION TREATMENT OF ENERGY Sigma1
                                  (REQUIRED FOR NARROW RESONANCES).    Sigma1
      VERSION 85-2 (AUGUST 1985) *FORTRAN-77/H VERSION                 Sigma1
      VERSION 86-1 (JANUARY 1986)*ENERGY DEPENDENT SCATTERING RADIUS   Sigma1
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O   Sigma1
                                  FILE NAMES (SEE, SUBROUTINE FILEIO   Sigma1
                                  FOR DETAILS).                        Sigma1
                                 *IMPROVED BASED ON USER COMMENTS.     Sigma1
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO   Sigma1
                                  INSURE PROGRAM WILL NOT DO ANYTHING  Sigma1
                                  CRAZY.                               Sigma1
                                 *UPDATED TO USE NEW PROGRAM CONVERT   Sigma1
                                  KEYWORDS.                            Sigma1
                                 *ADDED LIVERMORE CIVIC COMPILER       Sigma1
                                  CONVENTIONS.                         Sigma1
      VERSION 90-1 (JUNE 1990)   *UPDATED BASED ON USER COMMENTS       Sigma1
                                 *ADDED FORTRAN SAVE OPTION            Sigma1
                                 *NEW MORE CONSISTENT ENERGY OUTPUT    Sigma1
                                  ROUTINES                             Sigma1
      VERSION 91-1 (JULY 1991)   *WARNING...INPUT PARAMETER FORMAT     Sigma1
                                  HAS BEEN CHANGED - SEE BELOW FOR     Sigma1
                                  DETAILS.                             Sigma1
                                 *ADDED CHARGED PARTICLE PROJECTILES   Sigma1
                                 *OUTPUT ENERGY RANGE IS ALWAYS AT     Sigma1
                                  LEAST AS LARGE AS INPUT ENERGY RANGE.Sigma1
                                 *NO 1/V EXTENSION OF CROSS SECTIONS   Sigma1
                                  FROM UNRESOLVED ENERGY RANGE.        Sigma1
      VERSION 92-1 (JANUARY 1992)*INSURE MINIMUM AND MAXIMUM CROSS     Sigma1
                                  SECTIONS ARE ALWAYS KEPT (NOT THINNED) Sigma1
                                 *MT=19 (FIRST CHANCE FISSION) TREATED Sigma1
                                  THE SAME AS FISSION.                 Sigma1
                                 *VARIABLE MINIMUM CROSS SECTION OF    Sigma1
```

```
                          INTEREST - TO ALLOW SMALL CROSS        Sigma1
                          SECTIONS NEAR THRESHOLDS TO BE         Sigma1
                          TREATED PROPERLY.                      Sigma1
                         *ALL ENERGIES INTERNALLY ROUNDED PRIOR  Sigma1
                          TO CALCULATIONS.                       Sigma1
                         *COMPLETELY CONSISTENT I/O AND ROUNDING Sigma1
                          ROUTINES - TO MINIMIZE COMPUTER        Sigma1
                          DEPENDENCE.                            Sigma1
VERSION 92-2 (JULY 1992)  *CORRECTED BUG ASSOCIATED WITH         Sigma1
                          THRESHOLD REACTIONS.                   Sigma1
                         *UNRESOLVED REGION COPIED WITHOUT       Sigma1
                          THINNING (IT SHOULD BE EXACTLY THE     Sigma1
                          SAME AT ALL TEMPERATURES).             Sigma1
                         *NO THINNING OF REACTIONS (MT) THAT     Sigma1
                          WERE NOT BROADENED.                    Sigma1
VERSION 93-1 (APRIL 1993) *INCREASED PAGE SIZE FROM 2004         Sigma1
                          TO 24000 ENERGY PONTS.                 Sigma1
VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES       Sigma1
                          TO ALLOW ACCESS TO FILE STRUCTURES     Sigma1
                          (WARNING - INPUT PARAMETER FORMAT      Sigma1
                          HAS BEEN CHANGED)                      Sigma1
                         *CLOSE ALL FILES BEFORE TERMINATING     Sigma1
                          (SEE, SUBROUTINE ENDIT)                Sigma1
VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                   Sigma1
                          *IMPROVED COMPUTER INDEPENDENCE        Sigma1
                          *ALL DOUBLE PRECISION                  Sigma1
                          *ON SCREEN OUTPUT                      Sigma1
                          *UNIFORM TREATMENT OF ENDF/B I/O       Sigma1
                          *IMPROVED OUTPUT PRECISION             Sigma1
                          *DEFINED SCRATCH FILE NAMES            Sigma1
                          *ALWAYS INCLUDE THERMAL VALUE          Sigma1
VERSION 97-1 (APRIL 1997)  *OPTIONALLY SET NEGATIVE CROSS        Sigma1
                           SECTIONS = 0 ON INPUT AND             Sigma1
                           OUTPUT.                               Sigma1
                          *INCREASED PAGE SIZE FROM 24000        Sigma1
                           TO 60000 ENERGY POINTS.               Sigma1
VERSION 99-1 (MARCH 1999)  *CORRECTED CHARACTER TO FLOATING      Sigma1
                           POINT READ FOR MORE DIGITS            Sigma1
                          *UPDATED TEST FOR ENDF/B FORMAT        Sigma1
                           VERSION BASED ON RECENT FORMAT CHANGE Sigma1
                          *TREAT LOW ENERGY INITIAL CROSS        Sigma1
                           SECTIONS AS LOG-LOG INTERPOLABLE      Sigma1
                          *CONSTANT (RATHER THAN 1/V) EXTENSION  Sigma1
                           TO HIGHER ENERGY.                     Sigma1
                          *UPDATED CONSTANTS BASED ON CSEWG      Sigma1
                           SUBCOMMITTEE RECOMMENDATIONS          Sigma1
                          *GENERAL IMPROVEMENTS BASED ON         Sigma1
                           USER FEEDBACK                         Sigma1
VERSION 99-2 (JUNE 1999)   *EXTENDED RANGE OF INTEGRALS FROM 4   Sigma1
                           TO 5 UNITS ON EACH SIDE OF ENERGY     Sigma1
                           POINT TO ALLOW FOR LARGER VARIATION   Sigma1
                           IN THE LOCAL CROSS SECTION            Sigma1
                          *ASSUME ENDF/B-VI, NOT V, IF MISSING   Sigma1
                           MF=1, MT-451.                         Sigma1
VERSION 99-3 (OCTOBER 1999))*IMPROVED ERFC FUNCTION DEFINITION.  Sigma1
                           I THANK BOB MACFARLANE (LANL) FOR     Sigma1
                           SUPPLYING A MORE ACCURATE ERFC        Sigma1
                           FUNCTION.                             Sigma1
VERS. 2000-1 (FEBRUARY 2000)*CORRECTED LOW ENERGY INTERPOLATION  Sigma1
                           FOR NON-POSITIVE CROSS SECTIONS       Sigma1
                          *GENERAL IMPROVEMENTS BASED ON         Sigma1
                           USER FEEDBACK                         Sigma1
VERS. 2002-1 (MAY 2002)    *OPTIONAL INPUT PARAMETERS            Sigma1
VERS. 2004-1 (JAN. 2004)   *OPTIONALLY IGNORE UNRESOLVED REGION   Sigma1
                          *CORRECTED PROBLEM AT THE RESOLVED/    Sigma1
                           UNRESOLVED ENERGY BOUNDARY.           Sigma1
                          *CORRECTED HIGH ENERGY CONSTANT CROSS  Sigma1
                           SECTION EXTENSION.                    Sigma1
```

```
                            *TIGHTER CRITERIA FOR INITIAL ENERGY   Sigma1
                             POINT SPACING                        Sigma1
                            *TEMPERATURE DEPENDENT ENERGY POINT    Sigma1
                             SPACING.                             Sigma1
                            *ADDED NEW REICH-MOORE (LRF=7) TO      Sigma1
                             FILE2 TO ALLOW COPY TO FIND ANY      Sigma1
                             FOLLOWING UNRESOLVED PARAMETERS      Sigma1
VERS. 2005-1 (JUNE 2005)    *CORRECTED ERROR IN EHOT3 EQUIVALENCE  Sigma1
                             TO EHOT - THIS ONLY EFFECTS VERY BIG  Sigma1
                             OUTPUT FILES.                        Sigma1
VERS. 2007-1 (JAN. 2007)    *CHECKED AGAINST ALL ENDF/B-VII.       Sigma1
                            *INCREASED PAGE SIZE FROM 60,000       Sigma1
                             TO 360,000 ENERGY POINTS.            Sigma1
                                                                  Sigma1
Acknowledgement 2004                                              Sigma1
--------------------                                              Sigma1
Currently almost all improvements to this code are based upon     Sigma1
feedback from code users who report problems. This feedback       Sigma1
benefits ALL users of this code, and ALL users are encouraged     Sigma1
to report problems.                                               Sigma1
                                                                  Sigma1
Improvements on the 2004 version of this code based on user       Sigma1
feedback including,                                               Sigma1
1) Bret Beck  - reported a problem at the resolved/unresolved     Sigma1
                energy boundary.                                  Sigma1
2) S. Ganesan - reported a problem for small temperature changes. Sigma1
                                                                  Sigma1
OWNED, MAINTAINED AND DISTRIBUTED BY                              Sigma1
------------------------------------                              Sigma1
THE NUCLEAR DATA SECTION                                          Sigma1
INTERNATIONAL ATOMIC ENERGY AGENCY                                Sigma1
P.O. BOX 100                                                      Sigma1
A-1400, VIENNA, AUSTRIA                                           Sigma1
EUROPE                                                            Sigma1
                                                                  Sigma1
ORIGINALLY WRITTEN BY                                             Sigma1
-------------------------------------                             Sigma1
DERMOTT E. CULLEN                                                 Sigma1
UNIVERSITY OF CALIFORNIA                                          Sigma1
LAWRENCE LIVERMORE NATIONAL LABORATORY                            Sigma1
L-159                                                             Sigma1
P.O. BOX 808                                                      Sigma1
LIVERMORE, CA 94550                                               Sigma1
U.S.A.                                                            Sigma1
TELEPHONE  925-423-7359                                           Sigma1
E. MAIL    CULLEN1@LLNL.GOV                                       Sigma1
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                            Sigma1
                                                                  Sigma1
AUTHORS MESSAGE                                                   Sigma1
---------------                                                   Sigma1
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION  Sigma1
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED Sigma1
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE Sigma1
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY    Sigma1
THE COMMENTS CONCERNING MACHINE DEPENDENT CODING.                 Sigma1
                                                                  Sigma1
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER Sigma1
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE    Sigma1
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT Sigma1
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY      Sigma1
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO Sigma1
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF   Sigma1
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR        Sigma1
COMPUTER.                                                         Sigma1
                                                                  Sigma1
PURPOSE                                                           Sigma1
-------                                                           Sigma1
THIS PROGRAM IS DESIGNED TO DOPPLER BROADEN NEUTRON INDUCED       Sigma1
```

```
CROSS SECTIONS. EACH SECTION OF CROSS SECTIONS (FILE 3) IS READ    Sigma1
FROM THE ENDF/B FORMAT. THE DATA IS DOPPLER BROADENED, THINNED     Sigma1
AND OUTPUT IN THE ENDF/B FORMAT.                                   Sigma1
                                                                   Sigma1
IN THE FOLLOWING DISCUSSION FOR SIMPLICITY THE ENDF/B TERMINOLOGY  Sigma1
---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE    Sigma1
TAPE, CARDS, DISK OR ANY OTHER MEDIUM.                             Sigma1
                                                                   Sigma1
ENDF/B FORMAT                                                      Sigma1
-------------                                                      Sigma1
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS     Sigma1
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION   Sigma1
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II, III, IV OR V FORMAT).    Sigma1
                                                                   Sigma1
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B       Sigma1

FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS     Sigma1
ASSUMED THAT THE MAT, MF AND MT ON EACH CARD IS CORRECT. SEQUENCE  Sigma1
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE          Sigma1
CORRECTLY OUTPUT ON ALL CARDS. THE FORMAT OF SECTION MF=1, MT=451  Sigma1
AND ALL SECTIONS OF MF=3 MUST BE CORRECT. THE PROGRAM COPIES ALL   Sigma1
OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO   Sigma1
THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.             Sigma1
                                                                   Sigma1
ALL CROSS SECTIONS THAT ARE USED BY THIS PROGRAM MUST BE TABULATED Sigma1
AND LINEARLY INTERPOLABLE IN ENERGY AND CROSS SECTION (ENDF/B      Sigma1
INTERPOLATION LAW 2). FILE 3 CROSS SECTIONS MAY BE MADE LINEARLY   Sigma1
INTERPOLABLE BY USING PROGRAM LINEAR (UCRL-50400, VOL.17, PART A). Sigma1
FILE 2 RESONANCE PARAMETERS MAY BE USED TO RECONSTRUCT ENERGY      Sigma1
DEPENDENT CROSS SECTIONS AND ADD IN FILE 3 BACKGROUND CROSS        Sigma1
SECTIONS TO DEFINE LINEARLY INTERPOLABLE CROSS SECTIONS BY USING   Sigma1
PROGRAM RECENT (UCRL-50400, VOL. 17, PART C). IF THIS PROGRAM      Sigma1
FINDS THAT THE FILE 3 CROSS SECTIONS ARE NOT LINEARLY INTERPOLABLE Sigma1
THIS PROGRAM WILL TERMINATE EXECUTION.                             Sigma1
                                                                   Sigma1
UNRESOLVED RESONANCE REGION                                        Sigma1
---------------------------                                        Sigma1
IN THE UNRESOLVED RESONANCE REGION IT IS NOT POSSIBLE TO EXACTLY   Sigma1
DEFINE THE ENERGY DEPENDENCE OF THE CROSS SECTIONS. THE AVERAGE    Sigma1
WIDTHS AND SPACINGS GIVEN IN ENDF/B ARE ONLY ADEQUATE TO DEFINE    Sigma1
AVERAGE VALUES OF THE CROSS SECTIONS. THEREFORE ALL CROSS SECTIONS Sigma1
IN THE ENDF/B FORMAT FOR THE UNRESOLVED REGION ARE REALLY AVERAGE  Sigma1
VALUES WHICH CANNOT BE DOPPLER BROADENED USING THE SIGMA1 METHOD   Sigma1
(WHICH REQUIRES TABULATED, LINEARLY INTERPOLABLE, ENERGY DEPENDENT Sigma1
CROSS SECTIONS.                                                    Sigma1
                                                                   Sigma1
THEREFORE,                                                         Sigma1
(1) ALL TABULATED POINTS WITHIN THE UNRESOLVED RESONANCE REGION    Sigma1
WILL BE COPIED, WITHOUT MODIFICATION OR BROADENING. ADOPTION OF    Sigma1
THIS CONVENTION WILL ALLOW SUBSEQUENT PROGRAMS TO PROPERLY DEFINE  Sigma1
SELF-SHIELDED, DOPPLER BROADENED CROSS SECTIONS IN THE UNRESOLVED  Sigma1
RESONANCE REGION.                                                  Sigma1
(2) CROSS SECTIONS WILL BE EXTENDED AS 1/V ABOVE THE UPPER ENERGY  Sigma1
LIMIT OF THE RESOLVED RESONANCE REGION AND BELOW THE LOWER ENERGY  Sigma1
LIMIT OF THE CONTINUUUM REGION (I.E. INTO THE UNRESOLVED           Sigma1
RESONANCE REGION). THIS CONVENTION WILL GUARANTEE A SMOOTH         Sigma1
BEHAVIOR CLOSE TO THE UNRESOLVED RESONANCE REGION BOUNDARIES.      Sigma1
                                                                   Sigma1
OUTPUT FORMAT                                                      Sigma1
-------------                                                      Sigma1
IN THIS VERSION OF SIGMA1 ALL FILE 3 ENERGIES WILL BE OUTPUT IN    Sigma1
F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN   Sigma1
WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN  Sigma1
OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS   Sigma1
OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS    Sigma1
TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE  Sigma1
TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA     Sigma1
JUST DUE TO TRANSLATION OF THE ENERGIES TO THE ENDF/B FORMAT.      Sigma1
```

