Abstract: PLOTTAB is designed as a general purpose plotting utility code to plot continuous and/or discrete physical data for use in almost any application. It is designed to be easily used by your application codes to produce your output results in a form that can be immediately used by PLOTTAB to allow you to see your results. This code is 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/plottab/
# Table of Contents

Part A: Basic features of PLOTTAB  
Part B: Examples
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.

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

Citation guidelines

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

This computer code package should be cited as follows: "Program PLOTTAB. General plotting program.", by Dermott E. Cullen, International Atomic Energy Agency, Nuclear Data Section (IAEA/NDS), IAEA-NDS-82, Rev. 2, November 22, 2013

Conditions for use of this code

Any comments on the use of this code, including difficulties encountered or any suggestions should be sent to the IAEA Nuclear Data Section. If any results obtained from using this code are used or referenced in a publication, a copy of the publication should be sent to the IAEA Nuclear Data Section.
PROGRAM PLOTTAB:
A Code Designed to Plot
Continuous and/or Discrete Physical Data
(Version 2013-1)

by
Dermott E. Cullen
University of California (retired)
1466 Hudson Way
Livermore, CA 94550

Tele: 925-443-1911
E.Mail redcullen1@comcast.mnet
Website: http://home.comcast.net/~redcullen1

November 22, 2013

Abstract

PLOTTAB is designed as a general purpose plotting utility code to plot continuous and/or
discrete physical data for use in almost any application. It is designed to be easily used by
your application codes to produce your output results in a form that can be immediately
used by PLOTTAB to allow you to see your results.

It produces on screen graphics as well as Postscript formatted output files that can be
viewed or printed on any Postscript printer. The code is designed to be easily used on any
computer - not only today's computers, but also anything that comes along in the future.
So you can be assured that once you start using PLOTTAB your graphics problems are
over - not just today, but well into the future.

Part A of this report documents the basic features of PLOTTAB.

Part B is designed to aid users in using the code, by describes a variety of applications,
including listings of input parameters and output plots.
PROGRAM PLOTTAB:
A Code Designed to Plot
Continuous and/or Discrete Physical Data
(Version 2013-1)

by
Dermott E. Cullen
University of California (retired)
1466 Hudson Way
Livermore, CA 94550

Tele: 925-443-1911
E.Mailredcullen1@comcast.mnet
Website: http://home.comcast.net/~redcullen1

November 22, 2013

Introduction

PLOTTAB is designed as a simple plotting code that can be used on virtually any computer and graphics device to plot continuous and/or discrete physical data for use in almost any application. It is designed to be easily used by your application codes to produce your output results in a form that can be immediately used by PLOTTAB to allow you to see your results.

It produces on screen graphics as well as Postscript formatted output files that can be viewed or printed on any Postscript printer. The code is designed to be easily used on any computer - not only today's computers, but also anything that comes along in the future.

Acknowledgments

First I MUST acknowledge the contribution of Bojan Zefran, who created the LINUX, 32-bit and 64-bit executables, and Jean-Christian Sublet, who created the MAC executable. Not only did they volunteer to create these executables, but by having PLOTTAB compiled on as many different computers/compilers as possible led to significant improvements in the coded we have today. So for all PLOTTAB users I say: Thank you Bojan and Jean-Christophe.

Only Do the Job Once

Best of all you can be assured that unlike other computer graphics codes that quickly come and go, PLOTTAB will be here not only today to meet your needs, but also into the future to meet your needs. The code has been conservatively designed to not only run on virtually any of today's computers, but also be to easily implemented on any new computers that come along in the future. I have now been using PLOTTAB and its predecessors for over 25 years [1], and during that time as each new computer has come...
along PLOTTAB has been a complete plug-in that has smoothly and effortlessly moved from one computer to the next.

With this approach you can be assured that once you start using PLOTTAB your plotting problems are over, not only for today, but also into the future. You only have to do the job once to modify your codes to produce output in the PLOTTAB input format, and then you can be assured that you will be able to produce graphic output well into the future.

**Concentrate on Your Applications**

You will find that in order to use PLOTTAB you do not have to be a graphics expert, nor do you have to spend much time learning how to use the code. This allows you to concentrate on your applications, instead of worrying about how you are going to plot your results. Once you have started using PLOTTAB you can take graphics output for granted; something that you never have to worry about or spend much time on ever again. It will simply always be there when you need it.

**What Computer Can You USE?**

The non-interactive version can be run on ANY computer. The non-interactive code is written in standard FORTRAN and outputs standard formatted Postscript files that can be printed on any Postscript printer, or viewed with any Postscript viewer, such as Ghostview. The non-interactive version runs on 32 or 64 bit systems.

The interactive version can be run on IBM-PC, LINUX, Power MAC and even small Laptop computers. The interactive code is identical to the non-interactive code, except that a very simple graphics interface for on screen graphics is loaded with the code. The code is distributed with graphic interfaces for IBM-PC, LINUX, and Power MAC. However, it should be very simple to interface this code for on screen graphics on any computer, e.g., it took me 3 days to write the IBM-PC interface and 2 days for the Power MAC version. The interactive version runs on 32 or 64 bit systems.

**Reading and Interpreting Data**

All data is read by this code in character form and internally translated into integer or floating point form as needed. This means: 1) it's difficult to get the code to crash by improperly defining input. 2) your input can be in quite general form and will still be properly interpreted by the code, e.g., 14, 1.4+1, 14E+00, 1.4D+01, are all 14 as far as this code is concerned. 3) the code can distinguish between BLANK and ZERO input - WARNING - when this documentation says BLANK, it means BLANK - in this case nothing else except a BLANK will be interpreted correctly as input.

**Data Formats**

The formats of the continuous and discrete physical data read by this code are designed to be very simple, so that any of your computer codes can be simply modified to produce output results in the PLOTTAB input format. There up to two different types of data used...
by PLOTTAB; Continuous Data defining curves and Discrete Points.

**Continuous Data Format**

The continuous data includes a one line title, followed by a series of (x,y) coordinates, one per line. Each "curve" of continuous data is terminated by a blank line. One curve can be followed by another, starting with the one line title, another followed by a series of (x,y) coordinates and terminated by a blank line. The input to this code can include any number of such "curves", one curve after the other in the continuous data input file PLOTTAB.CUR. Each pair of (x,y) coordinates are in fixed fields each 11 columns wide, corresponding to FORTRAN 2E11.4 format. For example,

Example Curve # 1
17   43.0
19   37.0
 .
71   12.9  
(BLANK LINE ENDS CURVE)

Example Curve # 2
.
.

**WARNING** - again, I'll stress that a BLANK LINE means completely blank in the first 22 columns - NOT zero, which is considered by the code to be perfectly legal input as part of a "curve". There are no implied units - everything is absolute - below you will learn how to physically interpret and identify your data.

**Discrete Data Format**

The format of the discrete data is very similar to the continuous data. Each set of discrete points starts with a one line title, followed by a series of points, and ends with a blank line. Each point is defined by an (x,y) coordinate plus uncertainties in both x and y - each point is defined by six values: x, -dx, +dx, y, -dy and +dy, one point per input line. The input to this code may include any number of sets of discrete points, one set after the other in the discrete data input file PLOTTAB.PNT. Each point of six values is in fixed fields each 11 columns wide, corresponding to FORTRAN 6E11.4 format. For example,

Example Set # 1
17   1.2   2.4   43.0   17.2  12.1
19   1.6   2.6   37.0   15.8  9.3
 .
71   8.2   10.7   12.9   7.2   2.3  
(BLANK LINE ENDS CURVE)

Example Set # 2
.
.

Note, uncertainties -dx, +dx, -dy and +dy are always interpreted as positive (sign ignored) in the same units as the data (not % or fraction or anything else), and they are interpreted x +/- dx - not a minimum, average and maximum, e.g., for the first x value 17 1.2 2.4, means an average value of 17 with errors extending -1.2 below 17, and +2.4 above 17 -
there are no implied units - everything is absolute - below you will learn how to physically interpret and identify your data.

Note, this format allows for zero, or blank, error fields, as well as asymmetric errors. If the errors are symmetric you must define both of them separately.

WARNING - again, I'll stress that a BLANK LINE means completely blank in the first 66 columns - NOT zero, which is considered by the code to be perfectly legal input as part of a set of discrete points.

Interpretation of the Data

When you generate data in these formats using one of your application codes you do not have to decide in advance how they will actually be interpreted and appear on a plot. This is controlled by an input file named PLOTTAB.INP. This file defines how many curves and/or sets of discrete points will appear on each plot, allows for a two line title to appear at the top of each plot, x and y axis labels and scaling (linear or log scaling), and x and y ranges (in case you do not want to plot all of the data on a single plot). Using these options you can customize each plot to exactly meet your needs. As in the case of the continuous and discrete point files, almost all input fields in PLOTTAB.INP are 11 columns wide corresponding to FORTRAN E11.4 or I11 format.

How Do You Produce Output

Let's first see how simple it is to update any of your codes to produce output that can be read as input to PLOTTAB. Assume that you have a code that is calculating lots of results in tabular form that until now you have had to wade through by hand to see what your results mean. Here's what you add to your code to output the results in a form that PLOTTAB can read as input,

C-----LOOP OVER CURVES
    DO ICURVE = 1,NCURVE
C-----PRINT FIRST LINE TITLE
    WRITE(16,1600) TITLE(ICURVE)
1600 FORMAT(A40)
C-----PRINT DATA POINTS
    DO IPOINT = 1,NPOINT(ICURVE)
        WRITE(16,1610) X(IPOINT,ICURVE),Y(IPOINT,ICURVE)
    1610 FORMAT(2E11.4)
C-----END OF POINT LOOP
    ENDDO
C-----PRINT BLANK LINE FOR END OF CURVE
    WRITE(16,1620)
1620 FORMAT(30X,'(BLANK LINE ENDS CURVE)')
C-----END OF CURVE LOOP
    ENDDO

That's all you have to add to your application codes. You just output any number of curves (defined by NCURVE), each with its own title line to identify it (defined by TITLE), each with any number of points defining each curve (defined by X, Y), and each curve ended with a blank line. What could be simpler? The above example is for
outputting continuous curves, but outputting discrete sets of points is no more difficult. The
only difference in the above coding for curves we output two numbers for each (x,y) point, whereas for
discrete points we would output six numbers to include the x and y uncertainty in the order x -dx +dx y -dy +dy.

That's it!!! You are now an expert at producing output that can immediately be read by
PLOTTAB to show you your results. That's all you need to know about producing output. Once you start using this very simple approach never again you will have to wade through piles of results trying to figure out what they mean. Instead you can immediately see your results, and you will see them on plots that are of high enough quality to be accepted by journals for publication without any modifications.

Interpreting and Plotting Your Data

Let's assume that you have now produced some output results that you want to plot, i.e.,
you have your results in the correct format, described above, in a file named
PLOTTAB.CUR for continuous curves and in PLOTTAB.PNT for discrete points. First let me make it clear that you don't need both; you can plot continuous and/or discrete data in any combination. For the following example I'll assume both merely so that I can discuss how to control both.

Now we will edit the control file PLOTTAB.INP to tell PLOTTAB how to interpret and plot your data. Below is an example PLOTTAB.INP that I recently used to produce a plot. At first this may look complicated, but let me point out that although I have now been using PLOTTAB and its predecessors for almost 20 years, I still have only one PLOTTAB.INP and every time I want to produce a plot all I do is edit a few things and bingo! Out come the plots I want. This is the approach that I suggest you also use - don't start from scratch - start with the PLOTTAB.INP file distributed with the code and modify it to meet your needs.

Let me first cover the input things that I change for each new plot that I want. Above are eight (8) lines from PLOTTAB.INP that are used to produce one plot and I'll discuss the important parameters from top to bottom. I've highlighted the parameters I will discuss so that you can more easily find them.

The first important thing to tell PLOTTAB is how many continuous curves and/or discrete sets of points to put on the plot. This is done on the second line, where my input says to display 3 continuous curves and 2 sets of discrete data. Regardless of how many curves and sets of points you have produced in PLOTTAB.CUR and PLOTTAB.PNT you can use these 2 input fields to tell PLOTTAB how many to actually read and put on the next plot. For example, I can use the above input to produce a plot with 3 curves on the
plot, or I can easily change the input (as we will see below) to display the curves one at a time on a series of plots.

Next we want to physically describe what data we are plotting. This is done using the next four (4) input lines. These are,

1) A label for the x axis - in this example Neutron Energy (MeV)
2) A label for the y axis - in this example Cross Section (barns)
3-4) A two line title to appear at the top of the plot - in this example Lithium-6 Major Cross Sections
   From the Livermore ENDL Cross Section Library

In most cases that's all I modify - the code takes care of everything else - so I can immediately run PLOTTAB and get the plots I want. That's all you need to know to successfully use PLOTTAB to generate plots for you.

