International Atomic Energy Agency
Nuclear Data Services
DOCUMENTATION SERIES OF THE IAEA NUCLEAR DATA SECTION

IAEA-NDS-39
Rev. 17, 4 May 2017

PREPRO 2017
2017 ENDF/B Pre-processing Codes
(ENDF/B-VII or Proposed VIII Tested)

Owned, Maintained and Distributed
by
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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 MAC (OSX). The codes are available on CD-ROM 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 or code is sent out by the IAEA Nuclear Data Section, it will be accompanied by an IAEA-NDS-report which should give the user all necessary documentation on contents, format and origin of the data library or code.

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

Neither the originator of the data libraries or codes 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 or code and/or to the data center which issued the data library or code. The editor of the IAEA-NDS-report is usually not the author of the data library or code.

This computer code package should be cited as follows: D.E. Cullen, "PREPRO 2017: 2017 ENDF/B Pre-processing Codes", report IAEA-NDS-39, Rev. 17, May 4, 2017.

Nuclear Data Section Introduction

Here I attempt to distinguish between the ENDF **format**, and the **data in the format.** ENDF is the internationally agreed upon **format** for dissemination of evaluated nuclear data; it now been through six (6) versions, ENDF-1 through the current ENDF-6 **formats**. In contrast, the ENDF/B **data library** has now been through seven (VII) versions; the latest identified as ENDF/B-VII. Until fairly recently the **format** and **data in the format** corresponded because ENDF/B-I through ENDF/B-VI **data** were in the ENDF-1 through ENDF-6 **format**. However, for the latest ENDF/B-VII data library the formats were not changed, so that the VII **data** is in the ENDF-6 **format**.

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/csewg/docs/endf-manual.pdf

or the Nuclear Data Section of the IAEA
http://www-nds.iaea.org/ndspub/endf/prepro/DOCUMENT/DOCUMENT.HTM

The 2017 ENDF/B Pre-processing codes process nuclear data formatted in any version of the ENDF **formats**; ENDF-1 through ENDF-6 evaluations, i.e. all versions of the ENDF/B **data**, I through VII. These codes can be used on virtually any computer: everything from large mainframe computers, to workstations, to IBM-PC (Windows or Linux) and 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 17) 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 2017 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, much of the work involved in maintaining, testing and distributing the previous and current versions of the PREPRO codes, was done by **Kevin McLaughlin** (NDS, IAEA, Vienna). For over 30 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 and nuclear data community in saying that Kevin will be greatly missed both as a co-worker and as a good friend.

Acknowledgement

Today's PREPRO 2017 codes represent the efforts of many more people than just the author. First I must acknowledge the contributions of those who prepared the PREPRO 2017 package for release. I thank **Jean Christophe Sublet** (NDS,IAEA), for preparing MAC (OSX) executables and testing the MAC (OSX) executables, and **Andrej Trkov** (NDS,IAEA) and **Bojan Zefran** (IJS, Slovenia), for preparing executables and testing the LINUX executables. I must express special thanks to **Arjan Koning** (NDS, IAEA) for testing all of the codes using many different compilers, and for doing a truly amazing job finding incredibly subtle faults, which because of his efforts have now all been corrected. I also thank **Andrej Trkov** (Nuclear Data Section, IAEA, Vienna), who are now in charge of PREPRO at IAEA, and prepared the final PREPRO 2017 package for release on the NDS website.

I thank Bob MacFarlane (LANL), for the decades of cooperation and coordination between NJOY and PREPRO that we have shared; together we recognized that our codes are far too complicated to allow us to assume that hard work and good intentions are enough to make them accurate and cooperation benefitted both of us and our codes – **only by code comparisons can we be confident of our results**. Now that Bob has retired I will greatest miss this cooperative effort and Bob's keen insight.

I gratefully acknowledge the contribution of **S. Ganesan** (BARC, India), **Andrej Trkov** (NDS, IAEA) and **Jean Christophe Sublet** (NDS, IAEA) in continuing to propose interesting and useful extensions to these codes; keep those great ideas coming guys I also acknowledge **Janice Arwood** (RSICC, Oak Ridge) and Mark Baird (RSICC, Oak Ridge), for their review of the documentation and testing of codes prior to their distribution through RSIC. I am sorry to announce that **Jennie Manneschmidt**, who worked on these codes at RSICC for so many years, and if my memory serves me right is the one who thought up the name PREPRO, has now retired; she will be greatly missed by the entire computer code and nuclear data communities.

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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 completely different formats, but circa 1970, when I worked at the NNDC, Brookhaven, I realized that two different formats were not needed, so we abandoned the ENDF/A format and adopted the ENDF/B format for both partial (A) and complete (B) evaluations; this is what we today call the **ENDF 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 United Stated the data is referred to as **ENDF/B-VII**, in Western Europe, **JEFF**, in Japan, **JENDL**, in China, **CENDL**, in Russia, **BROND**, 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**. In contrast the United States **ENDF/B data library** has now been through seven major versions, with the current data library defined by **ENDF/B-VII**.

Features of 2017 Version

What is New

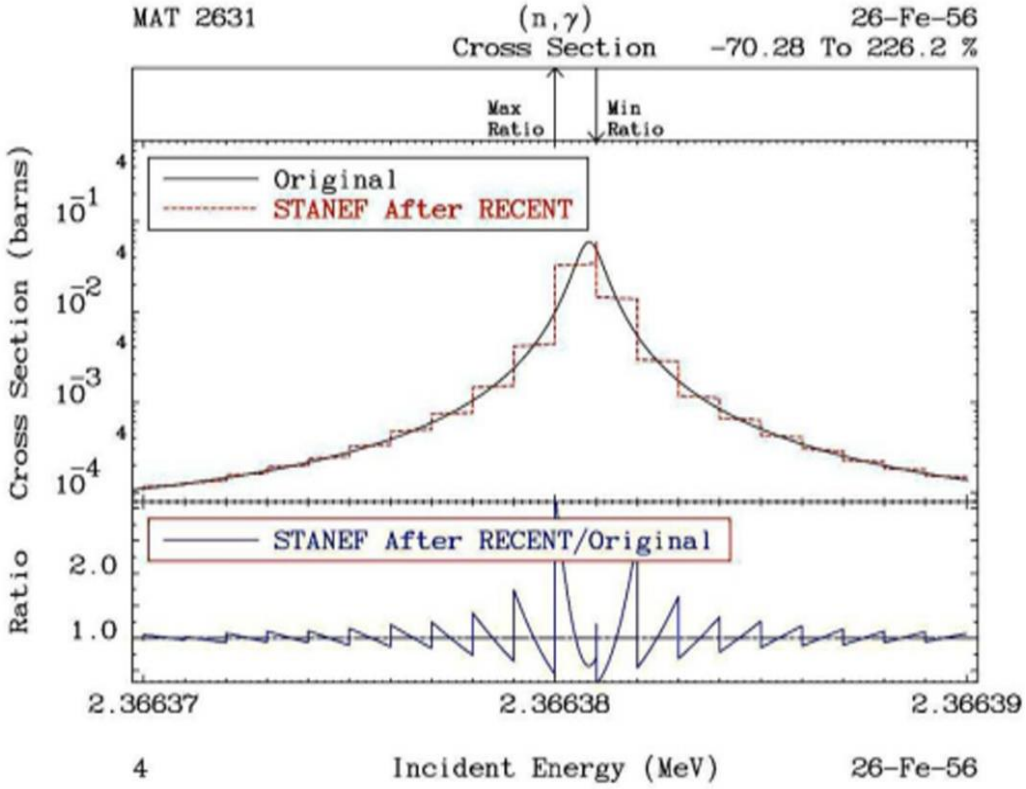
Compared to earlier versions of these codes the 2017 version has the following features,

Codes Modernized: The codes have ALL been modernized and updated to make them even more compatible for use on ANY COMPUTER. All of the codes are now designed to be 100% compatible for use on 32 or 64 bit computers. All of the codes have been further optimized and improved; in most cases the improvements are based on feedback from code users; this feedback is most appreciated and benefits all of us, by insuring that the codes are as compatible as possible with our needs.

The 2017 versions are bigger and faster than preceding versions, in line with the ever increasing size and speed of our computers. This will allow you to treat much larger and more complex problems in a reasonable amount of time. It has also led to improved precision of the tabulated cross sections, particularly for very narrow resonances. Code Modernization (described above) allows the codes to be further sped up by using very aggressive optimization.

PREPRO uses 9 or 10 digit precision for all ENDF output. For example consider: 9 digits: 12324.56789, versus 7 digits: 1.234567+3. Here in we can see that the 9 digit output is a hundred times more precise compared to the 7 digit output. This is very important for narrow milli-eV wide resonances in the keV or today even in the

MeV energy range. Below I show the difference between PREPRO 2017 output data using 9 or 10 digits of accuracy compared to STANEF using 7 digits. For this narrow resonance the differences are very dramatic, with PREPRO showing a smooth resonance shape and STANEF showing a Ziggurat (i.e., a stepped pyramid). The differences seen here are solely due to the precision each code uses to output data in the ENDF format, resulting in differences up to over a factor of 2, i.e., not 2%, a factor of 2, over 100% differences.



FORTRAN, C and C++ Compatible ENDF results: I have added the ENDF2C code to PREPRO, to insure that ALL PREPRO output in the ENDF format are completely FORTRAN, C and C++ compatible. As of today (January 2017) evaluated data even from major code centers are still not completely FORTRAN, C and C++ compatible. Therefore when I begin pre-processing any evaluation the first PREPRO code I run is ENDF2C to insure that ALL ENDF formatted output in subsequent codes are completely compatible. This is a very important step: it would be such a shame if after all of the effort invested to produce accurate results it cannot be accurately read and used by application codes. If as recommended you ALWAYS use ENDF2C first you will be able to avoid this problem. To maintain 100% ENDF-6 compatible PREPRO2017 also uses the current ENDF convention that sequence numbers start at 1 for each section (MAT/MF/MT), instead of the older convention starting at 1 for each material (MAT).

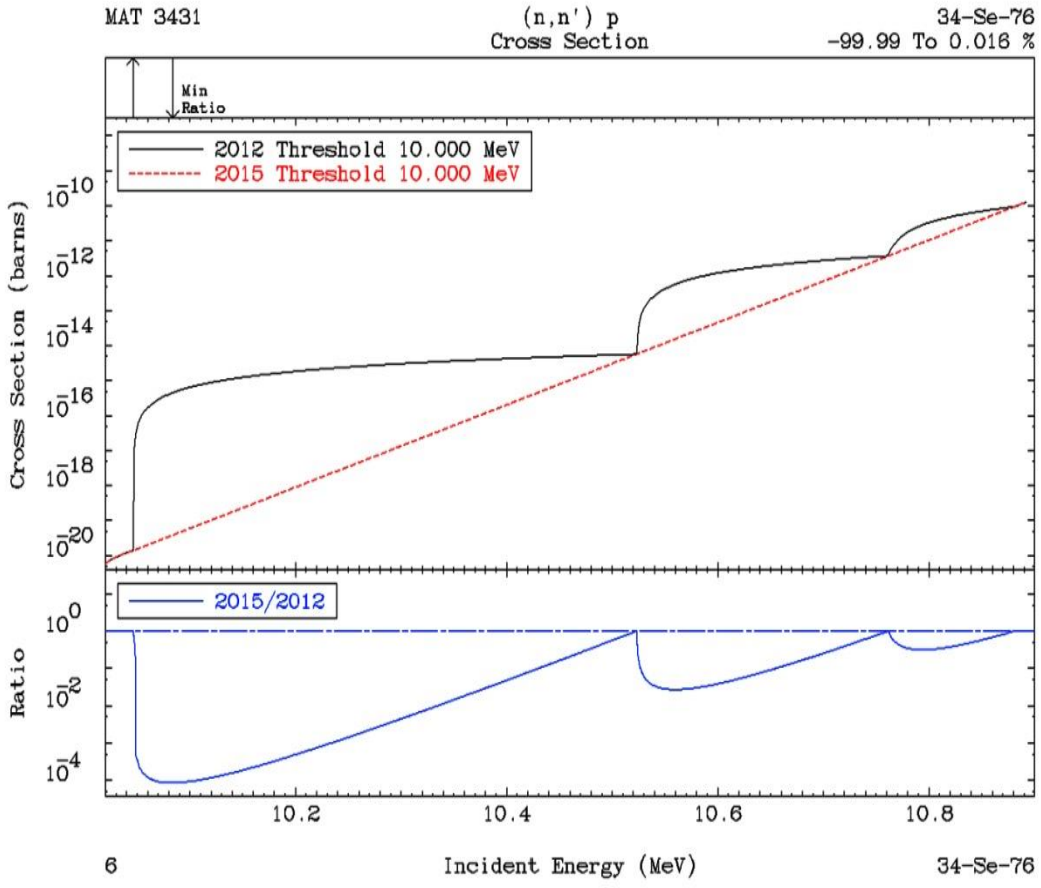
Before ENDF2C

```
1.002000+3 1.996800+0          0          0          0          0 128 3  1  125
0.000000+0 0.000000+0          0          0          1        149 128 3  1  126
       149          2                                             128 3  1  127
1.000000-5 3.420300+0 1.000000-4 3.403000+0 2.530000-2 3.395510+0 128 3  1  128
1.000000+2 3.395010+0 1.000000+3 3.394900+0 2.000000+3 3.394800+0 128 3  1  129
3.000000+3 3.394400+0 4.000000+3 3.389400+0 5.000000+3 3.385000+0 128 3  1  130
1.000000+4 3.367000+0 2.000000+4 3.342000+0 3.000000+4 3.321000+0 128 3  1  131
4.000000+4 3.302000+0 5.000002+4 3.285000+0 6.000002+4 3.270000+0 128 3  1  132
```

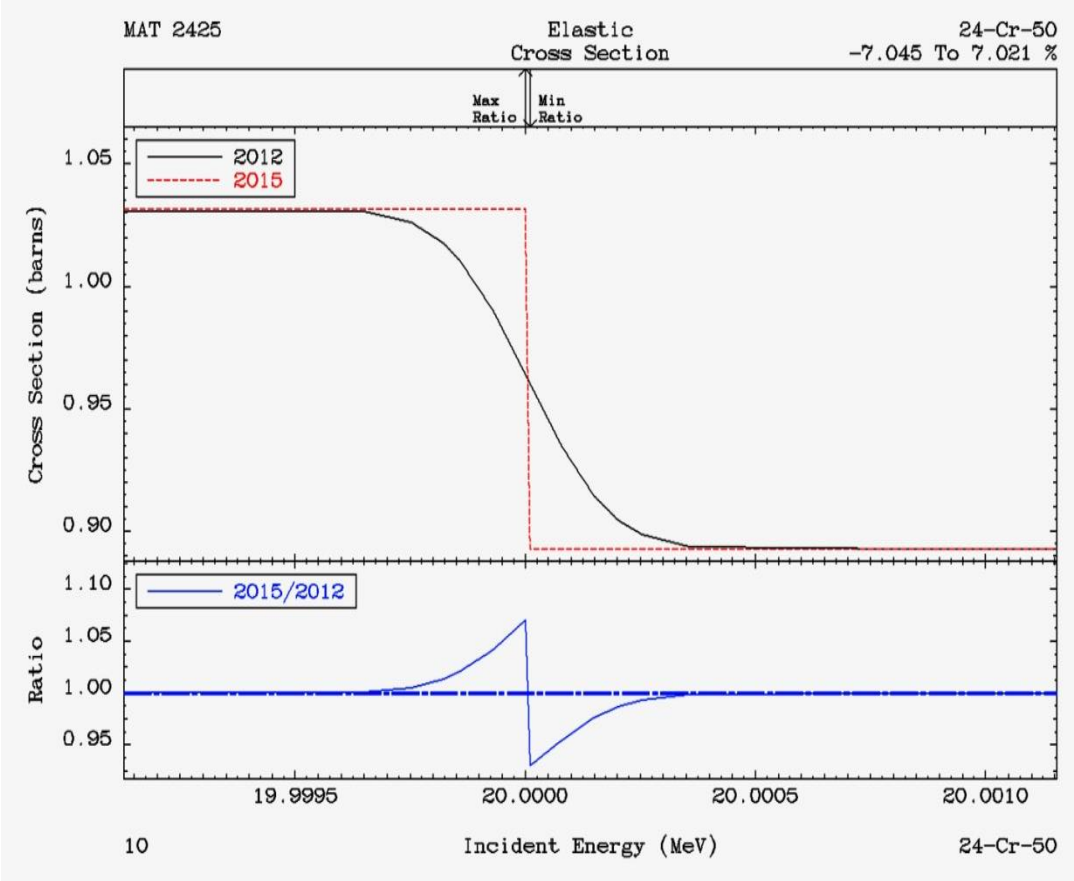
After ENDF2C

```
1002.00000 1.99680000          0          0          0          0 128 3  1    1
0.0        0.0                 0          0          1        149 128 3  1    2
       149          2                                             128 3  1    3
1.00000E-5 3.42030000 1.00000E-4 3.40300000 .025300000 3.39551000 128 3  1    4
100.000000 3.39501000 1000.00000 3.39490000 2000.00000 3.39480000 128 3  1    5
3000.00000 3.39440000 4000.00000 3.38940000 5000.00000 3.38500000 128 3  1    6
10000.0000 3.36700000 20000.0000 3.34200000 30000.0000 3.32100000 128 3  1    7
40000.0000 3.30200000 50000.0200 3.28500000 60000.0200 3.27000000 128 3  1    8
```

Improved BEST Input Parameters, based on extensive use of the earlier versions of the PREPRO codes. Of particular note is decreasing the minimum cross section from 10^{-10} to 10^{-30} barns to be linearized (tabulated data below the minimum are copied, ignoring the ENDF interpolation code). This has a rather dramatic effect, particularly on (neutron, charged particle) reactions, which often have long, slowly decreasing tails toward the reaction threshold. Here the cross section can be quite small, but extend over a large energy range, so there might be an integral effect; in the below plot interpolated values differ by up to a factor of 1 million – let me repeat that: a factor of 1 million. Since this extension has only a minor effect on the overall size of the pre-processed ENDF data it is now accurately included.



Doppler Broadening High Energy Cutoff: Today many modern evaluations extend to very high energies well above the traditional ENDF 20 MeV high energy limit. In these cases the theoretical models used for the evaluations change at or near 20 MeV, which can cause an abrupt change (a non-physical discontinuity) in cross sections. To compensate for the "intent" of the evaluators, PREPRO Doppler broadening now only extends up to 10 MeV. This has the effect of making the "discontinuities" in the cross section at or near 20 MeV, temperature independent, which I judge to be the "intent" of the evaluators.



ENDF/B Tested: All of ENDF/B-VII, version 0 and 1, as well as all ENDF/B-VIII Proposed, evaluations have been processed to high precision at many temperatures to create **POINT2009** (VII.0) and **POINT2015** (VII.1) data, and the results are now available on-line at,

http://www-nds.iaea.org/point2009/pt2009.htm

http://www.nndc.bnl.gov/POINT2017/POINT2017/htm"

ENDF2C is a new code for PREPRO 2017, to insure that ALL PREPRO output in the ENDF format are completely FORTRAN, C and C++ compatible. As of today (April 2017) evaluated data even from major code centers are still not completely FORTRAN, C and C++ compatible. Therefore when I begin pre-processing any evaluation the first PREPRO code I run is ENDF2C to insure that ALL ENDF formatted output in subsequent codes are completely compatible. This is a very

important step: it would be such a shame if after all of the effort invested to produce accurate results it cannot be accurately read and used by application codes.

SPECTRA was a new code for PREPRO 2010, which starting from models and tabulated data, linearizes and tabulates neutron emission spectra (MF=5); it is similar to and is an extension of the LINEAR code that performs a similar function for cross sections (MF=3). It has been extended for 2017.

RECENT for 2017 is extended to handle multiple resolved resonance energy ranges for the general Reich-Moore (LRF=7) resolved resonance formalism. The other resolved formalisms calculate and output total, elastic, capture and fission cross sections. The general Reich-Moore allows many more output channels; RECENT 2017 has been further extended and allows up to 10 output channels, and outputs cross sections are all of these channels in the ENDF format. The extension to multiple LRF=7 resonance regions makes PREPRO capable of handling all current and planned evaluations.

SIGMA1 for 2017 have been updated for improved low energy treatment, as well as improved accuracy and consistency throughout. For 2017 Doppler broadening is now restricted to an upper limit of 10 MeV, i.e., all tabulated cross sections at energies higher than this are assumed to be temperature independent and are copied exactly as read from the ENDF input to the ENDF output.

SIXPAK and **ACTIVATE** have been extended to handle newer data that can now be coded using MF=3, 6, 9, and 10 formats.

BEST INPUT is provided separately for all codes. As distributed PREPRO includes a series of test cases to quickly run each code to insure it is operating correctly. The input for these test runs are designed to allow adequate testing in a reasonable amount of time; as such this input may not correspond to what we recommend for your production work. **What we recommend you use** for each code for your actual applications is provided in a separate directory. **After you have tested the codes it is recommended that you use the BEST INPUT, which is distributed with PREPRO 2017. This BEST** input will guarantee that PREPRO results will be generated to high accuracy needed for use in applications.