```
                                                                      Sigma1
CONTENTS OF OUTPUT                                                    Sigma1
------------------                                                    Sigma1
ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE BROADENED FILE 3          Sigma1
CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO        Sigma1
INCLUDED.                                                             Sigma1
                                                                      Sigma1
DOCUMENTATION                                                         Sigma1
-------------                                                         Sigma1
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED     Sigma1
BY THE ADDITION OF THREE COMMENTS CARDS AT THE END OF EACH            Sigma1
HOLLERITH SECTION IN THE FORM                                         Sigma1
                                                                      Sigma1
***************** PROGRAM SIGMA1 (2007-1) ***************           Sigma1
DATA DOPPLER BROADENED TO 300.0   KELVIN AND                         Sigma1
DATA THINNED TO WITHIN AN ACCURACY OF  0.1 PER-CENT                   Sigma1
                                                                      Sigma1
THE ORDER OF ALL SIMILAR COMMENTS (FROM LINEAR,RECENT AND GROUPY)     Sigma1
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON          Sigma1
THE DATA.                                                             Sigma1
                                                                      Sigma1
THESE COMMENT CARDS ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,    Sigma1
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT    Sigma1
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF         Sigma1
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451       Sigma1
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF         Sigma1
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF         Sigma1
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO             Sigma1
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND      Sigma1
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT     Sigma1
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                         Sigma1
                                                                      Sigma1
REACTION INDEX                                                        Sigma1
--------------                                                        Sigma1
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN        Sigma1
SECTION MF=1, MT=451 OF EACH EVALUATION.                              Sigma1
                                                                      Sigma1
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.      Sigma1
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT            Sigma1
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS    Sigma1
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING     Sigma1
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE     Sigma1
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM    Sigma1
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.        Sigma1
                                                                      Sigma1
SECTION SIZE                                                          Sigma1
------------                                                          Sigma1
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT     Sigma1
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS         Sigma1
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                    Sigma1
                                                                      Sigma1
SELECTION OF DATA                                                     Sigma1
-----------------                                                     Sigma1
THE PROGRAM SELECTS MATERIALS TO BE BROADENED BASED EITHER ON         Sigma1
MAT (ENDF/B MAT NO.) OR ZA. THE PROGRAM ALLOWS UP TO 100 MAT OR       Sigma1
ZA RANGES TO BE SPECIFIED. THE PROGRAM WILL ASSUME THAT THE           Sigma1
ENDF/B TAPE IS IN EITHER MAT OR ZA ORDER, WHICHEVER CRITERIA IS       Sigma1
USED TO SELECT MATERIALS, AND WILL TERMINATE WHEN A MAT OR ZA         Sigma1
IS FOUND THAT IS ABOVE THE RANGE OF ALL REQUESTS.                     Sigma1
                                                                      Sigma1
ENERGY GRID OF BROADENED DATA                                         Sigma1
-----------------------------                                         Sigma1
THE ENERGY GRID FOR THE DOPPLER BROADENED CROSS SECTIONS IS           Sigma1
SELECTED TO INSURE THAT THE BROADENED DATA IS LINEAR-LINEAR           Sigma1
INTERPOLABLE. AS SUCH THE ENERGY GRID FOR THE BROADENED DATA          Sigma1
MAY NOT BE THE SAME AS THE ENERGY GRID FOR THE ORIGINAL               Sigma1
UNBROADENED DATA. GENERALLY AFTER BROADENING THERE WILL BE            Sigma1
FEWER DATA POINTS IN THE RESONANCE REGION, BUT AT LOW ENERGY          Sigma1
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THERE MAY BE MORE POINTS, DUE TO THE 1/V LOW ENERGY EFFECT         Sigma1
CREATED BY DOPPLER BROADENING.                                     Sigma1
                                                                   Sigma1
EFFECTIVE TEMERATURE INCREASE                                      Sigma1
-----------------------------                                      Sigma1
IF THE ORIGINAL DATA IS NOT AT ZERO KELVIN THE PROGRAM WILL        Sigma1
BROADEN THE DATA BY THE EFFECTIVE TEMPERATURE DIFFENCE TO THE      Sigma1
FINAL TEMPERATURE. IF THE DATA IS ALREADY AT A TEMPERATURE THAT    Sigma1
IS HIGHER THAN THE FINAL TEMPERATURE DOPPLER BROADENING IS         Sigma1
NATURALLY NOT PERFORMED AND THE TEMPERATURE IN THE SECTION IS LEFT Sigma1
AT ITS ORIGINAL VALUE.                                             Sigma1
                                                                   Sigma1
MULTIPLE FINAL TEMPERATURES                                        Sigma1
---------------------------                                        Sigma1
THE PRESENT VERSION ONLY DOPPLER BROADENS TO ONE FINAL TEMPERATURE Sigma1
(IF THERE IS SUFFICIENT INTEREST EXPRESSED BY USERS FUTURE         Sigma1
VERSION MAY BROADEN TO MULTIPLE TEMPERATURES. PLEASE               Sigma1
CONTACT THE AUTHOR IF YOU ARE INTERESTED IN A MULTIPLE             Sigma1
TEMPERATURE OPTION).                                               Sigma1
                                                                   Sigma1
PROGRAM OPERATION                                                  Sigma1
-----------------                                                  Sigma1
EACH SECTION OF FILE 3 DATA IS CONSIDERED SEPERATELY. THE DATA     Sigma1
IS READ AND DOPPLER BROADENED A PAGE AT A TIME (ONE PAGE IS        Sigma1
60000 DATA POINTS). UP TO THREE PAGES OF DATA MAY BE IN THE CORE   Sigma1
AT ANY GIVEN TIME, THE PAGE BEING BROADENED, THE PAGE BELOW IT     Sigma1
IN ENERGY AND THE PAGE ABOVE IT IN ENERGY. AFTER A PAGE HAS BEEN   Sigma1
BROADENED IT IS THINNED, IF THE ENTIRE SECTION CONTAINS ONLY       Sigma1
ONE PAGE OR LESS, IT WILL STILL BE CORE RESIDENT AND WILL BE       Sigma1
WRITTEN DIRECTLY FROM CORE TO THE OUTPUT TAPE. IF THE BROADENED,   Sigma1
THINNED SECTION IS LARGER THAN A PAGE, AFTER A PAGE HAS BEEN       Sigma1
BROADENED AND THINNED IT IS WRITTEN TO A SCRATCH FILE. AFTER THE   Sigma1
ENTIRE SECTION HAS BEEN BROADENED AND THINNED THE DATA IS READ     Sigma1
FROM SCRATCH TO CORE, ONE PAGE AT A TIME, THE OUTPUT TO THE OUTPUT Sigma1
TAPE.                                                              Sigma1
                                                                   Sigma1
ALLOWABLE ERROR                                                    Sigma1
---------------                                                    Sigma1
AFTER DOPPLER BROADENING THE CROSS SECTION IN THE RESONANCE REGION Sigma1
WILL GENERALLY BE MUCH SMOOTHER THAN THE UNBROADENED DATA AND CAN  Sigma1
BE REPRESENTED TO THE SAME ACCURACY BY A SMALLER NUMBER OF ENERGY  Sigma1
POINTS. THEREFORE AFTER DOPPLER BROADENING THE DATA CAN BE THINNED Sigma1
WITH ESSENTIALLY NO LOSE OF INFORMATION.                           Sigma1
                                                                   Sigma1
THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY Sigma1
DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED         Sigma1
FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION Sigma1
BETWEEN TABULATED POINTS. IF ONLY ONE TABULATED POINT IS GIVEN THE Sigma1
ERROR WILL BE CONSIDERED CONSTANT OVER THE ENTIRE ENERGY RANGE.    Sigma1
WITH THIS ENERGY DEPENDENT ERROR ONE MAY OPTIMIZE THE OUTPUT FOR   Sigma1
ANY GIVEN APPLICATION BY USING A SMALL ERROR IN THE ENERGY RANGE   Sigma1
OF INTEREST AND A LESS STRINGENT ERROR IN OTHER ENERGY RANGES.     Sigma1
                                                                   Sigma1
INPUT FILES                                                        Sigma1
-----------                                                        Sigma1
UNIT  DESCRIPTION                                                  Sigma1
----  -----------                                                  Sigma1
   2  INPUT CARDS (BCD - 80 CHARACTERS/RECORD)                     Sigma1
  10  ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)            Sigma1
                                                                   Sigma1
OUTPUT FILES                                                       Sigma1
------------                                                       Sigma1
UNIT  DESCRIPTION                                                  Sigma1
----  -----------                                                  Sigma1
   3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                  Sigma1
  11  FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)               Sigma1
                                                                   Sigma1
SCRATCH FILES                                                      Sigma1
```

```
------------                                                    Sigma1
UNIT  DESCRIPTION                                               Sigma1
----  -----------                                               Sigma1
  12  SCRATCH FILE FOR BROADENED DATA                           Sigma1
      (BINARY - 180000 WORDS/RECORD - DOUBLE PRECISION/         Sigma1
                 42000 WORDS/RECORD - SINLGE PRECISION)         Sigma1
                                                                Sigma1
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)            Sigma1
--------------------------------------------------              Sigma1
UNIT  FILE NAME                                                 Sigma1
----  ----------                                                Sigma1
  2   SIGMA1.INP                                                Sigma1
  3   SIGMA1.LST                                                Sigma1
 10   ENDFB.IN                                                  Sigma1
 11   ENDFB.OUT                                                 Sigma1
 12   (SCRATCH)                                                 Sigma1
                                                                Sigma1
INPUT CARDS                                                     Sigma1
-----------                                                     Sigma1
CARD  COLS.  DESCRIPTION                                        Sigma1
----  -----  -----------                                        Sigma1
   1   1-11  SELECTION CRITERIA (0=MAT, 1=ZA)                   Sigma1
      12-22  MONITOR MODE SELECTOR                              Sigma1
             = 0 - NORMAL OPERATION                             Sigma1
             = 1 - MONITOR PROGRESS OF DOPPLER BROADENING OF DATA. Sigma1
                   EACH TIME A PAGE OF DATA POINTS IS WRITTEN TO Sigma1
                   THE SCRATCH FILE PRINT OUT THE TOTAL NUMBER OF Sigma1
                   POINTS ON SCRATCH AND THE LOWER AND UPPER    Sigma1
                   ENERGY LIMITS OF THE PAGE (THIS OPTION MAY BE Sigma1
                   USED IN ORDER TO MONITOR THE EXECUTION SPEED Sigma1
                   OF LONG RUNNING JOBS).                       Sigma1
      23-33  KELVIN TEMPERATURE                                 Sigma1
      34-44  MINIMUM CROSS SECTION OF INTEREST                  Sigma1
             (DEFAULT VALUE = 1.0E-10 BARNS).                   Sigma1
      45-55  NEGATIVE CROSS SECTION TREATMENT                   Sigma1
             = 0 - O.K. - NO CHANGE                             Sigma1
             = 1 - SET = 0                                      Sigma1
      56-66  UNRESOLVED RESONANCE REGION TREATMENT              Sigma1
             = 0 - COPY (NO BROADENING)                         Sigma1
             = 1 - IGNORE (BROADEN)                             Sigma1
   2   1-60  ENDF/B INPUT DATA FILENAME                         Sigma1
             (STANDARD OPTION = ENDFB.IN)                       Sigma1
   3   1-60  ENDF/B OUTPUT DATA FILENAME                        Sigma1
             (STANDARD OPTION = ENDFB.OUT)                      Sigma1
 4-N   1-11  LOWER MAT OR ZA LIMIT                              Sigma1
      12-22  UPPER MAT OR ZA LIMIT                              Sigma1
             UP TO 100 MAT OR ZA RANGES MAY BE SPECIFIED, ONE   Sigma1
             RANGE PER CARD. THE LIST OF RANGES IS TERMINATED BY Sigma1
             A BLANK CARD. IF THE UPPER LIMIT IS LESS THAN THE  Sigma1
             LOWER LIMIT THE UPPER LIMIT WILL BE SET EQUAL TO THE Sigma1
             LOWER LIMIT. IF THE FIRST REQUEST CARD IS BLANK IT Sigma1
             WILL TERMINATE THE LIST OF REQUESTS AND CAUSE ALL  Sigma1
             DATA TO BE RETRIEVED (SEE EXAMPLE INPUT).          Sigma1
 VARY  1-11  ENERGY FOR ERROR LAW                               Sigma1
      12-22  ERROR FOR ERROR LAW                                Sigma1
             THE ACCEPTABLE LINEARIZING ERROR CAN BE GIVEN AS AN Sigma1
             ENERGY DEPENDENT FUNCTION SPECIFIED BY UP TO 20    Sigma1
             (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION      Sigma1
             TABULATE POINTS. ENERGIES MUST BE IN ASCENDING ORDER. Sigma1
             THE ERROR LAW IS TERMINATED BY A BLANK CARD. IF THE Sigma1
             FIRST ERROR LAW CARD IS BLANK IT WILL TERMINATE THE Sigma1
             ERROR LAW AND THE ERROR WILL BE TREATED AS ENERGY  Sigma1
             INDEPENDENT, EQUAL TO ZERO, WHICH INDICATES THAT THE Sigma1
             BROADENED DATA SHOULD NOT BE THINNED.              Sigma1
                                                                Sigma1
EXAMPLE INPUT NO. 1                                             Sigma1
-------------------                                             Sigma1
```

```
    BROADEN ALL URANIUM ISOTOPES AND THORIUM-232 TO 300 KELVIN. FROM   Sigma1

    0 TO 100 EV THIN OUTPUT DATA TO 0.1 PER-CENT ACCURACY. FROM 100 EV Sigma1
    TO 1 KEV VARY THE ERROR BETWEEN 0.1 AND 1 PER-CENT. ABOVE 1 KEV    Sigma1
    USE 1 PER-CENT ACCURACY.                                           Sigma1
                                                                       Sigma1
    EXPLICITLY SPECIFY THE STANDARD FILENAMES.                         Sigma1
                                                                       Sigma1
    THE FOLLOWING 11 CARDS ARE REQUIRED                                Sigma1
                                                                       Sigma1
         1          0 3.00000+ 2                                       Sigma1
ENDFB.IN                                                               Sigma1
ENDFB.OUT                                                              Sigma1
     92000      92999                                                  Sigma1
     90232               (UPPER LIMIT WILL AUTOMATICALLY BE DEFINED)   Sigma1
                         (BLANK CARD INDICATES END OF REQUEST LIST)    Sigma1
0.00000+ 0 1.00000-03                                                  Sigma1
1.00000+ 2 1.00000-03                                                  Sigma1
1.00000+ 3 1.00000-02                                                  Sigma1
1.00000+ 9 1.00000-02                                                  Sigma1
                         (BLANK CARD INDICATES END OF ERROR LAW)       Sigma1
                                                                       Sigma1
    EXAMPLE INPUT NO. 2                                                Sigma1
    ------------------                                                 Sigma1
    BROADEN ALL DATA TO 300 KELVIN AND DO NOT THIN THE BROADEN DATA.   Sigma1
    ALL OF THE STANDARD OPTION MAY BE INVOKED MERELY BY SPECIFYING     Sigma1
    THE KELVIN TEMPERATURE ON THE FIRST CARD. ALL OTHER FIELDS MAY     Sigma1
    BE LEFT BLANK.                                                     Sigma1
                                                                       Sigma1
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL     Sigma1
    THEN USE STANDARD FILENAMES.                                       Sigma1
                                                                       Sigma1
    THE FOLLOWING 5 CARDS ARE REQUIRED                                 Sigma1
                                                                       Sigma1
                     3.00000+ 2                                        Sigma1
                     (USE STANDARD FILENAME = ENDFB.IN)                Sigma1
                     (USE STANDARD FILENAME = ENDFB.OUT)               Sigma1
                     (RETRIEVE ALL DATA, TERMINATE REQUEST LIST)       Sigma1
                     (0.0 ALLOWABLE ERROR, TERMINATE ERROR LAW)        Sigma1
                                                                       Sigma1
    EXAMPLE INPUT NO. 3                                                Sigma1
    ------------------                                                 Sigma1
    THE SAME AS ABOVE, ONLY DEFINE THE MINIMUM CROSS SECTION OF        Sigma1
    INTEREST TO BE 1.0E-30 BARNS (INSTEAD OF THE DEFAULT VALUE OF      Sigma1
    1.0E-10).                                                          Sigma1
                                                                       Sigma1
    READ ENDF/B DATA FROM \ENDFB6\RECENT\ZA092238 AND WRITE ENDF/B     Sigma1
    DATA TO \ENDFB\SIGMA1\ZA092238                                     Sigma1
                                                                       Sigma1
    THE FOLLOWING 5 CARDS ARE REQUIRED                                 Sigma1
                                                                       Sigma1
                     3.00000+ 2 1.00000-30                             Sigma1
\ENDFB6\RECENT\ZA092238                                                Sigma1
\ENDFB6\SIGMA1\ZA092238                                                Sigma1
                     (RETRIEVE ALL DATA, TERMINATE REQUEST LIST)       Sigma1
                     (0.0 ALLOWABLE ERROR, TERMINATE ERROR LAW)        Sigma1
                                                                       Sigma1
======================================================================= Sigma1
```

```
====================================================================== Sixpak
                                                                       Sixpak
      PROGRAM SIXPAK                                                   Sixpak
      ================================================================ Sixpak
      VERSION 92-1 (JANUARY 1992)                                      Sixpak
      VERSION 92-2 (FEBRUARY 1992)*INCREASED CORE ALLOCATION TO        Sixpak
                                   ACCOMMODATE JEF AND EFF EVALUATIONS.Sixpak
      VERSION 92-3 (APRIL 1992)   *ADDED ADDITIONAL DATA TESTS.        Sixpak
      VERSION 92-4 (SEPT. 1992)   *CORRECTED KALBACH-MANN CALCULATIONS. Sixpak
                                  *FOR PHOTON PRODUCTION OUTPUT MF=12  Sixpak
                                   (MULTIPLICITY), MF=14 (ISOTROPIC    Sixpak
                                   ANGULAR DISTRIBUTIONS) AND MF=15    Sixpak
                                   (SPECTRA) - PREVIOUSLY ONLY MF=15.  Sixpak
                                  *FIRST ORDER CORRECTIONS TRANSFORMING Sixpak
                                   CENTER-OF-MASS SPECTRA TO LAB SYSTEM Sixpak
                                   FOR OUTPUT IN MF=5                  Sixpak
                                  *CORRECTED ISOTROPIC ANGULAR         Sixpak
                                   DISTRIBUTION FLAG (LI)              Sixpak
      VERSION 94-1 (JANUARY 1994) *VARIABLE ENDF/B INPUT DATA FILENAME Sixpak
                                   TO ALLOW ACCESS TO FILE STRUCTURES  Sixpak
                                   (WARNING - INPUT PARAMETER FORMAT   Sixpak
                                   HAS BEEN CHANGED)                   Sixpak
                                  *CLOSE ALL FILES BEFORE TERMINATING  Sixpak
                                   (SEE, SUBROUTINE ENDIT)             Sixpak
                                  *INCREASED MAXIMUM TABLE SIZE FROM   Sixpak
                                   2000 TO 6000.                       Sixpak
      VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                   Sixpak
                                  *IMPROVED COMPUTER INDEPENDENCE      Sixpak
                                  *ALL DOUBLE PRECISION                Sixpak
                                  *ON SCREEN OUTPUT                    Sixpak
                                  *UNIFORM TREATMENT OF ENDF/B I/O     Sixpak
                                  *IMPROVED OUTPUT PRECISION           Sixpak
      VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING     Sixpak
                                   POINT READ FOR MORE DIGITS          Sixpak
                                  *UPDATED TEST FOR ENDF/B FORMAT      Sixpak
                                   VERSION BASED ON RECENT FORMAT CHANGE Sixpak
                                  *GENERAL IMPROVEMENTS BASED ON       Sixpak
                                   USER FEEDBACK                       Sixpak
      VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING Sixpak
                                   MF=1, MT-451.                       Sixpak
      VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON       Sixpak
                                   USER FEEDBACK                       Sixpak
      VERS. 2002-1 (JANUARY 2002) *CORRECTED ANGULAR DISTRIBUTION (MF=4) Sixpak
                                   OUTPUT TO INSURE USED FIELDS ARE 0  Sixpak
                   (MAY 2002)     *OPTIONAL INPUT PARAMETERS           Sixpak
                   (NOV. 2002)    *EXTENDED TO ALLOW CHARGED PARTICLE  Sixpak
                                   ANGULAR DISTRIBUTION IN MF=4 -      Sixpak
                                   WARNING - STRICTLY SPEAKING THIS IS Sixpak
                                   NOT LEGAL, SINCE MF=4 IS SUPPOSED TO Sixpak
                                   BE USED ONLY FOR NEUTRON ANGULAR    Sixpak
                                   DISTRIBUTIONS - BUT WHERE MT MAKES  Sixpak
                                   IT OBVIOUS THAT THE OUTGOING PARTICLE Sixpak
                                   IS NOT A NEUTRON HOPEFULLY IT WILL  Sixpak
                                   NOT CAUSE A PROBLEM IF MF=4 IS USED Sixpak
                                   FOR CHARGED PARTICLES.              Sixpak
      VERS. 2004-1 (MARCH 2004)   *ADDED INCLUDE FOR COMMON           Sixpak
                                  *INCREASED MAXIMUM TABLE SIZE FROM   Sixpak
                                   6,000 TO 12,000.                    Sixpak
                                  *ADDED DUMMY A FOR ELEMENTS          Sixpak
                                  *CORRECTED OUTPUT INTERPOLATON LAWS  Sixpak
      VERS. 2007-1 (JAN.  2007)   *CHECKED AGAINST ALL ENDF/B-VII.     Sixpak
                                  *INCREASED MAXIMUM TABLE SIZE FROM   Sixpak
                                   12,000 TO 120,000.                  Sixpak
                                                                       Sixpak
      OWNED, MAINTAINED AND DISTRIBUTED BY                             Sixpak
      -----------------------------------                              Sixpak
      THE NUCLEAR DATA SECTION                                         Sixpak
      INTERNATIONAL ATOMIC ENERGY AGENCY                               Sixpak
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P.O. BOX 100                                                          Sixpak
A-1400, VIENNA, AUSTRIA                                               Sixpak
EUROPE                                                                Sixpak
                                                                      Sixpak
ORIGINALLY WRITTEN BY                                                 Sixpak
----------------------------------                                    Sixpak
DERMOTT E. CULLEN                                                     Sixpak
UNIVERSITY OF CALIFORNIA                                              Sixpak
LAWRENCE LIVERMORE NATIONAL LABORATORY                                Sixpak
L-159                                                                 Sixpak
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U.S.A.                                                                Sixpak
TELEPHONE  925-423-7359                                               Sixpak
E. MAIL    CULLEN1@LLNL.GOV                                           Sixpak
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                Sixpak
                                                                      Sixpak
COLLABORATION                                                         Sixpak
=====================================================================Sixpak
DEVELOPED IN COLLABORATION WITH,                                      Sixpak
                                                                      Sixpak
*THE NATIONAL NUCLEAR DATA CENTER, BROOKHAVEN NATIONAL LAB            Sixpak
                                                                      Sixpak
*THE NUCLEAR DATA SECTION, IAEA, VIENNA, AUSTRIA                      Sixpak
                                                                      Sixpak
*CENTRO TECNICO AEROSPACIAL, SAO JOSE DOS CAMPOS, BRAZIL              Sixpak
                                                                      Sixpak
AS A PART OF AN INTERNATIONAL PROJECT ON THE EXCHANGE OF              Sixpak
NUCLEAR DATA                                                          Sixpak
                                                                      Sixpak
ACKNOWLEDGEMENT (VERSION 92-1)                                        Sixpak
=====================================================================Sixpak
THE AUTHOR THANKS SOL PEARLSTEIN (BROOKHAVEN NATIONAL LAB) FOR        Sixpak
SIGNIFICANTLY CONTRIBUTING TOWARD IMPROVING THE ACCURACY AND          Sixpak
COMPUTER INDEPENDENCE OF THIS CODE - THANKS, SOL                      Sixpak
                                                                      Sixpak
ACKNOWLEDGEMENT (VERSION 92-4)                                        Sixpak
=====================================================================Sixpak
THE AUTHOR THANKS BOB MACFARLANE (LOS ALAMOS) FOR SUGGESTING HOW      Sixpak
TO PROPERLY OUTPUT THE PHOTON PRODUCTION DATA TO PUT IT INTO           Sixpak
EXACTLY THE FORM NEEDED FOR USE IN PROCESSING CODES.                  Sixpak
                                                                      Sixpak
THE AUTHOR THANKS CHRIS DEAN (WINFRITH) FOR POINTING OUT ERRORS       Sixpak
IN THE EARLIER TREATMENT OF THE KALBACH-MANN FORMALISM AND IN         Sixpak
THE DEFINITION OF THE ISOTROPIC ANGULAR DISTRIBUTION FLAG (LI).       Sixpak
                                                                      Sixpak
AUTHORS MESSAGE                                                       Sixpak
=====================================================================Sixpak
THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENTATION      Sixpak
INCLUDING ALL RECENT IMPROVEMENTS. PLEASE READ ALL OF THESE           Sixpak
COMMENTS BEFORE IMPLEMENTING AND USING THESE CODES.                   Sixpak
                                                                      Sixpak
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER    Sixpak
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE        Sixpak
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT    Sixpak
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY          Sixpak
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO     Sixpak
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF       Sixpak
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR            Sixpak
COMPUTER.                                                             Sixpak
                                                                      Sixpak
PURPOSE                                                               Sixpak
=====================================================================Sixpak
1) CHECK ALL DOUBLE-DIFFERENTIAL DATA (MF=6)                          Sixpak
                                                                      Sixpak
2) OUTPUT EQUIVALENT MF = 4, 5, 12, 14 AND 15 DATA.                   Sixpak
                                                                      Sixpak
DATA CHECKING                                                         Sixpak
```