Note, with this approach the code does not have to have any idea what the physical significance of the data is, and any data can be put into the PLOTTAB input format and plotted. Physical interpretation of the data is all in your hands - by changing plot titles and axis labels you are free to interpret the data any way that you see fit - and you can easily produce plots to specifically meet your needs.

Let me briefly cover the meaning of the other input fields, just in case you want to get fancy.

The first input line, again shown below, defines the (x,y) dimensions of the plot, how many sub-plots to put on each plot, and how large to make the characters. Reading left to right the below line says the plot size is x=0 to 13.5, and y=0 to 10. This will give you a full page plot on 8-1/2 by 11" paper, and except for special purpose you won't want to change this. One case in which you will want to change them is if your plotter doesn't use inches, but rather use cm, mm, anything - no problem - just change these once for your system and you probably will never have to change them again. The next 2 fields say that each page will contain 1 plot in the x direction and 1 y in the y direction = one single, full page plot. If I would like 6 plots on each page I could change these to 3 plots in the x direction and 2 in the y direction. The last field, 1.5, says to make the characters 1-1/2 times normal size.

0.00000  13.50000  0.00000  10.00000  1  1 1.5

On the next line you already know about the first two fields. The remaining fields, from left to right, allow you to:
1) add a border around each plot
2) add an (x,y) grid - the code has 6 built-in grids
3) plot the ratio of everything to the first curve
4) change the thickness of all lines drawn

3 2 0 0 0 0

You already know about the next four lines, so all we need discuss is the last two lines.
These two lines are used to control the x and y features of the plot: the first line is for x and the second for y. Again from left to right, the six (6) fields on each line control,

1) the lower x limit
2) the upper x limit
3) should discrete point x errors be plotted = no(0), yes (1)
4) x scaling = automatic (0), linear (1), log(2)
5) round x limit to avoid touching edge of plot = yes(0), no(1)
6) show legend box = yes(0), no(1)

1) the lower y limit
2) the upper y limit
3) should discrete point y errors be plotted = no(0), yes (1)
4) y scaling = automatic (0), linear (1), log(2)
5) round y limit to avoid touching edge of plot = yes(0), no(1)
6) show data points on curves = no(0), yes(1)

WARNING - let me again stress that this code can tell the difference between BLANK and ZERO - for example, on the above two input lines the BLANK x and y lower and upper limits means scale the plot to show all of the data as read. In contrast, if one of these fields contained 0.0 the specified limit would be forced to be zero, regardless of the range of the data read.

Again, that's it!!! If you want to get fancy you can use these parameters to customize plots to obtain almost any output that you want to meet any specific need.

Multiple Plots

Let's now generalize to more than one plot. Don't worry there isn't much to generalize. For more than one plot you basically have two options:

1) If the layout of each plot is the same you need merely copy the last four lines as many times as you want, changing any parameters that you want on these lines. You can do this as many times as you want for as many plots as you want. For example here's a generalization of our above input for three plots - in this case all I did was copy the last four lines twice and change the titles for Li\(^6\), Al\(^27\) and U\(^238\) - this assumes that in PLOTTAB.CUR I have 3 curves for each plot (at least 9 curves), and that in PLOTTAB.PNT I have 2 sets of discrete points for each (at least 6 sets).

<table>
<thead>
<tr>
<th>Neutron Energy (MeV)</th>
<th>Cross Section (barns)</th>
<th>Lithium-6 Major Cross Sections</th>
<th>From the Livermore ENDL Cross Section Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000</td>
<td>13.50000</td>
<td>0.00000</td>
<td>10.00000</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>
### Aluminum-27 Major Cross Sections
From the Livermore ENDL Cross Section Library

<table>
<thead>
<tr>
<th>Neutron Energy (MeV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>13.50000</td>
<td>10.00000</td>
</tr>
<tr>
<td>13.50000</td>
<td>10.00000</td>
</tr>
<tr>
<td>13.50000</td>
<td>10.00000</td>
</tr>
</tbody>
</table>

**Uranium-238 Major Cross Sections**
From the Livermore ENDL Cross Section Library

<table>
<thead>
<tr>
<th>Neutron Energy (MeV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>13.50000</td>
<td>10.00000</td>
</tr>
<tr>
<td>13.50000</td>
<td>10.00000</td>
</tr>
<tr>
<td>13.50000</td>
<td>10.00000</td>
</tr>
</tbody>
</table>

2) If the layout of each plot is different you can follow the eight (8) line input for one plot by a **BLANK** (not 0, BLANK) line, and then add eight lines for the next plot. You can do this as many times as you want for as many plots as you want. For example here's a generalization of our above input for three plots using this second method - in this case the input is EXACTLY equivalent to what I have shown above using the first method - use either method, or a combination of the two, in any order that you want - the choice is your’s.

<table>
<thead>
<tr>
<th>Neutron Energy (MeV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000</td>
<td>13.50000</td>
</tr>
<tr>
<td>0.00000</td>
<td>10.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>10.00000</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Lithium-6 Major Cross Sections**
From the Livermore ENDL Cross Section Library

<table>
<thead>
<tr>
<th>Neutron Energy (MeV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000</td>
<td>13.50000</td>
</tr>
<tr>
<td>0.00000</td>
<td>10.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>10.00000</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neutron Energy (MeV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000</td>
<td>13.50000</td>
</tr>
<tr>
<td>0.00000</td>
<td>10.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>10.00000</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

You might wonder why I wrote out the names instead of just using Li$^6$, Al$^{27}$ and U$^{238}$ - if you prefer this form, no problem - see the documentation within the code on how to use sub and super-scripts, as well as Greek characters and other interesting goodies that I cannot cover in detail in a brief introduction.
Data is Read in Order

In controlling the flow of curves from PLOTTAB.CUR and sets of discrete data points from PLOTTAB.PNT remember each time you use input in PLOTTAB.INP to tell it to read data from these files the code continues to read further and further into each file. For example, in the above case the first plot will contain the first three curves from PLOTTAB.CUR and first two sets of points from PLOTTAB.PNT. The second plot will contain curves four through six from PLOTTAB.CUR and sets of points three and four from PLOTTAB.PNT, etc. It's your responsibility to insure that you have properly ordered the curves and sets of points, and properly arrange their grouping on successive plots.

Terminating Plotting

Execution terminates when there are no more requests for plots in PLOTTAB.INP, or no more data to plot from PLOTTAB.CUR and PLOTTAB.PNT. Note, regardless of how many curves and sets of points you have in PLOTTAB.CUR and PLOTTAB.PNT only as many plots will be produced as you define in the control file PLOTTAB.INP. Also if one input stream of data (curves or sets of points) is exhausted, but the other isn't, the code will continue producing any plots that you request. For example, for the above three plots if there are 9 curves in PLOTTAB.CUR, but only 2 sets of points in PLOTTAB.PNT, the first plot will contain 3 curves and 2 sets of points (which exhausts the sets of points), and the following two plots will each contain 3 curves and 0 sets of points.

Editing Files

All of the files PLOTTAB.CUR, PLOTTAB.PNT and PLOTTAB.INP are simple text files, so you can use any editor to edit them. For example, after you have produced output in PLOTTAB.CUR if you can want to change anything just open the file and do it. You can change titles for the curves, deletes curves, rearrange the order of curves, anything you want to do to meet your needs.

How Do You Define Input Parameters Before You Have Seen ANY Plots

It very nice to have all of these options to select x and y scaling, x and y ranges, etc. But how can you possibly know what options to select before you have seen plots of you data? The answer is: you don't! PLOTTAB is supplied in two versions: an interactive version that only produces on-screen output, and a non-interactive version that only produces Postscript hardcopy output.

What I recommend is that you start by not selecting any special options and first run the interactive version. This version will allow you to interactively select many of the options described above, e.g., x and y scaling, x range, etc. Then after you have seen your data and played with it you can decide what options you want to set to produce your final Postscript output.
As I use PLOTTAB well over 90 % of the plots that I look at are generated by the interactive code and I never even bother to generate Postscript output. In this way PLOTTAB can be used very simply to quickly look at enormous amounts of data. In this case I don't care what the x and y axis labels are or what the two lines at the top of the plot say - I know how to physically interpret the data I'm looking at - so I just use my existing PLOTTAB.INP file and all I have to tell it is how many curves and sets of discrete points to display on each plot, and I quickly start looking at my results.

Only when I see something of interest that I need a hardcopy of do I bother making any of the changes I have described above. If you also use this pragmatic approach you can save yourself a lot of time and energy and use PLOTTAB much more effectively in your work.

How Do You Remember ALL of the Options

You don't - or at least, I don't. Whenever I want to find out what a given field in the PLOTTAB.INP input parameters means I run PLOTTAB, immediately kill it (use CONTROL C) and then look in the output file PLOTTAB.LST that contains an interpretation of all of the input parameters. For example, for the following input,

```
0.00000   13.50000    0.00000   10.00000          1          1 1.5
3          0          0          1          0          0
```

Neutron Energy (MeV)
Production, Absorption and Leakage
Production, Absorption and Leakage
For Test Problem

Here's the interpretation of the above input from the output file PLOTTAB.LST. As you can see there is a line by line and field by field interpretation of the input parameters in exactly the order they appear in the input. For example, if I can't remember which input field controls plotting ratios, from the below listing I can see that it is the fifth field of the second input line.

```
PLOT TABULATED DATA (PLOTTAB VERSION 97-1)

DESCRIPTION OF PLOTTER AND FRAME LAYOUT

X DIMENSIONS (X-MIN TO X-MAX).....   .00000+ 0 TO   1.35000+ 1
Y DIMENSIONS (Y-MIN TO Y-MAX).....   .00000+ 0 TO   1.00000+ 1
PLOTS PER FRAME (X BY Y)..........           1 BY            1
CHARACTER SIZE MULTIPLIER.........       1.500

READ AND PLOT (FOR EACH PLOT).....    3 CURVES
SETS OF POINTS PER PLOT..........    NONE
SHOULD BORDER BY PLOTTED.........    NO
TYPE OF GRID......................DASHED GRID (COARSE)
SHOULD RATIOS BE PLOTTED.........    NO
LINE THICKNESS....................   0
X AXIS LABEL AND UNITS............ Neutron Energy (MeV)
Y AXIS LABEL AND UNITS............ Production, Absorption and Leakage
```

14
PLOT TITLE
Production, Absorption and Leakage
For Test Problem
-----------------------------------------------------------------------
REQUESTED X RANGE................. PLOT ALL POINTS
PLOT X ERROR BARS................. NO
X PLANE ON PLOTS (IF POSSIBLE)....LOG (NO INTERPOLATION)
ROUND X LIMITS.................... NO
LEGEND BOX ON PLOT.............. YES
-----------------------------------------------------------------------
REQUESTED Y RANGE................. PLOT ALL POINTS
PLOT Y ERROR BARS................. NO
Y PLANE ON PLOTS (IF POSSIBLE)....LOG (NO INTERPOLATION)
ROUND Y LIMITS.................... NO
SHOW DATA POINTS................ NO
-----------------------------------------------------------------------
X LIMITS (PLANE).............. 1.02360-10 TO 1.99760+ 1 (LOG)
Y LIMITS (PLANE)............ 2.02610- 5 TO 1.57230+ 7 (LOG)
-----------------------------------------------------------------------
CONTINUOUS CURVES
INDEX POINTS DESCRIPTION

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>566 Production</td>
</tr>
<tr>
<td>2</td>
<td>566 Absorption</td>
</tr>
<tr>
<td>3</td>
<td>498 Leakage</td>
</tr>
</tbody>
</table>

Postscript Output Files

When you run the non-interactive version of the code it will produce a series of Postscript output files, one plot per file. The files will be named,
PLOT0001.ps
PLOT0002.ps
.
.
These postscript files can be printed on any Postscript printer, or viewed with any Postscript viewer, such as Ghostview; note, Ghostview is available FREE on the web.

WARNING - every time you run the code it uses the same file names. So if you want to save any file make sure you rename it before you again run the code.

Interpolation Along Curves

When you start using PLOTTAB you will find that your results can look quite different depending upon how you display the data, e.g., linear or log scaling in the x or y direction.

By default PLOTTAB assumes that between tabulated points of curves it should interpolate assuming linear interpolation in x and y. If your data is not linearly interpolable you can get some very strange looking results when PLOTTAB interpolates in say log/log x/y scaled plots. PLOTTAB ALWAYS uses the defined interpolation to show the TRUE shape of each curve between tabulated points in each possible combination of linear and log x and y scaling. For example, if I have only two tabulated
points at $x=1$ and $x=100$, using standard linear interpolation this will be a straight line on a linearly scaled $x$ and $y$ plot. But if you use log $x$ and/or $y$ scaling PLOTTAB will display a curved line corresponding to the TRUE (assuming linear interpolation) shape of the curve.