LINKING and TRACKING sequences of codes, has now been simplified by having each code identify itself when it starts and when it finishes correctly in its output report (.LST files), and if it does not finish correctly each code will identify the problem that caused it to terminate and print an ERROR message rather than the code name. This allows user to automate and run long sequences of codes and still easily monitor performance. For example, to create the POINT2009 (VII.0) and POINT2015 (VII.1) data libraries only required me to run one non-interactive batch file to process hundreds of evaluations, requiring thousands of code executions (each evaluation was processed using a series of codes). Using this approach, what used to take months to accomplish can now be done in a day.

MORE COMPLETE packages are included for each type of computer; in particular the graphics codes EVALPLOT and COMPLOT are now included so that users can quickly view nuclear data on their computer screen and/or produce Postscript files

for later use, i.e., as in reports. Interactive graphics are a powerful tool that allows us to quickly check the enormous amount of data currently included in modern nuclear data libraries.

Recommended Accuracy

There is almost no cross section for any material, at any energy and temperature that we know to better than an uncertainty of about 1%. With the PREPRO codes we try to introduce an additional ERROR due to processing that is much less than the basic UNCERTAINTY in the cross section data itself. This is done in an attempt to insure that the final combined uncertainty is essentially equivalent to only the UNCERTAINTY in the basic data itself, i.e., **our data processing introduced no significant additional uncertainty.**

We therefore recommend that integral **cross sections** be processed using an allowable uncertainty of 0.1%, and in the thermal, low energy range 0.01%; we use the latter because the thermal range is better known (at least in an integral sense), and has few if any resonances, so that the cross sections are smoothly varying and can be very accurately represented using a relatively small number of tabulated data points.

Angular and energy distributions are less well known and normalized. We therefore recommend that these be reconstructed to within an accuracy of 1%.

You, the PREPRO code user need not memorize there recommendations, because these criteria are included in the **BEST INPUT** supplied with PREPRO 2017. **All you need remember is to use the BEST INPUT.**

WARNING About File Formats

We have made every effort to insure that the files for each computer are in the correct native format for that computer. But you should be WARNED that some files may be actually ONLY in IBM-PC (DOS) format. If you successfully verify the installation on your computer, you can be confident that the files are in the correct format for use on your computer.

If you have an installation problem, it may be due to file formats. This may cause problems if you attempt to use them in this form on other types of computers. The major difference between files is how the end of each line is defined. The characters: carriage return (CR) and/or Line Feed (LF) are used at the end of line. For example,

Windows(DOS)	CR/LF
UNIX	LF
LINUX	LF
MAC (OSX)	LF
VMS	LF (implied; UNIX compatible)
MAC Classic	CR (no longer supported)

For PREPRO 2017 CD we supply both DOS and UNIX compatibles files; this combination will work on all of the computers that we supply packages for: Windows, LINUX (UNIX) and MAC (OSX).

Failure to insure files are in the correct format can lead to unreliable results. Fortunately, converting files from DOS to other formats for use on other types of computers is usually simple and straightforward. For example,

1) On UNIX type computers (today this includes LINUX and MAC), you can use **dos2UNIX** to convert files and **chmod** if a file is to be executed, e.g.,

dos2UNIX sun.mak SUN.MAK
chmod 777 SUN.MAK

2) On other types of computers, you need merely use a word processing code to edit the file – check the end of each file and delete any blank lines that you may find; generally when you then close the file it will be saved in the local format for use on your computer.

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 an IBM-PC, a $ 300 computer, 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. This has allowed us to change our focus to producing much more reliable results, to high precision, e.g., 9 or 10 digit floating point output numbers in the ENDF format.

All ENDF Formats and Procedures

These codes can automatically determine the ENDF format version that each evaluation is coded in (ENDF-1 through ENDF-6 format), 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 been tested with all of the newest ENDF/B-VII.1 evaluations as well as all Proposed ENDF/B-VIII evaluations.

WARNING: The 2017 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 2017 codes completely supersede all earlier versions and it is strongly recommended that all users of these codes only use the 2017 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 PREPRO 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 2017 if you follow the recommended procedures, and first use ENDF2C, the ENDF output will be 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, and we can change these default values built into the codes, without you having to be aware of these changes or you having to change your input parameters.

Computer Independence

The only computer dependence in the 2017 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.

32 versus 64 bit Computers

All of the codes are now designed to be 100% compatible for use on 32 or 64 bit computers. Executables are provided for,

1) **32 bit Windows** – these will execute on 32 and 64 bit Window systems. So far I have not found any significant speed difference between 32 and 64 bit executables, and both give exactly the same answers.

2) **64 bit MAC** – MAC computers have been 64 bit for many years, so today we deem it only necessary to supply 64 bit executables.

3) **32 and 64 bit LINUX** – executables are **not** completely interchangeable between 32 and 64 systems using LINUX, so we provide both; choose whichever meets your needs.

MAC OSX Executables

Earlier versions of PREPRO supplied executables for MAC OS9. The current PREPRO supplies executable for MAC OSX (there are no executables for OS9 included). 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.

Bigger, Faster, Improved Accuracy

In line with the enormous increase in computer sizes during the last few years, the 2017 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 (except for the graphics codes, that use the 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 of some codes 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 you use in your applications be documented. This is the purpose of the comment lines at the beginning of each ENDF/B evaluation. The PREPRO codes are designed to supplement the evaluator supplied comments by documenting any operations that they perform on ENDF/B data, that changes the evaluated data in any way. 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 the PREPRO codes or the evaluations to remove this documentation. WARNING: It is VERY IMPORTANT that you know the PEDIGREE of the data you are using, which is EXACTLY what these PREPRO added comments are designed to do for you.**

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, MAC (OSX), LINUX 32 and 64 bit), 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 or viewed on many computer screens.

For use on IBM-PC running Windows (DOS) or Linux (32 or 64 bit), and on MAC (OSX), the distribution includes executables, ready to use immediately. For use on a variety of UNIX, LINUX and MAC based computers, the distribution includes a batch file for each type of computer, to compile and load all 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 YOUR 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 subsequent 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 may only allow 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 – the exception being **ENDF2C** which uses fixed names for the ENDF input and output filenames = ENDFB.IN and ENDFB.OUT, and thus avoids the need for any input parameters.

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 72 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-VII data files in a directory named ENDFB7, the following input filename used with **linear** will read a file named za092238 on an IBM-PC,

\ENDFB7\ORIGINAL\za092238

or on a UNIX workstation,

/ENDFB7/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/ENDFB7/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 (in the recommended order to use)

Endf2c	- Convert ENDF data to FORTRAN, C and C++, compatible form
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
Spectra - Convert model and general tabulation to linearized spectra (MF=5)
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, particularly using graphics, 2) pre-process the data into a form that will make subsequent use of the data much easier, e.g., a processing code can avoid having to start from an original evaluation, and instead start processing PREPRO output where the data has been linearized, resonance contribution added, and cross sections Doppler broaden.

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 **ENDF2C** first the ENDF data will not be in FORTRAN, C and C++ compatible format, and 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) **ENDF2C -** is a new code for PREPRO 2017, that is designed to insure that ALL PREPRO output in the ENDF format are completely FORTRAN, C and C++ compatible. As of today (January 2017) evaluated data even from major code centers are still not completely FORTRAN, C and C++ compatible. Therefore when I begin pre-processing any evaluation the first PREPRO code I run is ENDF2C to insure that ALL ENDF formatted output in subsequent codes are completely compatible. This is a very important step: it would be such a shame if after all of the effort invested to produce accurate results it cannot be accurately read and used by application codes.

2) **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; the accuracy we use today is much, much smaller than the inherent uncertainly in today's ENDF evaluated data, so we do not add any additional significant uncertainly.

3) **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.

4) **SIGMA1** - Doppler broaden cross sections to any temperature of interest for use 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.

5) **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.

6) **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, optionally 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.

7) **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. **Recently SIXPAK was extended to also create MF/MT=9/5 output from the yields of MF/MT=6/5, which can be used as input to ACTIVATE to define activation cross sections.**

8) **SPECTRA** – Linearize and tabulate neutron emission spectra (MF=5). ENDF format allows neutron spectra to be represented as nuclear models or 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 nuclear models and tables with 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 spectra, i.e., replace the original nuclear model or tabulated data points and interpolation law by a new table

where one can use linearly interpolation between tabulated points to within any required accuracy.

9) **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.

10) **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 PREPRO 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 your 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 (MF=3), angular distributions (MF=4), Legendre coefficients (MF=4) and/or energy distributions (MF=5), 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 and VII have moved in the direction of representing separate isotopes for each element, this code is particularly useful if your applications only require a natural mixture of isotopes, e.g., use MIXER to combine isotopes into the natural element, such as natural Fe from its isotopes.

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 the PREPRO codes. Users should be WARNING that I (D.E.Cullen) extensively use

RELABEL to maintain my codes based on my very conservative use of FORTRAN, but it is not intended for general use = **CAVEAT EMPTOR!!!!**

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 given computer.

Verifying Implementation

This distribution comes with a file named VERIFY (or verify), which is designed to run 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,

endf2c
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.BAT. 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 2017. 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 %; up to 2%. 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, e.g. I recommend you subsequently use the BEST input for each code.

WARNING – for UNIX users - some UNIX systems now include **diction** as a system command. In order to avoid this conflict, in PREPRO 2017 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**, ENDF2C**, **LINEAR, RECENT, SIGMA1, ACTIVATE, LEGEND, FIXUP** and **DICTIN** and only keep the original data read by **ENDF2C** 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,

```
endf2c
rename ENDFB.OUT LINEAR.IN
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 **ENDF2C** is still in the file named **ENDFB.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 ENDFB7, and within this directory I have three sub-directories: ORIGINAL, TMP, and K300 (data Doppler broadened to 300 Kelvin). What I can do is first copy a file from ENDFB7/ORIGINAL to ENDFB.IN, the standard **ENDF2C** ENDF input data file (ENDF2C is the only PREPRO code that uses fixed ENDF input and output filenames), define input parameters to **LINEAR, RECENT, SIGMA1, ACTIVATE, LEGEND** and **FIXUP** to produce ENDF output in ENDFB7/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 ENDFB7/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.,

endf2c
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 OUTPUT REPORT files.**

Details of Compiling and Loading Codes

For use on IBM-PC running Windows or Linux (32 or 64 bit), and on MAC (OSX), the distribution includes executables, ready to immediately use. For use on a variety of UNIX, LINUX and MAC 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) Include files 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 MAC (OSX) (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 sixteen (16) 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 endf2c    -O endf2c.f    endfio.f scratchb.f timer.f sun.f
f77 -o activate  -O activate.f  endfio.f scratchb.f timer.f sun.f
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 spectra   -O spectra.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                      timer.f sun.f
f77 -o convert   -O convert.f                      timer.f sun.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**. For 2017 2 variations are included: **comhard** create a separate file for each plot and **comhard1** create a single file containing all of the plots. Similarly for **evalhard** and **evalhard1**.

2) On screen graphics, using executables named **complot** and **evalplot**.

The 3 executables, **complot**, **comhard** and **comhard1**, are exactly the same code, loaded with different graphics interfaces; all executables use the same input and output files, **COMPLOT.INP** and **COMPLOT.LST**. Similarly, the 3 executables, **evalplot**, **evalhard and evalhard1**, 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 repeatedly running a code 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 or hardsave1.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, LINUX and MAC 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/compiler, so that we can build up a library of Makefiles to be distributed with the codes; this will make future versions as compatible as possible with your needs.

The codes are distributed with graphics interfaces for,

1) UNIX, LINUX, 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 energy 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
COMPLOT
CONVERT
DICTIN
ENDF2C
EVALPLOT
FIXUP
GROUPIE
LEGEND
LINEAR
MERGER
MIXER
RECENT
RELABEL
SIGMA1
SIXPAK
SPECTRA
VIRGIN

```
======================================================================== Activate
                                                                         Activate
      PROGRAM ACTIVATE                                                   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
      VERS. 2007-2 (DEC. 2007)    *72 CHARACTER FILE NAMES.              Activate
      VERS. 2010-1 (Apr. 2010)    *General update based on user feedback Activate
      VERS. 2012-1 (Aug. 2012)    *Added CODENAME                        Activate
                                  *Added ERROR stop                      Activate
                                  *32 and 64 bit Compatible              Activate
      VERS. 2015-1 (Jan. 2015)    *Corrected ERROR for missing or extra  Activate
                                   SEND and MEND lines.                  Activate
                                  *Changed MF=8 pointer from MF=9 to 10. Activate
                                  *INCREASED MAX. POINTS to 3,000,000.   Activate
                                  *Added Consistency checks, e.g.,       Activate
                                   Any MT in MF=9 requires data in MF=3. Activate
                                  *Extended OUT9 - OUT10 is not used.    Activate
                                  *Only processes ONE ENDF Tape - this   Activate
                                   restriction is necessary to insure    Activate
                                   compatibility with ALL PREPRO codes.  Activate
                                  *Changed to current ENDF sequence      Activate
                                   number convention, e.g., reset number Activate
                                   for each section (MAT/MF/MT).         Activate
                                  *Replaced ALL 3 way IF statements.     Activate
      VERS. 2017-1 (May  2017)    *Increased MAX. POINTS to 6,000,000.   Activate
                                  *Do not create MF=10 for any MT that   Activate
                                   already has MF=10 data = copy MF=10   Activate
                                   data in its original form.            Activate
                                  *Message for every MF=7 output,        Activate
                                   whether created or copied from input. Activate
                                  *Updated based on user feedback.       Activate
                                                                         Activate
      Acknowledgement 2015                                               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 2015 version of this code based on user        Activate
      feedback, including IMPORTANT feedback from Andrej Trkov, up       Activate
      to and including Feb. 2015.                                        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
                                                                         Activate
      PRESENT CONTACT INFORMATION                                        Activate
      ---------------------------                                        Activate
      Dermott E. Cullen                                                  Activate
      1466 Hudson Way                                                    Activate
      Livermore, CA 94550                                                Activate
      U.S.A.                                                             Activate
      Telephone  925-443-1911                                            Activate
      E. Mail    RedCullen1@Comcast.net                                  Activate
      Website    RedCullen1.net/HOMEPAGE.NEW                             Activate
                                                                         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 TERMINOLOGY   Activate
---ENDF 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 FORMAT                                                       Activate
-----------                                                       Activate
THIS PROGRAM ONLY USES THE ENDF BCD OR CARD IMAGE FORMAT (AS       Activate
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION   Activate
OF THE ENDF FORMAT (I.E., ENDF-1, 2, 3, 4, 5 OR 6 FORMAT).        Activate
                                                                  Activate
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF         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 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 (2017-1) ***************       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-5 DIFFERS FROM THE THAT OF        Activate
EARLIER VERSIONS OF ENDF. BY READING AN EXISTING MF=1, MT=451      Activate
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF      Activate
THE ENDF 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 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 3,000,000 Activate
ENERGY POINTS.                                                     Activate
                                                                   Activate
THERE IS NO LIMIT ON THE NUMBER OF ENERGY POINTS IN MF=3 AND 10    Activate
TABLES = THIS DATA IS READ AS CHARACTERS, ONE LINE AT A TIME.      Activate
                                                                   Activate
SELECTION OF DATA                                                  Activate
-----------------                                                  Activate
THE PROGRAM PROCESSES ALL ENDF DATA ON ONE ENDF TAPE.              Activate
                                                                   Activate
2015 - IT NOW ONLY DOES ONE ENDF TAPE.                             Activate
                                                                   Activate
PROGRAM OPERATION                                                  Activate
-----------------                                                  Activate
PASS #1                                                            Activate
-------                                                            Activate
THE ENTIRE MAT IS COPIED TO A SCRATCH FILE IN THE ENDF 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 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 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   1-72  ENDF INPUT DATA FILENAME                            Activate
                 (STANDARD OPTION = ENDFB.IN)                        Activate
       2   1-72  ENDF OUTPUT DATA FILENAME                           Activate
                 (STANDARD OPTION = ENDFB.OUT)                       Activate
                                                                     Activate
    ONE PAIR OF INPUT LINES MAY BE USED, TO PROCESS ANY ENDF TAPE.   Activate
                                                                     Activate
    2015 - NOW ONLY DOES ONE ENDF TAPE.                              Activate
                                                                     Activate
    EXAMPLE INPUT NO. 1                                              Activate
    -------------------                                              Activate
    PROCESS ENDF TAPE NAMED ACTIVATE.IN AND NAME THE OUTPUT FILE     Activate
    ACTIVATE.OUT.                                                    Activate
                                                                     Activate
    IN THIS CASE THE FOLLOWING 2 INPUT LINES ARE REQUIRED            Activate
                                                                     Activate
 ACTIVATE.IN                                                         Activate
 ACTIVATE.OUT                                                        Activate
                                                                     Activate
    EXAMPLE INPUT NO. 2                                              Activate
    -------------------                                              Activate
    SAME AS THE ABOVE CASE, EXCEPT THAT IN THIS CASE THE ORIGINAL    Activate
    TAPE IS 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\ACTIVATE.IN                                        Activate
 \ENDFB6\ACTIVATE\ACTIVATE.OUT                                       Activate
                                                                     Activate
    EXAMPLE INPUT NO. 3                                              Activate
    -------------------                                              Activate
    IF THERE IS NO ACTIVATE.INP FILE, OR THE FILENAMES ARE BLANK     Activate
    THIS CODE WILL USE THE DEFAULT NAMES,                            Activate
                                                                     Activate
 ENDFB.IN                                                            Activate
 ENDFB.OUT                                                           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
                                   *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
VERS. 2009-1 (JAN.  2009)   *IGNORED DIFFERENCES NEAR RESONANCE     Complot
                             REGION BOUNDARIES (RESOLVED AND        Complot
                             UNRESOLVED).                           Complot
VERS. 2010-1 (July  2010)   *Allow comparison plot even if there    Complot
                             is no difference (just see data).      Complot
                            *ONLY plot linearly interpoolable data  Complot
                            *Include threshold energy points to     Complot
                             show cross sections, but NOT ratios    Complot
                             near threshold.                        Complot
VERS. 2011-1 (Jan.  2011)   *Increased MT.DAT from 200 to 1,000     Complot
                             entries, to accommodate new MTs.       Complot
VERS. 2012-1 (Aug.  2012)   *Increased incident particle list to    Complot
                             include photon (ZA = 0).               Complot
                            *Added CODENAME                         Complot
                            *32 and 64 bit Compatible               Complot
                            *Added ERROR stop                       Complot
VERS. 2013-1 (Nov. 2013)    *ONLY use min/max ratios to decide      Complot
                             whether or not to plot - non-positive  Complot
                             cross sections are no longer used.     Complot
                            *Limited per-cent differences to fit    Complot
                             output format = -9999 to +9999 %.      Complot
                            *OUT9 replaced NORMX                    Complot
VERS. 2015-1 (Jan. 2015)    *Added MF=10 Radionuclide Production    Complot
                             which requires longer plot titles.     Complot
```