```
================================================================= Sixpak
ALL OF THE ENDF/B-VI MF=6 DATA IS CHECKED - FOR DETAILS SEE BELOW. Sixpak
                                                                  Sixpak
THE MF=6 DATA IS NOT CORRECTED AND OUTPUT IN THE ENDF/B FORMAT.   Sixpak
IT IS MERELY CHECKED. IF ERRORS ARE FOUND IT IS UP TO THE USER    Sixpak
TO TAKE CORRECTIVE ACTION ON THE MF=6 DATA.                       Sixpak
                                                                  Sixpak
IN CONTRAST WHEN PROBLEMS ARE FOUND IN DATA WHICH WILL BE OUTPUT  Sixpak
IN THE ENDF/B FORMAT (MF=4, 5, 12, 14 AND 15), WHENEVER POSSIBLE  Sixpak
CORRECTIVE ACTION WILL BE TAKEN.                                  Sixpak
                                                                  Sixpak
FURTHER CHECKS AND CORRECTIONS                                    Sixpak
================================================================= Sixpak
ONCE THE DATA HAS BEEN OUTPUT IN MF = 4, 5, 12, 14 AND 15 FORMATS Sixpak
FURTHER CORRECTIVE ACTION CAN BE TAKEN AS FOLLOWS,                Sixpak
                                                                  Sixpak
PROGRAM LEGEND                                                    Sixpak
==============                                                    Sixpak
CAN BE USED TO CORRECT ANGULAR DISTRIBUTIONS WHICH ARE NEGATIVE,  Sixpak
TO CONVERT FROM LEGENDRE COEFFICIENTS TO TABULATED ANGULAR        Sixpak
DISTRIBUTIONS AND GENERALLY PERFORM MORE EXTENSIVE TESTS OF       Sixpak
ALL MF=4 DATA.                                                    Sixpak
                                                                  Sixpak
PROGRAM EVALPLOT                                                  Sixpak
================                                                  Sixpak
VERSION 92-1 AND LATER VERSIONS CAN PLOT ALL OF THE MF=4, 5 AND 15 Sixpak
DATA OUTPUT BY THIS CODE. EARLIER VERSIONS CAN PLOT MF=4 AND 5.   Sixpak
GRAPHICS IS AN EXCELLENT WAY TO CHECK THIS DATA.                  Sixpak
                                                                  Sixpak
PROGRAM PLOTTAB                                                   Sixpak
===============                                                   Sixpak
THIS IS A GENERAL PLOTTING PROGRAM AND THERE IS AN INTERFACE IN   Sixpak
THIS CODE TO PRODUCE OUTPUT FOR ANY MF=6 DATA IN THE PLOTTAB      Sixpak
INPUT FORMAT. THIS PROGRAM CAN BE USED TO CHECK ALL OF THE MF=6   Sixpak
DATA AS WELL AS THE EQUIVALENT MF=4, 5, 12, 14 AND 15 DATA - AS   Sixpak
WELL AS COMPARING THE ORIGINAL MF=6 AND EQUIVALENT DATA.          Sixpak
                                                                  Sixpak
DATA OUTPUT                                                       Sixpak
================================================================= Sixpak
THE ENDF/B MF=4, 5, 12, 14 AND 15 FORMATS ONLY ALLOW FOR NEUTRONS Sixpak
INCIDENTS                                                         Sixpak
                                                                  Sixpak
THE ENDF/B MF=4 AND 5 FORMATS ONLY ALLOW FOR NEUTRONS OUTGOING.   Sixpak
                                                                  Sixpak
THE ENDF/B MF=12, 14 AND 15 ONLY ALLOWS FOR PHOTONS OUTGOING.     Sixpak
                                                                  Sixpak
THESE ARE THE ONLY COMBINATIONS OF DATA OUTPUT BY THIS CODE.      Sixpak
                                                                  Sixpak
ALL OTHER COMBINATIONS OF INCIDENT AND OUTGOING PARTICLES ARE     Sixpak
CHECKED, BUT THE RESULTS CANNOT BE OUTPUT IN THE ENDF/B FORMAT.   Sixpak
HOWEVER, USING THE PLOTTAB INTERFACE BUILT INTO THIS CODE THIS    Sixpak
DATA CAN, AND HAS BEEN, OUTPUT AND CHECKED.                       Sixpak
                                                                  Sixpak
THE NEUTRON DATA IN MF=4 CAN BE IN THE FORM OF EITHER TABULATED   Sixpak
ANGULAR DISTRIBUTIONS OR LEGENDRE COEFFICIENTS.                   Sixpak
                                                                  Sixpak
THE NEUTRON (MF=5) OR PHOTON (MF=15) SPECTRA ARE BOTH IN EXACTLY  Sixpak
THE SAME FORMAT = ARBITRARY TABULATED FUNCTIONS - ENDF/B OPTION   Sixpak
LF=1.                                                             Sixpak
                                                                  Sixpak
ENDF/B DATA OUTPUT ORDER                                          Sixpak
================================================================= Sixpak
ENDF/B DATA IS OUTPUT IN ASCENDING MAT, MF, MT ORDER. IN ORDER TO Sixpak
ALLOW THIS PROGRAM TO PRODUCE ALL OUTPUT IN A SINGLE PASS THROUGH Sixpak
THE MF=6 DATA, OUTPUT FOR EACH (MAT, MT) IS OUTPUT TO SEPERATE    Sixpak
FILES FOR MF=4, 5, 12, 14 AND 15.                                 Sixpak
                                                                  Sixpak
FOR SUBSEQUENT USE THE ENDF/B FORMATTED DATA OUTPUT BY THIS CODE  Sixpak
```

```
CAN BE MERGED TOGETHER USING PROGRAM MERGER (CONTAIN THE AUTHOR    Sixpak
OF THIS CODE FOR A COPY OF MERGER), E.G., MERGE MF=12, 14 AND 15   Sixpak
DATA IN ORDER TO THEN CALCULATE PHOTON PRODUCTION DATA OR MF=4     Sixpak
AND 5 CAN BE MERGED TOGETHER TO CALCULATE NEUTRON TRANSFER - OR    Sixpak
ALL OF THEM CAN BE MERGED TOGETHER TO PERFORM NEUTRON AND PHOTON   Sixpak
CALCULATIONS.                                                      Sixpak
                                                                   Sixpak
CORRELATED (MF=6) VS. UNCORRELATED (MF=4 AND 5) DATA               Sixpak
================================================================== Sixpak
THE ENDF/B DOUBLE DIFFERENTAL = CORRELATED - DATA IN MF=6          Sixpak
REPRESENTS DATA IN THE FORM,                                       Sixpak
                                                                   Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F(E,EP,COS)                     Sixpak
                                                                   Sixpak
SIG(E)      = MF=3 CROSS SECTIONS                                  Sixpak

Y(E)        = YIELD (MULTIPLICITY)                                 Sixpak
G0(E,EP)    = ENERGY SPECTRUM                                      Sixpak
F(E,EP,COS) = ANGULAR DISTRIBUTION                                 Sixpak
                                                                   Sixpak
IN A SITUATION WHERE YOU HAVE MONOENERGETIC AND MONODIRECTIONAL    Sixpak
NEUTRONS INCIDENT YOU WILL BE ABLE TO OBSERVE CORRELATION EFFECTS  Sixpak
IN THE NEUTRON SPECTRUM AND ANGULAR DISTRIBUTION.                  Sixpak
                                                                   Sixpak
EVEN IN SITUATIONS WHERE YOU HAVE A NARROW SPECTRUM OF NEUTRONS    Sixpak
THAT ARE HIGHLY DIRECTIONALLY ORIENTED YOU MAY BE ABLE TO OBSERVE  Sixpak
THESE CORRELATION EFFECTS, E.G., A NARROW 14 MEV FUSION SOURCE     Sixpak
INCIDENT ON THE FIRST WALL OF A CTR DEVICE.                        Sixpak
                                                                   Sixpak
FOR SUCH SITUATIONS USE OF THE CORRELATED (MF=6) DATA IS REQUIRED  Sixpak
IN CALCULATIONS.                                                   Sixpak
                                                                   Sixpak
HOWEVER, IN MANY APPLICATIONS WHERE THERE IS A BROAD SPECTRUM OF   Sixpak
NEUTRONS AND THE NEUTRON FLUX IS NOT HIGHLY DIRECTIONALLY          Sixpak
ORIENTED, THE NEUTRON MULTIPLICATION, SPECTRUM AND ORIENTATION     Sixpak
CAN BE FAIRLY ACCURATELY CALCULATED WITHOUT CONSIDERING            Sixpak
CORRELATION EFFECTS.                                               Sixpak
                                                                   Sixpak
THE UNCORRELATED DATA PRODUCED BY THIS CODE REPLACES THE           Sixpak
CORRELATED DATA,                                                   Sixpak
                                                                   Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F(E,EP,COS)                     Sixpak
                                                                   Sixpak
BY THE UNCORRELATED DATA,                                          Sixpak
                                                                   Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F0(E,COS)                       Sixpak
                                                                   Sixpak
BY INTEGRATING G0(E,EP)*F(E,EP,COS) OVER SECONDARY ENERGY (EP)     Sixpak
TO DEFINE AN AVERAGE ANGULAR DISTRIBUTION, F0(E,COS).              Sixpak
                                                                   Sixpak
WHAT IS LOST IN THIS PROCESS IS THE CORRELATION BETWEEN EP AND COS Sixpak
SO THAT IN A TRANSPORT CALCULATION ALL MOMENTS OF THE FLUX WILL    Sixpak
HAVE THE SAME SPECTRUM, G0(E,EP) AND EACH WILL BE EFFECTED BY THE  Sixpak
AVERAGE ANGULAR DISTRIBUTION.                                      Sixpak
                                                                   Sixpak
FOR APPLICATIONS TO HIGH ENERGY FUSION APPLICATIONS CORRELATED     Sixpak
DATA SHOULD BE USED. HOWEVER, FOR LOWER ENERGY APPLICATIONS,       Sixpak
SUCH AS FISSION REACTORS, IT SHOULD BE ADEQUATE TO USE THE         Sixpak
UNCORRELATED DATA - IN THIS CASE THE MOST IMPORTANT EFFECT         Sixpak
WILL BE THE OVERALL NEUTRON MULTIPLICATION AND SPECTRUM.           Sixpak
                                                                   Sixpak
AN IMPORTANT CONSIDERATION IN DESIGNING THIS PROGRAM IS THAT        Sixpak
MANY COMPUTER CODES - DATA PROCESSING AND TRANSPORT CODES -         Sixpak
CANNOT USE THE CORRELATED (MF=6) DATA - NOR ARE THEY INTENDED      Sixpak
FOR HIGH ENERGY USE. FOR THESE CODES THE UNCORRELATED DATA         Sixpak
PRODUCED BY THIS CODE SHOULD BE ADEQUATE TO MEET THEIR NEEDS.      Sixpak
                                                                   Sixpak
WARNING - IT CANNOT BE STRESSED ENOUGH THAT THE OUTPUT OF THIS     Sixpak
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CODE SHOULD ONLY BE USED FOR LOW ENERGY APPLICATIONS - FAILURE     Sixpak
TO HEED THIS WARNING CAN LEAD TO COMPLETELY UNRELIABLE RESULTS.    Sixpak
                                                                   Sixpak
ENDF/B FORMAT                                                      Sixpak
================================================================== Sixpak
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS     Sixpak
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION   Sixpak
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT). Sixpak
                                                                   Sixpak
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B       Sixpak
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS     Sixpak
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE  Sixpak
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE          Sixpak
CORRECTLY OUTPUT ON ALL LINES. THE FORMAT OF SECTION MF=1, MT=451  Sixpak
AND ALL SECTIONS OF MF=6 MUST BE CORRECT. THE PROGRAM SKIPS ALL    Sixpak
OTHER SECTIONS OF DATA AND AS SUCH IS INSENSITIVE TO THE FORMAT    Sixpak
OF ALL OTHER SECTIONS.                                             Sixpak
                                                                   Sixpak
CONTENTS OF OUTPUT                                                 Sixpak
================================================================== Sixpak
5 ENDF/B FORMATTED OUTPUT FILES ARE PRODUCED FOR NEUTRON INCIDENT  Sixpak
DATA,                                                              Sixpak
                                                                   Sixpak
1) ENDFB.MF4 - ANGULAR DISTRIBUTIONS AND LEGENDRE COEFFICIENTS     Sixpak
               FOR NEUTRONS                                        Sixpak
2) ENDFB.MF5 - TABULATED NEUTRON ENERGY SPECTRA                    Sixpak
3) ENDFB.M12 - PHOTON EMISSION MULTIPLICITY                        Sixpak
4) ENDFB.M14 - PHOTON EMISSION ANGULAR DISTRIBUTIONS (ALWAYS       Sixpak
               ISOTROPIC)                                          Sixpak
5) ENDFB.M15 - TABULATED PHOTON EMISSION SPECTRA                   Sixpak
                                                                   Sixpak
EMITTED PARTICLE YIELD                                             Sixpak
================================================================== Sixpak
NEUTRONS                                                           Sixpak
========                                                           Sixpak
IN MF=6 THE YIELD FOR EACH REACTION IS THE ACTUAL MULTIPLICITY OF  Sixpak
THE REACTION, E.G., (N,2N) = 2. IN USING MF=4 AND 5 DATA THE       Sixpak
ENDF/B CONVENTION IS THAT THE MULTIPLICITY IS IMPLIED BY THE       Sixpak
MT NUMBER, E.G., MT=16 = (N,2N) = 2.                               Sixpak
                                                                   Sixpak
THE ONLY EXCEPT IN ENDF/B-VI IS MT=201 = TOTAL NEUTRON PRODUCTION  Sixpak
WHERE AN ACTUAL ENERGY DEPENDENT YIELD IS INCLUDED IN MF=6.        Sixpak
HOWEVER, IN THIS CASE THE MF=3 CROSS SECTION INCLUDES THE          Sixpak
MULTIPLICITY (S. PEARLSTEIN, PRIVATE COMMUNICATION, JAN. 1992),    Sixpak
SIG(MT=201) = 2*SIG(N,2N)+3*SIG(N,3N).....ETC.                     Sixpak
                                                                   Sixpak
SO THAT FOR ALL ENDF/B-VI DATA AS OF JANUARY 1992 THE MF=4 AND 5   Sixpak
DATA OUTPUT BY THIS CODE CAN BE USED IN CONJUNCTION WITH THE MF=3  Sixpak
CROSS SECTIONS - WITHOUT ANY REFERENCE TO THE MF=6 YIELD.          Sixpak
                                                                   Sixpak
PHOTONS                                                            Sixpak
=======                                                            Sixpak
UNLIKE THE NEUTRONS WHERE WITH ONLY ONE EXCEPTION (MT=201) THE     Sixpak
MF=6 YIELD IS ENERGY INDEPENDENT, IN THE CASE OF PHOTON EMISSION   Sixpak
ALMOST ALL OF THE PHOTONS HAVE AN ENERGY DEPENDENT YIELD.          Sixpak
                                                                   Sixpak
THIS PROGRAM WILL OUTPUT THE PHOTON MULTIPLICITY IN MF=12 AND      Sixpak
INDICATE THAT THERE IS A NORMALIZED DISTRIBUTION IN MF=15          Sixpak
(LF=1 IN MF=12).                                                   Sixpak
                                                                   Sixpak
THIS PROGRAM WILL OUTPUT THE NORMALIZED PHOTON SPECTRA IN MF=15.   Sixpak
CONTINUOUS ENERGY SPECTRA AND DISCRETE PHOTONS WILL ALL BE OUTPUT  Sixpak
AS NORMALIZED SPECTRA.                                             Sixpak
                                                                   Sixpak
THIS PROGRAM WILL ALSO OUTPUT MF=14 PHOTON ANGULAR DISTRIBUTION    Sixpak
DATA, ALWAYS USING THE ISOTROPIC FLAG TO MINIMIZE OUTPUT.          Sixpak
                                                                   Sixpak
WARNING OF ENERGY DEPENDENT YIELD                                  Sixpak
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================================                                    Sixpak
THIS PROGRAM WILL PRINT A WARNING MESSAGE IF A SECTION OF DATA      Sixpak
BEING OUTPUT IN THE ENDF/B FORMAT HAS AN ENERGY DEPENDENT MF=6      Sixpak
YIELD AND THE EMITTED PARTICLE IS A NEUTRON - SINCE THE ENDF/B      Sixpak
CONVENTION IS THAT FOR EACH MT NUMBER THE MULTIPLICITY IS IMPLIED   Sixpak
WE DO NOT EXPECT AN ENERGY DEPENDENT MULTIPLICITY FOR NEUTRON       Sixpak
EMISSION.                                                           Sixpak
                                                                    Sixpak
USING THE OUTPUT                                                    Sixpak
================================================================== Sixpak
NOTE, THAT IN USING THIS DATA, STARTING FROM THE RELATIONSHIP,      Sixpak
                                                                    Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F0(E,COS)                        Sixpak
                                                                    Sixpak
USING THE ENDF/B CONVENTION THAT THE MULTIPLICITY IS EITHER         Sixpak
IMPLIED BY THE MT NUMBER (E.G., MT=16 = N,2N - MULTIPLICITY = 2)    Sixpak
OR INCLUDED IN THE CROSS SECTION (E.G., MT=201 = TOTAL NEUTRON      Sixpak
PRODUCTION) ALL THE INFORMATION REQUIRED FOR A CALCULATION IS       Sixpak
AVAILABLE IN,                                                       Sixpak
                                                                    Sixpak
MF=3       - SIG(E)                                                 Sixpak
MF=4       - F0(E,COS) - FOR OUTGOING NEUTRONS                      Sixpak
MF=5       - G0(E,EP)  - FOR OUTGOING NEUTRONS                      Sixpak
MF=12      - Y(E)      - FOR OUTGOING PHOTONS                       Sixpak
MF=14      - F0(E,COS) - FOR OUTGOING PHOTONS (ALWAYS ISOTROPIC)    Sixpak
MF=15      - G0(E,EP)  - FOR OUTGOING PHOTONS                       Sixpak
                                                                    Sixpak
DOCUMENTATION                                                       Sixpak
================================================================== Sixpak
ONLY SECTIONS OF MF=4, 5, 12, 14, 15 ARE OUTPUT ON A ENDF/B FILE.   Sixpak
THE ONLY DOCUMENTATION IS THE ENDF/B TAPE LABEL (FIRST RECORD OF    Sixpak
EACH FILE) WHICH IDENTIFIES THE DATA AS SIXPAK OUTPUT.              Sixpak
                                                                    Sixpak
REACTION INDEX                                                      Sixpak
================================================================== Sixpak
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN      Sixpak
SECTION MF=1, MT=451 OF EACH EVALUATION.                            Sixpak
                                                                    Sixpak
SECTION SIZE                                                        Sixpak
================================================================== Sixpak
ALL OF THE DATA IN ENDF/B-VI, MF=6 ARE QUITE SMALL TABLES. AS SUCH  Sixpak
THIS PROGRAM ONLY ALLOWS TABLES OF UP TO 12000 POINTS (12,000 X,    Sixpak
Y VALUES). THIS SIZE IS MORE THAN ADEQUATE TO HANDLE ALL OF THE     Sixpak
CURRENT ENDF/B-VI DATA, AND IT CAN BE EASILY INCREASED TO HANDLE    Sixpak
ANY NEWER DATA AS IT BECOMES AVAILABLE.                             Sixpak
                                                                    Sixpak
PLEASE CONTACT THE AUTHOR IF YOU HAVE AN EVALUATION WHICH EXCEEDS   Sixpak
THIS LIMIT.                                                         Sixpak
                                                                    Sixpak
SELECTION OF DATA                                                   Sixpak
================================================================== Sixpak
THE PROGRAM SELECTS DATA TO BE PROCESSED BASED ON MAT/MT RANGES     Sixpak
(MF=6 ASSUMED). THIS PROGRAM ALLOWS UP TO 100 MAT/MT RANGES TO BE   Sixpak
SPECIFIED BY INPUT PARAMETERS. THE PROGRAM WILL ASSUME THAT THE     Sixpak
ENDF/B TAPE IS IN MAT ORDER. THE PROGRAM WILL TERMINATE EXECUTION   Sixpak
WHEN A MAT IS FOUND THAT IS ABOVE ALL REQUESTED MAT RANGES.         Sixpak
                                                                    Sixpak
PROGRAM OPERATION                                                   Sixpak
================================================================== Sixpak
EACH SECTION (MT) OF MF=6 DATA IS SUBDIVIDED INTO SUBSECTIONS -     Sixpak
ONE SUBSECTION FOR EACH EMITTED PARTICLE.                           Sixpak
                                                                    Sixpak
EACH SUBSECTION OF DATA IS CONSIDERED SEPARATELY. EACH SUBSECTION   Sixpak
OF ENDF/B MF=6 DATA TO PROCESS IS IN THE FORM,                      Sixpak
                                                                    Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F(E,EP,COS)                      Sixpak
                                                                    Sixpak
SIG(E)      = MF=3 CROSS SECTIONS                                   Sixpak
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Y(E)        = YIELD (MULTIPLICITY)                                  Sixpak
G0(E,EP)    = ENERGY SPECTRUM                                       Sixpak
F(E,EP,COS) = ANGULAR DISTRIBUTION                                  Sixpak
                                                                    Sixpak
G0(E,EP) = 1 WHEN INTEGRATED OVER EP (SECONDARY ENERGY)             Sixpak
G0(E,EP)*F(E,EP,COS) = 1 WHEN INTEGRATED OVER EP AND COS            Sixpak
                                                                    Sixpak
THIS PROGRAM WILL DEFINE THE ZEROTH ORDER MOMENTS OF THE            Sixpak
ENERGY AND ANGULAR DISTRIBUTIONS,                                   Sixpak
                                                                    Sixpak
G0(E,EP)  = G0(E,EP)*F(E,EP,COS) INTEGRATED OVER COS                Sixpak
F0(E,COS) = G0(E,EP)*F(E,EP,COS) INTEGRATED OVER EP                 Sixpak
                                                                    Sixpak
FOR NEUTRON INDUCED REACTIONS THE ENDF/B FORMATTED OUTPUT WILL BE   Sixpak
                                                                    Sixpak
F0(E,COS)- IN ENDFB.MF4 FOR NEUTRONS OUT OF A REACTION              Sixpak
G0(E,EP) - IN ENDFB.MF5 FOR NEUTRONS OUT OF A REACTION              Sixpak
         - IN ENDFB.M15 FOR PHOTONS OUT OF A REACTION               Sixpak
                                                                    Sixpak
FOR NEUTRONS INCIDENT AND NEUTRONS EMITTED THIS DATA WILL BE        Sixpak
OUTPUT IN MF=4 AND 5 FORMATS.                                       Sixpak
                                                                    Sixpak
FOR NEUTRONS INCIDENT AND PHOTONS EMITTED THIS DATA WILL BE         Sixpak
OUTPUT IN MF=15 FORMAT - THE SPECTRA ARE OUTPUT AND THE             Sixpak
ANGULAR DISTRIBUTION IS IGNORED.                                    Sixpak
                                                                    Sixpak
ALL PHOTON EMISSION IN THE ENDF/B-VI LIBRARY AS OF JANUARY 1992     Sixpak
IS ISOTROPIC AND AS SUCH NO DISTRIBUTION OF PHOTON ANGULAR          Sixpak
DISTRIBUTIONS NEED BE OUTPUT - IT IS ALWAYS ISOTROPIC.              Sixpak
                                                                    Sixpak
FOR ALL OTHER COMBINATIONS INCIDENT AND EMITTED PARTICLES           Sixpak
THERE WILL BE NO ENDF/B FORMATTED OUTPUT.                           Sixpak
                                                                    Sixpak
VARIATIONS FROM ENDF/B MANUAL                                       Sixpak
================================================================    Sixpak
LAW=1, LANG=2 = KALBACH-MANN                                        Sixpak
============================                                        Sixpak
FOR THE DISTRIBUTIONS,                                              Sixpak
                                                                    Sixpak
F(MU,E,EP) = G0(E,EP)*A*(COSH(MU*A)+R(E,EP)*SINH(MU*A))             Sixpak
                                                                    Sixpak
G0(E,EP) = 1 - WHEN INTEGRATED OVER EP.                             Sixpak
                                                                    Sixpak
A*(COSH(MU*A)+R(E,EP)*SINH(MU*A)) = 2 - WHEN INTEGRATD OVER MU      Sixpak
                                                                    Sixpak
THIS MEANS AS DEFINED IN THE ENDF/B MANUAL THE DISTRIBUTIONS        Sixpak
ARE NORMALIZED TO 2, INSTEAD OF 1. IN ORDER TO OBTAIN CORRECTLY     Sixpak
NORMALIZED DISTRIBUTIONS THE DISTRIBUTION SHOULD BE DEFINED         Sixpak
TO INCLUDE A FACTOR OF 1/2 MULTIPLYING THE ANGULAR PART OF          Sixpak
THE DISTRIBUTION.                                                   Sixpak
                                                                    Sixpak
F(MU,E,EP) = G0(E,EP)*0.5*A*(COSH(MU*A)+R(E,EP)*SINH(MU*A))         Sixpak
                                                                    Sixpak
THIS IS THE FORM USED IN THIS CODE                                  Sixpak
                                                                    Sixpak
LAW=1, ND NOT 0 = DISCRETE SECONDARY ENERGY DISTRIBUTION            Sixpak
=====================================================               Sixpak
THE ENDF/B MANUAL SAYS THESE ARE FLAGGED WITH NEGATIVE ENERGIES.    Sixpak
IN ENDF/B-VI ALL OF THESE HAVE POSITIVE ENERGY. THIS CODE DOES      Sixpak
NOT CONSIDER THE ENDF/B-VI DATA TO BE IN ERROR.                     Sixpak
                                                                    Sixpak
WITH THE CONVENTION ACTUALLY USED IN ENDF/B-VI ALL SECONDARY        Sixpak
ENERGIES SHOULD BE NON-NEGATIVE AND IN ASCENDING ENERGY ORDER       Sixpak
FOR EACH INCIDENT ENERGY.                                           Sixpak
                                                                    Sixpak
FROM THE ENDF/B MANUAL IT IS NOT OBVIOUS WHAT G0(E,EP) SHOULD BE    Sixpak
FOR DISCRETE PHOTONS - PHYSICALLY THIS IS A DELTA FUNCTION. IN      Sixpak
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ENDF/B-VI IT IS ENTERED AS 1.0 = INTERPRETING IT AS INTEGRATED     Sixpak