You can control how PLOTTAB interpolates in $x$ and $y$ separately by defining the interpolation to be linear or log in each dimension. Above I briefly described how to control the $x$ and $y$ scaling of each plot = automatic (0), linear (1), log(2). In this case, any non-negative values specify scaling with linear interpolation. To control interpolation, any negative values specify scaling and the same type of interpolation; the only meaningful negative value is $-2 = \log$ scaling and interpolation.

An important point to note, is that generally if you are using tabulated data in your applications it is important how the data is interpreted not only at the points that you tabulate data, but AT EVERY SINGLE POINT along the curve, e.g., integrals and interpolate values depend crucially on EXACTLY HOW YOU INTERPOLATE.

This PLOTTAB option can supply you with value information that you can use in your applications. For example, if you assume your data is linearly interpolable, but you see funny bumps and cusps in the results when you plot it in various combinations of linear and log, $x$ and $y$ scaling, you better think again about your assumption, because your data is not smoothly linearly interpolable. In this case you should consider either adding more, closer spaced points along your curves, or try PLOTTAB's log interpolation and see if this solves your problem. It ONLY SOLVES YOUR PROBLEM if you are willing to interpret your data in your applications using more complicated log interpolation. What should you do? The choice is yours. But whatever you do, be sure that you use PLOTTAB to check your final results to insure that you are not incorrectly interpreting your data in your applications.

**You are NOW a PLOTTAB Expert**

Sorry, that's about all I can quickly teach you about PLOTTAB. If you now understand how to produce output from your codes to be used as input to PLOTTAB, and how to edit PLOTTAB.INP to define the layout of each plot, you are now an expert, and you can immediately start generating plots. If you want to get even fancier, see the following documentation for more details - there's a lot more that this code can do to meet your specific needs than I have been able to cover in this brief introduction.
Characters

In order to make this code as computer independent as possible it uses an input file PLOT.CHR to define the strokes necessary to plot each character – this is called a software character set. Using this method the graphics interface for each computer and plotting device need only be able to draw lines from one (X, Y) coordinate to another, and all character sizes and aspect ratios will be plotted identically on all plotters.

Control Characters

This code uses three control characters for special effects,

{   - Shift the following character up – for superscript.
}   - Shift the following character down = for subscript.
|    - Shift the following character left 1 character = for backspace.

Standard and Alternate Character Sets

The software character set includes two sets of characters: a Standard and an Alternate Set. To use the standard character as input you need merely type the desired character; all of the standard characters are available on most computer keyboards.

To use the alternate character set you should consult the following equivalence table and precede each character by }. For example, to plot (n, Greek alpha), you should type (n,]a); here the ] indicates that the next character is from the alternate character set and the following equivalence table indicate that – a – is equivalent to a low case Greek alpha.

\[
\begin{array}{cccccccc}
A & = & A & M & = & M & Y & = & \Psi \\
B & = & B & N & = & N & Z & = & Z \\
C & = & X & O & = & O & a & = & \alpha \\
D & = & \Delta & P & = & \Pi & b & = & \beta \\
E & = & E & Q & = & \Theta & c & = & \chi \\
F & = & \Phi & R & = & P & d & = & \delta \\
G & = & \Gamma & S & = & \Sigma & e & = & \varepsilon \\
H & = & H & T & = & T & f & = & \varphi \\
I & = & I & U & = & \Upsilon & g & = & \gamma \\
J & = & V & h & = & \eta & t & = & \tau \\
K & = & K & W & = & \Omega & i & = & \iota \\
L & = & \Lambda & X & = & \Xi & j & = & \nu \\
\end{array}
\]

\( B = \infty \)
**Character Thickness**

All lines on a plot, except the grid, may be drawn using a specified line thickness. This option may be used to good advantage to insure that data can properly and easily distinguished from the background grid. For reference purposes the following tables illustrate the effect of using line thickness from 0 (standard) to 5 (maximum allowed).

<table>
<thead>
<tr>
<th>Thickness</th>
<th>0 Thick</th>
<th>1 Thick</th>
<th>2 Thick</th>
<th>3 Thick</th>
<th>4 Thick</th>
<th>5 Thick</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+−*/$()=abcdefghijklmnopqrstuvwxyz,:.;?!&lt;&gt;%’@&amp;&quot;_1”</td>
<td>αβχδεζηι χκλμνπρστυ ωξψζ→↑↓≠±≤≥≈∈ε×∂∇∫f[]</td>
<td>αβχδεζηι χκλμνπρστυ ωξψζ→↑↓≠±≤≥≈∈ε×∂∇∫f[]</td>
<td>αβχδεζηι χκλμνπρστυ ωξψζ→↑↓≠±≤≥≈∈ε×∂∇∫f[]</td>
<td>αβχδεζηι χκλμνπρστυ ωξψζ→↑↓≠±≤≥≈∈ε×∂∇∫f[]</td>
<td>αβχδεζηι χκλμνπρστυ ωξψζ→↑↓≠±≤≥≈∈ε×∂∇∫f[]</td>
<td>αβχδεζηι χκλμνπρστυ ωξψζ→↑↓≠±≤≥≈∈ε×∂∇∫f[]</td>
</tr>
</tbody>
</table>
Software Symbols and Line Types

In order to identify sets of points or curves this code uses in input file PLOT.SYM to define the strokes required to draw any one of 30 different symbols (to identify sets of points), and any one of 30 different types of lines (to identify curves).
Composite Plots

Below are examples of composite plots, first with sub-plots outside the main frame, and the second with sub-plots inside the main frame.
Randomly Positioned Titles

Below is an example of adding additional title information randomly anywhere on the plot. In this case the legend box identifies the individual sub-shell cross sections, and the randomly positioned titles indicate the approximate position of the shell energies, K through P.

![Plot Example](image)

**Code Installation**

The code is distributed with detailed instructions concerning installation and testing of the code. These instructions are periodically updated for distribution with the code, to insure that the instructions are as up-to-date as possible, and exactly correspond to the version of the code that you will be implementing and using.

When you receive this code system you will find it arranged in a file directory structure. At each level of the directory you will find a file named **README** - be sure that you read all such files as you proceed with installation and testing.
Example of Different Grid Types (0 through 5)

Below I illustrate the six (6) different types of grid available, varying from simply tick marks on the border (grid 0) through very detailed (grid 5). Here I use exactly the same data on all six plots, and I used the option to plot 3 X 2 plots all on the same page.

Example PLOTTAB Problem

When I run the PLOTTAB test problem I have no idea what the results will look like, so I first used PLOTTAB to produce on-screen graphics. The below PLOTTAB.INP will produce one plot of the entire energy range of the data. I then used the ZOOM option to look at energy ranges I am interested in; in doing this I produced the following four on-screen plots,
Once I saw the data on the screen I selected the energy ranges I was interested in and I ran PLOTSAVE to produce the below plots as hardcopy PostScript files.

<table>
<thead>
<tr>
<th>Energy (eV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000</td>
<td>13.5000</td>
</tr>
<tr>
<td>0.0000</td>
<td>10.0000</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

Comparison of Evaluation and Measurement

Fe-56 Total

<table>
<thead>
<tr>
<th>Energy (eV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000</td>
<td>13.5000</td>
</tr>
<tr>
<td>0.0000</td>
<td>10.0000</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

Comparison of Evaluation and Measurement

Fe-56 Total

<table>
<thead>
<tr>
<th>Energy (eV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>175000.</td>
<td>200000.</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Comparison of Evaluation and Measurement

Fe-56 Total

<table>
<thead>
<tr>
<th>Energy (eV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>175000.</td>
<td>200000.</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Original Reference


Latest Documentation

This code is designed to be self-documenting, in the sense that the latest documentation for the code is included as comment lines at the beginning of the code. Printed documentation, such as this report, is periodically published and consists mostly of a copy of the comment lines from the beginning of the code. The user should be aware that the comment lines in the code are continuously updated to reflect the most recent status of the code and these comment lines should always be considered to be the most recent documentation for the code and may supersede published documentation, such as this report. Therefore users are advised to always read the documentation within the actual code.

Comment Lines from the Beginning of PLOTTAB

C=================================================================
C
C     Program PLOTTAB
C
C     OWNED, Maintained and Distributed by
C
C     The Nuclear Data Section
C     International Atomic Energy Agency
C     P.O. Box 100
C     A-1400, Vienna, Austria
C     Europe
C
C     Originally written by
C
C     Dermott E. Cullen
C     University of California (retired)
C
C     Present Home Address
C     1466 Hudson Way
C     Livermore, CA 94550
C     U.S.A.
C     Telephone 925-443-1911
C     E-Mail RedCullen1@Comcast.net
C     Website http://home.comcast.net/~redcullen1
C=================================================================
C
C     HISTORY
C
C     Version 87-1 (January, 1987) *Original WINDOWS Version
C     Version 87-2 (May, 1987) *SOFTWARE UPPER AND LOWER CASE
C     CHARACTERS
C     *SOFTWARE SPECIAL SYMBOLES TO IDENTIFY
C     SETS OF DISCRETE POINTS.
C     *SOFTWARE LINE TYPES TO IDENTIFY
VERSION 87-3 (NOVEMBER, 1987)  *IMPROVED GROUPING OF DATA ON PLOTS
   (NOTE, CHANGE IN DEFINITION OF
   INPUT VARIABLES).
   *ALL INPUT READ AS CHARACTERS AND
   INTERNALLY CONVERTED TO FLOATING
   OR FIXED POINT AS NEEDED.
   *IMPROVED LINE TYPES TO DESCRIBE
   CURVES.
   *IMPROVED SCALING.

VERSION 88-1 (JULY, 1988)  *SIMPLER INTERFACE TO ALLOW PROGRAM
   TO BE USED ON VIRTUALLY ANY PLOTTER
   *OPTION..TURN OFF INTERPOLATION FROM
   LINEAR-LINEAR TO PLANE OF PLOT.
   *OPTION..INTERNALLY DEFINE FILENAMES
   *(SEE SUBROUTINE FILEIO FOR DETAILS).
   *ALLOW RE-DEFINITION OF GLOBAL
   PARAMETERS DURING RUN (ALLOW
   IMPROVED GROUPING OF DATA ON PLOTS)
   *IMPROVED COMPUTER COMPATIBILITY.

VERSION 88-2 (OCTOBER 1988)  *UPDATED BASED ON USER COMMENTS.
   *UPDATED TO USE NEW PROGRAM CONVERT
   KEYWORDS.
   *TREAT CHARACTER ARRAYS AS EITHER
   - CHARACTER (FORTRAN-77 CONVENTION)
   - INTEGER (FORTRAN-H CONVENTION)

VERSION 89-1 (MAY 1989)  *UPDATED BASED ON USER COMMENTS.
   *ONE SIDED X AND Y LIMITS
   *10,000 POINTS FOR CURVES AND
   2,000 DISCRETE POINTS
   *3 CHARACTER FONTS
   *LINEAR OR LOG X AND Y INTERPOLATION
   *OPTIONAL Rounding OF PLOT LIMITS
   *OPTIONAL LEGEND BOX ON PLOT

VERSION 89-1 (JULY 1989)  *UPDATED BASED ON USER COMMENTS.
   *UP TO 20000 POINTS FOR CURVES
   *IMPROVED LEGEND BOX POSITIONING.
   *ADDITIONAL GRIDS COMBINING TICK
   MARKS WITH SOLID OR DASHED GRID.
   *ONE SIDED X AND Y Rounding
   *THICK CURVES, ETC., BUT NOT THICK
   CHARACTERS.

VERSION 90-1 (MAY 1991)  *UPDATED BASED ON USER COMMENTS.
   *ADDED NEW GRID TYPES
   *UP TO 10000 DISCRETE POINTS

VERSION 92-1 (MARCH 1992)  *UPDATED BASED ON USER COMMENTS.
   *ADDED THICK MASTER CURVE OPTION
   *ADDED MANY NEW FEATURES
   *CORRECTED MANY OLD PROBLEMS

VERSION 92-2 (APRIL 1992)  *VARIABLE CHARACTER SIZE INPUT OPTION
   *ALLOW COMPLETE FLEXIBILITY TO CHANGE
   PAGE LAYOUT ANY NUMBER OF TIMES
   DURING A SINGLE RUN.