```
                          *Restricted character size multiplier  Complot
                           to 0.5 to 1.5 to accommodate longer   Complot
                           plot titles.                          Complot
                          *Replaced ALL 3 way if statements.     Complot
VERS. 2015-2 (Mar. 2015)  *Corrected tables for X and Y axis     Complot
                           labels = see change search for 2015-2 Complot
VERS. 2015-3 (Oct. 2015)  *Allow multiple LRF=7 regions plus     Complot
                           unreslved region - earlier assumed    Complot
                           LRF=7 never used unrsesolved.         Complot
VERS. 2017-1 (May  2017)  *For MF=2 use MT=151 to define         Complot
                           Unresolved Resonance Region (URR).    Complot
                           Ignore NJOY MT=152 and 153.           Complot
                          *All floating input parameters changed Complot
                           to character input + IN9 conversion.  Complot
                          *Added MF=4 Legendre Coefficient       Complot
                           Comparison: f1 through f6             Complot
                          *Doubled in core storage to 1,200,000. Complot
                          *Replaced Q MeV by MT= at top of plots Complot
                           (Q value in ENDF is now only defined  Complot
                            in MF=3, making it difficult for all Complot
                            other MF now treated by this code)   Complot
                          *Initial Linear X scaling for MF=1     Complot
                           (nu-bar) and MF=4 (Legendre) =        Complot
                           this can be turned OFF by ZOOM        Complot
                          + Unless energy range is requested =   Complot
                           allows MF=1 and 4 default Linear X    Complot
                           scaling to be turned off by input     Complot
                           parameters, i.e., by COMHARD          Complot
                          *Zoom lower energy limit restricted    Complot
                           1.0d-5 eV - to lower zoom of linear   Complot
                           energy plots (otherwise cannot find   Complot
                           actual lower limit on plot).          Complot
                                                                 Complot
2015-2 Acknowledgment                                            Complot
=====================                                            Complot
I thank Chuck Whitmer (TerraPower,WA) for reporting the errors   Complot
that led to the 2015-2 Improvements in this code.                Complot
                                                                 Complot
I thank Jean-Christophe Sublet (UKAEA) for contributing MAC      Complot
executables and Bojan Zefran (IJS, Slovenia) for contributing    Complot
LINUX (32 or 63 bit) executables. And most of all I must thank   Complot
Andrej Trkov (NDS, IAEA) for overseeing the entire PREPRO project Complot
at IAEA, Vienna. This was a truly International team who worked  Complot
together to produce PREPRO 2015-2.                               Complot
                                                                 Complot
OWNED, MAINTAINED AND DISTRIBUTED BY                             Complot
-----------------------------------                              Complot
THE NUCLEAR DATA SECTION                                         Complot
INTERNATIONAL ATOMIC ENERGY AGENCY                               Complot
P.O. BOX 100                                                     Complot
A-1400, VIENNA, AUSTRIA                                          Complot
EUROPE                                                           Complot
                                                                 Complot
ORIGINALLY WRITTEN BY                                            Complot
-----------------------------------                              Complot
Dermott E. Cullen                                                Complot
                                                                 Complot
PRESENT CONTACT INFORMATION                                      Complot
---------------------------                                      Complot
Dermott E. Cullen                                                Complot
1466 Hudson Way                                                  Complot
Livermore, CA 94550                                              Complot
U.S.A.                                                           Complot
Telephone  925-443-1911                                          Complot
E. Mail    RedCullen1@Comcast.net                                Complot
Website    RedCullen1.net/HOMEPAGE.NEW                           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
2015 PLOTTER DIMENSIONS                                            Complot
================================================================== Complot
PLOTTER DIMENSIONS ARE IN INCHES - NOT CM, MM, OR CUBITS.          Complot
THIS IS DONE FOR HISTORICAL REASONS AND HOPEFULLY THIS WILL        Complot
NOT INCONVENIENCE ANYONE - IN PRACTICE I HAVE USED EXACTLY THE     Complot
SAME DIMENSION = X = 0 to 12.5 and Y = 0 to 10 FOR DECADES         Complot
TO PRODUCE BOTH ON-SCREEN AND HARDCOPY POSTSCRIPT PLOTS.           Complot
                                                                   Complot
I STRONGLY SUGGEST THAT YOU NOT CHANGE THESE DIMENSIONS UNLESS     Complot
YOU MUST = BASED ON THE PLOT SIZE YOU OBTAIN WHEN YOU FIRST RUN    Complot
THIS CODE.                                                         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
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     A72   FILENAME FOR FIRST ENDF/B DATA FILE             Complot
                       (LEAVE BLANK FOR ENDFB.IN1)                     Complot
  3     1-72     A72   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 RATIO.	Complot
			= 4 - TWO CROSS SECTIONS ON SAME PLOT OVER RATIO.	Complot
	56-66	I11	STARTING PLOT NUMBER	Complot
			= 0 - DO NOT NUMBER PLOTS	Complot
			= .GT.0 - NUMBER PLOTS IN LOWER LEFT HAND 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 PLOTTING RATIOS. ANY REACTION WHERE THE TWO EVALUATIONS DIFFER BY MORE THAN THE ALLOWABLE DIFFERENCE WILL BE PLOTTED. IF ZERO IS INPUT THE STANDARD ALLOWABLE DIFFERENCE OF 0.001 (0.1 PER-CENT) WILL BE USED.	Complot
	12-22	E11.4	MAXIMUM ALLOWABLE RATIO. IF RATIOS ARE PLOTTED THEY WILL BE IN THE RANGE RATMAX TO 1/RATMAX. IF 0.0 IS INPUT THERE WILL BE NO LIMIT ON THE RANGE OF THE RATIOS. THIS OPTION MAY BE USED TO IGNORE LARGE DIFFERENCES OVER VERY NARROW ENERGY RANGES (WHICH MAY BE UNIMPORTANT) AND ALLOW ONE TO SEE IMPORTANT, BUT SMALLER DIFFERENCES, OVER EXTENDED ENERGY RANGES.	Complot
6	1-40	40A1	IDENTIFICATION FOR UPPER EVALUATIONS	Complot
7	1-40	40A1	IDENTIFICATION FOR LOWER EVALUATIONS (IDENTIFICATIONS SHOULD BE LEFT ADJUSTED TO START IN COLUMN 1).	Complot
8-N	1- 6	I6	LOWER MAT OR ZA LIMIT (SEE SELECTION MODE, 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, 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 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 MOUSE AFTER EACH PLOT AND ALLOW YOU TO INTERACTIVELY SPECIFY PLOT LIMITS.	Complot
			*IF YOU DO NOT WISH TO INTERACT WITH A PLOT OR IF YOU HAVE NO INTERACTIVE CAPABILITY THIS OPTION SHOULD BE SET = 0.	Complot
				Complot
			*WARNING...DATA POINTS IDENTIFIED OPTION IS NOT RECOMMENDED FOR PLOTS CONTAINING MANY (I.E. THOUSANDS) OF DATA POINTS SINCE IT WILL MERELY INCREASE THE RUNNING TIME OF THE PROGRAM AND STILL NOT ALLOW ONE TO ACCURATELY SEE DATA POINTS.	Complot
				Complot
			*UP TO 100 MAT OR ZA RANGES ARE ALLOWED. 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
  EXAMPLE DEFINITION OF PLOTTER                                     Complot
  ----------------------------                                      Complot
  2015 - WARNING - THE FOLLOWING DESCRIPTION IS OUT-OF-DATE.        Complot
  TODAY THE DIMENSIONS OF THE PLOTTER ARE IN INCHES.                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
      ===============                                                  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
      VERS. 2007-2 (DEC.  2007)   *72 CHARACTER FILE NAMES.           Convert
      VERS. 2010-1 (Apr.  2010)   *General update based on user feedback Convert
      VERS. 2012-1 (Aug.  2012)   *Added CODENAME                     Convert
                                  *32 and 64 bit Compatible            Convert
                                  *Added ERROR stop                    Convert
      VERS. 2015-1 (Jan.  2015)   *Replaced ALL 3 way IF Statements    Convert
      VERS. 2017-1 (May   2017)   *Updated based on user feedback.     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
                                                                       Convert
PRESENT CONTACT INFORMATION                                            Convert
---------------------------                                            Convert
Dermott E. Cullen                                                      Convert
1466 Hudson Way                                                        Convert
Livermore, CA 94550                                                    Convert
U.S.A.                                                                 Convert
Telephone  925-443-1911                                                Convert
E. Mail    RedCullen1@Comcast.net                                      Convert
Website    RedCullen1.net/HOMEPAGE.NOW                                 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     VERS. 2007-2 (DEC. 2007)    *72 CHARACTER FILE NAMES.              Dictin
C     VERS. 2010-1 (Apr. 2010)    *General update based on user feedback Dictin
C     VERS. 2012-1 (Aug. 2012)    *Added CODENAME                        Dictin
C                                 *32 and 64 bit Compatible              Dictin
C                                 *Added ERROR stops                     Dictin
C     VERS. 2015-1 (Jan. 2015)    *Corrected END = it was saying ERROR.  Dictin
C                                 *Replaced ALL 3 way IF Statements.     Dictin
C     VERS. 2015-2 (Mar. 2015)    *Corrected Seqence Numbers             Dictin
C                                  1) Restart at 1 for each MAT/MF/MT.   Dictin
C                                  2) 99999 on section end, MT=0         Dictin
C                                  3)     0 on MF = 0                    Dictin
C     VERS. 2017-1 (May  2017)    *Updated based on user feedback.       Dictin
C                                                                       Dictin
C     2015-2 Acknowledgment                                             Dictin
C     =====================                                             Dictin
C     I thank Jean-Christophe Sublet (UKAEA) for contributing MAC       Dictin
```

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executables and Bojan Zefran (IJS, Slovenia) for contributing      Dictin
LINUX (32 or 64 bit) executables. And most of all I must thank     Dictin
Andrej Trkov (NDS, IAEA) for overseeing the entire PREPRO project  Dictin
at IAEA, Vienna. This was a truly International team who worked    Dictin
together to produce PREPRO 2015-2.                                 Dictin
                                                                   Dictin
OWNED, MAINTAINED AND DISTRIBUTED BY                               Dictin
-----------------------------------                                Dictin
THE NUCLEAR DATA SECTION                                           Dictin
INTERNATIONAL ATOMIC ENERGY AGENCY                                 Dictin
P.O. BOX 100                                                       Dictin
A-1400, VIENNA, AUSTRIA                                            Dictin
EUROPE                                                             Dictin
                                                                   Dictin
ORIGINALLY WRITTEN BY                                              Dictin
-----------------------------------                                Dictin
Dermott E. Cullen                                                  Dictin
                                                                   Dictin
PRESENT CONTACT INFORMATION                                        Dictin
---------------------------                                        Dictin
Dermott E. Cullen                                                  Dictin
1466 Hudson Way                                                    Dictin
Livermore, CA 94550                                                Dictin
U.S.A.                                                             Dictin
Telephone  925-443-1911                                            Dictin
E. Mail    RedCullen1@Comcast.net                                  Dictin
Website    RedCullen1.net/HOMEPAGE.NEW                             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
    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
==========================================================================
```

```
====================================================================== Endf2c
                                                                       Endf2c
      Program ENDF2C                                                   Endf2c
      ==============                                                   Endf2c
      Convert ENDF Data to Standard FORTRAN, C and C++ Format.         Endf2c
                                                                       Endf2c
      Version 2014-1 Feb. 2014 * Initial version.                      Endf2c
              2014-2 Oct. 2014 * Changed from D to E exponential form  Endf2c
                                 to improve compatibility between      Endf2c
                                 computer languages.                   Endf2c
              2015-1 Jan. 2015 * General updates for release with      Endf2c
                                 PREPRO2015.                           Endf2c
                               * Changed ENDF data filenames from ENDF2C Endf2c
                                 to ENDFB, to agree with PREPRO default Endf2c
                                 definitions.                          Endf2c
                               * Added code name (to be compatible     Endf2c
                                 with PREPRO output), but NOT TIME (to Endf2c
                                 keep this code as computer independent Endf2c
                                 as possible).                         Endf2c
              2017-1 May  2017 * Updated based on user feedbsck        Endf2c
                                                                       Endf2c
      Purpose                                                          Endf2c
      ======================================================================= Endf2c
      This code is designed for,                                       Endf2c
      1) ENDF Data in any ENDF format = ENDF-1 through ENDF-6.         Endf2c
      2) On any type of computer = 32 or 64 bit system/compiler        Endf2c
                                                                       Endf2c
      This code tries to keep things as simple as possible             Endf2c
      1) There are NO INPUT PARAMETERS.                                Endf2c
      2) It reads  an ENDF formatted file named ENDFB.IN               Endf2c
      3) It writes an ENDF formatted file named ENDFB.OUT              Endf2c
      4) It writes a report file named          ENDF2C.LST             Endf2c
                                                                       Endf2c
      Author's Message                                                 Endf2c
      ----------------                                                 Endf2c
      I consider insuring that ENDF data is in a standard, officially  Endf2c
      approved format for FORTRAN, C and C++ is SO IMPORTANT this code Endf2c
      does only one thing - and only one thing - and it does it in the Endf2c
      simplest possible manner - efficiency is NOT a consideration -   Endf2c
      ONLY accuracy and general utility of the ENDF data is considered. Endf2c
                                                                       Endf2c
      Method                                                           Endf2c
      ------                                                           Endf2c
      Other codes that attempt to do the same thing - including codes  Endf2c
      written be me decades ago - are very complicated, and therefore  Endf2c
      ERROR PRONE because they try to deal with each and every variant Endf2c
      in which data can be coded in the ENDF format. Needless to say   Endf2c
      this means that every time the ENDF formats and procedures change Endf2c
      these codes MUSE also be changed.                                Endf2c
                                                                       Endf2c
      In contrast, ENDF2C uses my almost 50 years of experience dealing Endf2c
      with the ENDF format to realize that except for the comments at  Endf2c
      the beginning for each evaluation (MF/MT=1/451), every line of   Endf2c
      ENDF data is IDENTICAL - in every version of the ENDF format, from Endf2c
      the original ENDF to today's ENDF-6. So to translate ENDF data   Endf2c
      into an official format I do not have to consider differences in Endf2c
      each section (MF/MT) of data.                                    Endf2c
                                                                       Endf2c
      Every line of ENDF is divided into 6 fields, each 11 columns wide. Endf2c
      Each of the 6 fields is either, blank, integer or floating point. Endf2c
      Floating point fields ALL include a decimal point (.). So that ALL Endf2c
      this code does is convert every floating point field to standard Endf2c
      format.                                                          Endf2c
                                                                       Endf2c
      In order to insure that this PRESERVES the accuracy of the data  Endf2c
      this is done by reading and writing each ENDF line as characters. Endf2c
      Blank and integer fields are copied exactly as read. ALL floating Endf2c
      point number that are read are converted internally from character Endf2c
      to floating point - they are then converted back into characters  Endf2c
      in a standard, officially approved format, for output.           Endf2c
                                                                       Endf2c
      As a last step to insure the accuracy of results the characters  Endf2c
      to be output are again converted from characters to floating     Endf2c
      point, and the numerical value that is output is compared to the Endf2c
      numerical value originally read, and if there is ANY DIFFERENCE  Endf2c
      the characters strings read and written are listed in the output: Endf2c
      the characters strings read and written as well as the difference Endf2c
```

```
     is listed in the output report (ENDF2C.LST) and on the screen.     Endf2c
                                                                        Endf2c
     Running Time                                                       Endf2c
     ------------                                                       Endf2c
     It takes only seconds to translate an ENDF formatted evaluation,   Endf2c
     so running time need not be a consideration. Concentrate on        Endf2c
     keeping it simple and reliable - that should be your focus.        Endf2c
                                                                        Endf2c
     Documentation                                                      Endf2c
     -------------                                                      Endf2c
     ALL of my codes that process ENDF data and change it in ANY WAY    Endf2c
     document what they have done by adding comment lines at the end    Endf2c
     of the comment section (MF/MT=1/451) of each evaluation. This      Endf2c
     allows data users to determine the pedigree of the data they are   Endf2c
     using, by reading these comments. This code documents what is has  Endf2c
     done by adding the following 2 comment lines.                      Endf2c
                                                                        Endf2c
 ***************** Program ENDF2C (Version 2017-1) ***************      Endf2c
      Convert ENDF Data to Standard FORTRAN, C and C++ Format           Endf2c
                                                                        Endf2c
     WARNING - This documentation is IMPORTANT to data users and it     Endf2c
     should not be deleted.                                             Endf2c
                                                                        Endf2c
     Written by                                                         Endf2c
     -----------------------------------                                Endf2c
     Dermott E. Cullen                                                  Endf2c
     University of California (retired)                                 Endf2c
-----Present Home Address---------------------------------------------- Endf2c
     Dermott E. Cullen                                                  Endf2c
     1466 Hudson Way                                                    Endf2c
     Livermore, CA 94550                                                Endf2c
     U.S.A.                                                             Endf2c
     Telephone  925-443-1911                                            Endf2c
     E. Mail    RedCullen1@Comcast.net                                  Endf2c
     Website    RedCullen1.net/HOMEPAGE.NEW                             Endf2c
                                                                        Endf2c
====================================================================== Endf2c
```

```
====================================================================== Evalplot
                                                                       Evalplot
      PROGRAM EVALPLOT                                                 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
                                  *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
                           *ADDED (N,REMAINDER) TO FIRST PLOT.    Evalplot
VERS. 2007-2 (DEC.  2007)   *72 CHARACTER FILE NAMES.             Evalplot
VERS. 2008-1 (JULY  2008)   *UPDATED FOR MF=4/LTT = 3 = LEGENDRE  Evalplot
                            PLUS TABULATED                        Evalplot
VERS. 2010-1 (Aug.  2010)   *Extended to plots up to 100 Legendre Evalplot
                            Coefficients versus incident energy.  Evalplot
VERS. 2011-1 (July  2011)   *Increased MT.DAT from 200 to 1,000   Evalplot
                            entries, to acommodate new MTs.       Evalplot
                           *Updated MF=10 plots to identify ZAP   Evalplot
                            and state for Neutron Activation.     Evalplot
                           *Updated for energy release parameters Evalplot
                            MF=3, MT=301 to 450.                  Evalplot
VERS. 2012-1 (Aug.  2012)   *Updated incident particle list to    Evalplot
                            include photon (ZA = 0).              Evalplot
                           *Added CODENAME                        Evalplot
                           *32 and 64 bit Compatible              Evalplot
                           *Added ERROR stops                     Evalplot
VERS. 2013-1 (Nov.  2013)   *OUT9 replaced NORMX                 Evalplot
VERS. 2015-1 (Jan.  2015)   *Updated MF=10 Labels, which requires Evalplot
                            longer plot titles.                   Evalplot
                           *Restricted character size multiplier  Evalplot
                            to 0.5 to 1.5 to accommodate longer   Evalplot
                            plot titles.                          Evalplot
                           *Replaced ALL 3 way if statements.     Evalplot
VERS. 2015-2 (Mar.  2015)   *Minor changes based on user feedback  Evalplot
```

```
VERS. 2017-1 (May   2017)   *Expanded storage to handle new        Evalplot
                             R-M (LRF=7) angular distributions.    Evalplot
                            *All floating input parameters changed Evalplot
                             tp character input + IN9 conversion.  Evalplot
                            *Replaced Q Mev by MT= at top of plots Evalplot
                             (Q value in ENDF is now only defined  Evalplot
                              in MF=3, making it difficult for all Evalplot
                              other MF now treated by this code)   Evalplot
                            *Initial Linear X scaling for MF=1     Evalplot
                            *(nu-bar) and MF=4 (Legendre).         Evalplot
                            + Unless energy range is requested =   Evalplot
                              allows MF=1 and MF=4 default X       Evalplot
                              scaling to be turned off by input    Evalplot
                              parameters, i.e., by EVALPLOT or     Evalplot
                              EVALHARD.                            Evalplot
                            *Changed default Y range from 10^10    Evalplot
                             to 10^8 (Based on experience).        Evalplot
                                                                   Evalplot
                                                                   Evalplot
2015-2 Acknowledgment                                              Evalplot
====================                                               Evalplot
I thank Chuck Whitmer (TerraPower,WA) for reporting the errors     Evalplot
that led to the 2015-2 Improvements in this code.                  Evalplot
                                                                   Evalplot
I thank Jean-Christophe Sublet (UKAEA) for contributing MAC        Evalplot
executables and Bojan Zefran (IJS, Slovenia) for contributing      Evalplot
LINUX (32 or 63 bit) executables. And most of all I must thank     Evalplot
Andrej Trkov (NDS, IAEA) for overseeing the entire PREPRO project  Evalplot
at IAEA, Vienna. This was a truly International team who worked    Evalplot
together to produce PREPRO 2015-2.                                 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
ORIGINALLY WRITTEN BY                                              Evalplot
-----------------------------------                                Evalplot
Dermott E. Cullen                                                  Evalplot
                                                                   Evalplot
PRESENT CONTACT INFORMATION                                        Evalplot
---------------------------                                        Evalplot
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1466 Hudson Way                                                    Evalplot
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Telephone  925-443-1911                                            Evalplot
E. Mail    RedCullen1@Comcast.net                                  Evalplot
Website    RedCullen1.net/HOMEPAGE.NEW                             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
2015 PLOTTER DIMENSIONS                                            Evalplot
================================================================== Evalplot
PLOTTER DIMENSIONS ARE IN INCHES - NOT CM, MM, OR CUBITS.          Evalplot
THIS IS DONE FOR HISTORICAL REASONS AND HOPEFULLY THIS WILL        Evalplot
NOT INCONVENIENCE ANYONE - IN PRACTICE I HAVE USED EXACTLY THE     Evalplot
SAME DIMENSION = X = 0 to 12.5 and Y = 0 to 10 FOR DECADES         Evalplot
TO PRODUCE BOTH ON-SCREEN AND HARDCOPY POSTSCRIPT PLOTS.           Evalplot
                                                                   Evalplot
I STRONGLY SUGGEST THAT YOU NOT CHANGE THESE DIMENSIONS UNLESS     Evalplot
YOU MUST = BASED ON THE PLOT SIZE YOU OBTAIN WHEN YOU FIRST RUN    Evalplot
THIS CODE.                                                         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
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 20 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 20 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
(19) ENERGY RELEASE PARAMETERS, MF=3, MT=301-450                       Evalplot
                                                                       Evalplot
ACTIVATION (MF=10)                                                     Evalplot
------------------                                                     Evalplot
(20) ALL mt=1 TO 999.                                                  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
                                                                       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   1-72    A72   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
                         = 1-20 - 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
    2015 - WARNING - THE FOLLOWING DESCRIPTION IS OUT-OF-DATE.           Evalplot
    TODAY THE DIMENSIONS OF THE PLOTTER ARE IN INCHES.                   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
      =============                                                    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-6 SUMMATION RULES AND     Fixup
                                   DEFINED MF AND MT NUMBERS. PROGRAM  Fixup
                                   WILL NOW USE MF=1, MT=451 TO DEFINE Fixup
                                   THE ENDF FORMAT OF THE DATA (E.G.,  Fixup
                                   ENDF-6 OR EARLIER) AND USE THE      Fixup
                                   CORRECT SUMMATION RULES FOR EACH    Fixup
                                   VERSION OF THE ENDF FORMAT. IF      Fixup
                                   MF=1, MT=451 IS NOT PRESENT PROGRAM Fixup
                                   WILL USE ENDF-6 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 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 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 FORMAT         Fixup
                                   VERSION BASED ON RECENT FORMAT CHANGE Fixup
                                  *GENERAL IMPROVEMENTS BASED ON        Fixup
                                   USER FEEDBACK                       Fixup
```

```
VERSION 99-2 (JUNE 1999)     *ASSUME ENDF-6, NOT 5, 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 DATA   Fixup
                             *INCREASED PAGE SIZE FROM 60,000 TO    Fixup
                              600,000 DATA POINTS.                  Fixup
VERS. 2007-2 (OCT. 2007)     *ADDED MT=16 AS SUM MT=875 THRU 891    Fixup
                             *72 CHARACTER FILE NAMES               Fixup
VERS. 2010-1 (Apr. 2010)     *Defining cross sections by summation  Fixup
                              to now mandatory - either build-in    Fixup
                              rules or by user input.               Fixup
VERS. 2011-1 (March 2011)    *Added new MT # to allowed and         Fixup
                              summation rules.                      Fixup
VERS. 2012-1 (Aug.  2012)    *Corrected definition of MT=3 to avoid Fixup
                              double counting of MT=18.             Fixup
                             *Extended incident particle list to    Fixup
                              include photon (ZA = 0).              Fixup
                             *Added CODENAME                        Fixup
                             *32 and 64 bit Compatible              Fixup
                             *Added ERROR stops.                    Fixup
VERS. 2015-1 (Jan.  2015)    *Extended OUT9.                        Fixup
                             *Replaced ALL 3 way IF Statements      Fixup
                                                                    Fixup
VERS. 2015-2 (Oct.  2015)    *Threshold Correction no longer        Fixup
                              allowed = TOO DANGEROUS!!!            Fixup
VERS. 2017-1 (May   2017)    *Updated based on user feekback        Fixup
                             *Increased tables to 3,000,000.        Fixup
                             *All floating input parameters changed Fixup
                              to character input + IN9 conversion.  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
                                                                    Fixup
PRESENT CONTACT INFORMATION                                         Fixup
---------------------------                                         Fixup
Dermott E. Cullen                                                   Fixup
1466 Hudson Way                                                     Fixup
Livermore, CA 94550                                                 Fixup
U.S.A.                                                              Fixup
Telephone  925-443-1911                                             Fixup
E. Mail    RedCullen1@Comcast.net                                   Fixup
Website    RedCullen1.net/HOMEPAGE.NEW                              Fixup
                                                                    Fixup
PURPOSE                                                             Fixup
=======                                                             Fixup
THIS PROGRAM IS DESIGNED TO READ EVALUATED DATA IN THE ENDF         Fixup
FORMAT, PERFORM CORRECTIONS AND OUTPUT THE RESULT IN THE ENDF       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 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 DATA FILE AND WILL NOT BE IN THE OUTPUT ENDF         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 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 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
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     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 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 DATA.                                 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 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. 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
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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) 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 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 FORMAT                                                        Fixup
===========                                                        Fixup
THIS PROGRAM MAY BE USED WITH DATA IN ANY VERSION OF THE ENDF      Fixup
FORMAT (I.E. ENDF-1, 2, 3, 4, 5 OR 6 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 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 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 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 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
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
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AND ARE WRITTEN IN THE ENDF 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 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 FORMAT.                           Fixup
 11    FINAL DATA IN THE ENDF 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    1-72      A72   ENDF INPUT DATA FILENAME                   Fixup
                       (STANDARD OPTION = ENDFB.IN)                Fixup
  3    1-72      A72   ENDF 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
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```
                      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
                            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
NEW    (MT= 16) = THE SUM OF MT=875 THROUGH 891                       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 CHANGE 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 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
  16=(875,891)                                                      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, 18)+( 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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C=====================================================================C Groupie
C                                                                     C Groupie
C     PROGRAM GROUPIE                                                 C Groupie
C     ===============                                                 C Groupie
C     VERSION 76-1 (NOVEMBER 1976)                                    C Groupie
C     VERSION 79-1 (OCTOBER 1979) CDC-7600 AND CRAY-1 VERSION.        C Groupie
C     VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION               C Groupie
C     VERSION 81-1 (JANUARY 1981) EXTENSION TO 3000 GROUPS            C Groupie
C     VERSION 81-2 (MARCH 1981) IMPROVED SPEED                        C Groupie
C     VERSION 81-3 (AUGUST 1981) BUILT-IN 1/E WEIGHTING SPECTRUM      C Groupie
C     VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY     C Groupie
C     VERSION 83-1 (JANUARY 1983)*MAJOR RE-DESIGN.                    C Groupie
C                               *ELIMINATED COMPUTER DEPENDENT CODING. C Groupie
C                               *NEW, MORE COMPATIBLE I/O UNIT NUMBERS.C Groupie
C                               *NEW MULTI-BAND LIBRARY BINARY FORMAT. C Groupie
C     VERSION 83-2 (OCTOBER 1983) ADDED OPTION TO ALLOW SIGMA-0 TO BE C Groupie
C                                 DEFINED EITHER AS MULTIPLES OF      C Groupie
C                                 UNSHIELDED TOTAL CROSS SECTION IN EACHGroupie
C                                 GROUP, OR POWERS OF 10 IN ALL GROUPS. Groupie
C     VERSION 84-1 (APRIL 1984)   ADDED MORE BUILT IN MULTIGROUP ENERGY Groupie
C                                 STRUCTURES.                         C Groupie
C     VERSION 85-1 (APRIL 1985)  *UPDATED FOR ENDF/B-VI FORMATS.      C Groupie
C                               *SPECIAL I/O ROUTINES TO GUARANTEE    C Groupie
C                                ACCURACY OF ENERGY.                  C Groupie
C                               *DOUBLE PRECISION TREATMENT OF ENERGY C Groupie
C                                (REQUIRED FOR NARROW RESONANCES).    C Groupie
C                               *MINIMUM TOTAL CROSS SECTION TREATMENT Groupie
C     VERSION 85-2 (AUGUST 1985) *FORTRAN-77/H VERSION                C Groupie
C     VERSION 86-1 (JANUARY 1986)*ENDF/B-VI FORMAT                    C Groupie
C     VERSION 86-2 (JUNE 1986)   *BUILT-IN MAXWELLIAN, 1/E AND FISSION Groupie
C                                 WEIGHTING SPECTRUM.                 C Groupie
C     VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O  C Groupie
C                                 FILE NAMES (SEE, SUBROUTINES FILIO1 C Groupie
C                                 FILIO2 FOR DETAILS).                C Groupie
C                               *IMPROVED BASED ON USER COMMENTS.     C Groupie
C     VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO  C Groupie
C                                 INSURE PROGRAM WILL NOT DO ANYTHING C Groupie
C                                 CRAZY.                              C Groupie
C                               *UPDATED TO USE NEW PROGRAM CONVERT   C Groupie
C                                KEYWORDS.                            C Groupie
C                               *ADDED LIVERMORE CIVIC COMPILER       C Groupie
C                                CONVENTIONS.                         C Groupie
C     VERSION 91-1 (JUNE 1991)   *INCREASED PAGE SIZE FROM 1002 TO 5010 Groupie
C                                 POINTS                              C Groupie
C                               *UPDATED BASED ON USER COMMENTS       C Groupie
C                               *ADDED FORTRAN SAVE OPTION            C Groupie
C                               *COMPLETELY CONSISTENT ROUTINE TO READ Groupie
C                                FLOATING POINT NUMBERS.              C Groupie
C     VERSION 92-1 (JANUARY 1992)*ADDED RESONANCE INTEGRAL CALCULATION - Groupie
C                                 UNSHIELDED AND/OR SHIELDED - FOR    C Groupie
C                                 DETAILS SEE BELOW                   C Groupie
C                               *INCREASED NUMBER OF ENERGY POINTS    C Groupie
C                                IN BUILT-IN SPECTRA - TO IMPROVE     C Groupie
C                                ACCURACY.                            C Groupie
C                               *ALLOW SELECTION OF ZA/MF/MT OR       C Groupie
C                                MAT/MF/MT RANGES - ALL DATA NOT      C Groupie
C                                SELECTED IS SKIPPED ON INPUT AND     C Groupie
C                                NOT WRITTEN AS OUTPUT.               C Groupie
C                               *COMPLETELY CONSISTENT I/O ROUTINES -  Groupie
C                                TO MINIMIZE COMPUTER DEPENDENCE.     C Groupie
C                               *NOTE, CHANGES IN INPUT PARAMETER     C Groupie
C                                FORMAT - FOR ZA/MF/MT OR MAT/MF/MT   C Groupie
C                                RANGES.                              C Groupie
C     VERSION 92-2 (JUNE 1992)   *MULTIBAND PARAMETERS OUTOUT AS      C Groupie
C                                 CHARACTER (RATHER THAN BINARY) FILE. Groupie
C     VERSION 93-1 (APRIL 1993)  *INCREASED PAGE SIZE FROM 5010 TO    C Groupie
C                                 30000 POINTS                        C Groupie
C                               *ELIMINATED COMPUTER DEPENDENCE.      C Groupie
C     VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES      C Groupie
C                                 TO ALLOW ACCESS TO FILE STRUCTURES  C Groupie
C                                 (WARNING - INPUT PARAMETER FORMAT   C Groupie
C                                 HAS BEEN CHANGED)                   C Groupie
C                               *CLOSE ALL FILES BEFORE TERMINATING   C Groupie
C                                (SEE, SUBROUTINE ENDIT)              C Groupie
C     VERSION 95-1 (JANUARY 1994)*CORRECTED MAXWELLIAN WEIGHTING      C Groupie
C                               *CHANGING WEIGHTING SPECTRUM FROM     C Groupie
C                                0.1 TO 0.001 % UNCERTAINTY           C Groupie
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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
                             1.0D-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.         Groupie
                           *INCREASED PAGE SIZE FROM 120,000 TO     Groupie
                            600,000 POINTS                          Groupie
VERS. 2008-1 (JAN. 2008)   *72 CHARACTER FILE NAMES.                Groupie
                           *GENERAL UPDATES                         Groupie
VERS. 2010-1 (Apr. 2010)   *INCREASED WEIGHTING SPECTRUM TO 30,000  Groupie
                            FROM 3,000 ENERGY POINTS.               Groupie
                           *ADDED OUTPUT TO PLOT/COMPARE SHIELDED   Groupie
                            AND UNSHIELDED CROSS SECTIONS.          Groupie
VERS. 2011-1 (June 2011)   *Corrected TART 700 groups to extend up  Groupie
                            to 1 GeV (1,000 MeV) - previously it    Groupie
                            was ERRONEOUSLY cutoff at 20 MeV.       Groupie
VERS. 2011-2 (Nov. 2011)   *Corrected TART 616 groups lowest        Groupie
                            energy from 1.0D-4 eV to 1.0D-5 eV.     Groupie
                           *Added TART 666 to 200 MeV (for TENDL).  Groupie
                           *Optional high energy cross section      Groupie
                            extension above tabulated energy range Groupie
                            (either = 0 = standard, or constant)    Groupie
                            WARNING - ENDF/B standard convention    Groupie
                            is that the cross section = 0 where it Groupie
                            is not explicitly defined - extension   Groupie
                            = 0 is standard, constant is NOT, so    Groupie
                            constant extension is NOT RECOMMENDED.  Groupie
VERS. 2012-1 (Aug. 2012)   *Added CODENAME                          Groupie
                           *32 and 64 bit Compatible                Groupie
                           *Added ERROR stop.                       Groupie
VERS. 2013-1 (Nov. 2013)   *Extended OUT9.                          Groupie
                           *Uses OUTG, not OUT10 for energies.      Groupie
```