OVER SECONDARY ENERGY - IN WHICH CASE THE DELTA FUNCTION = 1.0.    Sixpak
                                                                   Sixpak
LIMITATIONS                                                        Sixpak
================================================================== Sixpak
CHECKING DATA                                                      Sixpak
================================================================== Sixpak
THIS PROGRAM CHECKS ALL ENDF/B-VI MF=6 DATA. THE FOLLOWING CHECKS  Sixpak
ARE PERFORMED.                                                     Sixpak
                                                                   Sixpak
PARAMETERS                                                         Sixpak
==========                                                         Sixpak
ALL PARAMETERS ARE CHECKED FOR CONSISTENCY. IF PARAMETERS ARE      Sixpak
NOT CONSISTENT THE PROGRAM MAY NOT BE ABLE TO PERFORM THE          Sixpak
FOLLOWING TESTS AND WILL MERELY SKIP A SECTION OF DATA.            Sixpak
                                                                   Sixpak
INTERPOLATION LAWS                                                 Sixpak
==================                                                 Sixpak
ALL INTEGRATIONS ARE PERFORMED USING THE INTERPOLATION LAW GIVEN   Sixpak
FOR SECONDARY ENERGY AND/OR COSINE. INTEGRATIONS ARE NOT           Sixpak
PERFORMED OVER INCIDENT - ONLY INTEGRATION OVER SECONDARY ENERGY   Sixpak
AND/OR COSINE ARE PERFORMED AT EACH INCIDENT ENERGY. THEREFORE     Sixpak
THE INTERPOLATION LAW FOR INCIDENT ENERGY IS NOT USED BY THIS      Sixpak
CODE.                                                              Sixpak
                                                                   Sixpak
ALL INTERPOLATION LAWS ARE CHECKED. ALL DATA ASSOCIATED WITH       Sixpak
INTERPOLATION LAWS ARE CHECKED, E.G., NO NON-NEGATIVE VALUES       Sixpak
REQUIRING LOG INTERPOLATION. IN ORDER TO PERFORM REQUIRED          Sixpak
INTEGRALS OVER COS AND EP IT IS IMPERATIVE THAT THE INTERPOLATION  Sixpak
LAWS BE COMPATIBLE WITH THE DATA.                                  Sixpak
                                                                   Sixpak
ENDF/B-VI ALLOWS NEW INTERPOLATION LAWS FOR CORRESPONDING POINT    Sixpak
AND UNIT BASE TRANSFORMATION INTERPOLATION. NONE OF THESE NEW      Sixpak
INTERPOLATION LAWS ARE USED IN THE ENDF/B-VI LIBRARY AS OF         Sixpak
JANUARY 1992 TO INTERPOLATE IN SECONDARY ENERGY OR COSINE.         Sixpak
THEREFORE THIS PROGRAM CAN PERFORM ALL OF THE REQUIRED INTEGRALS   Sixpak
OVER SECONDARY ENERGY AND/OR COSINE USING ONLY THE OLDER           Sixpak
INTERPOLATION CODES. THIS PROGRAM ONLY PERFORMS INTEGRALS FOR      Sixpak
EACH INCIDENT ENERGY, SO THAT INTERPOLATION IN INCIDENT ENERGY     Sixpak
IS NOT PERFORMED BY THIS PROGRAM.                                  Sixpak
                                                                   Sixpak
NEW INTERPOLATION SCHEMES ARE USED FOR INCIDENT ENERGY - FOR       Sixpak
EXAMPLE, CORRESPONDING POINT INTERPOLATION IS SPECIFIED TO ALLOW   Sixpak
INTERPOLATION IN G0(E,EP) TO SIMULATE CASES WHERE THE INPUT ENERGY Sixpak
LIMIT IS DEFINED BY E-EP = A DIAGONAL CURVE ACROSS (E,EP) SPACE.   Sixpak
THIS INTERPOLATION CODE CANNOT BE SPECIFIED IN THE MF=5 OUTPUT     Sixpak
OF THIS CODE - MF=5 ONLY ALLOWS THE OLDER INTERPOLATION LAWS       Sixpak
INT=1 THROUGH 5. THEREFORE THIS PROGRAM WILL USE THE CLOSEST       Sixpak
CORRESPONDING INTERPOLATION CODE FOR OUTPUT TO MF=5. FOR USE       Sixpak
WHERE THE OUTPUT OF THIS CODE = LOW ENERGY APPLICATIONS - THIS     Sixpak
SHOULD HAVE LITTLE EFFECT ON RESULTS.                              Sixpak
                                                                   Sixpak
FOR CONSISTENCY WITH EARLIER VERSIONS OF ENDF/B IN CREATING THE    Sixpak
ENDF/B OUTPUT, IF ANY INPUT INTERPOLATION LAW IS NOT IN THE        Sixpak
RANGE 1-5, IT WILL FIRST BE TESTED TO SEE IF MOD(10) IT IS         Sixpak
IN THIS RANGE, FINALLY IF EVEN THIS DOESN'T WORK IT IS SET         Sixpak
EQUAL TO 2 (LINEARLY INTERPOLATION). THIS METHOD WILL EFFECTIVELY  Sixpak
REPLACE CORRESPONDING POINT AND UNIT BASE TRANSFORMATION BY THE    Sixpak
CLOSEST RELATED INTERPOLATION LAW 1 THROUGH 5 - AGAIN NOTE, AS     Sixpak
OF JANUARY 1992 NONE OF THESE NEW LAWS ARE USED IN ENDF/B-VI. IF   Sixpak
THIS MUST BE DONE FOR INTERPOLATION IN SECONDARY ENERGY OR COSINE  Sixpak
AN ERROR MESSAGE WILL BE PRINTED - SINCE THIS WOULD EFFECT THE     Sixpak
ACCURACY OF THE INTEGRALS PERFORMED BY THIS PROGRAM. IF THIS MUST  Sixpak
BE DONE FOR INCIDENT ENERGY NO MESSAGE IS PRINTED - SINCE THIS     Sixpak
WILL NOT EFFECT THE ACCURACY OF THE INTEGRALS PERFORMED BY THIS     Sixpak
PROGRAM.                                                           Sixpak
                                                                   Sixpak
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SPECTRA AND ANGULAR DISTRIBUTIONS                                    Sixpak
================================                                     Sixpak
ALL SPECTRA AND ANGULAR DISTRIBUTIONS ARE CHECKED TO INSURE          Sixpak
THEY ARE NORMALIZED AND DO NOT INCLUDE ANY NEGATIVE VALUES.          Sixpak
                                                                     Sixpak
LEGENDRE COEFFICIENTS                                                Sixpak
=====================                                                Sixpak
THE NORMALIZATION, F0, CANNOT BE NEGATIVE.                           Sixpak
                                                                     Sixpak
LEGENDRE COEFFICIENTS IN NORMAL FORM ARE CHECKED TO INSURE           Sixpak
THEY ARE IN THE RANGE -1 TO +1 = THE LEGENDRE EXPANSION OF A         Sixpak
DELTA FUNCTION AT COS=+1 OR -1 - COEFFICIENTS SHOULD NOT             Sixpak
EXCEED WHAT YOU GET FROM A DELTA FUNCTION.                           Sixpak
                                                                     Sixpak
ANGULAR DISTRIBUTIONS ARE CHECKED AT COS = -1, 0 AND +1.             Sixpak
                                                                     Sixpak
CREATING ENDF/B OUTPUT                                               Sixpak
=============================================================        Sixpak
THIS PROGRAM CAN CREATE EQUIVALENT MF =4, 5, 12, 14, 15 DATA FOR     Sixpak
ALL OF THE DATA INCLUDED IN ENDF/B-VI AS OF JANUARY 1992, EXCEPT     Sixpak
FOR 1 SECTION OF LAW=6 DATA (SEE DETAILS BELOW).                     Sixpak
                                                                     Sixpak
THIS PROGRAM HAS NOT BEEN TESTED ON OTHER DATA LIBRARIES, E.G.,      Sixpak
JEF, JENDL, ETC.                                                     Sixpak
                                                                     Sixpak
THE PROGRAM HAS THE FOLLOWING LIMITATION AS FAR AS CREATING          Sixpak
ENDF/B FORMATTED OUTPUT.                                             Sixpak
                                                                     Sixpak
ISOTROPIC PHOTON EMISSION                                            Sixpak
=========================                                            Sixpak
FOR PHOTON EMISSION THE DISTRIBUTIONS ARE ASSUMED TO BE ISOTROPIC    Sixpak
AND ONLY THE MULTIPLICITY IS OUTPUT IN MF=12, ISOTROPIC ANGULAR      Sixpak
DISTRIBUTIONS IN MF=14 AND THE SPECTRA IN MF=15. ALL ENDF/B-VI       Sixpak
MF=6 DATA AS OF JANUARY 1992 INCLUDE ONLY ISOTROPIC PHOTON           Sixpak
EMISSION - SO THAT THIS IS NOT A LIMITATION ON TRANSLATING           Sixpak
ENDF/B-VI DATA.                                                      Sixpak
                                                                     Sixpak
EITHER TABULATED OR LEGENDRE COEFFICIENTS                            Sixpak
=========================================                            Sixpak
FOR LAW=2 THE REPRESENTATION, EITHER TABULATED OR LEGENDRE           Sixpak
COEFFICIENTS, CAN BE SPECIFIED FOR EACH INCIDENT ENERGY.             Sixpak
                                                                     Sixpak
IN ORDER TO OBTAIN CORRECT ENDF/B OUTPUT THE REPRESENTATION          Sixpak
MUST BE THE SAME FOR ALL INCIDENT ENERGIES = MF=4 DATA CAN ONLY      Sixpak
BE TABULATED OR LEGENDRE OVER THE ENTIRE ENERGY RANGE.               Sixpak
                                                                     Sixpak
YIELD AND OUTPUT NORMALIZATION                                       Sixpak
==============================                                       Sixpak
THE YIELD INCLUDED WITH EACH SECTION OF DATA IS NOT USED FOR         Sixpak
OUTPUT FOR NEUTRONS, BUT IS INCLUDED IN THE OUTPUT FOR PHOTONS.      Sixpak
IN ALL CASES THE ANGULAR DISTRIBUTIONS AND SPECTRA OUTPUT ARE        Sixpak
NORMALIZED TO UNITY.                                                 Sixpak
                                                                     Sixpak
LAW=0                                                                Sixpak
=====                                                                Sixpak
NO OUTPUT - INCIDENT NEUTRON - EMITTED PHOTON OR NEUTRON             Sixpak
            REACTIONS ARE NOT EXPECTED.                              Sixpak
                                                                     Sixpak
LAW=1                                                                Sixpak
=====                                                                Sixpak
FOR EACH INCIDENT ENERGY DISCRETE AND CONTINUOUS EMISSION SPECTRA    Sixpak
CANNOT BE MIXED TOGETHER - THEY MUST BE ALL EITHER DISCRETE OR       Sixpak
CONTINUOUS. IF DISCRETE EMISSION IS GIVEN ONLY 1 SECONDARY           Sixpak
ENERGY (NEP=1) MAY BE GIVEN = A NORMALIZED DISTRIBUTION FOR A        Sixpak
SINGLE DISCRETE EMISSION ENERGY. ALL OF THE ENDF/B-VI DATA AS        Sixpak
OF JANUARY 1992 CONFORM TO THESE LIMITATIONS.                        Sixpak
                                                                     Sixpak
SINCE THE FLAG NA, TO INDICATE ISOTROPIC DISTRIBUTIONS, IS ONLY      Sixpak
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GIVEN FOR EACH SECONDARY ENERGY (EP) THE PROGRAM CANNOT DECIDE     Sixpak
IN ADVANCE WHETHER OR NOT THE DISTRIBUTION WILL BE ISOTROPIC       Sixpak
AT ALL INCIDENT ENERGIES. THEREFORE ISOTROPIC DISTRIBUTIONS        Sixpak
WILL BE OUTPUT EITHER: LANG = 1 - AS 1 LEGENDRE COEFFICIENT = 0.0  Sixpak
OR LANG = NOT 1 - AS A 2 POINT ANGULAR DISTRIBUTION AT COS = -1.0  Sixpak
AND +1.0 WITH BOTH VALUES EQUAL TO 0.5 (A NORMALIZED ISOTROPIC     Sixpak
DISTRIBUTION).                                                     Sixpak
                                                                   Sixpak
DISCRETE PHOTONS ARE OUTPUT IN MF=15 AS 3 POINT DISTRIBUTIONS      Sixpak
WITH SECONDARY ENERGY POINTS AT EP-DEP, EP, EP+DEP, WHERE          Sixpak
DEP=0.001*EP. THE VALUES AT EP-DEP AND EP+DEP ARE 0.0, AND         Sixpak
AT EP THE VALUE IS 1000.0/EP TO NORMALIZE THE DISTRIBUTION.        Sixpak
                                                                   Sixpak
LAW=2                                                              Sixpak
=====                                                              Sixpak
NO LIMITATION ON REPRESENTATIONS.                                  Sixpak
                                                                   Sixpak
LAW=3                                                              Sixpak
=====                                                              Sixpak
NO LIMITATION ON REPRESENTATIONS.                                  Sixpak
                                                                   Sixpak
LAW=4                                                              Sixpak
=====                                                              Sixpak
NO OUTPUT - INCIDENT NEUTRON - EMITTED PHOTON OR NEUTRON           Sixpak
            REACTIONS ARE NOT EXPECTED.                            Sixpak
                                                                   Sixpak
LAW=5                                                              Sixpak
=====                                                              Sixpak
NO OUTPUT - INCIDENT NEUTRON - EMITTED PHOTON OR NEUTRON           Sixpak
            REACTIONS ARE NOT EXPECTED.                            Sixpak
                                                                   Sixpak
LAW=6                                                              Sixpak
=====                                                              Sixpak
NO OUTPUT - ENDF/B-VI ONLY INCLUDES 1 SECTION OF THIS TYPE OF DATA Sixpak
            FOR (N,D) 2N,P.                                        Sixpak
                                                                   Sixpak
LAW=7                                                              Sixpak
=====                                                              Sixpak
FOR EACH INCIDENT ENERGY THE REPRESENTATION MUST BE EITHER,        Sixpak
                                                                   Sixpak
1) SQUARE = FOR EACH INCIDENT COSINE EXACTLY THE SAME SECONDARY    Sixpak
            ENERGIES.                                              Sixpak
                                                                   Sixpak
2) LINEAR = FOR EACH INCIDENT COSINE THE INTERPOLATION LAW         Sixpak
            BETWEEN SECONDARY ENERGIES MUST BE LINEAR.             Sixpak
                                                                   Sixpak
THESE 2 PRESENTATIONS ARE THE ONLY ONES PRESENTED IN ENDF/B-VI     Sixpak
AS OF JANUARY 1992 - SO THIS PROGRAM CAN TRANSLATED ALL LAW=7      Sixpak
DATA FOR ENDF/B-VI.                                                Sixpak
                                                                   Sixpak
LABORATORY VS. CENTER-OF-MASS SYSTEM                               Sixpak
================================================================== Sixpak
IN MANY CASES PEOPLE ASSUME THAT FOR HEAVY (HIGH ATOMIC WEIGHT)    Sixpak
MATERIALS THE CENTER-OF-MASS AND LAB SYSTEMS ARE ALMOST IDENTICAL, Sixpak
SINCE IN THIS CASE THE CENTER-OF-MASS ENERGY WILL BE MUCH SMALLER  Sixpak
THAN THE INCIDENT ENERGY. FOR A PROCESS SUCH AS ELASTIC SCATTERING Sixpak
WHERE FOR HEAVY MATERIALS THE SECONDARY ENERGY, EP, WILL ALWAYS    Sixpak
BE A LARGE FRACTION OF THE INCIDENT ENERGY, THIS ASSUMPTION IS     Sixpak
VALID. HOWEVER, FOR THE TYPICAL REACTIONS INCLUDED IN MF=6 THIS    Sixpak
IS NOT ALWAYS TRUE - IN MANY OF THESE CASES THE SECONDARY ENERGY   Sixpak
CAN EXTEND ALL THE WAY DOWN TO ZERO, AND IN PARTICULAR IT CAN      Sixpak
BE SMALL COMPARED TO THE CENTER-OF-MASS ENERGY - WHICH MAKES THE   Sixpak
TRANSFORMATION FROM CENTER-OF-MASS TO LAB IMPORTANT. THEREFORE     Sixpak
GENERALLY TO TREAT MF=6 DATA WE MUST CONSIDER THIS TRANSFORMATION. Sixpak
                                                                   Sixpak
THE FOLLOWING DISCUSSING ONLY APPLIES TO SPECTRA THAT MAY BE       Sixpak
OUTPUT IN MF=5 = ONLY DATA FOR NEUTRONS INCIDENT AND EMITTED -     Sixpak
IN PARTICULAR THE FOLLOWING DEFINITIONS ARE NOT GENERAL - THEY     Sixpak
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ARE ONLY VALID FOR INCIDENT AND EMITTED NEUTRONS.                    Sixpak
                                                                     Sixpak
DOUBLE DIFFERENTIAL DATA IN MF=6 MAY BE GIVEN IN EITHER THE LAB      Sixpak
OR C.M. SYSTEM. SIMILARLY ANGULAR DISTRIBUTIONS IN MF=4 MAY BE       Sixpak
GIVEN IN EITHER THE LAB OR C.M. SYSTEM. IN CONTRAST ENERGY           Sixpak
SPECTRA IN MF=5 CAN ONLY BE GIVEN IN THE LABORATORY SYSTEM.          Sixpak
                                                                     Sixpak
THE ANGULAR DISTRIBUTIONS OUTPUT BY THIS CODE IN MF=4 ARE IN THE     Sixpak
SAME SYSTEM IN WHICH THEY ARE GIVEN IN MF=6 - EITHER LAB OR          Sixpak
CENTER-OF-MASS SYSTEM.                                               Sixpak
                                                                     Sixpak
THE ENERGY SPECTRA OUTPUT BY THIS CODE IN MF=5 MUST BE IN THE LAB    Sixpak
SYSTEM - THIS IS THE ONLY ALLOWED FORM FOR MF=5 DATA.                Sixpak
                                                                     Sixpak
FOR MF=6 SPECTRA GIVEN IN THE LAB SYSTEM THIS MERELY REQUIRES        Sixpak
COPYING THE GIVEN SPECTRA TO MF=5 OUTPUT.                            Sixpak
                                                                     Sixpak
FOR MF=6 SPECTRA GIVEN IN THE CENTER-OF-MASS SYSTEM ONLY FIRST       Sixpak
ORDER CORRECTIONS IN THE SPECTRA AND USED AND THEY ARE THEN          Sixpak
OUTPUT IN MF=5 AS IN THE LAB SYSTEM - THE FIRST ORDER CORRECTIONS    Sixpak
ARE DESCRIBED BELOW.                                                 Sixpak
                                                                     Sixpak
DEFINING,                                                            Sixpak
MM      = CENTER OF MASS MOTION                                      Sixpak
CM      = OUTGOING (EMITTED) PARTICLE IN CENTER OF MASS              Sixpak
LAB     = OUTGOING (EMITTED) PARTICLE IN LAB                         Sixpak
THETA   = CM SCATTERING ANGLE RELATIVE TO INCIDENT DIRECTION         Sixpak
COS(CM) = COSINE OF THE CM SCATTERING ANGLE                          Sixpak
                                                                     Sixpak
FOR NEUTRONS INCIDENT WITH AN ENERGY, E, AND THEREFORE A SPEED,      Sixpak
                                                                     Sixpak
VN(E) = 2*SQRT(E)/MASS(IN)                                           Sixpak
                                                                     Sixpak
THE CENTER-OF-MASS SPEED IS GIVEN BY,                                Sixpak
                                                                     Sixpak
V(MM) = VN(E)/(1 + A)                                                Sixpak
                                                                     Sixpak
AND THE CENTER OF MASS ENERGY BY,                                    Sixpak
                                                                     Sixpak
E(MM) = 1/2*MASS(IN)*V(MM)**2                                        Sixpak
      = 1/2*MASS(IN)*VN(E)**2/(1 + A)**2                             Sixpak
      = E/(1 + A)**2                                                 Sixpak
                                                                     Sixpak
FOR DISTRIBUTIONS GIVEN IN MF=6 IN THE CM, THE SPEED, V(CM),         Sixpak
SHOULD BE VECTORIALLY ADDED TO THAT OF OUTGOING PARTICLES TO         Sixpak
DEFINE THE OUTGOING PARTICLES LAB VELOCITY, AND IN TURN IT'S         Sixpak
ENERGY,                                                              Sixpak
                                                                     Sixpak
V(LAB)*COS(LAB) = V(MM) + V(CM)*COS(CM)                              Sixpak
V(LAB)*SIN(LAB) =         V(CM)*SIN(CM)                              Sixpak
                                                                     Sixpak
V(LAB)**2 = V(MM)**2 + V(CM)**2 + 2*COS(CM)*V(MM)*V(CM)              Sixpak
                                                                     Sixpak
EP(LAB)   = 0.5*MASS(OUT)*V(LAB)**2                                  Sixpak