VERSION 93-1 (MARCH 1993)  *UPDATED BASED ON USER COMMENTS.
   *UPDATED GRAPHICS INTERFACE FOR LAHEY
   IBM-PC FORTRAN COMPILER FOR ON
   SCREEN GRAPHICS (SEE, DESCRIPTION
   OF GRAPHICS INTERFACE BELOW).
*INCREASED MAXIMUM NUMBER OF POINTS FOR CURVES FROM 20000 TO 200000.


*ADDED INTERACTIVE INTERFACE USING MOUSE.

VERSION 96-1 (SEPTEMBER 1996) *GENERAL UPDATE BASED ON USER COMMENTS

VERSION 97-1 (SEPTEMBER 1997) *GENERAL UPDATE BASED ON USER COMMENTS

VERSION 98-1 (MAY 1998) *GENERAL UPDATE BASED ON USER COMMENTS

VERSION 2000-1 (MAY 2000) *GENERAL UPDATE BASED ON USER COMMENTS

VERSION 2002-1 (Nov. 2002) *GENERAL UPDATE BASED ON USER COMMENTS

VERSION 2004-1 (April 2004) *REAL*8 VERSION

*ADDED INCLUDE FOR COMMON

*IMPROVED POSTSCRIPT FILES


VERSION 2011-1 (Mar. 2011) *Many Updates

VERSION 2013-1 (Nov. 2013) *32 and 64 bit Compatible.

*Limit discrete data

*Data MUST be positive

*ERRORS cannot exceed 90% of Data

*Replaced Old Routines for character translation by Current IN9 and OUT9 for ALL Floating Point Translation.

*Removed arbitrary positioned titles.

This can now be accomplished easier by editing finished plots.

PURPOSE

======================================================================
THIS PROGRAM IS DESIGNED TO PLOT ANY COMBINATION OF CONTINUOUS CURVES AND/OR DISCRETE POINTS (WITH ASSOCIATED ERROR BARS) USING USER SUPPLIED TITLES AND X AND Y AXIS LABELS AND UNITS.

IN ADDITION IF CURVES ARE PLOTTED THE FIRST CURVE MAY BE USED AS A STANDARD AND NOT ONLY THE DATA, BUT ALSO THE RATIO OF THE DATA TO THE STANDARD WILL BE PLOTTED.

USING THIS METHOD THE PROGRAM HAS NO IDEA OF WHAT DATA IS BEING PLOTTED AND YET BY SUPPLYING TITLES, X AND Y AXIS LABELS AND UNITS THE USER CAN PRODUCE ANY NUMBER OF PLOTS WITH EACH PLOT CONTAINING ALMOST ANY COMBINATION OF CURVES AND POINTS WITH EACH PLOT PROPERLY IDENTIFIED.

GRAPHICS INTERFACE

======================================================================
THIS PROGRAM USES A SIMPLE CALCOMP LIKE GRAPHICS INTERFACE WHICH REQUIRES ONLY 4 SUBROUTINES...EACH SUBROUTINE IS DESCRIBED IN DETAIL BELOW. ALL CHARACTERS AND SYMBOLS ARE DRAWN USING TABLES OF PEN STROKES (SUPPLIED WITH THIS PROGRAM). USING THIS METHOD THE PROGRAM SHOULD BE SIMPLE TO INTERFACE TO VIRTUALLY ANY PLOTTER OR GRAPHICS TERMINAL AND THE APPEARANCE AND LAYOUT OF THE PLOTS SHOULD BE INDEPENDENT OF WHICH PLOTTER IS USED.
ON WHAT COMPUTERS WILL THE PROGRAM RUN
=================================================================
THIS PROGRAM WILL RUN ON ALMOST ANY COMPUTER. PERSONAL COMPUTERS
ALLOW ON-SCREEN GRAPHICS AND INTERACTION WITH THE PLOTS, AS WELL
AS HARDCOPY PLOTS IN POSTSCRIPT FORMAT. CONTROL COMPUTERS CAN ALSO
BE USED WITHOUT INTERACTION TO PRODUCE HARDCOPY PLOTS POSTSCRIPT
FORMAT.

ON WHAT PLOTTERS WILL THE PROGRAM RUN
=================================================================
THE PLOTTER MAY USE UNITS OF INCHES, CENTIMETERS, MILLIMETERS,
VIRTUALLY ANYTHING. INTERNALLY THE PROGRAM WILL DEFINE PLOTS IN
APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. AS PART OF THE
INPUT THE USER DEFINES THE ACTUAL SIZE OF THE PLOT IN THE UNITS
(I.E., INCHES, CENTIMETERS, MILLIMETERS, WHATEVER) OF THE REAL
PLOT. THE PLOT IS TRANSFORMED TO THE SIZE OF THE LOCAL PLOTTER
AND OUTPUT. USING THIS CONVENTION THIS PROGRAM SHOULD BE EASY
TO INTERFACE TO VIRTUALLY ANY PLOTTER OR GRAPHICS TERMINAL.

OPTIONAL FILE NAMES
=================================================================
THIS PROGRAM CONTAINS A SUBROUTINE FILEIO WHICH MAY BE USED TO
OPTIONALLY DEFINE STANDARD FILE NAMES TO EACH I/O FILE. SEE THIS
SUBROUTINE FOR DETAILS ON HOW TO MODIFY THIS PROGRAM TO EITHER
(1) ASSUME ALL FILE NAMES ARE DEFINED FROM OUTSIDE THE PROGRAM
(E.G. USING JOB CONTROL LANGUAGE) OR (2) DEFINE ALL FILE NAMES
INTERNALLY USING SUBROUTINE FILEIO.

METHOD
=================================================================
STARTING FROM FILES OF,
(1) OPTIONS = TO CONTROL SELECTION AND PLOTTING OF DATA.
(2) CURVES  = IDENTIFIED BY A TITLE AND (X,Y) COORDINATES.
(3) POINTS  = IDENTIFIED BY A TITLE AND (X,+DX,-DX,Y,+DY,-DY)
COORDINATES.

THIS PROGRAM IS DESIGNED TO CREATE PLOTS OF THE USER SELECTED DATA

FORMAT OF INPUT OPTIONS, CURVES AND DISCRETE POINTS
=================================================================
THE FORMAT OF ALL FIXED AND FLOATING POINT DATA USED BY THIS
PROGRAM ARE ALL IN FIELDS 11 COLUMNS WIDE (E.G. I11 OR E11.4)
WHICH WAS SELECTED TO BE COMPATIBLE WITH THE ENDF/B (EVALUATED
NUCLEAR DATA FILE/VERSION B), ENDL (LIVERMORE EVALUATED NUCLEAR
DATA LIBRARY) AND EXFOR (EXPERIMENTAL NUCLEAR DATA LIBRARY)
FORMATS. DATA IN THE ENDF/B, ENDL OR EXFOR FORMAT CAN EASILY BE
TRANSLATED INTO THE FORMATS READ BY THIS PROGRAM.

DATA UNITS AND IDENTIFICATION
=================================================================
BY INPUT PARAMETERS THE USER CAN SPECIFY THE UNITS OF THE DATA
FOR THE X AND Y AXIS OF THE PLOTS (E.G., EV, KEV, MEV, BARNs,
CM**2,......) AND THE PHYSICAL IDENTIFICATION OF THE DATA TO APPEAR
AT THE TOP OF THE PLOT (E.G., 26-FE-56 (N,2N) CROSS SECTION,
HELIUM ELECTRON IONIZATION CROSS SECTIONS,....). AS SUCH THE DATA
TO BE PLOTTED MAY BE IN ANY UNITS THAT THE USER FINDS CONVENIENT TO
(E.G., EXFOR DATA IN KEV VS. MILI-BARNs NEED NOT BE CONVERTED TO
EV AND BARNs UNLESS THE USER FINDS IT CONVENIENT TO DO SO).

IF THE USERS WISHES TO USE THIS PROGRAM TO COMPARE DIFFERENT SETS
OF DATA (E.G., COMPARE AN EVALUATION TO A NUMBER OF EXPERIMENTAL
MEASUREMENTS OR COMPARE A NUMBER OF DIFFERENT EVALUATION) ALL OF
THE DATA TO BE COMPARED MUST BE IN THE SAME UNITS.

BLANK VERSUS ZERO
====================================================================
THIS PROGRAM WILL READ ALL DATA AS CHARACTERS AND INTERNALLY
CONVERT THEM TO NUMERICAL VALUES AS NEEDED. AS SUCH THIS PROGRAM
CAN DISTINGUISH BETWEEN BLANK AND ZERO INPUT. THIS CAPABILITY
IS IMPORTANT TO ALLOW THE PROGRAM TO DISTINGUISH BETWEEN WHEN
YOU ARE TRYING TO TELL THE PROGRAM NOTHING VERSUS ZERO, E.G.,
THE DIFFERENCE BETWEEN SPECIFYING A LOWER X LIMIT OF ZERO OR
NO LOWER LIMIT (IN WHICH CASE THE LIMIT WILL BE DEFINED BY THE
X RANGE OF THE DATA).

INPUT OPTIONS
====================================================================
I/O UNIT 2 CONTAINS CONTROL INFORMATION OF 3 TYPES (NOTE, UNIT
3 IS RESERVED FOR COMPUTER TERMINAL INTERACTION),

PLOTTER PARAMETERS
====================================================================
PARAMETERS WHICH DEFINE THE PHYSICAL X AND Y DIMENSIONS OF A
FRAME AND THE NUMBER OF PLOTS TO APPEAR ON EACH FRAME (A FRAME
MAY BE SUBDIVIDED INTO ANY NUMBER OF PLOTS IN THE X AND Y
DIRECTION).

PLOTTER PARAMETERS ARE READ AS THE FIRST LINE OF INPUT AND CAN
BE USED TO APPLY TO ALL SUBSEQUENT PLOTS OR CAN BE READ AGAIN
TO CHANGE THE LAYOUT OF A FRAME AND/OR THE GLOBAL PARAMETERS
WHICH FOLLOW (SEE, HOW TO RE-DEFINE THE PLOTTER AND GLOBAL
PARAMETERS, BELOW).

GLOBAL PARAMETERS
====================================================================
PARAMETERS WHICH APPLY TO ALL PLOTS, INCLUDING,
(1) WHETHER OR NOT TO PLOT CURVES AND HOW TO GROUP THEM.
(2) WHETHER OR NOT TO PLOT POINTS AND HOW TO GROUP THEM.
(3) WHETHER OR NOT TO PLOT AN OUTER BORDER ON EACH PLOT.
(4) TYPE OF GRID (TICK MARKS, FULL GRID OR DASHED GRID).
(5) WHETHER ONLY DATA SHOULD BE PLOTTED OR DATA AND RATIO OF ALL
DATA TO FIRST CURVE.
(6) THE WIDTH OF PLOTTED LINES (APPLIES TO ALL LINES EXCEPT THE
GRID).
(7) X AND Y AXIS LABELS AND UNITS.

THERE ARE 3 LINES OF GLOBAL PARAMETERS AND THESE PARAMETERS WILL
APPLY TO ALL SUBSEQUENT PLOTS UNTIL THE END OF THE RUN OR THE
USER Chooses TO RECYCLE BACK TO THE PLOTTER PARAMETER AND GLOBAL
PARAMETERS (SEE, HOW TO RE-DEFINE THE PLOTTER AND GLOBAL
PARAMETERS, BELOW).

PLOT PARAMETERS
====================================================================
PARAMETERS WHICH ONLY APPLY TO ONE PLOT, INCLUDING,
PLOTTAB

(1) A 2 LINE TITLE TO BE CENTERED AND APPEAR AT TOP OF PLOT.
(2) A REQUESTED X RANGE (IF ANY).
(3) WHETHER OR NOT X ERROR BARS SHOULD BE PLOTTED FOR POINTS.
(4) X SCALING AND INTERPOLATION (AUTOMATIC, LINEAR OR LOG)
(5) WHETHER OR NOT TO ROUND X LIMITS OUTWARD SO THAT DATA DOES
     EXTEND ALL THE WAY TO THE BORDER OF THE PLOT.
(6) A REQUESTED Y RANGE (IF ANY).
(7) WHETHER OR NOT Y ERROR BARS SHOULD BE PLOTTED FOR POINTS.
(8) Y SCALING AND INTERPOLATION (AUTOMATIC, LINEAR OR LOG)
(9) WHETHER OR NOT TO ROUND Y LIMITS OUTWARD SO THAT DATA DOES
     EXTEND ALL THE WAY TO THE BORDER OF THE PLOT.

FOR EACH PLOT THERE ARE 3 LINES OF PLOT PARAMETERS.

PLOTTING IS CONTROLLED BY PLOT PARAMETERS, NOT THE CURVE OR POINT
DATA. EACH SET OF PLOT PARAMETERS WILL PRODUCE ONE PLOT. PLOTTING
ENDS WHEN ALL SETS OF PLOT PARAMETERS HAVE BEEN READ OR WHEN THERE
IS NO MORE DATA TO PLOT.