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VERS. 2015-1 (Jan. 2015)   *Corrected SPECTM - handle ALL included Groupie
                            group structures, i.e., even those     Groupie
                            that start above thremal range by      Groupie
                            ALWAYS constructing weigthing spectrum Groupie
                            to be AT LEAST 1.0D-5 eV to 20 MeV.    Groupie
                           *Extended OUTG                          Groupie
                           *Replaced ALL 3 way IF Statements.      Groupie
                           *Generalized TART Group Strructures.    Groupie
                           *Generalized SAND-II Group Structures.  Groupie
                           *Extended SAND-II to 60, 150, 200 MeV.  Groupie
VERS. 2015-2 (Mar. 2015)   *Deleted 1P from formats reading input  Groupie
                            parameters, causing incorrect scaling  Groupie
                           *Changed ALL data to "D" instead of     Groupie
                            "E" to insure it is REAL*8 and avoid   Groupie
                            Truncation ERRORS.                     Groupie
VERS. 2015-3 (July 2015)   *Insure no 10 digit output - not        Groupie
                            needed for multi-group and this makes  Groupie
                            listings simpler.                      Groupie
                           *Corrected High Energy Extension =      Groupie
                            Can effect highest energy group.       Groupie
VERS. 2016-1 (July 2016)   *Added UKAEA 1102 Group Structure.      Groupie
                           *Increased storage to accommodate       Groupie
                            much larger group structures =         Groupie
                            up to 20,000 Groups.                   Groupie
                           *Added output listing of the complete   Groupie
                            input parameters for URRFIT, including Groupie
                            the NJOY parameters LSSF and ICOMP.    Groupie
                           *Changed multiple IF statements to      Groupie
                            accommodate compiler optimizer         Groupie
                           *Cosmetic changes based on FREUD        Groupie
                            psychoanalysis.                        Groupie
                           *Updated multi-band treatment to        Groupie
                            explcitly handle small shielding       Groupie
                            limit - without this update the small  Groupie
                            limit becomes numerically unstable.    Groupie
VERS. 2017-1 (May  2017)   *Increased max. points to 3,000,000.    Groupie
                           *METHODB was incorrecctly named         Groupie
                            METHOD  in one routine = corrected.    Groupie
                           *Default multi-band is method #2 =      Groupie
                            conserve <x>, <1/(x+<x>>, <1/x>.       Groupie
                           *Definition of built-in group structure Groupie
                            using SUBROUTINE GROPE is identical    Groupie
                            for GROUPIE and VIRGIN.                Groupie
                           *All floating input parameters changed  Groupie
                            to character input + IN9 conversion.   Groupie
                           *Output report identfies MF now that    Groupie
                            this code does more than just MF=3.    Groupie
                                                                   Groupie
2015-2 Acknowledgment                                              Groupie
=====================                                              Groupie
I thank Chuck Whitmer (TerraPower,WA) and Andrej Trkov (NDS,IAEA)  Groupie
for reporting the errors that led to the 2015-2 Improvements in    Groupie
this code.                                                         Groupie
                                                                   Groupie
I thank Jean-Christophe Sublet (UKAEA) for contributing MAC        Groupie
executables and Bojan Zefran (IJS, Slovenia) for contributing      Groupie
LINUX (32 or 63 bit) executables. And most of all I must thank     Groupie
Andrej Trkov (NDS, IAEA) for overseeing the entire PREPRO project  Groupie
at IAEA, Vienna. This was a truly International team who worked    Groupie
together to produce PREPRO 2015-2.                                 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
                                                                   Groupie
ORIGINALLY WRITTEN BY                                              Groupie
-----------------------------------                                Groupie
Dermott E. Cullen                                                  Groupie
                                                                   Groupie
PRESENT CONTACT INFORMATION                                        Groupie
---------------------------                                        Groupie
Dermott E. Cullen                                                  Groupie
1466 Hudson Way                                                    Groupie
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Livermore, CA 94550                                                    Groupie
U.S.A.                                                                 Groupie
Telephone  925-443-1911                                                Groupie
E. Mail    RedCullen1@Comcast.net                                      Groupie
Website    RedCullen1.net/HOMEPAGE.NEW                                 Groupie
                                                                       Groupie
AUTHORS MESSAGE                                                        Groupie
---------------                                                        Groupie
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION       Groupie
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED     Groupie
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE     Groupie
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY         Groupie
THE COMMENTS CONCERNING MACHINE DEPENDENT CODING.                      Groupie
                                                                       Groupie
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER     Groupie
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE         Groupie
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT     Groupie
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY           Groupie
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO      Groupie
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF        Groupie
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR             Groupie
COMPUTER.                                                              Groupie
                                                                       Groupie
PURPOSE                                                                Groupie
-------                                                                Groupie
THIS PROGRAM IS DESIGNED TO CALCULATE ANY COMBINATION OF               Groupie
THE FOLLOWING QUANTITIES FROM LINEARLY INTERPOLABLE TABULATED          Groupie
CROSS SECTIONS IN THE ENDF/B FORMAT                                    Groupie
                                                                       Groupie
(1) UNSHIELDED GROUP AVERAGED CROSS SECTIONS                           Groupie
(2) BONDARENKO SELF-SHIELDED GROUP AVERAGED CROSS SECTIONS             Groupie
(3) MULTI-BAND PARAMETERS                                              Groupie
                                                                       Groupie
IN THE FOLLOWING FOR SIMPLICITY THE ENDF/B TERMINOLOGY--ENDF/B         Groupie
TAPE--WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS,      Groupie
DISK OR ANY OTHER MEDIUM.                                              Groupie
                                                                       Groupie
ENDF/B FORMAT                                                          Groupie
-------------                                                          Groupie
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS         Groupie
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION       Groupie
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV OR V FORMAT).         Groupie
                                                                       Groupie
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B           Groupie
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS         Groupie
ASSUMED THAT THE MAT, MF AND MT ON EACH CARD IS CORRECT. SEQUENCE      Groupie
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE              Groupie
CORRECTLY OUTPUT ON ALL CARDS. THE FORMAT OF SECTION MF=1, MT=451      Groupie
AND ALL SECTIONS OF MF= 3 MUST BE CORRECT. THE PROGRAM COPIES ALL      Groupie
OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO       Groupie
THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.                 Groupie
                                                                       Groupie
ALL FILE 3 CROSS SECTIONS THAT ARE USED BY THIS PROGRAM MUST BE        Groupie
LINEARLY INTERPOLABLE IN ENERGY AND CROSS SECTION (ENDF/B              Groupie
INTERPOLATION LAW 2). FILE 3 BACKGROUND CROSS SECTIONS MAY BE MADE     Groupie
LINEARLY INTERPOLABLE USING PROGRAM LINEAR (UCRL-50400, VOL. 17,       Groupie
PART A). THE RESONANCE CONTRIBUTION MAY BE ADDED TO THE BACKGROUND     Groupie
CROSS SECTIONS USING PROGRAM RECENT (UCRL-50400, VOL. 17, PART B).     Groupie
IF THIS PROGRAM FINDS THAT THE FILE 3 CROSS SECTIONS ARE NOT           Groupie
LINEARLY INTERPOLABLE THIS PROGRAM WILL TERMINATE EXECUTION.           Groupie
                                                                       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 (2017-1) ***************         Groupie
UNSHIELDED GROUP AVERAGES USING   69 GROUPS (WIMS)                     Groupie
MAXWELLIAN, 1/E AND FISSION WEIGHTING SPECTRUM                         Groupie
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                                                                        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
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 20,000.                   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
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(10)  28 GROUP (ABBN STRUCTURE)                                        Groupie
(11) 616 GROUP (TART STRUCTURE TO 20 MeV)                              Groupie
(12) 700 GROUP (TART STRUCTURE TO 1 GEV)                               Groupie
(13) 665 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 18 MEV)            Groupie
(14) 685 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 20 MEV)            Groupie
(15) 666 GROUP (TART STRUCTURE TO 200 MeV)                             Groupie
(16) 725 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO  60 MEV)           Groupie
(17) 755 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 150 MEV)           Groupie
(18) 765 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 200 MEV)           Groupie
(19)1102 GROUP (UKAEA   STRUCTURE, 1.0D-5 eV, UP TO   1 GeV)           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
     KT     = 0.253 EV (293 KELVIN)                                    Groupie
     WA     = 9.65D+5                                                  Groupie
     WB     = 2.29D-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 20,000 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 20,000 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
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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
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
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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
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
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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
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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
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     E11.4   TEMPERATURE (KELVIN)                   Groupie
          45-55    1X,10A1  HOLLERITH DESCRIPTION OF ZA            Groupie
   3       1-11     E11.4   ENERGY (EV) - GROUP BOUNDARY.          Groupie
          12-22     E11.4   TOTAL      (FIRST BAND)                Groupie
          23-33     E11.4   ELASTIC                                Groupie
          34-44     E11.4   CAPTURE                                Groupie
          35-55     E11.4   FISSION                                Groupie
   4       1-11     -----   BLANK                                  Groupie
          12-22     E11.4   TOTAL      (SECOND BAND)               Groupie
          23-33     E11.4   ELASTIC                                Groupie
          34-44     E11.4   CAPTURE                                Groupie
          35-55     E11.4   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     E11.4   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
UNIT  FILENAME  DESCRIPTION                                        Groupie
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----  --------  -----------                                          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 20,000 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    616 GROUPS TO 20 MEV         Groupie
                     =-12   - TART    700 GROUPS TO 1 GEV          Groupie
                     =-13   - SAND-II 665 GROUPS TO 18 MEV         Groupie
                     =-14   - SAND-II 685 GROUPS TO 20 MEV         Groupie
                     =-15   - TART    666 GROUPS TO 200 MEV        Groupie
                     =-16   - SAND-II 725 GROUPS TO 60 MEV         Groupie
                     =-17   - SAND-II 755 GROUPS TO 150 MEV        Groupie
                     =-18   - SAND-II 765 GROUPS TO 200 MEV        Groupie
                     =-19   - UKAEA  1102 GROUPS TO   1 GeV        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
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                                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   E11.4   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
      1   67-70    I4       High energy extension = definition of cross Groupie
                            section above highest tabulated energy.    Groupie
                            = 0 = cross section = 0 (standard ENDF/B)  Groupie
                            = 1 = cross section = constant (equal to   Groupie
                                  value at highest tabulated energy).  Groupie
    2-4    1-66 6E11.4   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    1-72    A72      ENDF/B INPUT DATA FILENAME                 Groupie
                            (STANDARD OPTION = ENDFB.IN)               Groupie
      3    1-72    A72      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
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                        = 2 - RESONANCE INTEGRALS                       Groupie
05/01/20 - ADDED THE BELOW OPTION                                       Groupie
      4    56-66   E11.4 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  6E11.4 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 20,000 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  6E11.4 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/E 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
      ==============                                                   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
                                   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
      VERS. 2007-2 (MAY   2007)   *CORRECTED SIZE OF XMUBASE IN ANGLEN  Legend
                                   FOR INCREASED NUMBER OF COEFFICIENTS. Legend
      VERS. 2010-1 (Apr.  2010)   *General update based on user feedback Legend
      VERS. 2012-1 (Aug.  2012)   *added CODENAME                       Legend
```

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                          *32 and 64 bit Compatible             Legend
                          *Added ERROR stop                     Legend
VERS. 2015-1 (Jan.  2015) *Extended OUT9                        Legend
                          *Replaced ALL 3 way IF Statements.    Legend
VERS. 2015-2 (Oct.  2015) *OPEN optional LEGEND.INP after       Legend
                           OPENING LEGEND.LST.                  Legend
                          *Coefficient checks are turned OFF    Legend
                           if LEGEND.INP is missing = this      Legend
                           agrees with BEST INPUT.              Legend
                          *Switched from LISTO to LISTO9        Legend
                           (no 10 digit output)                 Legend
VERS. 2016-1 (May   2016) *Changed multiple IF statement to     Legend
                           accommodate compiler optimizer       Legend
                          *Increased Maximum allowed points per Legend
                           angular distribution from 900 to     Legend
                           MAXPOINT (currently 240,000)         Legend
VERS. 2017-1 (May   2017) *More tests. Expanded to handle new   Legend
                           R-M (LRF=7) detailed angular         Legend
                           distributions.                       Legend
                          *Max. points increased to 3,000,000.  Legend
                          *All floating input parameters changed Legend
                           to characte input + IN9 conversion.  Legend
                          *If near COS=0 - set = 0              Legend
                          *Default changed to negative fixes.   Legend
                          *At end print tallies for,            Legend
                           1-Number of negative distributions.  Legend
                           2-Number of duplicate or out-of-order Legend
                             Ehnergies                          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
                                                                Legend
PRESENT CONTACT INFORMATION                                     Legend
---------------------------                                     Legend
Dermott E. Cullen                                               Legend
1466 Hudson Way                                                 Legend
Livermore, CA 94550                                             Legend
U.S.A.                                                          Legend
Telephone  925-443-1911                                         Legend
E. Mail    RedCullen1@Comcast.net                               Legend
Website    RedCullen1.net/HOMEPAGE.NEW                          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
```