                                                                     Sixpak
          = E(MM) + EP(CM) + 2*COS(CM)*SQRT(E(MM)*EP(CM))            Sixpak
                                                                     Sixpak
WE CAN ALSO DEFINE THE REVERSE TRANSFORMATION USING,                 Sixpak
                                                                     Sixpak
V(CM)*COS(CM) = V(LAB)*COS(LAB) - V(MM)                              Sixpak
V(CM)*SIN(CM) = V(LAB)*SIN(LAB)                                      Sixpak
                                                                     Sixpak
V(CM)**2 = V(MM)**2 + V(LAB)**2 - 2*COS(LAB)*V(MM)*V(LAB)            Sixpak
                                                                     Sixpak
EP(CM)   = 0.5*MASS(OUT)*V(CM)**2                                    Sixpak
                                                                     Sixpak
          = E(MM) + EP(LAB) - 2*COS(LAB)*SQRT(E(MM)*EP(LAB))         Sixpak
```

```
                                                                      Sixpak
WE CAN DEFINE COS(LAB) FROM THE RELATIONSHIP,                         Sixpak
                                                                      Sixpak
V(LAB)*COS(LAB) = V(MM) + V(CM)*COS(CM)                               Sixpak
                                                                      Sixpak
COS(LAB)        =[V(MM) + V(CM)*COS(CM)]/V(LAB)                       Sixpak
                                                                      Sixpak
                 [V(MM) + V(CM)*COS(CM)]                              Sixpak
COS(LAB)        =-----------------------------------------           Sixpak
                 SQRT[V(MM)**2+V(CM)**2+2*COS(CM)*V(MM)*V(CM)]        Sixpak
                                                                      Sixpak
OR COS(CM) FROM THE RELATIONSHIP,                                     Sixpak
                                                                      Sixpak
V(CM)*COS(CM)  = V(LAB)*COS(LAB) - V(MM)                              Sixpak
                                                                      Sixpak
COS(CM)         =[V(LAB)*COS(LAB) - V(MM)]/V(CM)                      Sixpak
                                                                      Sixpak
                 [V(LAB)*COS(LAB) - V(MM)]                            Sixpak
COS(CM)         =-----------------------------------------------     Sixpak
                 SQRT[V(LAB)**2+V(CM)**2-2*COS(LAB)*V(LAB)*V(MM)]     Sixpak
                                                                      Sixpak
THE JACOBIAN CAN BE DEFINED FROM,                                     Sixpak
                                                                      Sixpak
V(LAB)*COS(LAB) = V(MM) + V(CM)*COS(CM)                               Sixpak
                                                                      Sixpak
J = D[COS(CM)]/D[COS(LAB)] = V(LAB)/V(CM)                             Sixpak
                           = SQRT[EP(LAB)/EP(CM)]                     Sixpak
                                                                      Sixpak
WITH THESE DEFINITIONS OF EP(LAB) AND COS(LAB) IN TERMS OF E(MM),     Sixpak
EP(CM) AND COS(CM) IT IS POSSIBLE TO PERFORM A POINT-BY-POINT         Sixpak
TRANSFORMATION OF DISTRIBUTIONS FROM THE CM TO LAB SYSTEM USING       Sixpak
THESE DEFINITIONS - OR IF WE WISHED WE COULD PERFORM THE REVERSE      Sixpak
TRANSFORMATION USING THE ABOVE RELATIONSHIPS AND THE IDENTITY,        Sixpak
                                                                      Sixpak
F(E,EP(LAB),COS(LAB))*D(COS(LAB))=F(E,EP(CM),COS(CM))*D(COS(CM))      Sixpak
                                                                      Sixpak
THIS IS NOT WHAT WILL BE DONE HERE, SINCE WE WILL ONLY BE             Sixpak
INTERESTED IN THE ZEROTH ORDER MOMENTS OF THESE DISTRIBUTIONS,        Sixpak
BUT WE WILL BE INTERESTED IN DEFINING THOSE MOMENTS IN THE            Sixpak
LAB SYSTEM IN TERMS OF MF=6 SPECTRA GIVEN IN THE CM SYSTEM USING,     Sixpak
                                                                      Sixpak
F(E,EP(LAB),COS(LAB)) = F(E,EP(CM),COS(CM))*J                         Sixpak
                                                                      Sixpak
THE LIMITS OF EP(LAB) ARE DEFINED BY SETTING COS(CM) = +1 OR -1,      Sixpak
                                                                      Sixpak
EP(LAB)   = (SQRT(EP(CM)) + SQRT(E(MM)))**2  FOR COS(CM) = +1         Sixpak
          = (SQRT(EP(CM)) - SQRT(E(MM)))**2  FOR COS(CM) = -1         Sixpak
                                                                      Sixpak
IN THIS FORM WE CAN SEE THAT AS LONG AS THE SECONDARY ENERGY IN       Sixpak
THE CENTER-OF-MASS SYSTEM, EP(CM), IS MUCH LARGER THAN THE            Sixpak
ENERGY OF THE CENTER-OF-MASS, E(MM), THE CENTER-OF-MASS AND LAB       Sixpak
ENERGIES WILL BE ALMOST EQUAL - SIMILARLY FOR THE COSINE, IN          Sixpak
THIS CASE COS(LAB) AND COS(CM) WILL BE ALMOST EQUAL - HOWEVER,        Sixpak
FOR THE MF=6 DATA WE CANNOT ASSUME THAT THIS IS TRUE.                 Sixpak
                                                                      Sixpak
TO FIRST ORDER THE ANGULAR DEPENDENCE CAN BE IGNORED,                 Sixpak
                                                                      Sixpak
EP(LAB)   = E(MM) + EP(CM)                                            Sixpak
                                                                      Sixpak
ALL THIS SAYS IS THAT TO FIRST ORDER THE EFFECT OF TRANSFORMING       Sixpak
FROM THE CM TO LAB SYSTEM IS TO INCREASE THE ENERGY OF THE            Sixpak
EMITTED PARTICLE IN THE CENTER-OF-MASS SYSTEM BY THE ENERGY OF        Sixpak
THE CENTER-OF-MASS TO DEFINE THE LAB ENERGY.                          Sixpak
                                                                      Sixpak
NOT ONLY THE ENERGY, BUT ALSO THE SPECTRA MUST BE TRANSFORMED.        Sixpak
STARTING FROM THE DOUBLE DIFFERENTIAL DATA IN THE LAB SYSTEM,         Sixpak
F(E,EP,COS(LAB)), WE CAN DEFINE THE LAB SCALAR SPECTRUM AS,           Sixpak
                                                                      Sixpak
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G0(E,EP) = INTEGRAL F(E,EP,COS(LAB))*D(COS(LAB))                    Sixpak
                                                                    Sixpak
THIS IS THE NORMAL CALCULATION DEFINED ABOVE AND USED FOR DATA      Sixpak
GIVEN IN THE LAB SYSTEM.                                            Sixpak
                                                                    Sixpak
STARTING FROM DATA IN THE CENTER OF MASS SYSTEM F(E,EP,COS(CM)),    Sixpak
WE CAN USE THE RELATIONSHIP,                                        Sixpak
                                                                    Sixpak
F(E,EP,COS(LAB))*D(COS(LAB)) = F(E,EP,COS(CM))*J*D(COS(LAB))        Sixpak
                                                                    Sixpak
J         = SQRT(EP(LAB)/EP(CM)) - THE JACOBIAN                     Sixpak
                                                                    Sixpak
          = E(MM)/EP(CM) + 1 + 2*COS(CM)*SQRT(E(MM)/EP(CM))         Sixpak
                                                                    Sixpak
AS IN THE CASE OF THE ENERGY, IN THIS FORM WE CAN SEE THAT AS       Sixpak
LONG AS THE SECONDARY ENERGY IN THE CENTER-OF-MASS SYSTEM,          Sixpak
EP(CM), IS LARGE COMPARED TO THE CENTER-OF-MASS ENERGY, E(MM),      Sixpak
THE JACOBIAN IS ESSENTIALLY UNITY AND THE CENTER-OF-MASS AND LAB    Sixpak
SPECTRA WILL BE VERY SIMILAR - AGAIN, GENERALLY WE CANNOT           Sixpak
ASSUME THAT THIS IS TRUE FOR THE MF=6 SPECTRA.                      Sixpak
                                                                    Sixpak
THEREFORE WE CAN ALSO DEFINE THE LAB SCALAR SPECTRUM IN TERMS OF    Sixpak
THE CM SPECTRUM IN THE FORM,                                        Sixpak
                                                                    Sixpak
G0(E,EP) = INTEGRAL F(E,EP,COS(CM))*J*D(COS(LAB))                   Sixpak
                                                                    Sixpak
CONSISTENT WITH THE ABOVE ASSUMPTION THAT THE ANGULAR DEPENDENCE    Sixpak
OF EP(LAB) CAN BE IGNORED THE JACOBIAN WILL NOT BE USED IN          Sixpak
PERFORMING THESE INTEGRALS - IN WHICH CASE THE INTEGRAL REDUCES     Sixpak
TO EXACTLY THE SAME FORM AS IF THE DATA WERE IN THE LAB SYSTEM.     Sixpak
                                                                    Sixpak
IT SHOULD BE NOTED THAT SINCE IN THIS CASE THE MF=4 ANGULAR         Sixpak
DISTRIBUTIONS ARE GIVEN IN THE CM SYSTEM AND WHEN USED IN ANY       Sixpak
APPLICATION THEY WILL BE TRANSFORMED TO THE LAB SYSTEM - WHEN       Sixpak
THIS IS DONE THE JACOBIAN WILL BE APPLIED.                          Sixpak
                                                                    Sixpak
IN THIS CODE WHERE WE ARE MOSTLY CONCERNED WITH CONSERVING THE      Sixpak
NUMBER OF EMITTED PARTICLES AND AVERAGE ENERGIES THE NEUTRON        Sixpak
SPECTRA OUTPUT IN MF=5 WILL NOT BE COMPLETELY CONVERTED TO THE      Sixpak
LAB SYSTEM - ONLY FIRST ORDER CORRECTIONS WILL BE INCLUDED BY       Sixpak
INCREASING THE EMITTED PARTICLE ENERGY BY THE CENTER OF MASS        Sixpak
ENERGY, I.E., FOR A CENTER OF MASS SPECTRUM TABULATED AT CENTER     Sixpak
OF MASS ENERGIES EP(CM) THESE WILL ALL BE UNIFORMLY INCREASED       Sixpak
BY E(MM) TO ACCOUNT FOR THE CENTER OF MASS MOTION - THE SPECTRA     Sixpak
WILL NOT BE MODIFIED BY THE JACOBIAN FACTOR SQRT(EP(LAB)/EP(CM))    Sixpak
SINCE THIS WOULD REQUIRE A DETAILED TRANSFORMATION IN ENERGY AND    Sixpak
COS(THETA) SPACE - WHICH IS JUDGED NOT TO BE WORTH PERFORMING       Sixpak
WITHIN THE LIMITS OF WHERE THE OUTPUT FROM THIS CODE IS INTENDED    Sixpak
TO BE USED.                                                         Sixpak
                                                                    Sixpak
SINCE THE ANGULAR DISTRIBUTION IS ALWAYS OUTPUT IN THE SAME         Sixpak
SYSTEM AS WHICH IT IS GIVEN IN MF=6, NO TRANSFORMATION IS           Sixpak
REQUIRED FOR THE MF=4 OUTPUT.                                       Sixpak
                                                                    Sixpak
WHEN USED IN LOW ENERGY APPLICATIONS (E.G., FISSION REACTORS) THE   Sixpak
HIGH ENERGY SPECTRA PRESENTED IN MF=6 WILL BE MOSTLY IMPORTANT      Sixpak
SIMPLY IN CONSERVING PARTICLES, (E.G., AS IN (N,2N)) AND ENERGY     Sixpak
AND THE DETAILS OF THE CORRELATION AND GROSS ENERGY SPECTRA WILL    Sixpak
NOTE PLAY THAT IMPORTANT A ROLE. IN THIS CASE THE SPECTRA OUTPUT    Sixpak
BY THIS PROGRAM IN MF=5 SHOULD BE ADEQUATE.                         Sixpak
                                                                    Sixpak
PLOTTAB FORMATTED OUTPUT                                            Sixpak
================================================================    Sixpak
THIS PROGRAM CONTAINS ROUTINES TO PRODUCE OUTPUT THAT CAN BE USED   Sixpak
AS INPUT TO THE PLOTTAB CODE TO OBTAIN GRAPHIC RESULTS.             Sixpak
                                                                    Sixpak
THESE ROUTINES ARE DESIGNED ONLY FOR USE BY THE AUTHOR TO CHECK     Sixpak
THIS CODE. USERS ARE ASKED NOT TO ACTIVATE OR TRY TO USE THESE      Sixpak
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ROUTINES. UNLESS YOU COMPLETELY UNDERSTAND THIS CODE THE RESULTS   Sixpak
CAN BE UNRELIABLE IF YOU ACTIVATE THESE ROUTINES.                  Sixpak
                                                                   Sixpak
INPUT FILES                                                        Sixpak
================================================================== Sixpak
UNIT  DESCRIPTION                                                  Sixpak
----  -----------                                                  Sixpak
   2  INPUT LINES (BCD - 80 CHARACTERS/RECORD)                     Sixpak
  10  ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)            Sixpak
                                                                   Sixpak
OUTPUT FILES                                                       Sixpak
================================================================== Sixpak
UNIT  DESCRIPTION                                                  Sixpak
----  -----------                                                  Sixpak
   3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                  Sixpak
  11  ENDF/B DATA MF=4 (BCD - 80 CHARACTERS/RECORD)                Sixpak
  12  ENDF/B DATA MF=5 (BCD - 80 CHARACTERS/RECORD)                Sixpak
  14  ENDF/B DATA MF=15 (BCD - 80 CHARACTERS/RECORD)               Sixpak
  17  ENDF/B DATA MF=12 (BCD - 80 CHARACTERS/RECORD)               Sixpak
  18  ENDF/B DATA MF=14 (BCD - 80 CHARACTERS/RECORD)               Sixpak
  15  PLOTTAB INPUT PARAMETERS (BCD - 80 CHARACTERS/RECORD)        Sixpak
  16  PLOTTAB FORMATTED OUTPUT (BCD - 80 CHARACTERS/RECORD)        Sixpak
                                                                   Sixpak
SCRATCH FILES                                                      Sixpak
================================================================== Sixpak
NONE                                                               Sixpak
                                                                   Sixpak
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)    Sixpak
================================================================== Sixpak
UNIT  FILE NAME                                                    Sixpak
----  ----------                                                   Sixpak
  2   SIXPAK.INP                                                   Sixpak
  3   SIXPAK.LST                                                   Sixpak
 10   ENDFB.IN                                                     Sixpak
 11   ENDFB.MF4                                                    Sixpak
 12   ENDFB.MF5                                                    Sixpak
 14   ENDFB.M15                                                    Sixpak
 17   ENDFB.M12                                                    Sixpak
 18   ENDFB.M14                                                    Sixpak
 15   PLOTTAB.INP                                                  Sixpak
 16   PLOTTAB.CUR                                                  Sixpak
                                                                   Sixpak
                                                                   Sixpak
INPUT PARAMETERS                                                   Sixpak
================================================================== Sixpak
LINE  COLS.  DESCRIPTION                                           Sixpak
----  -----  -----------                                           Sixpak
   1   1-60  ENDF/B INPUT DATA FILENAME                            Sixpak
             (STANDARD OPTION = ENDFB.IN)                          Sixpak
 2-N   1-6   MINIMUM MAT FOR REQUESTED RANGE                       Sixpak
       9-11  MINIMUM MT FOR REQUESTED RANGE                        Sixpak
      12-17  MAXIMUM MAT FOR REQUESTED RANGE                       Sixpak
      20-22  MAXIMUM MT FOR REQUESTED RANGE                       Sixpak
                                                                   Sixpak
LEAVE THE DEFINITION OF THE FILENAME BLANK - THE PROGRAM WILL      Sixpak
THEN USE THE STANDARD FILENAME (ENDFB.IN).                         Sixpak
                                                                   Sixpak
UP TO 100 MAT/MT RANGES MAY BE SPECIFIED. THE LIST OF RANGES IS    Sixpak
TERMINATED BY A BLANK LINE. IF THE FIRST INPUT LINE IS COMPLETELY  Sixpak
BLANK ALL DATA WILL BE PROCESSED.                                  Sixpak
                                                                   Sixpak
EXAMPLE INPUT NO. 1                                                Sixpak
-------------------                                                Sixpak
PROCESS ALL MF=6 DATA ON AN ENDF/B TAPE. USE THE STANDARD INPUT    Sixpak
DATA FILENAME ENDFB.IN IN THIS CASE THE USER CAN EITHER EXPLICITLY Sixpak
SPECIFY THE FILENAME AND MAT/MT RANGE BY THE FOLLOWING  2 INPUT    Sixpak
LINES,                                                             Sixpak
                                                                   Sixpak
```

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     ENDFB.IN                                                          Sixpak
          1    1  9999  999                                           Sixpak
                            (BLANK LINE, TERMINATES REQUEST LIST)      Sixpak
                                                                       Sixpak
     OR BY INPUTTING 2 BLANK LINE = PROCESS EVERYTHING.                Sixpak
                                                                       Sixpak
     EXAMPLE INPUT NO. 2                                               Sixpak
     -------------------                                               Sixpak
     PROCESS BE-9, MAT=425, MT=16. READ THE DATA FROM ENDFB6\BE9.      Sixpak
     IN THIS CASE THE FOLLOWING 3 INPUT LINES ARE REQUIRED,            Sixpak
                                                                       Sixpak
     ENDFBB6\BE9                                                       Sixpak
        425   16   425   16                                           Sixpak
                            (BLANK LINE, TERMINATES REQUEST LIST)      Sixpak
                                                                       Sixpak
     EXAMPLE INPUT NO. 3                                               Sixpak
     -------------------                                               Sixpak
     PROCESS ALL MT=16 (N,2N) DATA. THIS CAN BE DONE BY SPECIFYING THE Sixpak
     MAXIMUM MAT RANGE = 1 TO 9999, AND MT=16 FOR THE MINIMUM AND      Sixpak
     MAXIMUM MT RANGE. READ THE DATA FROM ENDFB6\K300. IN THIS CASE    Sixpak
     CASE THE FOLLOWING 3 INPUT LINES ARE REQUIRED,                    Sixpak
                                                                       Sixpak
     ENDFB6\K300                                                       Sixpak
          1   16  9999   16                                           Sixpak
                            (BLANK LINE, TERMINATES REQUEST LIST)      Sixpak
                                                                       Sixpak
=====================================================================  Sixpak
```

```
====================================================================== Virgin
                                                                       Virgin
      PROGRAM VIRGIN                                                   Virgin
      VERSION 76-1 (NOVEMBER 1976)                                     Virgin
      VERSION 84-1 (JUNE 1984)   *DOUBLE PRECISION ENERGY              Virgin
      VERSION 86-1 (JANUARY 1986)*FORTRAN-77/H VERSION                 Virgin
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O    Virgin
                                  FILE NAMES (SEE, SUBROUTINE FILEIO   Virgin
                                  FOR DETAILS).                        Virgin
                                 *IMPROVED BASED ON USER COMMENTS.      Virgin
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO    Virgin
                                  INSURE PROGRAM WILL NOT DO ANYTHING   Virgin
                                  CRAZY.                               Virgin
                                 *UPDATED TO USE NEW PROGRAM CONVERT    Virgin
                                  KEYWORDS.                            Virgin
                                 *ADDED LIVERMORE CIVIC COMPILER        Virgin
                                  CONVENTIONS.                         Virgin
      VERSION 92-1 (JANUARY 1992)*COMPLETE RE-WRITE                    Virgin
                                 *OUTPUT IN PLOTTAB FORMAT             Virgin
                                 *UP TO 2000 THICKNESSES               Virgin
                                 *INCREASED INCORE PAGE SIZE TO 6000   Virgin