RE-DEFINING THE PLOTTER AND GLOBAL PARAMETERS
=================================================================
IF THE FIRST LINE OF THE TITLE INCLUDED WITH THE PLOT PARAMETERS
(DESCRIBED ABOVE) IS BLANK THE PROGRAM WILL RE-CYCLE BACK TO
THE POINT OF READING THE PLOTTER PARAMETERS, FOLLOWED BY THE
GLOBAL PARAMETERS, FOLLOWED BY PLOT PARAMETERS FOR ANY NUMBER
OF PLOTS. THIS METHOD MAY BE USED ANY NUMBER OF TIMES DURING
EXECUTION IN ORDER TO CHANGE THE FRAME LAYOUT AND/OR GLOBAL
PARAMETERS.

CURVES
=================================================================
I/O UNIT 10 CONTAINS INFORMATION DESCRIBING THE CURVES TO BE
PLOTTED (IF ANY), INCLUDING,
(1) A ONE LINE TITLE TO IDENTIFY EACH CURVE.
(2) TABULATED (X,Y) PAIRS, ONE PAIR PER LINE, TERMINATED BY
     A BLANK (NOT 0.0) LINE.

THE SEQUENCE OF CURVE TITLE FOLLOWED BY A TABLE OF VALUES AND
TERMINATED BY BLANK MAY BE REPEATED ANY NUMBER OF TIMES TO CREATE
A SERIES OF CURVES. INPUT PARAMETERS MAY BE USED TO PLOT EACH
CURVE SEPARATELY OR TO GROUP CURVES ON ONE OR MORE PLOTS.

IF REQUESTED, THE PROGRAM WILL USE THIS DATA TO DRAW CONTINUOUS
CURVES CONNECTING THE TABULATED VALUES. EACH CURVE (UP TO 30 MAY
APPEAR ON EACH PLOT) WILL BE IDENTIFIED BY ITS TITLE IN A LEGEND
BOX WITHIN THE PLOTTING AREA. FOR EACH PLOT THE TOTAL NUMBER OF
DATA POINTS USED TO DEFINE THE CURVE MAY BE UP 200000 (IF THIS IS
EXCEEDED ONLY THE FIRST 200000 POINTS WILL BE USED).

POINTS
=================================================================
I/O UNIT 11 CONTAINS INFORMATION DESCRIBING THE POINTS TO BE
PLOTTED (IF ANY), INCLUDING,
(1) A ONE LINE TITLE TO IDENTIFY EACH SET OF POINTS.
(2) TABULATED (X,+DX,-DX,Y,+DY,-DY) SEXTUPLETS, ONE SEXTUPLE PER
     LINE, TERMINATED BY A BLANK (NOT 0.0) LINE.

THE SEQUENCE OF POINT TITLE FOLLOWED BY A TABLE OF POINTS AND
TERMINATED BY BLANK MAY BE REPEATED ANY NUMBER OF TIMES TO CREATE
A SERIES OF SETS OF POINTS. INPUT PARAMETERS MAY BE USED TO PLOT
THE SETS OF POINTS SEPARATELY OR TO GROUP SETS OF POINTS ON ONE
OR MORE PLOTS.

IF REQUESTED, THE PROGRAM WILL USE THIS DATA TO DRAW A SET OF
DISCRETE POINTS AND ASSOCIATED ERROR BARS (IF REQUESTED). EACH
SET OF POINTS (UP TO 30 SETS MAY APPEAR ON EACH PLOT) WILL BE
IDENTIFIED BY ITS TITLE IN A LEGEND BOX WITHIN THE PLOTTING AREA.
FOR EACH PLOT THE TOTAL NUMBER OF DISCRETE DATA POINTS MAY BE UP
TO 100000 (IF THIS NUMBER IS EXCEEDED ONLY THE FIRST 100000 POINTS
WILL BE USED).

COMBINED CURVES AND POINTS
===============================================================================
A COMBINATION OF UP TO 30 CURVES AND SETS OF DISCRETE POINTS MAY
APPEAR ON EACH PLOT (E.G., IF THERE ARE 10 CURVES THERE CANNOT BE
MORE THAN 20 SETS OF DISCRETE POINTS).

WARNING...THE PROGRAM WILL ALLOW THE USER TO SPECIFY UP TO 30
CURVES AND 30 SETS OF DISCRETE POINTS, BUT WILL NOT READ MORE THAN
A COMBINATION OF UP TO 30 CURVES AND DISCRETE POINTS FOR ANY ONE
PLOT. IF THE USER EXCEEDS THIS LIMIT IT MAY CAUSE THE DATA THAT
APPEARS ON EACH PLOT TO GET OUT OF SYNC WITH THE PLOT PARAMETERS
AND APPEAR ON THE WRONG PLOT.

OPERATION
===============================================================================
THE PROGRAM WILL,
(1) READ PLOTTER PARAMETERS
(2) READ ALL GLOBAL PARAMETERS
(3) READ ALL THE FIRST TITLE LINE (PLOT PARAMETERS). IF THE LINE
IS COMPLETELY BLANK THE PROGRAM WILL GO TO (1) - ABOVE, TO
RE-DEFINE THE PLOTTER AND GLOBAL PARAMETERS. IF THE LINE IS
NOT COMPLETELY BLANK IT WILL PROCEED TO (4) BELOW.
(4) READ THE SECOND TITLE LINE AND TWO PLOT PARAMETER LINES.
(5) READ ALL REQUESTED CURVE AND/OR POINT DATA (BASED ON CURRENT
GLOBAL PARAMETERS).
(6) DETERMINE THE MINIMUM AND MAXIMUM X AND Y VALUES.
(7) DECIDE WHETHER FOR X AND Y AXIS TO USE LINEAR OR LOG SCALING.
LOG SCALING IS USED UNLESS,
(A) USER INPUT SPECIFIES LINEAR
(B) THE MINIMUM IS NOT POSITIVE
(C) THE MAXIMUM IS LESS THAN 10 TIMES THE MINIMUM
(8) IF LINEAR SCALING IS USED FOR THE X AND/OR Y AXIS THE DATA
WILL BE SCALED TO OBTAIN AXIS ANNOTATION IN NORMAL FORM TO 3
DIGITS ACCURACY (I.E., IF THE X UNITS ARE EV AND THE MAXIMUM
X VALUE IS 0.00350 THE AXIS ANNOTATION WILL BE SCALED TO
3.50 AND THE UNITS MODIFIED TO (10**-3 EV))
(9) PRODUCE A PLOT CONTAINING THE USER SUPPLIED TITLES, X AND Y
AXIS LABEL AND UNITS IDENTIFYING EACH CURVE AND SET OF POINTS.
THE PLOT WILL ALWAYS CONTAIN THE DATA (CURVES AND/OR DISCRETE
POINTS). IF PLOTTING CURVES THE USER MAY OPTIONALLY SPECIFY BY
INPUT THAT THE FIRST CURVE IS TO BE USED AS A STANDARD AND THE
RATIO OF ALL OTHER DATA (CURVES AND/OR POINTS) TO THE STANDARD
SHOULD ALSO APPEAR ON THE PLOT (DATA = TOP 2/3 OF PLOT, RATIO=
BOTTOM 1/3 OF PLOT).
THE CYCLE OF STEPS (3)-(9) IS REPEATED UNTIL ALL SETS OF PLOT
PARAMETERS HAS BEEN READ.

USING THIS METHOD THE PROGRAM HAS NO IDEA OF WHAT DATA IS BEING
PLOTTED AND YET BY SUPPLYING TITLES, X AND Y AXIS LABELS AND
UNITS THE USER CAN PRODUCE A SERIES OF PLOTS OF ALMOST COMBINATION
OF CURVES AND POINTS WITH EACH PLOT PROPERLY IDENTIFIED.

X ORDER OF DATA
=================================================================
IF ALL DATA IS TO APPEAR ON THE PLOTS (I.E., THE USER DOES NOT
SPECIFY AN X RANGE..SEE DESCRIPTION OF INPUT OPTIONS) THE DATA FOR
EACH CURVE OR SET OF DISCRETE POINTS MAY BE IN ANY X ORDER, E.G.,
THE POINTS FOR A CURVE MAY BE ASCENDING OR DESCENDING ORDER OR MAY
EVEN REVERSE IN X.

IF YOU WISH TO SPECIFY X RANGES OR HAVE RATIOS ON A PLOT THE DATA
FOR EACH CURVE OR SET OF DISCRETE POINTS MUST BE IN ASCENDING
OR DESCENDING (DISCONTINUITY ALLOWED) X ORDER. FAILURE TO CONFORM
TO THIS RULE CAN RESULT IN UNPREDICTABLE RESULTS.

INTERPOLATION OF CURVES
=================================================================
IN ORDER TO DEFINE A CONTINUOUS CURVE BETWEEN TABULATED POINTS
THIS PROGRAM MUST KNOW HOW TO INTERPOLATE BETWEEN POINTS. BY
INPUT THE USER MAY SPECIFY EITHER THE DEFAULT OPTION OF LINEAR X
VERSUS LINEAR Y INTERPOLATION OR ALTERNATIVELY LOG X AND/OR LOG
Y INTERPOLATION. IN ALL CASES, REGARDLESS OF THE INTERPOLATION
SPECIFIED, THE PROGRAM WILL ALWAYS INTERPOLATE THE DATA TO THE
PLANE OF THE PLOT (LINEAR OR LOG X AND Y PLANE) IN ORDER TO
PRESENT THE TRUE VARIATION OF THE DATA BETWEEN TABULATED POINTS,
BASED ON THE USER SPECIFIED INTERPOLATION LAW.

IF THE USER WISHES THE CURVES TO MERELY BE STRAIGHT LINES BETWEEN
TABULATED POINTS IN THE PLANE OF THE PLOT THE INTERPOLATION LAW
NEED ONLY CORRESPOND TO THE PLANE OF THE PLOT (LINEAR OR LOG X
AND Y PLANE), WHICH CAN BE SPECIFIED BY INPUT.

TABULATED POINTS SHOULD BE TABULATED AT A SUFFICIENT NUMBER OF X
VALUES TO INSURE THAT THE DIFFERENCE BETWEEN THE SPECIFIED
INTERPOLATION AND THE 'TRUE' VARIATION OF A CURVE BETWEEN
TABULATED VALUES IS RELATIVELY SMALL.

FOR SOME APPLICATIONS THIS CAN BE VERY IMPORTANT, E.G., CONSIDER
THE CASE WHEN WE HAVE THE SIMPLE FUNCTION Y=1/X. TRY COMPARING
THE RESULTS OBTAINED AT X=500.0 FOR,
(1) THE EXACT VALUE.....Y=1/500.=0.002
(2) THE RESULT OBTAINED BY ONLY TABULATING THE FUNCTION AT X=1.0
(Y=1.0) AND X=1000.0 (Y=0.001) AND LINEARLY INTERPOLATING
BETWEEN THESE 2 VALUES.....Y=ABOUT 0.5
(3) THE RESULTS OBTAINED BY TABULATING THE FUNCTION AT X=1.0 UP
TO X=1000.0 USING STEPS IN X OF 1.0.....Y=0.002

IN (2) WHERE AN INSUFFICIENT NUMBER OF POINTS WERE USED THE
PREDICTED Y IS A FACTOR OF 250 TOO HIGH. IF THIS TABULATED DATA
IS EVER USED IN AN INTEGRAL THE INTEGRAL OF THE DATA IN (2) IS
ABOUT 500. WHEREAS THE EXACT INTEGRAL IS ABOUT 6.9 (THE CASE (2)
INTEGRAL IS OVER 70 TIMES TOO HIGH).
THE ABOVE EXAMPLE IS NATURALLY AN EXTREME EXAMPLE, BUT HOPEFULLY
IT ILLUSTRATES THE PROBLEMS WHICH CAN OCCUR WHEN TRYING TO PRODUCE
ACCURATE CURVES FROM TABULATED VALUES.

IF YOU HAVE A FUNCTION WHICH YOU WISH TO TABULATE AND YOU ARE NOT
SURE HOW MANY TABULATED VALUES TO USE AND WHERE TO LOCATE THEM
CONTACT THE AUTHOR FOR A COPY OF PROGRAM LINTAB, WHICH IS DESIGNED
TO START FROM ANY USER SUPPLIED FUNCTION AND TO CREATE A TABLE OF
LINEARLY INTERPOLABLE POINTS TO WITHIN ANY USER DESIRED ACCURACY.