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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
```

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    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
```

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        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
      ==============                                                      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
                                  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
VERS. 2007-2 (DEC. 2007)    *72 CHARACTER FILE NAMES.             Linear
VERS. 2010-1 (Apr. 2010)    *Skipped leading cross section = 0    Linear
                            up to effective start, unless keeping Linear
                            ALL original energy points.           Linear
                           *Replaced ETHRES by ESTART - it is     Linear
                            not a threshold - just a minimum      Linear
                            energy - if a section starts above    Linear
                            this energy with a positive cross     Linear
                            section, an additional point will     Linear
                            inserted with cross section = 0.      Linear
VERS. 2012-1 (Aug. 2012)    *Minor Updates based on User Feedback. Linear
                           *Added CODENAME                        Linear
                           *32 and 64 bit Compatible              Linear
                           *Added ERROR stops.                    Linear
VERS. 2012-2 (Nov. 2012)    *Never thin nu-bar.                   Linear
VERS. 2013-1 (Nov. 2013)    *Extended OUT9.                       Linear
VERS. 2015-1 (Jan. 2015)    *Allow Imaginary Anomolous Scattering Linear
                            Factor to be Negative (MF/MT=27/506). Linear
                           *Replaced ALL 3 way IF Statements.     Linear
VERS. 2016-1 (June 2016)    *Cosmetic changes based on FREUD      Linear
                            psychoanalysis.                       Linear
VERS. 2017-1 (May  2017)    *Updated based on user feedback.      Linear
                           *Inceased page size to 3,000,000.      Linear
                           *All floating input parameters changed Linear
                            to character input + IN9 conversion.  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
                                                                  Linear
PRESENT CONTACT INFORMATION                                       Linear
---------------------------                                       Linear
Dermott E. Cullen                                                 Linear
1466 Hudson Way                                                   Linear
Livermore, CA 94550                                               Linear
```

```
U.S.A.                                                                Linear
Telephone  925-443-1911                                               Linear
E. Mail    RedCullen1@Comcast.net                                     Linear
Website    RedCullen1.net/HOMEPAGE.NEW                                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
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 (2017-1) ***************           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   1-72  ENDF/B INPUT DATA FILENAME                            Linear
             (STANDARD OPTION = ENDFB.IN)                          Linear
   3   1-72  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
```

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           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
      ==============                                                   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
      VERS. 2007-2 (JUNE  2007)   *UP, TO 1,000 ENDF/B FILES.         Merger
                                  *72 CHARACTER FILE NAMES.             Merger
      VERS. 2010-1 (Apr.  2010)   *General update based on user feedback Merger
      VERS. 2012-1 (Aug.  2012)   *Added CODENAME                      Merger
                                  *32 and 64 bit Compatible             Merger
                                  *Added ERROR stop                     Merger
      VERS. 2015-1 (Jan.  2015)   *Replaced ALL 3 way IF Statements.   Merger
      VERS. 2017-1 (May   2017)   *Updated based on user feedbck.      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
                                                                       Merger
      PRESENT CONTACT INFORMATION                                      Merger
      ---------------------------                                      Merger
      Dermott E. Cullen                                                Merger
      1466 Hudson Way                                                  Merger
      Livermore, CA 94550                                              Merger
      U.S.A.                                                           Merger
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Telephone  925-443-1911                                                 Merger
E. Mail    RedCullen1@Comcast.net                                       Merger
Website    RedCullen1.net/HOMEPAGE.NEW                                  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       Merger
                LOWER LIMIT.                                            Merger
(2) MF OR MT  - IF THE UPPER LIMIT IS ZERO IT IS SET EQUAL TO THE       Merger
                MAXIMUM POSSIBLE VALUE, 99 OR 999 RESPECTIVELY.         Merger
                                                                        Merger
WITH THESE CONVENTIONS AN ENTIRE EVALUATION MAY BE SELECTED BY          Merger
MERELY SPECIFYING THE LOWER LIMIT OF MAT OR ZA. THE UPPER MAT OR        Merger
ZA LIMIT WILL BE SET EQUAL TO THE LOWER LIMIT, THE LOWER LIMITS OF      Merger
```

```
MF/MT WILL BE 0/0 AND THE UPPER LIMITS OF MF/MT WILL BE SET TO     Merger
99/999. THIS WILL CAUSE ALL SECTIONS OF A SINGLE EVALUATION TO BE  Merger
SELECTED.                                                          Merger
                                                                   Merger
SATISFYING SELECTION CRITERIA                                      Merger
-----------------------------                                      Merger
IN ORDER FOR A SECTION TO MEET THE SELECTION CRITERIA SPECIFIED    Merger
BY ONE OF THE RETRIEVAL REQUESTS, EACH OF THE THREE FIELDS (       Merger
MAT/MF/MT OR ZA/MF/MT) MUST INDIVIDUALLY SATISFY THE CORRESPONDING Merger
LIMITS OF THE REQUEST. IT IS NOT SUFFICIENT THAT THE MAT OF A      Merger
SECTION LIE BETWEEN THE MINIMUM AND MAXIMUM MATS OF A REQUEST. THE Merger
MF AND MT WILL ALSO BE INDIVIDUALLY COMPARED TO THE MF AND MT      Merger
LIMITS OF THE REQUEST. FOR EXAMPLE, A SECTION WITH MAT/MF/MT=      Merger
2500/3/2 DOES NOT SATISFY A REQUEST THAT SPECIFIES A REQUEST USING Merger
THE RANGE 2000/3/1 THROUGH 3000/3/1. THIS REQUEST SPECIFIES ALL    Merger
MATERIALS WITH MAT BETWEEN 2000 AND 3000, BUT ONLY THOSE SECTIONS  Merger
WITH MF/MT=3/1. SIMILARLY A REQUEST FOR 2000/3/1 THROUGH 3000/99/  Merger
999 WILL NOT SELECT ANY SECTIONS WITH MF=1 OR 2, SINCE THE         Merger
REQUEST SPECIFIES ALL MATERIALS WITH MAT BETWEEN 2000 AND 3000,    Merger
BUT ONLY THOSE SECTIONS WITH MF= 3, OR MORE.                       Merger
                                                                   Merger
DUPLICATE SECTIONS                                                 Merger
------------------                                                 Merger
IF TWO OR MORE SECTIONS WITH THE SAME MAT/MF/MT ARE FOUND EITHER   Merger
ON THE SAME OR DIFFERENT TAPES, THE SECTION FROM THE TAPE DEFINED  Merger
EARLIEST IN THE INPUT CARDS WILL BE COPIED TO THE FINAL TAPE AND   Merger
ALL OTHER SECTIONS WITH THE SAME MAT/MF/MT WILL BE SKIPPED. THE    Merger
OUTPUT REPORT WILL INDICATE WHICH SECTIONS WERE COPIED FROM WHICH  Merger
TAPES, AS WELL AS WHICH SECTIONS ARE DUPLICATE AND WERE SKIPPED.   Merger
                                                                   Merger
REACTION INDEX                                                     Merger
--------------                                                     Merger
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.   Merger
FOR EACH MATERIAL THE PROGRAM WILL FOLLOW THE CONVENTIONS          Merger
DEFINED ABOVE AND ONLY COPY ONE SECTION MF=1, MT=451 AND SKIP      Merger
ALL OTHERS (IF MORE THAN ONE). THIS CONVENTION HAS BEEN ADOPTED    Merger
BECAUSE MOST USERS DO NOT REQUIRE A CORRECT REACTION INDEX FOR     Merger
THERE APPLICATIONS AND IT WAS NOT CONSIDERED WORTHWHILE TO INCLUDE Merger
THE OVERHEAD OF CONSTRUCTING A CORRECT REACTION INDEX IN THIS      Merger
PROGRAM. HOWEVER, IF YOU REQUIRE A REACTION INDEX FOR YOUR         Merger
APPLICATION AFTER RUNNING THIS PROGRAM YOU MAY USE PROGRAM         Merger
DICTIN TO CREATE ONE.                                              Merger
                                                                   Merger
RETRIEVAL STATISTICS                                               Merger
--------------------                                               Merger
THERE WILL ALWAYS BE AN OUTPUT REPORT LISTING INDICATING WHICH     Merger
SECTIONS WHERE SELECTED, WHICH DUPLICATE SECTIONS WERE SKIPPED,    Merger
WHICH TAPE THE SECTION WAS ON, WHICH REQUEST (MAT/MF/MT OR         Merger
ZA/MF/MT RANGE) CAUSED THE SECTION TO BE SELECTED AND HOW MANY     Merger
CARDS WERE IN THE SECTION. IN ADDITION THE USER MAY OPTIONALLY     Merger
OBTAIN A FILE CONTAINING THE SAME INFORMATION. THIS FILE MAY BE    Merger
COMBINED WITH OTHER SIMILAR FILES OUTPUT BY THIS PROGRAM IN ORDER  Merger
TO ACCUMULATE RETRIEVAL STATISTICS OVER A PERIOD OF TIME. IF       Merger
SPECIFIED THIS FILE WILL CONTAIN THE FOLLOWING INFORMATION IN      Merger
6I7 FORMAT.                                                        Merger
                                                                   Merger
(1) ZA                                                             Merger
(2) MAT                                                            Merger
(3) MF                                                             Merger
(4) MT                                                             Merger
(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     1-72    A72    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    1-72    A72    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
      VERS. 2007-2 (DEC. 2007)    *72 CHARACTER FILE NAMES.              Mixer
      VERS. 2008-1 (JUNE 2008)    *ADDED GRAMS OR ATOMS INPUT            Mixer
      VERS. 2010-1 (Apr. 2010)    *General update based on user feedback Mixer
      VERS. 2012-1 (Aug. 2012)    *Added CODENAME                        Mixer
                                 *32 and 64 bit Compatible               Mixer
                                 *Added ERROR stop                       Mixer
      VERS. 2015-1 (Jan. 2015)    *Extended OUT9.                        Mixer
                                 *Replaced ALL 3 way IF Statements.      Mixer
      VERS. 2017-1 (May  2017)    *Increse max. points to 1,200,000      Mixer
                                 *updated based on user feedbsck.        Mixer
                                 *All floating input parameters changed Mixer
```

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                              to character input + IN9 conversion.  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
                                                                    Mixer
PRESENT CONTACT INFORMATION                                         Mixer
---------------------------                                         Mixer
Dermott E. Cullen                                                   Mixer
1466 Hudson Way                                                     Mixer
Livermore, CA 94550                                                 Mixer
U.S.A.                                                              Mixer
Telephone  925-443-1911                                             Mixer
E. Mail    RedCullen1@Comcast.net                                   Mixer
Website    RedCullen1.net/HOMEPAGE.NEW                              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 OR ATOMS OF EACH CONSTITUENT. IN ADDITION THE USER     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 INTO ATOMS 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
    ============                                                    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
```

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             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 2017-1) ********************** 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 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
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
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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
    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
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    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
 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   1-72                  ENDF/B INPUT DATA FILENAME           Mixer
                              (STANDARD OPTION = ENDFB.IN)         Mixer
    4   1-72                  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
    5  23-33    I11   DEFINE INPUT DENSITY                         Mixer
                      = 0 = GRAMS = BACKWARDS COMPATIBLE           Mixer
                      > 0 = ATOMS = NEW IN 2008                    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   MATERIAL DENSITY (ATOMS OR GRAMS)    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
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     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 OR ATOMS. THIS IS  Mixer
     DEFINED AS THE PRODUCT OF THE STANDARD DENSITY (GRAMS)             Mixer
     TIMES THE VOLUME FRACTION. FOR THIS EXAMPLE THE FOLLOWING 12       Mixer
     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          0                                  Mixer
          26000           1 5.88676    (NOTE, GRAMS 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.      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
     -------------------                                                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 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.      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
      ==============                                                       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
                                  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
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                          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
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                          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
VERS. 2007-2 (OCT. 2007)  *NO MT=19 OUTPUT IF NO BACKGROUND,     Recent
                           REGARDLESS OF INPUT OPTION.           Recent
                          *72 CHARACTER FILE NAMES.              Recent
VERS. 2008-1 (FEB. 2008)  *CORRECTED NAPS ERROR - NOW DEFINE FOR Recent
                           ALL TYPES OF PARAMETERS - EARLIER     Recent
                           ONLY DEFINED FOR B-W PARAMETERS.      Recent
VERS. 2008-2 (APRIL 2008) *CORRECTED NRO/NAPS=1/1 - MUST         Recent
                           DEFINE RHOX2 AT EACH RESONANCE USING  Recent
                           SETRHO1 BEFORE ENERGY DEPENDENT       Recent
                           CALCULATION.                          Recent
                          *ADDED PRECISION TO RESONANCE PROFILE  Recent
                           IN SUBROUTINE SUBINT                  Recent
VERS. 2009-1 (JULY 2009)  *NEW REICH-MOORE COMPETITIVE WIDTHS -  Recent
                           IF CHARGED PARTICLE REACTION (MT=103  Recent
                           THROUGH 107) WILL ADD RESONANCE       Recent
                           CONTRIBUTION TO COMPETITIVE MT AND IF Recent
                           PRESENT, THE GROUND LEVEL, MT = 600   Recent
                           THROUGH 800. IF COMPETITIVE CHANNEL   Recent
                           IS mt=4 (TOTAL N.N') IT WILL ALSO ADD Recent
                           COMPETITIVE RESONANCE CONTRIBUTION TO Recent
                           MT=50 (N,N' GROUND).                  Recent
                          *NEW REICH-MOORE - SUM COMPETITIVE     Recent
                           WIDTHS IF ALL FOR THE SAME STATE (MT) Recent
VERS. 2009-2 (AUG. 2009)  *RE-WRITE TO USE 12, RATHER THAN 6,    Recent
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                          PAAMETERS PER RESONANCE.              Recent
                         *MAJOR RE-WRITE TO ACCOMODATE GENERAL  Recent
                          REICH-MOORE (LRF=7).                  Recent
                         *COMPLETE RE-WRITE FOR ADLER-ADLER     Recent
                          AND HRF (N O LONGER USED IN ENDF/B)   Recent
                          TO USE 12 PARAMETERS PER RESNANCE.    Recent
VERS. 2010-1 (April 2010) *ADDED SAMRML LOGIC TO HANDLE ALL     Recent
                          LRF=7 CASES.                          Recent
                         *EXTENDED SAMRML LOGIC TO PROCESS ALL  Recent
                          EVALUATIONS = RESOLVED + UNRESOLVED + Recent
                          TABULATED - SAMRML ONLY DOES ONE      Recent
                          SECTION OF RESOLVED LRF=7 DATA        Recent
                          WITHOUT TABULATED BACKGROUND.         Recent
                         *UPDATED ELASTIC POTENTIAL CALCULATION Recent
                          FOR TOTAL (SLBW) AND CORRECTION FOR   Recent
                          MISSING SEQUENCES (MLBW, RM, HRF).    Recent
                         *ADDED HIDDEN (OPTIONAL) UNRESOLVED    Recent
                          COMPETITION LISTING (NOT ENDF/B).     Recent
                         *ADDED BOB MACFARLANE'S PROPOSAL - USE Recent
                          LRX TO DEFINE COMPETITIVE L VALUE -   Recent
                          COMPETITIVE L = LRX - 1, IF LRX > 0.  Recent
                         *CHECKED FOR NEGATIVE WIDTHS.          Recent
VERS. 2012-1 (Nov.  2012) *ADDED ENERGY DEPENDENT STEP SIZE     Recent
                          FOR STARTING GRID AROUND RESONANCES.  Recent
                         *Added CODENAME                        Recent
                         *32 and 64 bit Compatible              Recent
                         *Added ERROR stops                     Recent
                         *Check for no capture for Reich-Moore. Recent
VERS. 2012-2 (Nov.  2012) *Eliminated ERROR in NHIGH(0) index.  Recent
VERS. 2013-1 (Nov.  2013) *Extended OUT9.                       Recent
VERS. 2015-1 (Jan.  2015) *Multiple LRF=7, General Reich-Moore  Recent
                          Resonance Regions.                    Recent
                         *Added OUT10.                          Recent
                         *Replaced ALL 3 way IF Statements.     Recent
                         *Replaced ALL LOGICAL by INTEGER.      Recent
VERS. 2016-1 (Jan.  2016) *Do not Change LSSF during the        Recent
                          reconstrcution - for compatibility    Recent
                          with later URR treatment.             Recent
                         *Insured that all ERROR stops print    Recent
                          a message explaining why the code     Recent
                          stopped.                              Recent
                         *Partial Energy Range Processing       Recent
                          no longer allowed - today's computers Recent
                          are so fast that this option is now   Recent
                          out-of-date and no longer allowed.    Recent
                         *L-Value dependent fission = Earlier   Recent
                          was done only by entire isotope.      Recent
                         *Denser Starting Energy Grid.          Recent
VERS. 2017-1 (May   2017) *Corrected ERROR in LRF=3 treatment.  Recent
                          This ERROR only existed in version    Recent
                          2016-1, which was never released to   Recent
                          the general public, so it will not    Recent
                          effect any results calculated by code Recent
                          users.                                Recent
                         *All floating input parameters changed Recent
                          to character input + IN9 conversion.  Recent
                         *Added points to starting energy grid  Recent
                          to approximate the shape of each      Recent
                          resonance = based on comparisons of   Recent
                          0.01% to 0.1% results.                Recent
                         *Increased max. points to 1,200,000.   Recent
                         *LRF=7 Shift option no longer allowed  Recent
                          Set = 0, print WARNING and continue.  Recent
                         *Corrected COMMON/NAPRHO/NRO,NAPS      Recent
                          /NAPRHO/ mispelled - Freud found.     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
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                                                                      Recent
PRESENT CONTACT INFORMATION                                           Recent
---------------------------                                           Recent
Dermott E. Cullen                                                     Recent
1466 Hudson Way                                                       Recent
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                                                                      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
```