                                  CROSS SECTION POINTS                 Virgin
                                 *ADDED PHOTON CALCULATIONS            Virgin
                                 *ADDED BLACKBODY SPECTRUM             Virgin
                                 *ADDED MULTIPLE LAYERS                Virgin
                                 *ADDED SPATIALLY DEPENDENT DENSITY    Virgin
                                 *ADDED FORTRAN SAVE OPTION            Virgin
                                 *COMPLETELY CONSISTENT I/O ROUTINES -  Virgin
                                  TO MINIMIZE COMPUTER DEPENDENCE.     Virgin
      VERSION 92-2 (MAY 1992)    *CORRECTED TO HANDLE MULTIGROUP CROSS  Virgin
                                  SECTIONS AS INPUT IN ENDF/B FORMAT.  Virgin
      VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                   Virgin
                                  *IMPROVED COMPUTER INDEPENDENCE       Virgin
                                  *ALL DOUBLE PRECISION                 Virgin
                                  *ON SCREEN OUTPUT                     Virgin
                                  *UNIFORM TREATMENT OF ENDF/B I/O      Virgin
                                  *IMPROVED OUTPUT PRECISION            Virgin
                                  *DEFINED SCRATCH FILE NAMES           Virgin
      VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING      Virgin
                                   POINT READ FOR MORE DIGITS           Virgin
                                  *UPDATED TEST FOR ENDF/B FORMAT       Virgin
                                   VERSION BASED ON RECENT FORMAT CHANGE Virgin
                                  *GENERAL IMPROVEMENTS BASED ON        Virgin
                                   USER FEEDBACK                        Virgin
      VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON       Virgin
                                   USER FEEDBACK                       Virgin
      VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS           Virgin
      VERS. 2004-1 (MARCH 2004)   *ADDED INCLUDE FOR COMMON            Virgin
                                  *UP TO 2000 THICKNESSES              Virgin
                                  *INCREASED INCORE PAGE SIZE TO 60,000 Virgin
      VERS. 2007-1 (JAN.  2007)   *CHECKED AGAINST ALL ENDF/B-VII.     Virgin
                                  *INCREASED INCORE PAGE SIZE TO       Virgin
                                   240,000 FROM 60,000.                Virgin
                                                                       Virgin
      OWNED, MAINTAINED AND DISTRIBUTED BY                             Virgin
      -----------------------------------                              Virgin
      THE NUCLEAR DATA SECTION                                         Virgin
      INTERNATIONAL ATOMIC ENERGY AGENCY                               Virgin
      P.O. BOX 100                                                     Virgin
      A-1400, VIENNA, AUSTRIA                                          Virgin
      EUROPE                                                           Virgin
                                                                       Virgin
      ORIGINALLY WRITTEN BY                                            Virgin
      ---------------------------------                                Virgin
      DERMOTT E. CULLEN                                                Virgin
      UNIVERSITY OF CALIFORNIA                                         Virgin
      LAWRENCE LIVERMORE NATIONAL LABORATORY                           Virgin
      L-159                                                            Virgin
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P.O. BOX 808                                                          Virgin
LIVERMORE, CA 94550                                                   Virgin
U.S.A.                                                                Virgin
TELEPHONE  925-423-7359                                               Virgin
E. MAIL    CULLEN1@LLNL.GOV                                           Virgin
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                                Virgin
                                                                      Virgin
PURPOSE                                                               Virgin
-------                                                               Virgin
THIS PROGRAM IS DESIGNED TO CALCULATE UNCOLLIDED (I.E. VIRGIN)        Virgin
FLUX AND REACTIONS DUE TO TRANSMISSION OF A MONODIRECTIONAL           Virgin
BEAM OF NEUTRONS THROUGH ANY THICKNESS OF MATERIAL. IN ORDER          Virgin
TO SIMULATE AN EXPERIMENTAL MEASUREMENT THE RESULTS ARE GIVEN         Virgin
AS INTEGRALS OVER ENERGY TALLY GROUPS (AS OPPOSED TO POINTWISE        Virgin
IN ENERGY). BY TAKING THE RATIO OF REACTIONS TO FLUX IN EACH          Virgin
GROUP AN EQUIVALENT SPATIALLY DEPENDENT GROUP AVERAGED CROSS          Virgin
SECTION IS CALCULATED BY THE PROGRAM.                                 Virgin
                                                                      Virgin
EVALUATED DATA                                                        Virgin
--------------                                                        Virgin
THE EVALUATED DATA MUST BE IN THE ENDF/B FORMAT. HOWEVER IT           Virgin
MUST BE LINEAR-LINEAR INTERPOLABLE IN ENERGY-CROSS SECTION            Virgin
BETWEEN TABULATED POINTS. SINCE ONLY CROSS SECTIONS (FILE 3 OR 23)    Virgin
ARE USED, THIS PROGRAM WILL WORK ON ANY VERSION OF ENDF/B             Virgin
(I.E. ENDF/B-I, II, III, IV, V OR VI).                                Virgin
                                                                      Virgin
RELATED COMPUTER CODES                                                Virgin
----------------------                                                Virgin
IN ORDER TO CONVERT ENDF/B DATA TO THE FORM REQUIRED BY THIS CODE     Virgin
THE FOLLOWING COMPUTER CODES MAY BE USED,                             Virgin
                                                                      Virgin
LINEAR  - CONVERT FROM GENERAL ENDF/B INTERPOLATION TO LINEAR-        Virgin
          LINEAR INTERPOLATION.                                       Virgin
RECENT  - ADD THE RESONANCE CONTRIBUTION TO TABULATED BACKGROUND      Virgin
          CROSS SECTIONS TO OBTAIN LINEAR-LINEAR INTERPOLABLE         Virgin
          RESULTS.                                                    Virgin
SIGMA1  - DOPPLER BROADEN CROSS SECTION TO OBTAIN LINEAR-LINEAR       Virgin
          INTERPOLABLE RESULTS.                                       Virgin
MIXER   - MIX INDIVIDUAL MATERIALS TOGETHER TO DEFINE COMPOSITE       Virgin
          MIXTURES, E.G., COMBINE MATERIALS TO DEFINE STAINLESS       Virgin
          STELL.                                                      Virgin
                                                                      Virgin
IN ORDER TO PLOT THE OUTPUT RESULTS OF THIS CODE USE PROGRAM          Virgin
PLOTTAB.                                                              Virgin
                                                                      Virgin
COPIES OF ANY OR ALL OF THESE CODES MAY BE OBTAINED FROM D.E.         Virgin
CULLEN AT THE ABOVE ADDRESS.                                          Virgin
                                                                      Virgin
OUTPUT FORMAT                                                         Virgin
-------------                                                         Virgin
FOR ALL VERSIONS OF THIS PROGRAM PRIOR TO VERSION 92-1 OUTPUT WAS     Virgin
IN TABULAR FORM.                                                      Virgin
                                                                      Virgin
FOR VERSION 92-1 AND LATER VERSIONS OF THIS CODE ALL OUTPUT IS IN     Virgin
THE PROGRAM PLOTTAB FORMAT TO ALLOW RESULTS TO BE EASILY PLOTTED.     Virgin
FOR A COPY OF PROGRAM PLOTTAB CONTACT D.E. CULLEN AT THE ABOVE        Virgin
ADDRESS.                                                              Virgin
                                                                      Virgin
TALLY GROUPS                                                          Virgin
------------                                                          Virgin
THE TALLY GROUP STRUCTURE MAY BE ANY SET OF MONONTONICALLY            Virgin
INCREASING ENERGY BOUNDARIES. THERE MAY BE UP TO 2000 TALLY           Virgin
GROUPS. BY USING THE INPUT PARAMETERS THE USER MAY SPECIFY ANY        Virgin
ARBITRARY TALLY GROUP STRUCTURE OR SELECT ONE OF THE FOLLOWING        Virgin
BUILT-IN GROUP STRUCTURES.                                            Virgin
                                                                      Virgin
(1) TART 175 GROUPS (INPUT  0)                                        Virgin
(2) ORNL  50 GROUPS (INPUT -1)                                        Virgin
```

```
 (3) ORNL 126 GROUPS (INPUT -2)                                          Virgin
 (4) ORNL 171 GROUPS (INPUT -3)                                          Virgin
 (5) SAND-II 620 GROUPS...UP TO 18 MEV (INPUT -4)                        Virgin
 (6) SAND-II 640 GROUPS...UP TO 20 MEV (INPUT -5)                        Virgin
 (7) WIMS 69 GROUPS (INPUT -6)                                           Virgin
 (8) GAM-I 68 GROUPS (INPUT -7)                                          Virgin
 (9) GAM-II 99 GROUPS (INPUT -8)                                         Virgin
(10) MUFT 54 GROUPS (INPUT -9)                                           Virgin
(11) ABBN 28 GROUPS (INPUT -10)                                          Virgin
                                                                         Virgin
 INCIDENT SPECTRUM                                                       Virgin
 -----------------                                                       Virgin
 THE INCIDENT SPECTRUM MAY BE ANY TABULATED FUNCTION THAT IS             Virgin
 GIVEN BY A SET OF POINTS THAT IS MONOTONICALLY INCREASING IN            Virgin
 ENERGY AND LINEAR-LINEAR INTERPOLABLE IN ENERGY-SPECTRUM                Virgin
 BETWEEN TABULATED POINTS. THERE IS NO LIMIT TO THE NUMBER OF            Virgin
 POINTS USED TO DESCRIBE THE SPECTRUM. THERE ARE FIVE BUILT-IN           Virgin
 OPTIONS FOR THE SPECTRUM.                                               Virgin
                                                                         Virgin
 (1) CONSTANT...ENERGY INDEPENDENT (INPUT 0)                             Virgin
 (2) 1/E (INPUT 1)                                                       Virgin
 (3) BLACKBODY - PHOTON SPECTRUM                                         Virgin
 (4) BLACKBODY - ENERGY SPECTRUM (E TIMES THE PHOTON SPECTRUM)           Virgin
 (5) TRANSMITTED SPECTRUM FROM PREVIOUS CASE                             Virgin
                                                                         Virgin
 NORMALIZATION OF SPECTRUM                                               Virgin
 -------------------------                                               Virgin
 ANY INCIDENT SPECTRUM, EITHER READ AS INPUT OR ONE OF THE               Virgin
 BUILT-IN SPECTRA, WILL BE NORMALIZED TO UNITY WHEN INTEGRATED           Virgin
 OVER THEIR ENTIRE ENERGY RANGE.                                         Virgin
                                                                         Virgin
 TRANSMITTED SPECTRA WILL NOT BE RE-NORMALIZED, SINCE IT ALREADY         Virgin
 INCLUDES THE NORMALIZATION OF THE INCIDENT SPECTRUM.                    Virgin
                                                                         Virgin
 NOTE, INCIDENT SPECTRA IS NORMALIZED TO UNITY OVER THEIR ENTIRE         Virgin
 ENERGY RANGE - NOT OVER THE ENERGY RANGE OF THE GROUPS. IF THE          Virgin
 ENERGY RANGE OF THE GROUPS IS LESS THAN THAT OF THE SPECTRUM            Virgin
 ONLY THAT PORTION OF THE SPECTRUM WILL BE USED AND THIS WILL            Virgin
 NOT BE RE-NORMALIZED TO UNITY.                                          Virgin
                                                                         Virgin
 COMPOSITION OF A LAYER                                                  Virgin
 ----------------------                                                  Virgin
 YOU MAY RUN PROBLEMS INVOLVING                                          Virgin
 1) A LAYER OF UNIFORM DENSITY - DENSITY FOR ATTENUATION IS THAT         Virgin
    OF THE TOTAL. DENSITY FOR REACTIONS IS THAT OF THE REACTION.         Virgin
 2) A LAYER OF UNIFORM DENSITY - DENSITY IS THE SUM OF THE TOTAL         Virgin
    AND REACTION DENSITIES - THE SUM OF THE CROSS SECTIONS IS            Virgin
    USED FOR ATTENUATION AND REACTIONS.                                  Virgin
 3) A LAYER OF VARYING DENSITY BASED ON A UNIFORM TOTAL DENSITY          Virgin
    PLUS A VARIATION BETWEEN 0 AND A MAXIMUM BASED ON THE                Virgin
    REACTION DENSITY - 0 AT 0 THICKNESS AND MAXIMUM AT MAXIMUM           Virgin
    THICKNESS. IN THIS CASE THE AVERAGE REACTION DENSITY IS EQUAL        Virgin
    TO THE INPUT REACTION DENSITY. THE VARIATION IN REACTION             Virgin
    DENSITY CAN BE LINEAR, SQUARE OR CUBIC.                              Virgin
 4) A LAYER OF VARYING DENSITY BASED ON A TOTAL DENSITY WHICH            Virgin
    VARYING FROM MAXIMUM AT 0 THICKNESS TO 0 AT MAXIMUM THICKNESS        Virgin
    PLUS A REACTION DENSITY WHICH VARIES FROM 0 AT 0 THICKNESS           Virgin
    TO MAXIMUM AT MAXIMUM THICKNESS. IN THIS CASE THE AVERAGE            Virgin
    DENSITY OF THE TOTAL AND REACTION WILL BOTH BE EQUAL TO THE          Virgin
    INPUT TOTAL AND REACTION DENSITIES. THE VARIATION IN TOTAL           Virgin
    AND REACTION DENSITY CAN BE LINEAR, SQUARE OR CUBIC.                 Virgin
                                                                         Virgin
 IN THE FIRST CASE THE TWO REQUESTED CROSS SECTIONS ARE CONSIDERED       Virgin
 TO BE INDEPENDENT - THE TOTAL CROSS SECTION IS USED TO CALCULATE        Virgin
 ATTENUATION AND THE REACTION CROSS SECTION IS USED TO CALCULATE         Virgin
 REACTIONS, E.G., TRANSMISSION THROUGH NATURAL URANIUM (THE TOTAL        Virgin
 CROSS SECTION SHOULD BE THAT OF NATURAL URANIUM) AND REACTIONS          Virgin
 IN A U-235 DETECTOR (THE REACTION CROSS SECTION SHOULD BE THAT OF       Virgin
```

```
U-235).                                                                 Virgin
                                                                        Virgin
IN THE OTHER THREE CASES THE TWO REQUESTED CROSS SECTIONS ARE           Virgin
TREATED AS TWO CONSTITUENTS OF A MIXTURE OF TWO MATERIALS AND           Virgin
THE TWO CROSS SECTIONS ARE USED BOTH TO DEFINE A TOTAL CROSS            Virgin
SECTION FOR ATTENUATION AND A REACTION CROSS SECTION TO DEFINE          Virgin
REACTIONS. IN THESE CASES THE MIXTURE WILL VARY CONTINUOUSLY,           Virgin
E.G., IN CASE 4) HALF WAY THROUGH THE LAYER THE COMPOSITION WILL        Virgin
BE 1/2 THE MATERIAL DEFINED BY THE TOTAL AND 1/2 THE MATERIAL           Virgin
BASED ON THE REACTION. IN THESE CASES RATHER THAN THINKING OF           Virgin
THE TWO CROSS SECTIONS AS A TOTAL AND REACTION CROSS SECTION,           Virgin
IT IS BETTER TO THINK OF THEM AS THE TOTAL CROSS SECTIONS FOR           Virgin
MATERIALS A AND B AND THE CALCULATED REACTIONS WILL BE BASED            Virgin
ON THESE TWO TOTAL CROSS SECTIONS.                                      Virgin
                                                                        Virgin

MULTIPLE LAYERS                                                         Virgin
---------------                                                         Virgin
THIS CODE MAY BE USED TO RUN EITHER A NUMBER OF INDEPENDENT             Virgin
PROBLEMS, EACH INVOLVING TRANSMISSION THROUGH A SINGLE LAYER OF         Virgin
MATERIAL, OR TRANSMISSION THROUGH A NUMBER OF LAYERS ONE AFTER          Virgin
THE OTHER.                                                              Virgin
                                                                        Virgin
IN THE CASE OF MULTIPLE LAYERS, ONE LAYER AFTER ANOTHER, THE            Virgin
TRANSMITTED ENERGY DEPENDENT SPECTRUM IS USED AS THE INCIDENT           Virgin
SPECTRUM FOR THE NEXT LAYER. THERE IS NO LIMIT TO THE NUMBER            Virgin
OF LAYERS WHICH MAY BE USED - EACH LAYER IS TREATED AS A                Virgin
COMPLETELY INDEPENDENT PROBLEM WITH A DEFINED INCIDENT SOURCE,          Virgin
AND AS SUCH THE CYCLE OF TRANSMISSION THROUGH EACH LAYER AND            Virgin
USING THE TRANSMITTED SPECTRUM AS THE INCIDENT SPECTRUM FOR THE         Virgin
NEXT LAYER MAY BE REPEATED ANY NUMBER OF TIMES.                         Virgin
                                                                        Virgin
REMEMBER - THE INCIDENT SPECTRUM IS ASSUMED TO BE LINEARLY              Virgin
INTERPOLABLE IN ENERGY AND SPECTRUM BETWEEN THE ENERGIES AT             Virgin
WHICH IT IS TABULATED. THE TRANSMITTED SPECTRUM WILL BE TABULATED       Virgin
AT THE UNION OF ALL ENERGIES OF THE INCIDENT SPECTRUM AND CROSS         Virgin
SECTIONS (TOTAL AND REACTION). IN ORDER TO INSURE THE ACCURACY          Virgin
OF THE RESULT WHEN PERFORMING MULTIPLE LAYER CALCULATION BE SURE        Virgin
TO SPECIFY THE INCIDENT SPECTRUM ON THE FIRST LAYER TO SUFFICIENT       Virgin
DETAIL (ENOUGH ENERGY POINTS CLOSELY SPACED TOGETHER) IN ORDER TO       Virgin
ALLOW THE TRANSMITTED SPECTRUM TO BE ACCURATELY REPRESENTED BY          Virgin
LINEAR INTERPOLATION BETWEEN SUCCESSIVE ENERGY POINTS - THERE IS        Virgin
NO LIMIT TO THE NUMBER OF POINTS ALLOWED IN THE INCIDENT SPECTRUM,      Virgin
SO IF YOU ARE IN DOUBT, SIMPLY USE MORE ENERGY POINTS TO SPECIFY        Virgin
THE INCIDENT SPECTRUM.                                                  Virgin
                                                                        Virgin
RESULT OUTPUT UNITS                                                     Virgin
-------------------                                                     Virgin
FLUX      = EXACTLY AS CALCULATED                                       Virgin
REACTIONS = 1/CM OR 1/GRAM                                              Virgin
AVERAGE   = 1/CM - MACROSCOPIC UNITS                                    Virgin
CROSS                                                                   Virgin
SECTION                                                                 Virgin
                                                                        Virgin
THICKNESS AND DENSITY                                                   Virgin
---------------------                                                   Virgin
THE UNCOLLIDED CALCULATION ONLY DEPENDS ON THE PRODUCT OF               Virgin
THICKNESS AND DENSITY (I.E. GRAMS PER CM SQUARED). THIS FACT            Virgin
MAY BE USED TO SIMPLIFY INPUT BY ALLOWING THE THICKNESS AND             Virgin
DENSITY TO BE GIVEN EITHER AS CM AND GRAMS/CC RESPECTIVELY              Virgin
OR ELSE TO GIVE THICKNESS IN GRAMS/(CM*CM) AND INPUT A                  Virgin
DENSITY OF 1.0 - OR IN ANY OTHER CONVENIENT UNITS AS LONG AS            Virgin
THE PRODUCT OF THICKNESS AND DENSITY IS IN THE CORRECT GRAMS            Virgin
PER CENTIMETER SQUARED.                                                 Virgin
                                                                        Virgin
GRAMS/(CM*CM) ARE RELATED TO ATOMS/BARN THROUGH THE RELATIONSHIP        Virgin
                                                                        Virgin
GRAMS/(CM*CM)=(ATOMS/BARN)*(GRAMS/MOLE)*(MOLE/ATOM)                     Virgin
```

```
                                                                      Virgin
OR...                                                                 Virgin
                                                                      Virgin
GRAMS/(CM*CM)=(ATOMS/BARN)*(ATOMIC WEIGHT)/0.602                      Virgin
                                                                      Virgin
CROSS SECTIONS AT A SPACE POINT AND OPTICAL THICKNESS                 Virgin
------------------------------------------------------                Virgin