NOTE, IF IN THE ABOVE EXAMPLE THE FUNCTION Y=1/X WERE TABULATED
AT ONLY X=1.0 AND X=1000.0 THE CORRECT INTERPOLATED VALUES AND
INTEGRALS WOULD BE OBTAINED IF LOG-LOG INTERPOLATION WERE ASSUMED.
IN THIS CASE INPUT PARAMETERS CAN BE USED TO (1) FORCE THE PLOT
TO BE INTO THE LOG-LOG PLANE, (2) SPECIFY LOG X VERSUS LOG Y
INTERPOLATION AND THE RESULTING PLOT WILL ACCURATELY REPRESENT
THE VARIATION OF THE CURVE BETWEEN TABULATED VALUES.

LAYOUT OF A FRAME
=================================================================
EACH FRAME MAY CONTAIN ANY NUMBER OF PLOTS - AS CONTROLLED BY
THE PLOTTER PARAMETERS (THE FIRST LINE OF INPUT) AND WHETHER OR
NOT YOU ARE IN THE COMPOSITION MODE. EACH PLOT WILL BE ANNOTATED
BY A 2 LINE TITLE AT THE TOP OF THE PLOT, X AND Y AXIS LABELS
TO DEFINE THE PHYSICAL SIGNIFICANCE AND DIMENSIONS OF EACH AXIS
AND A LEGEND BOX WITH THE PLOT TO IDENTIFY EACH CURVE AND SET OF
PLOTS AND IF PLOTTING RATIOS, THE MAXIMUM DIFFERENCE AND WHERE
(IN TERMS OF X) THIS DIFFERENCE OCCURRED.

LEGEND BOX
=======================================================
FOR SIMPLE PLOTS WHICH ONLY INVOLVE A SINGLE CURVE OR A SINGLE
SET OF POINTS THE LEGEND BOX IS USUALLY REDUNDANT, SINCE IN
THIS CASE THE 2 LINE TITLE IS SUFFICIENT TO IDENTIFY THE DATA
BEING PLOTTED - FOR SOME APPLICATIONS YOU MAY WISH NOT TO
USE A LEGEND BOX AND TO IDENTIFY EACH CURVE AND/OR SET OF
SEPARATELY. FOR WHATEVER REASON IF YOU CHOOSE NOT TO HAVE THE
LEGEND BOX PLOTTED, YOU CAN SPECIFY THIS AS AN INPUT OPTION
TO THE CODE.

VERTICAL VS. HORIZONTAL PLOTS
================================
IF YOUR PLOTTING AREA IS NOT SQUARE YOU MAY WISH TO RE-ORIENT
THE PLOTS BY SWITCHING THE X AND Y AXI. FOR EXAMPLE, IF YOUR
PLOTTING AREA IS 13.5 BY 10 INCHES (X BY Y), NORMALLY YOU WILL
OBTAIN A PLOT WHICH IS UPRIGHT WHEN THE X AXIS IS HORIZONTAL.
IF YOU WISH TO OBTAIN A PLOT WHICH IS UPRIGHT WHEN THE Y AXIS
IS HORIZONTAL THIS MAY BE DONE BY SETTING THE UPPER X LIMIT OF
THE PLOTTING AREA TO ITS NEGATIVE.

FOR EXAMPLE, FOR 13.5 BY 10.0 INCH PLOTS WITH THE X AXIS
HORIZONTAL, COLUMNS 1-44 OF THE FIRST INPUT LINE SHOULD BE,
0.0 13.5 0.0 10.0

IN CONTRAST FOR 13.5 BY 10.0 INCH PLOTS WITH THE Y AXIS HORIZONTAL
COLUMNS 1-44 OF THE FIRST INPUT LINE SHOULD BE,
NOTE, THESE 2 CASES DIFFER ONLY IN THE SIGN OF 13.5.

THAT IS ALL YOU NEED DO – THE NEGATIVE UPPER X LIMIT WILL SERVE AS A SIGNAL TO THE PROGRAM TO ROTATE THE PLOT THROUGH 90 DEGREES.

NOTE – THE PRESENT CONVENTION DIFFERS FROM THE CONVENTION USED IN EARLIER VERSIONS OF THIS CODE – IN EARLIER VERSIONS IT WAS NECESSARY TO NOT ONLY CHANGE THE SIGN OF THE UPPER X DIMENSION, BUT ALSO TO SWITCH THE X AND Y DIMENSIONS OF THE PLOT – THIS WAS CUMBERSOME AND IS NO LONGER REQUIRED.

I/O UNITS
=================================================================
UNIT DESCRIPTION
=================================================================
  2  INPUT OPTIONS (NOTE, UNIT 3 IS RESERVED FOR KEYBOARD INTERACTION ON A COMPUTER TERMINAL OR PERSONAL COMPUTER).
  5  KEYBOARD INTERACTION (USUALLY JUST TO INDICATE WHEN TO PROCEED TO THE NEXT PLOT).
  3  OUTPUT REPORT
 10  TITLES AND SETS OF POINTS FOR EACH CURVE.
 11  TITLES AND SETS OF DISCRETE POINTS.
 12  SOFTWARE CHARACTER TABLE
 14  SOFTWARE SYMBOL AND LINE TYPE TABLE

OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)
=================================================================
UNIT FILE NAME
=================================================================

STANDARD
=================================================================
  2  PLOTTAB.INP
  3  PLOTTAB.LST
 10  PLOTTAB.CUR
 11  PLOTTAB.PNT
 12  PLOT.CHR
 14  PLOT.SYM

INPUT PARAMETERS (ON I/O UNIT 2)
=================================================================
DESCRIPTION OF PLOTTER AND FRAME LAYOUT
=================================================================
CARD  COLUMNS  FORMAT  DESCRIPTION
-------  ---------  ------  -----------------------------
  1  1-11         E11.4  LOWER X LIMIT OF PLOTTER
  12-22    E11.4  UPPER X LIMIT OF PLOTTER
  23-33    E11.4  LOWER Y LIMIT OF PLOTTER
  34-44    E11.4  UPPER Y LIMIT OF PLOTTER
  45-55     I11  NUMBER OF PLOTS PER FRAME IN X DIRECTION
  56-66     I11  NUMBER OF PLOTS PER FRAME IN Y DIRECTION
  67-70    F4.2  CHARACTER SIZE MULTIPLIER.
             =0 OR 1 = STANDARD CHARACTER SIZE.
             =OTHERWISE = SCALE CHARACTER SIZE BY THIS
FACTOR.
IF GREATER THAN 2 IT IS SET = 2
IF LESS THAN 1/2 IT IS SET = 1/2

EXAMPLE DEFINITION OF PLOTTER

THE FIRST INPUT LINE DEFINES THE DIMENSIONS OF THE PLOTTER BEING
USED IN ANY UNITS (INCHES, CENTIMETERS, MILLIMETERS, ANYTHING)
WHICH APPLY TO THE PLOTTER. IN ADDITION THE FIRST LINE DEFINES
HOW MANY PLOTS SHOULD APPEAR ON EACH FRAME. THE PLOTTING AREA
DEFINED ON THE FIRST INPUT LINE MAY BE SUBDIVIDED INTO ANY NUMBER
OF PLOTS IN THE X AND Y DIRECTION. FOR EXAMPLE, TO PRODUCE A
SERIES OF FRAMES EACH CONTAINING 3 PLOTS IN THE X DIRECTION AND
2 PLOTS IN THE Y DIRECTION (6 PLOTS PER FRAME) COLUMN 45-55 OF
THE FIRST INPUT LINE SHOULD BE 3 AND COLUMNS 56-66 SHOULD BE 2.

IF THE LOCAL PLOTTER USES DIMENSIONS OF INCHES IN ORDER TO OBTAIN
10 X 10 INCH FRAMES WITH 3 X 2 PLOTS PER FRAME THE FIRST INPUT
LINE SHOULD BE,

0.0  10.0  0.0  10.0  3  2  0

IF THE LOCAL PLOTTER USES DIMENSIONS OF MILLIMETERS THE SAME
PHYSICAL SIZE PLOT MAY BE OBTAINED IF THE FIRST INPUT LINE IS,

0.0  254.0  0.0  254.0  3  2  0

FOR THE SAME PHYSICAL SIZE AND PLOT LAYOUT AS INDICATED ON THE
ABOVE LINE, IF YOU WOULD LIKE THE CHARACTERS TO BE 1.5 TIMES THEIR
STANDARD SIZE, YOU NEED MERELY DEFINE COLUMNS 67-70 TO BE 1.5,
AS INDICATED BELOW.

0.0  254.0  0.0  254.0  3  2  1.5

FOR SIMPLICITY THE FOLLOWING EXAMPLE INPUTS WILL NOT DISCUSS THE
PHYSICAL DIMENSIONS OF THE PLOTTER AND THE FIRST INPUT LINE WILL
IN ALL CASES INDICATE 10 X 10 INCH PLOTS WITH ONLY 1 PLOT PER
FRAME.

THIS FIRST INPUT CARD IS ALWAYS READ AS THE FIRST LINE OF INPUT
PARAMETERS. IT IS POSSIBLE TO RE-CYCLE BACK TO THIS POINT IN
THE INPUT TO RE-DEFINE THE LAYOUT OF EACH FRAME AND/OR THE
GLOBAL PARAMETERS WHICH FOLLOW (AS DESCRIBED ABOVE).

GLOBAL PARAMETERS

<table>
<thead>
<tr>
<th>LINE</th>
<th>COLUMNS</th>
<th>FORMAT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1-11</td>
<td>I11</td>
<td>NUMBER OF CURVES ON EACH PLOT.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>= 0 - NO CURVES. IGNORE CURVE FILE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>=+1 TO +30 - FOR EACH PLOT READ 1 TO 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CURVES AND PLOT. AFTER PLOT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>READ 1 TO 30 AGAIN AND PLOT.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CONTINUE READING AND PLOTTING</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>UNTIL EITHER ALL CURVE DATA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OR INPUT PARAMETERS HAVE BEEN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>READ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>=-1 TO -30 - READ 1 TO 30 CURVES ONLY ONCE</td>
</tr>
</tbody>
</table>

36 PLOTTAB
AND SAVE IN CORE TO ALLOW ANY
NUMBER OF PLOTS OF THE SAME
DATA (E.G., OVER DIFFERENT X
RANGES). CONTINUE PLOTTING
UNTIL ALL INPUT PARAMETERS
HAVE BEEN READ. AFTER READING
THE INITIAL DATA FOR 1 TO 30
CURVES DO NOT READ ANY MORE
CURVE DATA.

= OTHER - TREAT AS INPUT ERROR AND DO
NOT PLOT ANY CURVE DATA.

12-22 I11 NUMBER OF SETS OF POINTS ON EACH PLOT.
= 0 - NO POINTS. IGNORE POINTS FILE.
=+1 TO +30 - FOR EACH PLOT READ 1 TO 30
SETS AND PLOT. AFTER PLOT
READ 1 TO 30 AGAIN AND PLOT.
CONTINUE READING AND PLOTTING
UNTIL EITHER ALL SETS OF DATA
OR INPUT PARAMETERS HAVE BEEN
READ.

=-1 TO -30 - READ 1 TO 30 SETS ONLY ONCE
AND SAVE IN CORE TO ALLOW ANY
NUMBER OF PLOTS OF THE SAME
DATA (E.G., OVER DIFFERENT X
RANGES). CONTINUE PLOTTING
UNTIL ALL INPUT PARAMETERS
HAVE BEEN READ. AFTER READING
THE INITIAL DATA FOR 1 TO 30
SETS DO NOT READ ANY MORE
SETS OF DATA.

= OTHER - TREAT AS INPUT ERROR AND DO
NOT PLOT ANY POINT DATA.

23-33 I11 SHOULD BORDER BE DRAWN AROUND PLOTS.
= 0 - NO
= 1 - YES

34-44 I11 TYPE OF GRID ON PLOTS
(NOTE, DEFINITION CHANGED IN VERSION 90-1)
= 0 - TICK MARKS ON BORDER OF PLOT.
= 1 - DASHED COARSE INTERVALS.
= 2 - SOLID COARSE INTERVALS.
= 3 - DASHED COARSE AND FINE INTERVALS.
= 4 - SOLID COARSE/DASHED FINE INTERVALS.
= 5 - SOLID COARSE AND FINE INTERVALS.