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------------                                                        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 2017-1) ***************          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
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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
                                                                   Recent
(2) THE LRU FLAG IN EACH SECTION OF FILE 2 DATA IS CHANGED TO      Recent
LRU=LRU+3. FOR EXAMPLE WHEN READING AN ENDF/B EVALUATION LRU=0     Recent
(NO RESONANCES), =1 (RESOLVED) OR =2 (UNRESOLVED) INDICATES THAT   Recent
THE DATA IS IN THE ORIGINAL ENDF/B FORM. LRU=3 (NO RESONANCES),    Recent
=4 (RESOLVED) OR =5 (UNRESOLVED) INDICATES THAT THE RESONANCE      Recent
CONTRIBUTION HAS ALREADY BEEN ADDED TO THE FILE 3 DATA. THIS       Recent
SECOND CONVENTION HAS BEEN ADOPTED AS INSURANCE THAT THE RESONANCE Recent
CONTRIBUTION WILL NOT BE ADDED TWICE, EVEN FOR EVALUATIONS WHICH   Recent
DO NOT CONTAIN MF=1, MT=451 (EVALUATIONS WHICH CONTAIN MF=1,       Recent
MT=451 ARE COVERED BY CONVENTION (1), DESCRIBED ABOVE).            Recent
                                                                   Recent
UNIFORM TREATMENT OF RESONANCE FORMALISMS                          Recent
================================================================== Recent
NORMALIZATION                                                      Recent
=============                                                      Recent
ALL OF THE RESONANCE FORMALISMS INCLUDE A FACTOR OF,               Recent
                                                                   Recent
PI*(FRACTIONAL ABUNDANCE)/(K**2)                                   Recent
                                                                   Recent
THIS FACTOR HAS BEEN REMOVED FROM THE CALCULATION OF EACH TYPE     Recent
OF RESONANCE FORMALISM AND IS APPLIED AS A FINAL NORMALIZATION     Recent
AFTER THE CALCULATION, ONLY ONE PLACE IN THIS PROGRAM.             Recent
                                                                   Recent
FOR SIMPLICITY THIS TERM IS NOT INCLUDED IN THE FOLLOWING          Recent
DERIVATIONS - IN ALL CASES THE ACTUAL CROSS SECTION IS A PRODUCT   Recent
OF THE ABOVE FACTOR TIMES THE RESULTS PRESENTED BELOW.             Recent
                                                                   Recent
SIMILARITIES                                                       Recent
============                                                       Recent
FOR THE RESOLVED RESONANCE REGION, EXCEPT FOR SINGLE LEVEL BREIT   Recent
WIGNER, PARAMETERS ALL OF THE FORMALISMS DEFINE THE CROSS SECTIONS Recent
IN AN EQUIVALENT FORM,                                             Recent
                                                                   Recent
TOTAL    = 2*GJ*REAL(1 - U)                                        Recent
         = 2*GJ*(1 - REAL(U))                                      Recent
ELASTIC  =   GJ*(1 - U)**2                                         Recent
         =   GJ*((1 - 2*REAL(U)) + (REAL(U)**2 + IM(U)**2))        Recent
         = 2*GJ*(1 - REAL(U)) - GJ*(1 - (REAL(U)**2 + IM(U)**2))   Recent
                                                                   Recent
SINCE THE FIRST TERM IS THE TOTAL, THE SECOND TERM MUST BE         Recent
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ABSORPTION. SO WE FIND,                                                 Recent
                                                                        Recent
ABSORPTION = GJ*(1 - (REAL(U)**2 + IM(U)**2))                           Recent
                                                                        Recent
IN ALL CASES U IS DEFINED IN THE FORM,                                  Recent
                                                                        Recent
U        = EXP(-I*2*PS)*((1-X) - I*Y)                                   Recent
                                                                        Recent
WHERE (X) AND (Y) ARE RELATED TO THE SYMMETRIC AND ANTI-SYMMETRIC       Recent
CONTRIBUTIONS OF THE RESONANCES, RESPECTIVELY. ONLY THE DEFINITION      Recent
OF (X) AND (Y) WILL BE DIFFERENT FOR EACH RESONANCE FORMALISM.          Recent
BELOW WE WILL SHOW THAT WHAT MIGHT APPEAR TO BE A STRANGE CHOICE        Recent
OF DEFINITION OF THE SIGN OF (X) AND(Y) HAS BEEN SELECTED SO THAT       Recent
FOR BREIT-WIGNER PARAMETERS (X) AND (Y) CORRESPOND EXACTLY TO THE       Recent
SYMMETRIC AND ANTI-SYMMETRIC CONTRIBUTION OF THE RESONANCES.            Recent
                                                                        Recent
U        = (COS(2*PS) - I*SIN(2*PS))*((1-X) - I*Y)                      Recent
         =   ((1-X)*COS(2*PS) - Y*SIN(2*PS))                            Recent
         =-I*((1-X)*SIN(2*PS) + Y*COS(2*PS))                            Recent
                                                                        Recent
REAL(U)  = ((1-X)*COS(2*PS) - Y*SIN(2*PS))                              Recent
IM(U)    =-((1-X)*SIN(2*PS) + Y*COS(2*PS))                              Recent
                                                                        Recent
R(U)**2  =((1-X)*COS(2*PS))**2 + (Y*SIN(2*PS))**2                       Recent
          -2*(1-X)*Y*COS(2*PS)*SIN(2*PS)                                Recent
I(U)**2  =((1-X)*SIN(2*PS))**2 + (Y*COS(2*PS))**2                       Recent
          +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
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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
```

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                                                                        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
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
BUT ONCE WE HAVE DEFINED (X) AND (Y) WE CAN IMMEDIATELY WRITE           Recent
THE CROSS SECTIONS USING A UNIFORM DEFINITION,                          Recent
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                                                                      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
------------------                                                    Recent
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
--------------------                                                  Recent
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
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    (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
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
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    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
    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
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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
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
```

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     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
     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
-----2016/3/10 - This option is no longer allowed - today's computers   Recent
                 are so mjuch faster that this option is no longer      Recent
                 needed.                                                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 2017-1) *************    Recent
     ONLY PROCESS  0.00000+ 0 TO  3.00000+ 3 EV                         Recent
     ***************** PROGRAM RECENT (VERSION 2017-1) *************    Recent
     ONLY PROCESS  3.00000+ 3 TO  1.00000+ 4 EV                         Recent
     ***************** PROGRAM RECENT (VERSION 2017-1) *************    Recent
     ONLY PROCESS  1.00000+ 4 TO  8.00000+ 4 EV                         Recent
     ***************** PROGRAM RECENT (VERSION 2017-1) *************    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
-----2016/3/10 - This option is no longer allowed - today's computers   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    1-72     A72   ENDF/B INPUT DATA FILENAME                    Recent
                          (STANDARD OPTION = ENDFB.IN)                  Recent
       3    1-72     A72   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
----- 2016/3/10 - Partial Processing no longer allowed.                 Recent
                    If these fields are not blank the code will STOP    Recent
                    with a WARNING that this is no longer allowed.      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
----- 2016/3/10 - Partial Processing no longer allowed.                 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
    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
      ===============                                                     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
      VERS. 2007-1 (DEC.  2007)   *72 CHARACTER FILE NAMES.               Relabel
      VERS. 2010-1 (Apr.  2010)   *General update based on user feedback  Relabel
      VERS. 2012-1 (Aug.  2012)   *Added CODENAME                         Relabel
                                  *32 and 64 bit COMPATIBLE               Relabel
                                  *Added ERROR stop                       Relabel
      VERS. 2015-1 (Jan.  2015)   *Replaced ALL 3 way IF Statements.      Relabel
      VERS. 2017-1 (May   2017)   *Updated based on user feedback.        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
```

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                                                                      Relabel
ORIGINALLY WRITTEN BY                                                 Relabel
-------------------------------------                                 Relabel
Dermott E. Cullen                                                     Relabel
                                                                      Relabel
PRESENT CONTACT INFORMATION                                           Relabel
---------------------------                                           Relabel
Dermott E. Cullen                                                     Relabel
1466 Hudson Way                                                       Relabel
Livermore, CA 94550                                                   Relabel
U.S.A.                                                                Relabel
Telephone  925-443-1911                                               Relabel
E. Mail    RedCullen1@Comcast.net                                     Relabel
Website    RedCullen1.net/HOMEPAGE.NEW                                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   1-72    INPUT PROGRAM FILENAME                                 Relabel
               (STANDARD OPTION = RELABEL.IN)                         Relabel
   2   1-72    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
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                            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
VERS. 2008-1 (APRIL 2008)   *1/2 INITIAL ENERGY POINT SPACING       Sigma1
                            *72 CHARACTER FILE NAMES.               Sigma1
VERS. 2010-1 (Apr. 2010)    *ASSUME LOW ENERGY LOG-LOG VARIATION    Sigma1
                             UP TO 1/A (eV) FOR ALL BUT TOTAL AND   Sigma1
                             ELASTIC.                               Sigma1
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                          *CHANGED DEFAULT UNCERTAINTY TO 0.01%  Sigma1
                           FROM 0.1%                             Sigma1
                          *ALLOW MULTIPLE, ADJACENT UNRESOLVED   Sigma1
                           RESONANCE REGIONS = COMBINE INTO ONE  Sigma1
                           LARGER ENERGY RANGE TO COPY.          Sigma1
                          *DO NOT BROADEN SECTIONS THAT START    Sigma1
                           ABOVE 1 MILLION KT - PREVIOUSLY IT    Sigma1
                           WAS ASSUMED TOTAL, ELASTIC, CAPTURE   Sigma1
                           AND FISSION, AND LARGE SECTIONS (OVER Sigma1
                           10,000 ENERGY POINTS) WOULD BROADEN.  Sigma1
VERS. 2012-1 (Aug. 2012)   *CHANGE COPY CRITERIA TO HANDLE NEW    Sigma1
                           (N,N') DATA = THRESHOLD MAY BE VERY   Sigma1
                           HIGH (OLD CRITERIA) BUT INCLUDES MANY Sigma1
                           TABULATED ENERGY POINTS (NEW ADDED    Sigma1
                           CRITERIA).                            Sigma1
                          *ADDED STOP IF INCIDENT PARTICLE DATA  Sigma1
                           CANNOT BE DOPPLER BROADENED, E.G.,    Sigma1
                           PHOTON INCIDENT.                      Sigma1
                          *Added CODENAME                        Sigma1
                          *32 and 64 bit Compatible              Sigma1
                          *Added ERROR stop                      Sigma1
VERS. 2013-1 (Nov. 2013)   *Added NO broadening above 10 MeV -    Sigma1
                           this is to handle newer evaluations   Sigma1
                           that extend to higher energies and    Sigma1
                           may do "strange" things to stop one   Sigma1
                           MT and then include it as part of     Sigma1
                           a sum at higher energies, e.g. this   Sigma1
                           change will copy ALL points above     Sigma1
                           10 MeV, thus avoiding problems near   Sigma1
                           transistion energies at 20. 30, etc.  Sigma1
                           MeV or higher energies.               Sigma1
VERS. 2015-1 (Jan. 2015)   *Replaced ALL 3 way IF Statements.    Sigma1
                          *Replaced ALL LOGICAL by INTEGER.      Sigma1
                          *Extended OUT9.                        Sigma1
VERS. 2017-1 (May  2017)   *For MF=2 only use MT=151 = Defines   Sigma1
                           Unresolved Resonance Region (URR).    Sigma1
                           Ignore - NJOY created MT=152 and 153. Sigma1
                          *Increased page size to 1,2000,000.    Sigma1
                          *All floating input parameters changed Sigma1
                           to character input + IN9 conversion.  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
                                                                 Sigma1
PRESENT CONTACT INFORMATION                                      Sigma1
---------------------------                                      Sigma1
Dermott E. Cullen                                                Sigma1
1466 Hudson Way                                                  Sigma1
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U.S.A.                                                           Sigma1
Telephone  925-443-1911                                          Sigma1
E. Mail    RedCullen1@Comcast.net                                Sigma1
Website    RedCullen1.nedt/HOMEPAGE.NEW                          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
AUTHORS MESSAGE                                                  Sigma1
```

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---------------                                                      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
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------------                                                        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 (2017-1) ***************          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
```

```
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.                                             Sigma1
                 = 1 - SET = 0                                          Sigma1
           56-66 UNRESOLVED RESONANCE REGION TREATMENT                  Sigma1
                 = 0 - COPY (NO BROADENING)                             Sigma1
                 = 1 - IGNORE (BROADEN)                                 Sigma1
       2   1-72  ENDF/B INPUT DATA FILENAME                             Sigma1
                 (STANDARD OPTION = ENDFB.IN)                           Sigma1
       3   1-72  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
```

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                        (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
      VERS. 2007-2 (DEC.  2007)   *72 CHARACTER FILE NAMES.            Sixpak
      VERS. 2010-1 (Apr.  2010)   *General update based on user feedback Sixpak
      VERS. 2011-1 (May   2011)   *Added MF/MT=9/5 yield output starting Sixpak
                                   from  MF/MT=6/5 distributions.       Sixpak
                                  *Increased maximum Legendre order from Sixpak
                                   30 to 1,000 - WARNING - using more   Sixpak
                                   than 30 results in NONSENSE = NOISE!! Sixpak
      VERS. 2012-1 (Oct.  2012)   *Increased max. point count to 500,000 Sixpak
                                  *Added CODENAME                       Sixpak
                                  *32 and 64 bit Compatible             Sixpak
                                  *Added ERROR stop                     Sixpak
                                  *For photons, combine discrete and    Sixpak
                                   continuum into tabulated increasing  Sixpak
                                   energy order.                        Sixpak
```

```
                          *Check energy output order increasing. Sixpak
                           Print WARNING if not increasing - do  Sixpak
                           not STOP- stopping would prevent ALL  Sixpak
                           output - the user may not be at all   Sixpak
                           interested in the BAD data, but may   Sixpak
                           be interested in other output data    Sixpak
                           that is o.k.                          Sixpak
VERS. 2015-1 (Jan.  2015)  *Extended OUT9.                       Sixpak
                          *Replaced ALL 3 way IF Statements.     Sixpak
                          *Deleted unused coding.                Sixpak
VERS. 2017-1 (May   2017)  *Increased max. point to 600,000      Sixpak
                          *Updated based on user feedback        Sixpak
                                                                 Sixpak
OWNED, MAINTAINED AND DISTRIBUTED BY                             Sixpak
-----------------------------------                              Sixpak
THE NUCLEAR DATA SECTION                                         Sixpak
INTERNATIONAL ATOMIC ENERGY AGENCY                               Sixpak
P.O. BOX 100                                                     Sixpak
A-1400, VIENNA, AUSTRIA                                          Sixpak
EUROPE                                                           Sixpak
                                                                 Sixpak
ORIGINALLY WRITTEN BY                                            Sixpak
-----------------------------------                              Sixpak
Dermott E. Cullen                                                Sixpak
                                                                 Sixpak
PRESENT CONTACT INFORMATION                                      Sixpak
---------------------------                                      Sixpak
Dermott E. Cullen                                                Sixpak
1466 Hudson Way                                                  Sixpak
Livermore, CA 94550                                              Sixpak
U.S.A.                                                           Sixpak
Telephone  925-443-1911                                          Sixpak
E. Mail    RedCullen1@Comcast.net                                Sixpak
Website    RedCullen1.net/HOMEPAGE.NEW                           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
```