THIS PROGRAM ALLOWS LAYERS OF EITHER UNIFORM DENSITY OR               Virgin
CONTINUOUSLY VARYING DENSITY. THE DENSITY CAN BE ONE OF THE           Virgin
FOLLOWING FORMS,                                                      Virgin
1) C                  = UNIFORM DENSITY                               Virgin
2) C*2*(X/T)          = LINEAR VARIATION FROM 0 TO C                  Virgin
3) C*(2-2*(X/T))      = LINEAR VARIATION FROM C TO 0                  Virgin
4) C*3*(X/T)**2       = SQUARE VARIATION FROM 0 TO C                  Virgin
5) C*(3-3*(X/T)**2)/2 = SQUARE VARIATION FROM C TO 0                  Virgin
6) C*4*(X/T)**3       = CUBIC VARIATION FROM 0 TO C                   Virgin
7) C*(4-4*(X/T)**3)/3 = CUBIC VARIATION FROM C TO 0                   Virgin
                                                                      Virgin
IN ORDER TO CALCULATE REACTIONS AT A POINT THE MICROSCOPIC            Virgin
REACTION CROSS SECTION NEED MERELY BE SCALED BY THESE DENSITIES.      Virgin
                                                                      Virgin
IN ORDER TO CALCULATE TRANSMISSION WE MUST DEFINE THE OPTICAL         Virgin
PATH LENGTH WHICH MAY BE DEFINED BY INTEGRATING EACH OF THE           Virgin
ABOVE DENSITY FORMS TO FIND,                                          Virgin
1) C*X                                                                Virgin
2) C*X*(X/T)                                                          Virgin
3) C*X*(2-(X/T))                                                      Virgin
4) C*X*(X/T)**2                                                       Virgin
5) C*X*(3-(X/T)**2)/2                                                 Virgin
6) C*X*(X/T)**3                                                       Virgin
7) C*X*(4-(X/T)**3))/3                                                Virgin
                                                                      Virgin
IN ORDER TO CALCULATE TRANSMISSION TO A POINT THE MICROSCOPIC         Virgin
TOTAL CROSS SECTION NEED MERELY BE SCALED BY THESE DENSITIES          Virgin
TO DEFINE THE OPTICAL PATH LENGTH.                                    Virgin
                                                                      Virgin
THE VARIATION OF THE DENSITY THROUGH THE LAYER MAY BE DEFINED         Virgin
BY SETTING X = 0 OR X = T TO FIND,                                    Virgin
   X = 0      X = T                                                   Virgin
   -----      -----                                                   Virgin
1) C          C                                                       Virgin
2) 0          2*C                                                     Virgin
3) 2*C        0                                                       Virgin
4) 0          3*C                                                     Virgin
5) 3*C/2      0                                                       Virgin
6) 0          4*C                                                     Virgin
7) 4*C/3      0                                                       Virgin
                                                                      Virgin
THE OPTICAL PATH THROUGH A LAYER OF THICKNESS T MAY BE DEFINED        Virgin
FROM THE ABOVE EXPRESSIONS BY SETTING X=T TO FIND THAT IN ALL         Virgin
CASES THE ANSWER WILL BY C*T. THE CONSTANTS IN THE ABOVE              Virgin
EXPRESSIONS HAVE BEEN INTRODUCED IN ORDER TO FORCE THIS RESULT.       Virgin
WITH THESE FACTORS THE OPTICAL PATH LENGTH THROUGH THE LAYER          Virgin
WILL EXACTLY CORRESPOND TO AN AVERAGE DENSITY CORRESPONDING TO        Virgin
THAT INPUT FOR THE TOTAL AND/OR REACTION, I.E., C CORRESPONDS         Virgin
TO THE INPUT DENSITY.                                                 Virgin
                                                                      Virgin
NOTE - FOR THE SAME OPTICAL PATH LENGTHS THROUGH THE LAYER THE        Virgin
TRANSMISSION WILL BE EXACTLY THE SAME. HOWEVER, VARYING THE           Virgin
DENSITY WILL ALLOW YOU TO MODIFY THE REACTION RATES AT SPECIFIC       Virgin
DEPTHS INTO THE LAYER.                                                Virgin
                                                                      Virgin
COMPUTATION OF INTEGRALS                                              Virgin
------------------------                                              Virgin
STARTING FROM TOTAL CROSS SECTIONS, REACTION CROSS SECTIONS AND       Virgin
A SOURCE SPECTRUM ALL OF WHICH ARE GIVEN IN TABULAR FORM WITH         Virgin
LINEAR INTERPOLATION BETWEEN TABULATED POINTS ALL REQUIRED            Virgin
INTEGRALS CAN BE DEFINED BY ANALYTICAL EXPRESSIONS INVOLVING          Virgin
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NOTHING MORE COMPLICATED THAN EXPONENTIALS. THE INTEGRALS THAT     Virgin
MUST BE EVALUATED ARE OF THE FORM...                               Virgin
                                                                   Virgin
FLUX                                                               Virgin
----                                                               Virgin
(INTEGRAL EK TO EK+1) (S(E)* EXP(-XCT(E)*Z)*DE)                    Virgin
                                                                   Virgin
REACTIONS                                                          Virgin
---------                                                          Virgin
(INTEGRAL EK TO EK+1) (S(E)*XCR(E)*EXP(-XCT(E)*Z)*DE)              Virgin
                                                                   Virgin
WHERE..                                                            Virgin
EK TO EK+1 = LONGEST ENERGY INTERVAL OVER WHICH S(E), XCT(E) AND   Virgin
             XCR(E) ARE ALL LINEARLY INTERPOLABLE.                 Virgin
S(E)       = ENERGY DEPENDENT WEIGHTING SPECTRUM                   Virgin
XCR(E)     = REACTION CROSS SECTION                                Virgin
XCT(E)     = OPTICAL PATH LENGTH (BASED ON TOTAL CROSS SECTION)    Virgin
Z          = MATERIAL THICKNESS                                    Virgin
                                                                   Virgin
S(E), XCR(E) AND XCT(E) ARE ALL ASSUMED TO BE GIVEN IN TABULAR     Virgin
FORM WITH LINEAR INTERPOLATION USED BETWEEN TABULATED POINTS.      Virgin
IN OTHER WORDS BETWEEN TABULATED POINTS EACH OF THESE THREE IS     Virgin
DEFINED BY A FUNCTION OF THE FORM...                               Virgin
                                                                   Virgin
F(E)=((E - EK)*FK+1 + (EK+1 - E)*FK)/(EK+1 - EK)                   Virgin
                                                                   Virgin
EACH OF THESE THREE CAN BE CONVERTED TO NORMAL FORM BY THE         Virgin
CHANGE OF VARIABLES....                                            Virgin
                                                                   Virgin
X=(E - 0.5*(EK+1 + EK))/(EK+1 - EK)                                Virgin
                                                                   Virgin
IN WHICH CASE X WILL VARY FROM -1 (AT EK) TO +1 (AT EK+1) AND      Virgin
EACH FUNCTION REDUCES TO THE NORMAL FORM...                        Virgin
                                                                   Virgin
F(X)=0.5*(FK*(1 - X) + FK+1*(1 + X))                               Virgin
    =0.5*(FK+1 + FK) + 0.5*(FK+1 - FK)*X                           Virgin
                                                                   Virgin
BY DEFINING THE AVERAGE VALUE AND 1/2 THE CHANGE ACROSS THE        Virgin
INTERVAL.                                                          Virgin
                                                                   Virgin
AVF=0.5*(FK+1 + FK)                                                Virgin
DF= 0.5*(FK+1 - FK)                                                Virgin
DE= 0.5*(EK+1 - EK)                                                Virgin
                                                                   Virgin
EACH OF THE THREE FUNCTIONS REDUCES TO THE SIMPLE FORM...          Virgin
                                                                   Virgin
F(X)=AVF+DF*X                                                      Virgin
                                                                   Virgin
AND THE TWO REQUIRED INTEGRALS REDUCE TO...                        Virgin
                                                                   Virgin
FLUX                                                               Virgin
----                                                               Virgin
DE*EXP(-AVXCT*Z) * (INTEGRAL -1 TO +1)                             Virgin
((AVS+DS*X)*EXP(-DXCT*Z*X)*DX)                                     Virgin
                                                                   Virgin
REACTION                                                           Virgin
--------                                                           Virgin
DE*EXP(-AVXCT*Z) * (INTEGRAL -1 TO +1)                             Virgin
((AVS*AVXCR+(AVS*DXCR+AVXCR*DS)*X+DS*DXCR*X*X)*EXP(-DXCT*Z*X)*DX)  Virgin
                                                                   Virgin
WHERE                                                              Virgin
                                                                   Virgin
AVXCT   = AVERAGE VALUE OF THE TOTAL CROSS SECTION                 Virgin
AVXCR   = AVERAGE VALUE OF THE REACTION CROSS SECTION              Virgin
AVS     = AVERAGE VALUE OF THE SOURCE                              Virgin
DXCT    = 1/2 THE CHANGE IN THE TOTAL CROSS SECTION                Virgin
DXCR    = 1/2 THE CHANGE IN THE REACTION CROSS SECTION             Virgin
DS      = 1/2 THE CHANGE IN THE SOURCE                             Virgin
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DE      = 1/2 THE CHANGE IN THE ENERGY                                  Virgin
                                                                        Virgin
NOTE THAT IN THIS FORM THE ENERGY ONLY APPEARS IN FRONT OF THE          Virgin
INTEGRALS AND THE INTEGRALS ARE EXPRESSED ONLY IN TERMS OF THE          Virgin
TABULATED VALUES OF S(E), XCT(E) AND XCR(E). IN PARTICULAR NO           Virgin
DERIVATIVES ARE USED, SO THAT THERE ARE NO NUMERICAL INSTABILITY        Virgin
PROBLEMS IN THE VACINITY OF DISCONTINUITIES IN S(E), XCT(E) OR          Virgin
XCR(E). INDEED, SINCE (EK+1 - EK) APPEARS IN FRONT OF THE INTEGRAL      Virgin
POINTS OF DISCONTINUITY AUTOMATICALLY MAKE ZERO CONTRIBUTION TO         Virgin
THE INTEGRALS.                                                          Virgin
                                                                        Virgin
THE REQUIRED INTEGRALS CAN BE EXPRESSED IN TERMS OF THE THREE           Virgin
INTEGRALS IN NORMAL FORM....                                            Virgin
                                                                        Virgin
F(A,N) = (INTEGRAL -1 TO 1) (X**N*EXP(-A*X)*DX), N=0,1 AND 2.           Virgin
                                                                        Virgin
THESE THREE INTEGRALS CAN BE EVALUATED TO FIND...                       Virgin
                                                                        Virgin
N=0                                                                     Virgin
---                                                                     Virgin
F(A,0) = (EXP(A)-EXP(-A))/A                                             Virgin
                                                                        Virgin
N=1                                                                     Virgin
---                                                                     Virgin
F(A,1) = ((1-A)*EXP(A)-(1+A)*EXP(-A))/(A*A)                             Virgin
                                                                        Virgin
N=2                                                                     Virgin
---                                                                     Virgin
F(A,2) = ((2-2*A+A*A)*EXP(A)-(2+2*A+A*A)*EXP(-A))/(A*A*A)               Virgin
                                                                        Virgin
HOWEVER THESE EXPRESSIONS ARE NUMERICALLY UNSTABLE FOR SMALL            Virgin
VALUES OF A. THEREFORE FOR SMALL A THE EXPONENTIAL IN THE               Virgin
INTEGRALS ARE EXPANDED IN A POWER SERIES...                             Virgin
                                                                        Virgin
EXP(-AX)=1.0-(AX)+(AX)**2/2-(AX)**3/6+(AX)**4/24-........               Virgin
        =(SUM K=0 TO INFINITY) (-AX)**K/(K FACTORIAL)                   Virgin
                                                                        Virgin
AND THE INTEGRAL REDUCES TO THE FORM....                                Virgin
                                                                        Virgin
(SUM K=0 TO INFINITY) ((-A)**K/(K FACTORIAL)) *                         Virgin
(INTEGRAL -1 TO 1) (X**(N+K))*DX                                        Virgin
                                                                        Virgin
WHICH CAN BE ANALYTICALLY EVAULATED TO FIND....                         Virgin
(K(N) = K FACTORIAL)                                                    Virgin
                                                                        Virgin
N=0                                                                     Virgin
---                                                                     Virgin
F(A,0) = 2*(1+(A**2)/K(3)+(A**4)/K(5)+(A**6)/K(7)+....                  Virgin
                                                                        Virgin
N=1                                                                     Virgin
---                                                                     Virgin
F(A,1) = -2*A*(2/K(3)+4*(A**2)/K(5)+6*(A**4)/K(7)+8*(A**6)/K(9)+..      Virgin
                                                                        Virgin
N=2                                                                     Virgin
---                                                                     Virgin
F(A,2) = 2*(2/K(3)+3*4*(A**2)/K(5)+5*6*(A**4)/K(7)+                     Virgin
         7*8*(A**6)/K(9)+....                                           Virgin
                                                                        Virgin
THESE EXPANSIONS ARE USED WHEN THE ABSOLUTE VALUE OF A IS LESS          Virgin
THAN 0.1. BY TRUNCATING THE ABOVE SERIES BEFORE A**8 THE ERROR          Virgin
RELATIVE TO THE LEADING TERM OF THE SERIES WILL BE 10**(-10),           Virgin
YIELDING 10 DIGIT ACCURACY.                                             Virgin
                                                                        Virgin
AFTER EVALUATING THE ABOVE FUNCTIONS, EITHER DIRECTLY OR BY USING       Virgin
THE EXPANSION THE TWO REQUIRED INTEGRALS CAN BE WRITTEN AS...           Virgin
                                                                        Virgin
FLUX                                                                    Virgin
```

```
----                                                                  Virgin

DE*EXP(-AVXCT*Z)*(AVS*F(A,0) + DS*F(A,1))                             Virgin
                                                                      Virgin
REACTIONS                                                             Virgin
---------                                                             Virgin
DE*EXP(-AVXCT*Z)*                                                     Virgin
(AVS*AVXCR*F(A,0) + (AVS*DXCR+AVXCR*DS)*F(A,1) + DS*DXCR*F(A,2))      Virgin
                                                                      Virgin
INPUT FILES                                                           Virgin
-----------                                                           Virgin
FILENAME  UNIT  DESCRIPTION                                           Virgin
--------  ----  -----------                                           Virgin
INPUT       2   INPUT LINES                                           Virgin
ENDFIN     10   EVALUATED DATA IN ENDF/B FORMAT                       Virgin
                                                                      Virgin
OUTPUT FILES                                                          Virgin
------------                                                          Virgin
FILENAME  UNIT  DESCRIPTION                                           Virgin
--------  ----  -----------                                           Virgin
OUTPUT      3   OUTPUT LISTING                                        Virgin
                                                                      Virgin
SCRATCH FILES                                                         Virgin
-------------                                                         Virgin
FILENAME  UNIT  DESCRIPTION                                           Virgin
--------  ----  -----------                                           Virgin
SCR1       12   REACTION, FLUX AND CROSS SECTION RESULTS (BCD)        Virgin
                (SORTED AT END OF RUN AND OUTPUT SEPARATELY)          Virgin
SCR2       13   TALLY GROUP ENERGY BOUNDARIES (BINARY)                Virgin
SCR3       14   SOURCE SPECTRUM (BINARY)                              Virgin
SCR4       15   TOTAL CROSS SECTION (BINARY)                          Virgin
SCR5       16   REACTION CROSS SECTION (BINARY)                       Virgin
                                                                      Virgin
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILEIO2)      Virgin
---------------------------------------------------------------       Virgin
UNIT  FILE NAME   FORMAT                                              Virgin
----  ----------  ------                                              Virgin
  2   VIRGIN.INP   BCD                                                Virgin
  3   VIRGIN.LST   BCD                                                Virgin
 10   ENDFB.IN     BCD                                                Virgin
11-15 (SCRATCH)   BINARY                                              Virgin
 16   PLOTTAB.CUR PLOTTAB OUTPUT FORMAT DATA                           Virgin
                                                                      Virgin
INPUT LINES                                                           Virgin
-----------                                                           Virgin
ANY NUMBER OF CASES MAY BE RUN ONE AFTER THE OTHER. AFTER THE         Virgin
FIRST CASE HAS BEEN RUN THE FOLLOWING CASES MAY USE THE SAME          Virgin
THICKNESSES, GROUP STRUCTURE AND SPECTRUM AS THE PRECEDING CASE.      Virgin
IN ADDITION THE TRANSMITTED SPECTRUM FROM ONE CASE MAY BE USED        Virgin
AS THE INCIDENT SPECTRUM IN THE NEXT CASE, TO ALLOW MULTIPLE          Virgin
LAYERS OF DIFFERENT MATERIALS.                                        Virgin
                                                                      Virgin
LINE  COLS.  FORMAT  DESCRIPTION                                      Virgin
----  -----  ------  ----------                                       Virgin
   1   1-60   ENDF/B INPUT DATA FILENAME                              Virgin
                (STANDARD OPTION = ENDFB.IN)                          Virgin
                                                                      Virgin
LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL        Virgin
THEN USE STANDARD FILENAMES.                                          Virgin
                                                                      Virgin
 2-3   1-72   18A4   TWO LINE TITLE DESCRIBING PROBLEM                 Virgin
   4   1- 6    I6    ZA (1000*Z+A) OF TARGET FOR TOTAL                 Virgin
       7-11    I5    MT OF TOTAL                                       Virgin
      12-22   E11.4  DENSITY FOR TOTAL                                 Virgin
      23-28    I6    ZA (1000*Z+A) OF TARGET FOR REACTION              Virgin
      29-33    I5    MT OF REACTION                                    Virgin
                     = 0 - NO REACTION CALCULATION (ONLY FLUX).        Virgin
                     = GREATER THAN 0 - CALCULATE REACTIONS.           Virgin
```