45-55 I11 SHOULD RATIO OF ALL DATA TO FIRST CURVE BE
PLOTTED.
= 0 - NO
= 1 - YES (GENERAL RATIO RANGE)
= 2 - YES (10000 % MAXIMUM DIFFERENCES)
= 3 - YES (1000 % MAXIMUM DIFFERENCES)
= 4 - YES (100 % MAXIMUM DIFFERENCES)
= 5 - YES (10 % MAXIMUM DIFFERENCES)
= 6 - YES (1 % MAXIMUM DIFFERENCES)
= 7 - YES (0.1 % MAXIMUM DIFFERENCES)

56-66 I11 LINE THICKNESS
= 0 - NORMAL
= 1 TO 5 - ALL LINES EXCEPT GRID
= -1 TO -5 - ONLY CURVES AND POINTS
(NO THICK CHARACTERS)
**PLOTTAB**

<table>
<thead>
<tr>
<th>COLUMNS</th>
<th>FORMATS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-72</td>
<td>72A1</td>
<td>FIRST LINE OF TITLE (FOR TOP OF PLOT)</td>
</tr>
<tr>
<td>6-72</td>
<td>72A1</td>
<td>SECOND LINE OF TITLE (FOR TOP OF PLOT)</td>
</tr>
<tr>
<td>1-11</td>
<td>E11.4</td>
<td>MINIMUM X LIMIT OF PLOT (BLANK INDICATES NO LIMIT = USE MINIMUM X VALUE OF DATA)</td>
</tr>
<tr>
<td>12-22</td>
<td>E11.4</td>
<td>MAXIMUM X LIMIT OF PLOT (BLANK INDICATES NO LIMIT = USE MAXIMUM X VALUE OF DATA)</td>
</tr>
<tr>
<td>23-33</td>
<td>I11</td>
<td>SHOULD X ERROR BARS BE PLOTTED.</td>
</tr>
<tr>
<td>34-44</td>
<td>I11</td>
<td>X AXIS SCALING</td>
</tr>
<tr>
<td>45-55</td>
<td>I11</td>
<td>SHOULD X LIMITS BE ROUNDED OUTWARD TO AVOID TOUCHING EDGE OF PLOT</td>
</tr>
</tbody>
</table>

The above 3 lines are lines 2 - 4 of input and if the user wishes to use the same global parameters for all plots these 3 lines will only be read once (not for each plot).

If the user wishes to change the global parameters in the middle of a run the first line of the plot parameters, described below, should be blank (as described above).

Note, only a combination of up to 30 curves and sets of points may be read and plotted on the same plot. The user may request more than this number but the program will only read and plot up to 30 (e.g., if it first reads 17 curves it will only read up to 13 sets of points).
PLOTTAB

= 2 - ONLY ROUND BOTTOM
= 3 - ONLY ROUND TOP

56-66 I11 OMIT LEGEND BOX FROM PLOT
      = 0 - NO - LEGEND BOX WILL APPEAR ON PLOT
      = 1 - YES - NO LEGEND BOX ON PLOT

8 1-11 E11.4 MINIMUM Y LIMIT OF PLOT (BLANK INDICATES NO
      LIMIT = USE MINIMUM Y VALUE OF DATA).
12-22 E11.4 MAXIMUM Y LIMIT OF PLOT (BLANK INDICATES NO
      LIMIT = USE MAXIMUM Y VALUE OF DATA).
23-33 I11 SHOULD Y ERROR BARS BE PLOTTED.
      = 0 - NO
      = 1 - YES

34-44 I11 Y AXIS SCALING
      = 0 - AUTOMATIC
      = 1 - LINEAR SCALING AND INTERPOLATION
      = 2 - LOG SCALING AND LINEAR INTERPOLATION
      =-1 - LINEAR SCALING AND INTERPOLATION
      (IDENTICAL TO +1)
      =-2 - LOG SCALING AND INTERPOLATION

45-55 I11 SHOULD Y LIMITS BE ROUNDED OUTWARD TO AVOID
      TOUCHING EDGE OF PLOT
      = 0 - YES
      = 1 - NO
      = 2 - ONLY ROUND BOTTOM
      = 3 - ONLY ROUND TOP

56-66 I11 SHOW DATA POINTS
      = 0 - NO
      = 1 - YES

WARNING - DO NOT USE THE SHOW DATA POINTS OPTIONS IF YOU HAVE MANY
POINTS ON A PLOT, E.G., MORE THAN A FEW HUNDRED. THIS OPTION WILL
WORK WITH ANY NUMBER OF POINTS, BUT IF THERE ARE TOO MANY POINTS
YOU MAY NOT BE ABLE TO SEE CURVES BETWEEN POINTS. THE PROPER WAY
TO USE THIS OPTION IS TO RESTRICT THE X, Y RANGE OF THE PLOT TO
INSURE THAT NOT TOO MANY POINTS WILL APPEAR ON THE PLOT.

NOTE, INPUT LINES 7 AND 8 ARE ALMOST IDENTICAL EXCEPT THAT LINE 7
APPLIES TO THE X AXIS AND LINE 8 TO THE Y AXIS.

NOTE, ONE SIDED LIMITS MAY BE SPECIFIED FOR X AND/OR Y, E.G.,
FOR X LIMITS BETWEEN 5.0 AND THE UPPER X LIMIT OF THE DATA
MERELY SPECIFY THE MINIMUM X LIMIT TO BE 5.0 AND LEAVE THE
MAXIMUM LIMIT BLANK (NOT 0.0). SIMILARLY FOR X BETWEEN THE
LOWER X LIMIT OF THE DATA AND 12.0 MERELY LEAVE THE MINIMUM
LIMIT BLANK (NOT 0.0) AND SPECIFY THE MAXIMUM X LIMIT TO BE
12.0. THE Y LIMITS CAN BE TREATED IN A SIMILAR MANNER.

NOTE, THE X AND Y SCALING CONTROL BOTH THE PLANE IN WHICH THE
PLOT IS PRESENTED (LINEAR OR LOG X AND Y SCALING) AND HOW THE
DATA IS INTERPOLATED INTO THIS PLANE.

THE ABOVE 4 LINES ARE READ FOR EACH PLOT. PROGRAM EXECUTION
TERMINATES AT THE END OF INPUT.

NOTE, REGARDLESS OF WHETHER OR NOT THE POINTS INCLUDE UNCERTAINTY
(+DX,-DX,+DY,-DY) COLUMNS 23-33 OF LINES 7 AND 8 CONTROL WHETHER
OR NOT THE X AND Y UNCERTAINTY IS CONSIDERED IN SCALING THE PLOT
AND WHETHER OR NOT ERROR BARS WILL APPEAR ON THE PLOT.
GROUPING DATA ON PLOTS

BY USING INPUT OPTIONS THE USER HAS CONTROL OVER HOW MANY SETS OF CURVES AND/OR POINTS WILL APPEAR ON EACH PLOT. ON THE GLOBAL INPUT LINE COLUMNS 1-11 CONTROL HOW CURVES SHOULD APPEAR ON EACH PLOT AND COLUMNS 12-22 CONTROL HOW POINTS SHOULD APPEAR ON EACH PLOT. THESE OPTIONS CONTROL HOW MANY SETS (IF ANY) OF A GIVEN TYPE OF DATA (CURVES OR POINTS) WILL BE READ OR KEPT IN CORE FOR THE NEXT PLOT. THE AVAILABLE OPTIONS ARE,

(LESS THAN -30 OR MORE THAN +30) IS TREATED AS AS AN ERROR, NO DATA IS READ (I.E., IT IS TREATED AS 0, AS DESCRIBED BELOW).

(0) DATA IS NOT TO BE READ OR APPEAR ON PLOT. WHEN YOU WISH TO PLOT ONE TYPE OF DATA (CURVES OR POINTS) THIS OPTION SHOULD BE SPECIFIED FOR THE OTHER TYPE OF DATA. YOU CANNOT SPECIFY THIS OPTION FOR BOTH TYPES OF DATA. IF YOU DO THE PROGRAM WILL SIMPLY TELL YOU THAT YOU ARE NOT REQUESTING ANY PLOTS AND TERMINATE. E.G., IF YOU WISH TO ONLY PLOT CURVES SPECIFY THIS OPTION FOR POINTS (COLUMNS 12-22 = 0).

(+1 TO +30) FOR THE NEXT PLOT READ 1 TO 30 SETS OF DATA (POINTS OR CURVES) AND USE THEM ONLY FOR THE NEXT PLOT. THIS OPTION MAY BE USED WHEN YOU WISH TO CREATE A SERIES OF PLOTS EACH CONTAINING 1 TO 30 SETS OF A TYPE OF DATA (POINTS OR CURVES) PLUS ANY NUMBER (0 TO 30) OF SETS OF THE OTHER TYPE OF DATA. NOTE, THE SETS OF DATA WILL ONLY APPEAR ON ONE PLOT, SO THAT YOU CANNOT FIRST SPECIFY THE ENTIRE X RANGE FOR ONE PLOT AND THEN SPECIFY A MINIMUM AND MAXIMUM RANGE FOR A SECOND PLOT. E.G., IF YOU WISH TO CREATE A SERIES OF PLOTS EACH CONTAINING 5 CURVES SPECIFY THIS OPTION FOR POINTS (COLUMNS 12-22 = 0).

(-1 TO -30) READ 1 TO 30 SETS OF DATA (POINTS OR CURVES) AND USE THEM ON ALL PLOTS. AFTER THE INITIAL READ NO MORE DATA (POINTS OR CURVES) WILL BE READ. THIS OPTION MAY BE USED IF YOU WISH TO CREATE A SERIES OF PLOTS EACH CONTAINING ALL OR THE FIRST 1 TO 30 SETS OF DATA OF A GIVEN TYPE (POINTS OR CURVES). NOTE, IN THIS CASE YOU MAY FIRST PLOT THE ENTIRE X RANGE AND THEN SPECIFY MINIMUM AND MAXIMUM RANGES FOR ANY NUMBER OF FOLLOWING PLOTS. E.G., IF YOU WISH TO A CREATE A SERIES OF PLOTS EACH CONTAINING 15 CURVES AND EACH INVOLVING A DIFFERENT X RANGES SPECIFY THIS OPTION FOR CURVES (COLUMNS 1-11 = -15).

IF YOU WISH TO CREATE A SERIES OF PLOTS CONTAINING A DIFFERENT NUMBER OF CURVES AND OR POINTS YOU MAY RE-DEFINE THE GLOBAL PARAMETERS, AS DESCRIBED ABOVE, IN THE MIDDLE OF A RUN TO PLOT ALMOST ANY COMBINATION OF CURVES AND/OR POINTS ON A SERIES OF PLOTS.
IN ORDER TO CREATE OTHER COMBINATIONS OF CURVES AND PLOTS IT IS
USUALLY EASIER TO EDIT YOUR CURVE AND POINT FILES TO CONTAIN THE
DATA TO APPEAR ON THE PLOTS THAN TO INCLUDE MORE INPUT OPTIONS
IN THIS PROGRAM. E.G., IF YOU HAVE A SERIES OF CURVES AND YOU WISH
TO PLOT EACH SEPARATELY, BUT YOU WOULD LIKE A SERIES OF PLOTS OF
DIFFERENT X RANGES FOR EACH CURVE, CREATE A NUMBER OF CURVE FILES
EACH CONTAINING ONLY ONE CURVE AND RUN EACH FILE SEPARATELY WITH
COLUMNS 1-11 = -1.

FOR VERSION 88-1 AND LATER VERSIONS THE ABOVE SERIES OF PLOTS MAY
BE CREATED BY RE-DEFINING THE GLOBAL PARAMETERS IN THE MIDDLE OF
A RUN. FOR EACH OF THE SERIES OF CURVES USE GLOBAL PARAMETERS
WITH COLUMNS 1-11 = -1, TO FORCE THE NEXT CURVE TO BE READ AND
KEPT IN CORE TO ALLOW A NUMBER OF DIFFERENT X RANGES TO BE PLOTTED
SEPARATELY. WHEN ALL RANGES HAVE BEEN PLOTTED INSERT A BLANK LINE
IN THE INPUT, FOLLOWED BY 3 LINES RE-DEFINING GLOBAL PARAMETERS
WITH COLUMNS 1-11 = -1 TO FORCE THE NEXT CURVE TO BE READ AND
KEPT IN CORE WHILE DIFFERENT X RANGES ARE PLOTTED. THIS CYCLE OF
RE-DEFINING GLOBAL PARAMETERS FOLLOWED BY A SERIES OF PLOTS MAY
BE REPEATED ANY NUMBER OF TIMES DURING A RUN.