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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
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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
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
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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
=================================                                  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
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                                                                      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
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
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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
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
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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
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
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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
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
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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
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
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          = 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
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
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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
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
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  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   1-72  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
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
```

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====================================================================== Spectra
                                                                       Spectra
      PROGRAM SPECTRA                                                  Spectra
      ===============                                                  Spectra
      An extension of LINEAR to linearize ALl MF=5 spectra.            Spectra
      05/28/2012 - Added MF=15 neutron induced, photon spectra.        Spectra
                                                                       Spectra
      First released in 2010 - Earlier below dates refer to LINEAR.    Spectra
                                                                       Spectra
      VERSION 74-1 (MAY 1974)                                          Spectra
      VERSION 75-1 (APRIL 1975)                                        Spectra
      VERSION 76-2 (OCTOBER 1976)                                      Spectra
      VERSION 77-1 (JANUARY 1977)                                      Spectra
      VERSION 78-1 (JULY 1978)                                         Spectra
      VERSION 79-1 (JULY 1979) CDC-7600 AND CRAY-1 VERSION.            Spectra
      VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION.               Spectra
      VERSION 80-2 (DECEMBER 1980)                                     Spectra
      VERSION 81-1 (MARCH 1981)                                        Spectra
      VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY.     Spectra
      VERSION 83-1 (JANUARY 1983) *MAJOR RE-DESIGN.                    Spectra
                                  *PAGE SIZE INCREASED - 1002 TO 3006. Spectra
                                  *ELIMINATED COMPUTER DEPENDENT CODING.Spectra
                                  *NEW, MORE COMPATIBLE I/O UNIT NUMBER.Spectra
                                  *ADDED OPTION TO KEEP ALL ORIGINAL   Spectra
                                   ENERGY POINTS FROM EVALUATION.      Spectra
                                  *ADDED STANDARD ALLOWABLE ERROR OPTION Spectra
                                   (CURRENTLY 0.1 PER-CENT).           Spectra
      VERSION 83-2 (OCTOBER 1983) IMPROVED BASED ON USER COMMENTS.     Spectra
      VERSION 84-1 (APRIL 1984)   IMPROVED BASED ON USER COMMENTS.     Spectra
      VERSION 84-2 (JUNE 1984)   *UPDATED FOR ENDF/B-VI FORMATS.      Spectra
                                 *SPECIAL I/O ROUTINES TO GUARANTEE    Spectra
                                  ACCURACY OF ENERGY.                  Spectra
                                 *DOUBLE PRECISION TREATMENT OF ENERGY Spectra
                                  (REQUIRED FOR NARROW RESONANCES).    Spectra
      VERSION 85-1 (AUGUST 1985) *FORTRAN-77/H VERSION                 Spectra
      VERSION 86-1 (JANUARY 1986)*ENDF/B-VI FORMAT                     Spectra
      VERSION 87-1 (JANUARY 1987)*DOUBLE PRECISION TREATMENT OF CROSS  Spectra
                                  SECTION                              Spectra
      VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O   Spectra
                                  FILE NAMES (SEE, SUBROUTINE FILEIO   Spectra
                                  FOR DETAILS).                        Spectra
                                 *IMPROVED BASED ON USER COMMENTS.     Spectra
      VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO   Spectra
                                  INSURE PROGRAM WILL NOT DO ANYTHING  Spectra
                                  CRAZY.                               Spectra
                                 *UPDATED TO USE NEW PROGRAM CONVERT   Spectra
                                  KEYWORDS.                            Spectra
                                 *ADDED LIVERMORE CIVIC COMPILER       Spectra
                                  CONVENTIONS.                         Spectra
      VERSION 90-1 (JUNE 1990)   *EXTENDED TO LINEARIZE PHOTON         Spectra
                                  INTERACTION DATA, MF=23 AND 27       Spectra
                                 *ADDED FORTRAN SAVE OPTION            Spectra
                                 *UPDATED BASED ON USER COMMENTS.      Spectra
                                 *NEW MORE CONSISTENT ENERGY OUTPUT    Spectra
                                  ROUTINE.                             Spectra
                                 *WARNING...INPUT PARAMETER FORMAT     Spectra
                                  HAS BEEN CHANGED...SEE DESCRIPTION   Spectra
                                  BELOW.                               Spectra
      VERSION 91-1 (JULY 1991)   *ADDED INTERPOLATION LAW 6 - ONLY USED Spectra
                                  FOR CHARGED PARTICLE CROSS SECTIONS  Spectra
                                  FOR COULOMB PENETRABILITIES.         Spectra
      VERSION 92-1 (JANUARY 1992)*ADDED NU-BAR (TOTAL, DELAYED, PROMPT) Spectra
                                  POLYNOMIAL OR TABULATED ALL CONVERTED Spectra
                                  TO LINEARLY INTERPOLABLE             Spectra
                                 *INCREASED PAGE SIZE FROM 3006 TO 5010 Spectra
                                  POINTS.                              Spectra
                                 *ALL ENERGIES INTERNALLY ROUNDED PRIOR Spectra
                                  TO CALCULATIONS.                     Spectra
                                 *COMPLETELY CONSISTENT I/O AND ROUNDING Spectra
                                  ROUTINES - TO MINIMIZE COMPUTER      Spectra
                                  DEPENDENCE.                          Spectra
      VERSION 92-2 (JULY 1992)   *CORRECTED CONVERSION OF NU-BAR FROM   Spectra
                                  POLYNOMIAL TO TABULATED - COPY       Spectra
                                  SPONTANEOUS NU-BAR (BY DEFINITION    Spectra
                                  THE SPONTANEOUS NU-BAR IS NOT AN     Spectra
                                  ENERGY DEPENDENT QUANTITY).          Spectra
      VERSION 93-1 (MARCH 1993)  *UPDATED FOR USE WITH LAHEY COMPILER  Spectra
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                          ON IBM-PCS.                                  Spectra
                         *INCREASED PAGE SIZE FROM 5010 TO             Spectra
                          30000 POINTS                                 Spectra
VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES            Spectra
                          TO ALLOW ACCESS TO FILE STRUCTURES           Spectra
                          (WARNING - INPUT PARAMETER FORMAT            Spectra
                          HAS BEEN CHANGED)                            Spectra
                         *CLOSE ALL FILES BEFORE TERMINATING           Spectra
                          (SEE, SUBROUTINE ENDIT)                      Spectra
VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                         Spectra
                          *IMPROVED COMPUTER INDEPENDENCE              Spectra
                          *ALL DOUBLE PRECISION                        Spectra
                          *ON SCREEN OUTPUT                            Spectra
                          *UNIFORM TREATMENT OF ENDF/B I/O             Spectra
                          *IMPROVED OUTPUT PRECISION                   Spectra
                          *DEFINED SCRATCH FILE NAMES                  Spectra
                          *ALWAYS INCLUDE THERMAL VALUE                Spectra
                          *INCREASED PAGE SIZE FROM 30000 TO           Spectra
                           60000 POINTS                                Spectra
VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING           Spectra
                           POINT READ FOR MORE DIGITS                  Spectra
                          *UPDATED TEST FOR ENDF/B FORMAT              Spectra
                           VERSION BASED ON RECENT FORMAT CHANGE       Spectra
                          *GENERAL IMPROVEMENTS BASED ON               Spectra
                           USER FEEDBACK                               Spectra
VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING       Spectra
                           MF=1, MT-451.                               Spectra
VERS. 2000-1 (FEBRUARY 2000)*ADDED MF = 9 AND 10 LINEARIZATION         Spectra
                          *GENERAL IMPROVEMENTS BASED ON               Spectra
                           USER FEEDBACK                               Spectra
VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS                 Spectra
VERS. 2004-1 (JAN. 2004)    *GENERAL UPDATE BASED ON USER FEEDBACK     Spectra
VERS. 2005-1 (JAN. 2005)    *ALWAYS KEEP ORIGINAL TABULATED            Spectra
                           NU-BAR POINTS.                              Spectra
VERS. 2006-1 (FEB. 2006)    *CORRECTED INT=6 NEAR THRESHOLD            Spectra
                          *NO SUBDIVIDE BELOW MINIMUM XCMIN            Spectra
VERS. 2007-1 (JAN. 2007)    *CHECKED AGAINST ALL ENDF/B-VII.           Spectra
                          *INCREASED PAGE SIZE FROM 60,000 TO          Spectra
                           600,000 POINTS                              Spectra
VERS. 2010-1 (JUNE 2010)    *ADDED MF = 5 - MF = 6 STILL PLANNED.      Spectra
                          *72 CHARACTER FILE NAMES.                    Spectra
                          *ONLY PROCESS MF=5 - SKIP ALL OTHERS         Spectra
                           TO PREVENT CONFLICT WITH LINEAR             Spectra
                           THINNING.                                   Spectra
VERS. 2012-1 (Aug. 2012)    *Added MF=15, neutron induced photon       Spectra
                           spectra.                                    Spectra
                          *Added CODENAME                              Spectra
                          *32 and 64 bit Compatible                    Spectra
                          *Added ERROR stop                            Spectra
VERS. 2015-1 (Jan. 2015)    *Extended OUT9.                            Spectra
                          *Replaced ALL 3 way IF Statements.           Spectra
                          *Corrected MF=15 Data - it was adding        Spectra
                           SEND between sub-sections.                  Spectra
                          *Deleted unused parts, e.g., NUBAR.          Spectra
VERS. 2017-1 (May  2017)    *Increased page size to 3,000,000          Spectra
                          *Updated based on user feedback              Spectra
                          *Changed DGAMMA to REDGAMMA to avoid         Spectra
                           conflict with possble RESERVED NAME         Spectra
                          *All floating input parameters changed       Spectra
                           to character input + IN9 conversion.        Spectra
                                                                       Spectra
OWNED, MAINTAINED AND DISTRIBUTED BY                                   Spectra
-----------------------------------                                    Spectra
THE NUCLEAR DATA SECTION                                               Spectra
INTERNATIONAL ATOMIC ENERGY AGENCY                                     Spectra
P.O. BOX 100                                                           Spectra
A-1400, VIENNA, AUSTRIA                                                Spectra
EUROPE                                                                 Spectra
                                                                       Spectra
ORIGINALLY WRITTEN BY                                                  Spectra
-----------------------------------                                    Spectra
Dermott E. Cullen                                                      Spectra
                                                                       Spectra
PRESENT CONTACT INFORMATION                                            Spectra
--------------------------                                             Spectra
Dermott E. Cullen                                                      Spectra
1466 Hudson Way                                                        Spectra
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Livermore, CA 94550                                                    Spectra
U.S.A.                                                                 Spectra
Telephone  925-443-1911                                                Spectra
E. Mail    RedCullen1@Comcast.net                                      Spectra
Website    RedCullen1.net/HOMEPAGE.NEW                                 Spectra
                                                                       Spectra
AUTHORS MESSAGE                                                        Spectra
---------------                                                        Spectra
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION       Spectra
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED     Spectra
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE     Spectra
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION.                      Spectra
                                                                       Spectra
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER     Spectra
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE         Spectra
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT     Spectra
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY           Spectra
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO      Spectra
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF        Spectra
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR             Spectra
COMPUTER.                                                              Spectra
                                                                       Spectra
PURPOSE                                                                Spectra
-------                                                                Spectra
THIS PROGRAM IS DESIGNED TO CONVERT ENDF/B FILE 3, 23 AND 27 DATA      Spectra
TO LINEAR-LINEAR INTERPOLABLE FORM. ANY SECTION THAT IS ALREADY        Spectra
LINEAR-LINEAR INTERPOLABLE WILL BE THINNED.                            Spectra
                                                                       Spectra
IN THE FOLLOWING DISCUSSION FOR SIMPLICITY THE ENDF/B TERMINOLOGY      Spectra
---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE        Spectra
TAPE, CARDS, DISK OR ANY OTHER MEDIUM.                                 Spectra
                                                                       Spectra
ENDF/B FORMAT                                                          Spectra
-------------                                                          Spectra
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS         Spectra
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION       Spectra
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT).     Spectra
                                                                       Spectra
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B           Spectra
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS         Spectra
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE      Spectra
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE              Spectra
CORRECTLY OUTPUT ON ALL LINES. THE FORMAT OF SECTION MF=1, MT=451      Spectra
AND ALL SECTIONS OF MF=3 MUST BE CORRECT. THE PROGRAM COPIES ALL       Spectra
OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO       Spectra
THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.                 Spectra
                                                                       Spectra
OUTPUT FORMAT                                                          Spectra
-------------                                                          Spectra
IN THIS VERSION OF LINEAR ALL ENERGIES WILL BE OUTPUT IN               Spectra
F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN       Spectra
WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN      Spectra
OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS       Spectra
OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS        Spectra
TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE      Spectra
TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA         Spectra
DUE TO TRUNCATION OF ENERGIES TO 6 DIGITS DURING OUTPUT.               Spectra
                                                                       Spectra
CONTENTS OF OUTPUT                                                     Spectra
------------------                                                     Spectra
ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE LINEARIZED DATA            Spectra
CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO         Spectra
INCLUDED.                                                              Spectra
                                                                       Spectra
DOCUMENTATION                                                          Spectra
-------------                                                          Spectra
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED      Spectra
BY THE ADDITION OF 3 COMMENT LINES AT THE END OF EACH HOLLERITH        Spectra
SECTION IN THE FORM                                                    Spectra
                                                                       Spectra
***************** PROGRAM SPECTRA (2017-1) ****************            Spectra
FOR ALL DATA GREATER THAN 1.00000-10 IN ABSOLUTE VALUE                 Spectra
DATA LINEARIZED TO WITHIN AN ACCURACY OF  0.1  PER-CENT                Spectra
                                                                       Spectra
THE ORDER OF SIMILAR COMMENTS (FROM RECENT, SIGMA1 AND GROUPIE)        Spectra
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON            Spectra
THE DATA BY THESE PROGRAMS.                                            Spectra
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                                                                      Spectra
THESE COMMENT LINES ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,    Spectra
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT    Spectra
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF         Spectra
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451       Spectra
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF         Spectra
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF         Spectra
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO             Spectra
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND      Spectra
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT     Spectra
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                         Spectra
                                                                      Spectra
REACTION INDEX                                                        Spectra
--------------                                                        Spectra
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN        Spectra
SECTION MF=1, MT=451 OF EACH EVALUATION.                              Spectra
                                                                      Spectra
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.      Spectra
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT            Spectra
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS    Spectra
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING     Spectra
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE     Spectra
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM    Spectra
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.        Spectra
                                                                      Spectra
SECTION SIZE                                                          Spectra
------------                                                          Spectra
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT     Spectra
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS         Spectra
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                    Spectra
                                                                      Spectra
FOR ANY LINEARIZED SECTION THAT CONTAINS 60000 OR FEWER POINTS        Spectra
THE ENTIRE OPERATION WILL BE PERFORMED IN CORE AND THE LINEARIZED     Spectra
DATA WILL BE OUTPUT DIRECTLY TO THE ENDF/B FORMAT. FOR ANY SECTION    Spectra
THAT CONTAINS MORE POINTS THE DATA WILL BE LINEARIZED A PAGE AT A     Spectra
TIME (1 PAGE = 60000 POINTS) AND OUTPUT TO SCRATCH. AFTER THE         Spectra
ENTIRE SECTION HAS BEEN LINEARIZED THE DATA WILL BE READ BACK FROM    Spectra
SCRATCH AND OUTPUT TO THE ENDF/B FORMAT.                              Spectra
                                                                      Spectra
SELECTION OF DATA                                                     Spectra
-----------------                                                     Spectra
THE PROGRAM SELECTS DATA TO BE LINEARIZED BASED EITHER ON EITHER      Spectra
MAT (ENDF/B MAT NO.) OR ZA AS WELL AS MF AND MT NUMBERS. THIS         Spectra
PROGRAM ALLOWS UP TO 100 MAT/MF/MT OR ZA/MF/MT RANGES TO BE           Spectra
SPECIFIED BY INPUT PARAMETERS. THE PROGRAM WILL ASSUME THAT THE       Spectra
ENDF/B TAPE IS IN MAT ORDER, REGARDLESS OF THE CRITERIA USED          Spectra
TO RETRIEVE MATERIALS. IF RETRIEVAL IS BY MAT RANGE THE PROGRAM       Spectra
WILL TERMINATE WHEN A MAT IS FOUND THAT IS ABOVE ALL REQUESTED        Spectra
MAT RANGES. IF RETRIEVAL IS BY ZA RANGE THE PROGRAM WILL SEARCH       Spectra
THE ENTIRE ENDF/B TAPE.                                               Spectra
                                                                      Spectra
PROGRAM OPERATION                                                     Spectra
-----------------                                                     Spectra
EACH SECTION OF DATA IS CONSIDERED SEPARATELY. EACH SECTION OF        Spectra
ENDF/B DATA TO LINEARIZE IS REPRESENTED BY A TABLE OF ENERGY          Spectra
VS. CROSS SECTION AND ANY ONE OF FIVE ALLOWABLE INTERPOLATION LAWS    Spectra
BETWEEN ANY TWO TABULATED POINTS. THIS PROGRAM WILL REPLACE EACH      Spectra
SECTION OF DATA CROSS SECTIONS BY A NEW TABLE OF ENERGY VS.           Spectra
CROSS SECTION IN WHICH THE INTERPOLATION LAW IS ALWAYS LINEAR IN      Spectra
ENERGY AND CROSS SECTION BETWEEN ANY TWO TABULATED POINTS.            Spectra
                                                                      Spectra
DATA IS READ AND LINEARIZED A PAGE AT A TIME (ONE PAGE CONTAINS       Spectra
60000 DATA POINTS). IF THE FINAL LINEARIZED SECTION CONTAINS TWO      Spectra
PAGES OR LESS, DATA POINTS IT WILL BE ENTIRELY CORE RESIDENT          Spectra
AFTER IT HAS BEEN LINEARIZED AND WILL BE WRITTEN DIRECTLY FROM        Spectra
CORE TO THE OUTPUT TAPE. IF THE LINEARIZED SECTION IS LARGER THAN     Spectra
TWO PAGES, AFTER EACH PAGE IS LINEARIZED IT WILL BE WRITTEN TO        Spectra
SCRATCH. AFTER THE ENTIRE SECTION HAS BEEN LINEARIZED IT WILL         Spectra
BE READ BACK FROM SCRATCH, TWO PAGES AT A TIME, AND WRITTEN TO        Spectra
THE OUTPUT TAPE.                                                      Spectra
                                                                      Spectra
KEEP EVALUATED DATA POINTS                                            Spectra
--------------------------                                            Spectra
SOMETIMES IT IS CONVENIENT TO KEEP ALL ENERGY POINTS WHICH WERE       Spectra
PRESENT IN THE ORIGINAL EVALUATION AND TO MERELY SUPPLEMENT THESE     Spectra
POINTS WITH ADDITIONAL ENERGY POINTS IN ORDER TO LINEARIZE THE        Spectra
CROSS SECTIONS. FOR EXAMPLE, IT IS OFTEN CONVENIENT TO KEEP THE       Spectra
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THERMAL VALUE (AT 0.0253 EV) OR THE VALUE AT 14.1 MEV.              Spectra
                                                                    Spectra
THE CURRENT VERSION OF THIS PROGRAM WILL ALLOW THE USER TO KEEP     Spectra
ALL ORIGINAL EVALUATED DATA POINTS BY SPECIFYING 1 IN COLUMNS       Spectra
34-44 OF THE FIRST INPUT LINE. THIS WILL TURN OFF THE BACKWARD      Spectra
THINNING (SEE UCRL-50400, VOL. 17, PART A FOR EXPLANATION) AND      Spectra
RESULT IN ALL ORIGINAL ENERGY POINTS BEING KEPT. CAUTION SHOULD     Spectra
BE EXERCISED IN USING THIS OPTION SINCE IT CAN RESULT IN A          Spectra
CONSIDERABLE INCREASE IN THE NUMBER OF DATA POINTS OUTPUT BY        Spectra
THIS CODE.                                                          Spectra
                                                                    Spectra
FOR ALL USERS WHO ARE NOT INTERESTED IN THIS OPTIONS NO CHANGES     Spectra
ARE REQUIRED IN THE INPUT TO THIS PROGRAM, I. E. IF COLUMNS         Spectra
34-44 ARE BLANK (AS FOR ALL PREVIOUS VERSIONS OF THIS CODE) THE     Spectra
PROGRAM WILL OPERATE EXACTLY AS IT DID BEFORE.                      Spectra
                                                                    Spectra
ALLOWABLE ERROR                                                     Spectra
--------------                                                      Spectra
ALLOWABLE ERROR MUST ALWAYS BE SPECIFIED IN THE INPUT TO THIS       Spectra
PROGRAM AS A FRACTION, NOT A PER-CENT. FOR EXAMPLE, INPUT THE       Spectra
ALLOWABLE FRACTIONAL ERROR 0.001 IN ORDER TO OBTAIN DATA THAT IS    Spectra
ACCURATE TO WITHIN 0.1 PER-CENT.                                    Spectra
                                                                    Spectra
THE CONVERSION OF THE DATA FROM THE GENERAL INTERPOLATION FORM TO    Spectra
LINARLY INTERPOLABLE FORM CANNOT BE PERFORMED EXACTLY. HOWEVER, IT  Spectra
CAN BE PERFORMED TO VIRTUALLY ANY REQUIRED ACCURACY AND MOST        Spectra
IMPORTANTLY CAN BE PERFORMED TO A TOLERANCE THAT IS SMALL COMPARED  Spectra
TO THE UNCERTAINTY IN THE CROSS SECTIONS THEMSELVES. AS SUCH THE    Spectra
CONVERSION OF CROSS SECTIONS TO LINEARLY INTERPOLABLE FORM CAN BE   Spectra
PERFORMED WITH ESSENTIALLY NO LOSE OF INFORMATION.                  Spectra
                                                                    Spectra
THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY  Spectra
DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED          Spectra
FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION  Spectra
BETWEEN TABULATED POINTS. IF ONLY ONE TABULATED POINT IS GIVEN THE  Spectra
ERROR WILL BE CONSIDERED CONSTANT OVER THE ENTIRE ENERGY RANGE.     Spectra
WITH THIS ENERGY DEPENDENT ERROR ONE MAY OPTIMIZE THE OUTPUT FOR    Spectra
ANY GIVEN APPLICATION BY USING A SMALL ERROR IN THE ENERGY RANGE    Spectra
OF INTEREST AND A LESS STRINGENT ERROR IN OTHER ENERGY RANGES.      Spectra
                                                                    Spectra
DEFAULT ALLOWABLE ERROR                                             Spectra
-----------------------                                             Spectra
IN ORDER TO INSURE CONVERGENCE OF THE LINEARIZING ALGORITHM THE     Spectra
ALLOWABLE ERROR MUST BE POSITIVE. IF THE USER INPUTS AN ERROR       Spectra
THAT IS NOT POSITIVE IT WILL AUTOMATICALLY BE SET TO THE DEFAULT    Spectra
VALUE (CURRENTLY 0.001, CORRESPONDING TO 0.1 PER-CENT) AND          Spectra
INDICATED AS SUCH IN THE OUTPUT LISTING.                            Spectra
                                                                    Spectra
COULOMB PENETRABILITY (INTERPOLATION LAW = 6)                       Spectra
---------------------------------------------                       Spectra
INTRODUCED FOR ENDF/B-VI. THIS IS DEFINED AS,                       Spectra
                                                                    Spectra
SIG(E) = C1*EXP(-C2/SQRT(E - T))                                    Spectra
                                                                    Spectra
THIS PROGRAM ONLY CONSIDERS EXOTHERMIC REACTIONS - T = 0            Spectra
                                                                    Spectra
SIG(E) = C1*EXP(-C2/SQRT(E))                                        Spectra
                                                                    Spectra
WARNING...THIS INTERPOLATION LAW SHOULD ONLY BE USED FOR REACTIONS   Spectra
          WHICH HAVE A POSITIVE Q-VALUE (EXOTHERMIC REACTIONS),     Spectra
          SINCE HERE WE ONLY CONSIDER T = 0.0 IN THE FORMALISM.     Spectra
          IN ALL OTHER CASES A WARNING MESSAGE WILL BE PRINTED.     Spectra
                                                                    Spectra
INPUT FILES                                                         Spectra
-----------                                                         Spectra
UNIT  DESCRIPTION                                                   Spectra
----  -----------                                                   Spectra
   2  INPUT LINES (BCD - 80 CHARACTERS/RECORD)                      Spectra
  10  ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)             Spectra
                                                                    Spectra
OUTPUT FILES                                                        Spectra
------------                                                        Spectra
UNIT  DESCRIPTION                                                   Spectra
----  -----------                                                   Spectra
   3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                   Spectra
  11  FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)                Spectra
                                                                    Spectra
```

```
SCRATCH FILES                                                          Spectra
------------                                                           Spectra
UNIT  DESCRIPTION                                                      Spectra
----  -----------                                                      Spectra
  12  SCRATCH FILE (BINARY - 180000 WORDS/RECORD                       Spectra
                                                                       Spectra
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)                   Spectra
----------------------------------------------------                   Spectra
UNIT  FILE NAME                                                        Spectra
----  ----------                                                       Spectra
  2   SPECTRA.INP                                                      Spectra
  3   SPECTRA.LST                                                      Spectra
 10   ENDFB.IN                                                         Spectra
 11   ENDFB.OUT                                                        Spectra
 12   (SCRATCH)                                                        Spectra
                                                                       Spectra
                                                                       Spectra
INPUT PARAMETERS                                                       Spectra
----------------                                                       Spectra
FOR VERSIONS EARLIER THAN 90-1 THIS PROGRAM ONLY ALLOWED THE USER      Spectra
TO SPECIFY BY INPUT PARAMETERS WHICH MATERIALS (MAT) TO PROCESS.       Spectra
FOR EACH REQUESTED MATERIAL NEUTRON INTERACTION CROSS SECTIONS         Spectra
(MF=3) WOULD BE LINEARIZED AND THE REMAINDER OF THE MATERIAL           Spectra
WOULD BE COPIED.                                                       Spectra
                                                                       Spectra
FOR VERSIONS 90-1 AND LATER THIS PROGRAM WILL ALLOW THE USER TO        Spectra
TO SPECIFY BY INPUT PARAMETERS EXACTLY WHAT SECTIONS OF DATA           Spectra
TO PROCESS. FOR EACH SECTION OF DATA, SPECIFIED BY MAT, MF, MT         Spectra
RANGES, SECTIONS OF MF=3, 23 AND 27 WILL BE LINEARIZED AND ALL         Spectra
OTHER REQUESTED SECTIONS WILL BE COPIED. ALL SECTIONS WHICH ARE        Spectra
NOT EXPLICITLY REQUESTED WILL BE SKIPPED AND WILL NOT APPEAR ON        Spectra
ENDF/B FILE OUTPUT BY THIS PROGRAM.                                    Spectra
                                                                       Spectra
WITH THIS NEW PROCEDURE YOU CAN MINIMIZE THE SIZE OF THE ENDF/B        Spectra
FILE OUTPUT BY THIS PROGRAM, E.G., IF YOU ONLY WANT NEUTRON            Spectra
CROSS SECTIONS FOR SUBSEQUENT PROCESSING YOU NEED ONLY REQUEST         Spectra
ONLY MF=3 DATA.                                                        Spectra
                                                                       Spectra
HOWEVER, YOU MUST UNDERSTAND THAT ONLY THOSE SECTIONS WHICH YOU        Spectra
EXPLICITLY REQUEST WILL APPEAR ON THE ENDF/B FILE OUTPUT BY            Spectra
THIS PROGRAM. FOR EXAMPLE, IF YOU WISH TO DOCUMENT EXACTLY             Spectra
HOW YOU LINEARIZED THE DATA BY INCLUDING COMMENTS IN MF=1, MT=451      Spectra
THEN YOU MUST EXPLICITLY REQUEST THAT MF=1, MT=451 BE PROCESSED        Spectra
FOR EACH MATERIAL THAT YOU REQUEST. SIMILAR IF YOU WANT THE            Spectra
ENTIRE EVALUATION YOU MUST REQUEST ALL MF AND MT TO BE OUTPUT.         Spectra
                                                                       Spectra
LINE  COLS.  DESCRIPTION                                               Spectra
----  -----  -----------                                               Spectra
   1   1-11  SELECTION CRITERIA (0=MAT, 1=ZA)                          Spectra
      12-22  MONITOR MODE SELECTOR                                     Spectra
             = 0 - NORMAL OPERATION                                    Spectra
             = 1 - MONITOR PROGRESS OF LINEARIZING OF THE DATA.        Spectra
                   EACH TIME A PAGE OF DATA POINTS IS WRITTEN TO       Spectra
                   THE SCRATCH FILE PRINT OUT THE TOTAL NUMBER OF      Spectra
                   POINTS ON SCRATCH AND THE LOWER AND UPPER           Spectra
                   ENERGY LIMITS OF THE PAGE (THIS OPTION MAY BE       Spectra
                   USED IN ORDER TO MONITOR THE EXECUTION SPEED        Spectra
                   OF LONG RUNNING JOBS).                              Spectra
      23-33  MINIMUM CROSS SECTION OF INTEREST (BARNS).                Spectra
             (IF 0.0 OR LESS IS INPUT THE PROGRAM WILL                 Spectra
             USE 1.0E-10). ENERGY INTERVALS WILL NOT BE                Spectra
             SUB-DIVIDED IF THE ABSOLUTE VALUE OF THE CROSS            Spectra
             SECTION WITHIN THE INTERVAL IS LESS THAN THIS VALUE.      Spectra
             AN EXCEPTION TO THIS RULE IS NEAR THRESHOLDS ENERGY       Spectra
             INTERVALS WILL BE SUB-DIVIDED UNTIL CONVERGENCE           Spectra
             REGARDLESS OF THE MAGNITUDE OF THE CROSS SECTION.         Spectra
      34-44  KEEP ORIGINAL EVALUATED DATA POINTS.                      Spectra
             = 0 - NO.                                                 Spectra
             = 1 - YES - ADDITIONAL POINTS MAY BE ADDED IN ORDER       Spectra
                         TO LINEARIZE DATA, BUT ALL ORIGINAL           Spectra
                         DATA POINTS WILL BE INCLUDED IN THE           Spectra
                         RESULTS.                                      Spectra
   2   1-72  ENDF/B INPUT DATA FILENAME                                Spectra
             (STANDARD OPTION = ENDFB.IN)                              Spectra
   3   1-72  ENDF/B OUTPUT DATA FILENAME                               Spectra
             (STANDARD OPTION = ENDFB.OUT)                             Spectra
 4-N   1- 6  LOWER MAT OR ZA LIMIT                                     Spectra
```

```
          7- 8  LOWER MF LIMIT                                          Spectra
          9-11  LOWER MT LIMIT                                          Spectra
         12-17  UPPER MAT OR ZA LIMIT                                   Spectra
         18-19  UPPER MF LIMIT                                          Spectra
         20-22  UPPER MT LIMIT                                          Spectra
                UP TO 100 RANGES MAY BE SPECIFIED, ONLY ONE RANGE       Spectra
                PER LINE. THE LIST OF RANGES IS TERMINATED BY A         Spectra
                BLANK LINE. IF THE UPPER MAT LIMIT OF ANY REQUEST       Spectra
                IS LESS THAN THE LOW LIMIT IT WILL BE SET EQUAL TO      Spectra
                THE LOWER LIMIT. IF THE UPPER LIMIT IS STILL ZERO       Spectra
                IT WILL BE SET EQUAL TO 999999. IF THE UPPER MF OR      Spectra
                MT LIMIT IS ZERO IT WILL BE SET TO 99 OR 999            Spectra
                RESPECTIVELY.                                           Spectra
    VARY  1-11  ENERGY FOR ERROR LAW                                    Spectra
         12-22  ALLOWABLE FRACTIONAL ERROR FOR ERROR LAW.                Spectra
                THE ACCEPTABLE LINEARIZING ERROR MAY BE SPECIFIED TO    Spectra
                BE EITHER ENERGY INDEPENDENT (DEFINED BY A SINGLE       Spectra
                ERROR), OR ENERGY DEPENDENT (DEFINED BY UP TO 20        Spectra
                ENERGY, ERROR PAIRS). FOR THE ENERGY DEPENDENT CASE     Spectra
                LINEAR INTERPOLATION WILL BE USED TO DEFINE THE ERROR   Spectra
                AT ENERGIES BETWEEN THOSE AT WHICH IT IS TABULATED.     Spectra
                IN ALL CASES THE ERROR LAW IS TERMINATED BY A BLANK     Spectra
                LINE. IF ONLY ONE ENERGY, ERROR PAIR IS GIVEN THE       Spectra
                THE LAW WILL BE CONSIDERED TO BE ENERGY INDEPENDENT.    Spectra
                IF MORE THAN ONE PAIR IS GIVEN IT WILL BE CONSIDERED    Spectra
                TO BE ENERGY DEPENDENT (NOTE, ENERGY INDEPENDENT        Spectra
                FORM WILL RUN FASTER THAN THE EQUIVALENT ENERGY         Spectra
                DEPENDENT FORM). FOR AN ENERGY DEPENDENT ERROR LAW      Spectra
                ALL ENERGIES MUST BE ASCENDING ENERGY ORDER. FOR        Spectra
                CONVERGENCE OF THE LINEARIZING ALGORITHM ALL ERRORS     Spectra
                MUST BE POSITIVE. IF AN ALLOWABLE ERROR IS NOT          Spectra
                POSITIVE IT WILL BE SET EQUAL TO THE STANDARD OPTION    Spectra
                (CURRENTLY 0.001, CORRESPONDING TO 0.1 PER-CENT).       Spectra
                IF THE FIRST ERROR LINE IS BLANK IT WILL TERMINATE      Spectra
                THE ERROR LAW AND THE ERROR WILL BE TREATED AS          Spectra
                ENERGY INDEPENDENT, EQUAL TO THE STANDARD OPTION        Spectra
                (CURRENTLY 0.1 PER-CENT). (SEE EXAMPLE INPUT 4).        Spectra
                                                                        Spectra
    EXAMPLE INPUT NO. 1                                                 Spectra
    ------------------                                                  Spectra
    RETRIEVE DATA BY ZA IN ORDER TO FIND ALL URANIUM ISOTOPES AND       Spectra
    THORIUM 232. RETRIEVE ALL NEUTRON INTERACTION CROSS SECTIONS        Spectra
    (MF=3). ALL ENERGY INTERVALS IN WHICH THE CROSS SECTION IS          Spectra
    AT LEAST 1 MICRO-BARN (1.0E-06 BARNS) WILL BE SUBDIVIDED.           Spectra
    BACKWARD THINNING WILL BE PERFORMED. FROM 0 TO 100 EV LINEARIZE     Spectra
    TO WITHIN 0.1 PER-CENT ACCURACY. FROM 100 EV TO 1 KEV VARY          Spectra
    ACCURACY BETWEEN 0.1 AND 1.0 PER-CENT. ABOVE 1 KEV USE 1            Spectra
    PER-CENT ACCURACY.                                                  Spectra
                                                                        Spectra
    EXPLICITLY SPECIFY THE STANDARD FILENAMES.                          Spectra
                                                                        Spectra
    IN THIS CASE THE FOLLOWING 11 INPUT LINES ARE REQUIRED              Spectra
                                                                        Spectra
         1          0 1.00000- 6          0                           Spectra
ENDFB.IN                                                                Spectra
ENDFB.OUT                                                               Spectra
92000 3  0 92999 3999                                                   Spectra
90232 3  0     0 3  0    (UPPER LIMIT AUTOMATICALLY SET TO 90232 3999) Spectra
                         (END OF REQUEST LIST)                          Spectra
0.00000+ 0 1.00000-03                                                   Spectra
1.00000+ 2 1.00000-03                                                   Spectra
1.00000+ 3 1.00000-02                                                   Spectra
1.00000+ 9 1.00000-02                                                   Spectra
                         (END OF ERROR LAW)                             Spectra
                                                                        Spectra
    EXAMPLE INPUT NO. 2                                                 Spectra
    ------------------                                                  Spectra
    SAME AS THE ABOVE CASE, EXCEPT LINEARIZE ALL DATA TO WITHIN THE     Spectra
    STANDARD ACCURACY (CURRENTLY 0.1 PER-CENT). IN ORDER TO USE THE     Spectra
    STANDARD ACCURACY YOU NEED NOT SPECIFY ANY ERROR LAW AT ALL. IN     Spectra
    THIS CASE INCLUDE THE HOLLERITH SECTION, MF=1, MT=451, FOR EACH     Spectra
    MATERIAL.                                                           Spectra
                                                                        Spectra
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL      Spectra
    THEN USE STANDARD FILENAMES.                                        Spectra
                                                                        Spectra
    IN THIS CASE THE FOLLOWING 9 INPUT LINES ARE REQUIRED               Spectra
```

```
                                                                        Spectra
         1          0 1.00000- 6          0                           Spectra
                        (USE DEFAULT FILENAME = ENDFB.IN)               Spectra
                        (USE DEFAULT FILENAME = ENDFB.OUT)              Spectra
 92000 1451 92999 1451                                                  Spectra
 92000 3  0 92999 3999                                                  Spectra
 90232 1451     0 1451                                                  Spectra
 90232 3  0     0 3  0    (UPPER LIMIT AUTOMATICALLY SET TO 90232 3999) Spectra
                        (END OF REQUEST LIST)                           Spectra
                        (0.1 PER-CENT ERROR, END OF ERROR LAW)          Spectra
                                                                        Spectra
    EXAMPLE INPUT NO. 3                                                 Spectra
    -------------------                                                 Spectra
    LINEARIZE ALL MATERIALS ON AN ENDF/B TAPE TO WITHIN AN ACCURACY     Spectra
    OF 0.5 PER-CENT (0.005 AS A FRACTION). IN THIS CASE YOU NEED NOT    Spectra
    SPECIFY THE MAT, MF, MT RANGES.                                     Spectra
                                                                        Spectra
    READ THE ENDF/B DATA FROM \ENDFB6\ZA092238 AND WRITE THE ENDF/B     Spectra
    DATA TO \ENDFB6\LINEAR\ZA092238.                                    Spectra
                                                                        Spectra
    IN THIS CASE THE FOLLOWING 6 INPUT LINES ARE REQUIRED               Spectra
                                                                        Spectra
                                          (MAT, 1.0E-10 BARNS, THIN)    Spectra
 \ENDFB6\ZA092238                                                       Spectra
 \ENDFB6\LINEAR\ZA092238                                                Spectra
                        (RETRIEVE ALL DATA, END REQUEST LIST)           Spectra
           5.00000-03                                                   Spectra
                        (END OF ERROR LAW)                              Spectra
                                                                        Spectra
    NOTE THAT IN THIS CASE IF THE INPUT HAD SPECIFIED AN EQUIVALENT     Spectra
    ENERGY DEPENDENT ERROR LAW BY GIVING A NUMBER OF ENERGY POINTS      Spectra
    AT EACH OF WHICH THE ERROR IS 0.5 PER-CENT THE PROGRAM WOULD TAKE   Spectra
    LONGER TO RUN (I.E., ONLY USE AN ENERGY DEPENDENT ERROR LAW WHEN    Spectra
    IT IS NECESSARY).                                                   Spectra
                                                                        Spectra
    EXAMPLE INPUT NO. 4                                                 Spectra
    -------------------                                                 Spectra
    IN ORDER TO LINEARIZE ALL MATERIALS ON AN ENDF/B TAPE TO THE        Spectra
    STANDARD OPTION OF 0.1 PER-CENT IT IS ADEQUATE TO INPUT A SET       Spectra
    OF COMPLETELY BLANK LINES WHICH WILL AUTOMATICALLY INVOKE ALL       Spectra
    OF THE STANDARD OPTIONS.                                            Spectra
                                                                        Spectra
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL      Spectra
    THEN USE STANDARD FILENAMES.                                        Spectra
                                                                        Spectra
    IN THIS CASE THE FOLLOWING THREE INPUT LINES ARE REQUIRED           Spectra
                                                                        Spectra
                                          (MAT, 1.0E-10 BARNS, THIN)    Spectra
                        (USE DEFAULT FILENAME = ENDFB.IN)               Spectra
                        (USE DEFAULT FILENAME = ENDFB.OUT)              Spectra
                        (RETRIEVE ALL DATA, END REQUEST LIST)           Spectra
                        (0.1 PER-CENT ERROR, END OF ERROR LAW)          Spectra
                                                                        Spectra
========================================================================= Spectra
```

```
====================================================================== 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
      VERS. 2007-2 (DEC.  2007)   *72 CHARACTER FILE NAME.            Virgin
      VERS. 2010-1 (Apr.  2010)   *General update based on user feedback Virgin
                                  *INCREASED INCORE PAGE SIZE TO       Virgin
                                   600,000 FROM 240,000.               Virgin
      VERS. 2012-1 (Aug.  2012)   *Added CODENAME                      Virgin
                                  *32 and 64 bit Compatible            Virgin
                                  *Added ERROR stop                    Virgin
      VERS. 2015-1 (Jan.  2015)   *Extended OUT9.                      Virgin
                                  *Replaced ALL 3 way IF Statements.   Virgin
                                  *Generalized TART Group Structures.  Virgin
                                  *Generalized SAND-II Group Structures. Virgin
                                  *Extended SAND-II to 60, 150, 200 MeV. Virgin
      VERS. 2015-2 (Apr.  2015)   *Changed ALL data to "D" instead of  Virgin
                                   "E" to insure it is REAL*8 and avoid Virgin
                                   Truncation ERRORS.                  Virgin
      VERS. 2017-1 (May   2017)   *Added UKAEA 1102 Group Structure.   Virgin
                                  *Increased points to 3,000,000       Virgin
                                  *Increased groupd to 30,000          Virgin
                                  *Updated based on user feedback      Virgin
                                  *Defintion of built-in group structure Virgin
                                   using SUBROUTINE GROPE is identical Virgin
                                   for GROUPIE and VIRGIN.             Virgin
                                  *All floating point parameters changed Virgin
                                   to character inout + IN9 conversion. Virgin
```

```
                                                                      Virgin
2015-2 Acknowledgment                                                 Virgin
=====================                                                 Virgin
I thank Andrej Trkov (NDS, IAEA) for finding the problem with         Virgin
the "E" formatted DATA (this effected both VIRGIN and GROUPIE).       Virgin
I also thank Andrej for overseeing the entire PREPRO project          Virgin
at IAEA, Vienna; he is part of a truly International team who         Virgin
worked together to produce PREPRO-2015-2, and to make it              Virgin
available Internationally on-line for FREE to ALL users.              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
                                                                      Virgin
PRESENT CONTACT INFORMATION                                           Virgin
---------------------------                                           Virgin
Dermott E. Cullen                                                     Virgin
1466 Hudson Way                                                       Virgin
Livermore, CA 94550                                                   Virgin
U.S.A.                                                                Virgin
Telephone  925-443-1911                                               Virgin
E. Mail    RedCullen1@Comcast.net                                     Virgin
Website    RedCullen1.net/HOMEPAGE.NEW                                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
 (0) TART 175 GROUPS                                                  Virgin
 (1) ORNL  50 GROUPS                                                  Virgin
 (2) ORNL 126 GROUPS                                                  Virgin
 (3) ORNL 171 GROUPS                                                  Virgin
 (4) SAND-II 620 GROUPS - 1.0D-4 eV UP TO 18 MEV                      Virgin
 (5) SAND-II 640 GROUPS - 1.0D-4 eV UP TO 20 MEV                      Virgin
 (6) WIMS 69 GROUPS                                                   Virgin
 (7) GAM-I 68 GROUPS                                                  Virgin
 (8) GAM-II 99 GROUPS                                                 Virgin
 (9) MUFT 54 GROUPS                                                   Virgin
(10) ABBN 28 GROUPS                                                   Virgin
(11) TART 616 GROUPS TO  20 MeV                                       Virgin
(12) TART 700 GROUPS To   1 GeV                                       Virgin
(13) SAND-II 665 GROUPS - 1.0D-5 eV UP TO 18 MEV                      Virgin
(14) SAND-II 685 GROUPS - 1.0D-5 eV UP TO 20 MEV                      Virgin
(15) TART 666 GROUPS TO 200 MeV                                       Virgin
(16) SAND-II 725 GROUPS - 1.0D-5 eV UP TO  60 MEV                     Virgin
(17) SAND-II 755 GROUPS - 1.0D-5 eV UP TO 150 MEV                     Virgin
(18) SAND-II 765 GROUPS - 1.0D-5 eV UP TO 200 MEV                     Virgin
(19) UKAEA  1102 GROUPS - 1.0D-5 eV UP TO 1 GeV                       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
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   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
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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
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
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
```