	34-44	E11.4	DENSITY FOR REACTION	Virgin
	45-50	I6	NUMBER OF TARGET THICKNESSES	Virgin
			= GREATER THAN 0 = READ FROM INPUT	Virgin
			(1 TO 2000 ALLOWED)	Virgin
			= 0 = SAME AS LAST CASE	Virgin
	51-55	I5	NUMBER OF TALLY GROUPS	Virgin
			(REMEMBER NUMBER OF GROUP BOUNDARIES	Virgin
			IS ONE MORE THAN THE NUMBER OF GROUPS)	Virgin
			UP TO 2000 GROUPS ARE ALLOWED	Virgin
			BUILT-IN GROUP STRUCTURES.	Virgin
			= GREATER THAN 0 = READ FROM INPUT	Virgin
			= 0 SAME AS LAST CASE	Virgin
			= -1 TART 175 GROUPS	Virgin
			= -2 ORNL 50 GROUPS	Virgin
			= -3 ORNL 126 GROUPS	Virgin
			= -4 ORNL 171 GROUPS	Virgin
			= -5 SAND-II 620 GROUPS..UP TO 18 MEV.	Virgin
			= -6 SAND-II 640 GROUPS..UP TO 20 MEV.	Virgin
			= -7 WIMS 69 GROUPS	Virgin
			= -8 GAM-I 68 GROUPS	Virgin
			= -9 GAM-II 99 GROUPS	Virgin
			=-10 MUFT 54 GROUPS	Virgin
			=-11 ABBN 28 GROUPS	Virgin
	56-60	I5	NUMBER OF POINTS IN SOURCE SPECTRUM	Virgin
			(MUST BE AT LEAST TWO POINTS)	Virgin
			= GREATER THAN 1 = READ FROM INPUT	Virgin
			= 0 = SAME AS LAST CASE	Virgin
			= -1 = CONSTANT (ENERGY INDEPENDENT)	Virgin
			= -2 = 1/E	Virgin
			= -3 = BLACKBODY - PHOTON SPECTRUM	Virgin
			= -4 = BLACKBODY - ENERGY SPECTRUM	Virgin
			= -5 = TRANSMITTED SPECTRUM FROM LAST CASE	Virgin
			NOTE, ALL SPECTRA, EXCEPT THE TRANSMITTED	Virgin
			SPECTRUM FROM THE LAST CASE, WILL BE	Virgin
			NORMALIZED SUCH THAT ITS INTEGRAL OVER	Virgin
			ENERGY WILL BE UNITY.	Virgin
	61-64	1X,3I1	SPATIALLY DEPENDENT OUTOUT	Virgin
			= 0 = NO	Virgin
			= 1 = YES	Virgin
			FOR THE 3 QUANTITIES	Virgin
			COLUMN 67 FLUX	Virgin
			68 REACTIONS	Virgin
			69 AVERAGE CROSS SECTION	Virgin
	65-65	I1	ENERGY DEPENDENT OUTOUT	Virgin
			= 0 = NONE	Virgin
			= 1 = INCIDENT SPECTRUM	Virgin
			= 2 = TRANSMITTED SPECTRUM	Virgin
			= 3 = INCIDENT REACTIONS	Virgin
			= 4 = TRANSMIITED REACTIONS	Virgin
			= 5 = TOTAL CROSS SECTION	Virgin
			= 6 = REACTION CROSS SECTION	Virgin
5	1-11	E11.4	BLACKBODY TEMPERATURE IN EV	Virgin
	12-22	E11.4	FLUX NORMALIZATION	Virgin
	23-33	E11.4	REACTION NORMALIZATION	Virgin
			CALCULATIONS WILL BE BASED ON THE SPECTRUM	Virgin
			AND CROSS SECTIONS AS READ. AT OUTPUT THE	Virgin
			RESULTS WILL BE MULTIPLIED BY THESE	Virgin
			NORMALIZATION FACTORS.	Virgin
	34-44	I11	DENSITY PROFILE	Virgin
			= 0 - UNIFORM - BASED ON TOTAL DENSITY	Virgin
			= 1 - UNIFORM - TOTAL + REACTION DENSITY	Virgin
			= 2 - TOTAL + LINEAR REACTION	Virgin
			= 3 - LINEAR (TOTAL + REACTION)	Virgin
			= 4 - TOTAL + SQUARE REACTION	Virgin
			= 5 - SQUARE (TOTAL + REACTION)	Virgin
			= 6 - TOTAL + CUBIC REACTION	Virgin
			= 7 - CUBIC (TOTAL + REACTION)	Virgin
6-N	1-66	6E11.4	TARGET THICKNESSES IN CM	Virgin

```
                      IF SAME AS LAST CASE THIS SECTION IS NOT      Virgin
                      INCLUDED IN THE INPUT.                        Virgin
     VARY   1-66  6E11.4  TALLY GROUP ENERGY BOUNDARIES            Virgin
                      (NUMBER OF BOUNDARIES IS ONE MORE THAN        Virgin
                      THE NUMBER OF TALLY GROUPS)                   Virgin
                      IF THE STANDARD OPTION (-11 TO 0) IS          Virgin
                      SELECTED THIS SECTION IS NOT INCLUDED         Virgin
                      IN THE INPUT                                  Virgin
     VARY   1-66  6E11.4  SOURCE SPECTRUM IN ENERGY (EV)-SOURCE PAIRS Virgin
                      (MUST BE AT LEAST TWO POINTS)                 Virgin
                      IF STANDARD OPTION (-5 TO 0) IS SELECTED THIS Virgin
                      SECTION IS NOT INCLUDED IN THE INPUT          Virgin
                                                                    Virgin
     ANY NUMBER OF CASES MAY BE RUN ONE AFTER ANOTHER.              Virgin
                                                                    Virgin
     EXAMPLE INPUT NO. 1                                            Virgin
     -------------------                                            Virgin
     CALCULATE THE UNCOLLIDED FLUX AND CAPTURE (MT=102) THROUGH     Virgin
     30 CM OF IRON (DENSITY 7.87 G/CC). TALLY THE RESULTS USING     Virgin
     THE TART 175 GROUP STRUCTURE. THE SOURCE WILL BE CONSTANT      Virgin
     FROM 1 KEV TO 20 MEV. USE THE STANDARD ENDF/B INPUT DATA       Virgin
     FILENAME.                                                      Virgin
                                                                    Virgin
     ENDFB.IN                                                       Virgin
     IRON 0 TO 30 CM THICK.                                         Virgin
     CONSTANT SOURCE FROM 1 KEV TO 20 MEV.                          Virgin
      26000    1 7.87000+ 0 26000  102 7.87000+ 0     2    0    2 1100  Virgin
      0.00000+ 0 1.00000+ 0 1.00000+ 0          0 0.00000+00            Virgin
      0.00000+00 3.00000+01                                         Virgin
      1.0000E+03 1.0000E+00 2.0000E+07 1.0000E+00                   Virgin
                                                                    Virgin
     EXAMPLE INPUT NO. 2                                            Virgin
     -------------------                                            Virgin
     CALCULATE THE UNCOLLIDED PHOTON FLUX THROUGH A MIXTURE OF SILICON  Virgin
     AND IRON FOR 100 MEV PHOTONS INCIDENT. THE TRANSMISSION WILL BE    Virgin
     CALCULATED FOR 21 THICKNESSES VARYING BETWEEN 0 AND 1 CM. THERE    Virgin
     WILL BE ONLY 1 TALLY GROUP SPANNING A VERY NARROW ENERGY RANGE     Virgin
     NEAR 100 MEV, AND THE SOURCE SPECTRUM WILL BE CONSTANT OVER THE    Virgin
     SAME ENERGY RANGE. USE THE STANDARD ENDF/B INPUT DATA FILENAME     Virgin
     BY LEAVING THE FIRST INPUT LINE BLANK.                         Virgin
                                                                    Virgin
     (THIS IS A BLANK LINE TO USE THE STANDARD INPUT FILENAME)      Virgin
     100 MEV PHOTONS                                                Virgin
     SILICON + 5 % IRON                                             Virgin
      14000  521 2.30000+ 0 26000  521 1.15000- 1    21    1    2 1000  Virgin
      0.00000+ 0 1.00000+ 0 1.00000+ 0          1 0.00000+00            Virgin
      0.00000+00 5.00000-01 1.00000+00 1.50000+00 2.00000+00 2.50000+00 Virgin
      3.00000+00 3.50000+00 4.00000+00 4.50000+00 5.00000+00 5.50000+00 Virgin
      6.00000+00 6.50000+00 7.00000+00 7.50000+00 8.00000+00 8.50000+00 Virgin
      9.00000+00 9.50000+00 1.00000+01                              Virgin
      9.99000+ 7 1.00100+ 8                                         Virgin
      9.99000+ 7 1.00000+ 4 1.00100+ 8 1.00000+ 4                   Virgin
                                                                    Virgin
=====================================================================  Virgin
```