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------------                                                        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 TART 175 GROUPS                           Virgin
                     = -1 ORNL  50 GROUPS                           Virgin
                     = -2 ORNL 126 GROUPS                           Virgin
                     = -3 ORNL 171 GROUPS                           Virgin
                     = -4 SAND-II 620 GROUPS..1.0D-4 eV TO 18 MEV   Virgin
                     = -5 SAND-II 640 GROUPS..1.0D-4 eV TO 20 MEV   Virgin
                     = -6 WIMS 69 GROUPS                            Virgin
                     = -7 GAM-I 68 GROUPS                           Virgin
                     = -8 GAM-II 99 GROUPS                          Virgin
                     = -9 MUFT 54 GROUPS                            Virgin
                     =-10 ABBN 28 GROUPS                            Virgin
                     =-11 TART 616 GROUPS TO  20 MeV                Virgin
                     =-12 TART 700 GROUPS TO   1 GeV                Virgin
                     =-13 SAND-II 665 GROUPS..1.0D-5 eV TO 18 MEV   Virgin
                     =-14 SAND-II 685 GROUPS..1.0D-5 eV TO 20 MEV   Virgin
                     =-15 TART 666 GROUPS TO 200 MeV                Virgin
                     =-16 SAND-II 725 GROUPS..1.0D-5 eV TO  60 MEV  Virgin
                     =-17 SAND-II 755 GROUPS..1.0D-5 eV TO 150 MEV  Virgin
                     =-18 SAND-II 765 GROUPS..1.0D-5 eV TO 200 MEV  Virgin
                     =-19 UKAEA  1102 GROUPS..1.0D-5 eV to   1 GeV  Virgin
      56-60    I5    NUMBER OF POINTS IN SOURCE SPECTRUM            Virgin
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                      (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 (-14 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 7.8700D+ 0 26000  102 7.8700D+ 0     2    0    2 1100  Virgin
 0.0000D+ 0 1.0000D+ 0 1.0000D+ 0          0 0.0000D+00             Virgin
 0.0000D+00 3.0000D+01                                              Virgin
 1.0000D+03 1.0000D+00 2.0000D+07 1.0000D+00                        Virgin
                                                                    Virgin
EXAMPLE INPUT NO. 2                                                 Virgin
-------------------                                                 Virgin
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     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
```