COMPOSITION MODE
=================================================================
IT IS POSSIBLE TO USE THIS CODE TO COMPOSE FRAMES WITH ANY NUMBER
OF PLOTS APPEARING ANYWHERE ON EACH FRAME. THIS COMPOSITION MODE
SHOULD ONLY BE USED TO POSITION ONE PLOT AT A TIME ON THE FRAME
AND THEN RE-CYCLE BACK TO THE PLOTTER PARAMETERS (AS DESCRIBED
ABOVE) TO POSITION THE NEXT PLOT ON THE SAME FRAME. THIS MODE IS
TURNED ON BY SPECIFYING A -1 FOR THE NUMBER OF PLOTS IN THE X
DIRECTION ON THE PLOTTER PARAMETER LINE. THIS -1 MERELY INDICATES
TO THE PROGRAM NOT TO ADVANCE TO THE NEXT PLOTTING AREA OR FRAME
AT THE END OF THE CURRENT PLOT. THE USER CAN THEN USE THE X AND
Y DIMENSIONS OF THE PLOTTER TO SPECIFY WHERE THIS PLOT SHOULD
APPEAR ON THE FRAME, E.G., FOR A PLOT LOCATED BETWEEN X = 3.0
AND Y = 2.0 AND 8.0, MERELY SPECIFY THESE X AND Y LIMITS
AS THE LIMIT OF THE PLOTTER ON THE PLOTTER PARAMETER LINE.

IN THIS MODE YOU HAVE COMPLETE FREEDOM TO COMPOSE FRAMES, BUT
YOU HAVE THE RESPONSIBILITY TO EXACTLY DEFINE WHERE YOU WANT
EACH PLOT POSITIONED. COMPOSITION CAN USUALLY BE DONE QUITE
QUICKLY USING A COMPUTER TERMINAL SCREEN. ONCE THE INPUT
CORRECTLY DEFINES THE COMPOSED FRAME YOU CAN THEN USE THIS
INPUT TO PRODUCE A HARD COPY PLOT.

AGAIN, WARNING...THIS MODE SHOULD ONLY BE USED TO POSITION ONE
PLOT AT A TIME ONTO A FRAME AND YOU SHOULD THEN USE THE PROPER
SEQUENCE OF INPUT TO RE-CYCLE BACK TO RE-DEFINE THE PLOTTER
AND GLOBAL PARAMETERS...FAILURE TO HEED THIS WARNING MAY PRODUCE
UNPREDICTABLE RESULTS.

IN ORDER TO STAY IN THE COMPOSITION MODE FOR A SERIES OF PLOTS
THE USER SHOULD CONTINUE TO SPECIFY -1 FOR THE NUMBER OF PLOTS
IN THE X DIRECTION (DO NOT ADVANCE AFTER PLOT). FOR THE LAST PLOT
OF A COMPOSED FRAME SPECIFY 1 FOR THE NUMBER OF PLOTS IN THE X
DIRECTION (LEAVE COMPOSITION MODE AND ADVANCE AFTER PLOT).
REMEMBER, TO LEAVE THE COMPOSITION MODE AND ADVANCE TO THE NEXT
FRAME THE LAST PLOT ON A FRAME MUST SPECIFY +1 FOR THE NUMBER OF
PLOTS IN THE X DIRECTION – IF YOU CREATE A NUMBER OF PLOTS ON A
FRAME AND THEN FINISH EXECUTING WITHOUT ADVANCING TO THE NEXT
FRAME, DEPENDING ON THE PLOTTING SYSTEM THAT YOU USE, YOU MAY
NOT GET ANY OUTPUT PLOTTING, I.E., YOU DIDN'T FINISH THE PLOT.

ONE SPECIAL CONVENTION HAS BEEN INTRODUCED FOR USE WITH THE
COMPOSITION MODE - THE MOST USEFUL PURPOSE OF THIS MODE IS TO
ALLOW A FULL SIZED PLOT OF THE FULL X AND Y RANGE AND THEN TO
INSERT INTO THIS FRAME ONE OR MORE EXPANDED VIEWS OF SPECIFIC
X AND Y RANGES - IN ORDER TO ALLOW THIS TO BE DONE THE PROGRAM
MUST KEEP THE SAME CURVES AND/OR POINTS IN CORE AS YOU MOVE
FROM ONE PLOT OF THE COMPOSITION TO THE NEXT - NORMALLY WHEN
THE PROGRAM READS THE GLOBAL PARAMETERS IT IS TOLD HOW MANY
CURVES AND/OR POINTS TO READ FOR THE NEXT PLOT - WHEN IN
COMPOSITION MODE FOR THE FIRST PLOT OF A FRAME THIS IS WHAT
THE CODE WILL DO - BUT IF YOU USE A MINUS COUNT FOR THE
NUMBER OF CURVES AND/OR SETS OF POINTS (SEE, DESCRIPTION OF
INPUT PARAMETERS ABOVE) YOU ARE TELLING THE CODE TO READ
AND KEEP THIS DATA IN CORE - IF SUCCESSIVE PLOTS FOR THE
SAME COMPOSITION FRAME ALSO SPECIFY A MINUS COUNT THE CODE
WILL NOT READ AND SAVE MORE DATA - IT WILL ASSUME THAT
WHAT YOU MEAN IS USE THE DATA ALREADY IN CORE, I.E., THE
DATA WHICH APPEARED ON THE LAST PLOT.

PLOTTING RATIOS

WHICHEVER DATA IS REQUESTED (CURVES AND/OR POINTS) WILL ALWAYS BE
PLOTTED. WHEN PLOTTING CURVES THE USER HAS THE OPTION TO USE THE
FIRST CURVE AS A STANDARD AND TO PLOT NOT ONLY THE DATA (UPPER 2/3
OF PLOT), BUT ALSO THE RATIO OF ALL CURVES AND/OR DATA POINTS TO
THE STANDARD (LOWER 1/3 OF PLOT). THIS OPTION IS EXTREMELY HANDY
WHEN YOU WOULD LIKE TO QUANTITATIVELY DEFINE THE AGREEMENT BETWEEN
CURVES AND/OR POINTS (E.G., IT IS EASY TO SEE FROM THE PLOT THAT
2 CURVES DIFFER BY 15 PER-CENT).

IF YOU WISH TO CHANGE THE STANDARD TO WHICH ALL OTHER DATA IS TO
BE COMPARED SIMPLY MOVE THE DATA THAT YOU WISH TO BE USED AS A
STANDARD TO THE BEGINNING OF THE CURVE FILE TO BE THE FIRST CURVE.

ALL OF THE FOLLOWING EXAMPLE INPUTS ASSUME A STANDARD 13.5 BY 10
SIZE FOR THE PLOTTER AND 1 BY 1 (FULL SIZE) PLOTS PER FRAME, AS
DEFINED BY THE BELOW INPUT, AND WILL NOT BE DISCUSSED FOR EACH
EXAMPLE INPUT.

EXAMPLE NO. 1 UNIT 2 INPUT

IF WE HAVE EVALUATED DATA FOR 27-CO-59 (N,2N) FROM 3 DIFFERENT
EVALUATED DATA LIBRARIES (ASSUME ENDF/B-V, ENDL AND JENDL-2) AND
EXPERIMENTAL DATA FROM A NUMBER OF MEASUREMENTS WE CAN PUT THE
EVALUATED DATA ON THE CURVE FILE AS 3 SEPARATE CURVES IDENTIFYING
EACH BY LIBRARY NAME AND THE EXPERIMENTAL DATA ON THE POINT FILE
IDENTIFYING EACH BY FIRST AUTHOR AND YEAR.

TO CREATE SEPARATE PLOTS OF EACH EVALUATION, EACH PLOT CONTAINING
ONE EVALUATION AND ALL EXPERIMENTAL DATA WE CAN SPECIFY 1 CURVE
(READ AND PLOT 1 CURVE PER PLOT) AND -30 SETS OF POINTS (READ ONCE
AND INCLUDE ON ALL PLOTS). THE FOLLOWING INPUT WILL CREATE 3 FULL
SIZED PLOTS WITH TICKS MARKS ON THE BORDER, NO RATIOS AND LINE
THICKNESS 0. X AND Y ERRORS FOR EXPERIMENTAL DATA (IF ANY) WILL BE
PLOTTAB

PLOTTED ON THE FIRST 2 PLOTS BUT WILL NOT APPEAR ON THE 3- RD PLOT.
NOTE, IN THIS EXAMPLE THE BELOW INPUT IS USED TO IDENTIFY THE
TARGET (27-CO-59) AND REACTION (N,2N) (FOR CONTRAST SEE EXAMPLE
INPUT NO. 3).

0.0 13.5 0.0 10.0 1 1
1 -30 0 0 0 0
INCIDENT ENERGY EV
CROSS SECTION BARNES (N,2N)
27-CO-59 CROSS SECTIONS
1 0 0
1 0 0
27-CO-59 CROSS SECTIONS
1 0 0
1 0 0
27-CO-59 CROSS SECTIONS
0 0 0
0 0 0

NOTE, TO OBTAIN A PLOT OF EACH EVALUATION SEPARATELY WITHOUT
EXPERIMENTAL DATA ONE CAN CHANGE COLUMNS 12-22 OF THE 2- ND INPUT
LINE FROM -30 TO 0 AND USE THE ABOVE INPUT.

EXAMPLE NO. 2 UNIT 2 INPUT
------------------------------------------------------------------
ASSUMING WE HAVE ALL OF THE DATA DESCRIBED IN EXAMPLE NO. 1 AND
WE WOULD LIKE TO CREATE PLOTS CONTAINING ALL EVALUATED AND
EXPERIMENTAL DATA AND THE RATIO OF ALL EVALUATED AND EXPERIMENTAL
DATA TO THE FIRST EVALUATION. TO DO THIS SPECIFY -30 FOR BOTH
CURVES AND POINTS (READ ONCE AND INCLUDE ON ALL PLOTS). IF WE
WILL LIKE TO OBTAIN 2 PLOTS, ONE FOR THE ENTIRE ENERGY RANGE AND
A SECOND FROM 10 TO 20 MEV (ASSUMING DATA IS GIVEN IN EV) THE
FOLLOWING INPUT CARDS WILL CREATE 2 FULL SIZED PLOTS WITH A
DASHED GRID, RATIOS AND LINE THICKNESS 3. X AND Y ERRORS (IF ANY)
WILL BE INCLUDED ON BOTH PLOTS. THE PLANE OF THE PLOT (LINEAR OR
LOG IN X OR Y) WILL BE AUTOMATICALLY SELECTED FOR THE FIRST PLOT.
THE SECOND PLOT WILL BE LOG IN X AND LINEAR Y WITH THE LOWER Y
LIMIT OF ZERO. THE Y LIMITS WILL NOT BE ROUNDED OUTWARD, SO THE
LOWER Y LIMIT OF THE PLOT WILL BE EXACTLY ZERO.

0.0 13.5 0.0 10.0 1 1
-30 -30 0 2 1 3
INCIDENT ENERGY EV
CROSS SECTION BARNES (N,2N)
27-CO-59 CROSS SECTIONS
1 0 0
1 0 0
27-CO-59 CROSS SECTIONS
1.00000+07 2.00000+07 1 2 0
0.0 1 1 1

NOTE, TO OBTAIN PLOTS OF ALL EVALUATIONS TOGETHER WITHOUT
EXPERIMENTAL DATA ONE CAN CHANGE COLUMNS 12-22 OF THE 2- ND INPUT
LINE FROM -30 TO 0 AND USE THE ABOVE INPUT.

NOTE, IF YOU WOULD LIKE THE EXPERIMENTAL DATA TO ONLY APPEAR ON
THE FIRST PLOT CHANGE COLUMNS 12-22 OF THE FIRST INPUT LINE FROM
-30 TO 30 (ASSUMING THERE ARE 30 OR FEWER SETS OF EXPERIMENTAL
DATA). SIMILARLY TO HAVE THE FIRST 6 EXPERIMENTAL REFERENCES
APPEAR ON THE FIRST PLOT AND THE NEXT 6 ON THE SECOND PLOT CHANGE

EXAMPLE NO. 3 UNIT 2 INPUT

IF WE HAVE THE ENDF/B-V 27-CO-59 (N,N'), (N,2N) AND (N,3N) DATA
WE CAN PUT THE DATA ON THE CURVE FILE AND IDENTIFY EACH BY THE
REACTION (AS OPPOSED TO LIBRARY NAME AS IN EXAMPLE NO. 1). TO
PLOT ALL 3 REACTIONS AND THE RATIO OF ALL REACTIONS TO THE (N,N')
OVER THE ENTIRE ENERGY RANGE AND THEN OVER 10 TO 20 MEV THE
FOLLOWING INPUT MAY BE USED. NOTE, IN THIS EXAMPLE THE BELOW
INPUT IS USED TO IDENTIFY THE TARGET AND LIBRARY NAME (AS OPPOSED
TO THE REACTION AS IN EXAMPLE NO. 1).

Example Input:

(0.0 13.5 0.0 10.0 1 1)
(-3 0 0 0 1 3)

INCIDENT ENERGY EV
CROSS SECTION BARNES
27-CO-59 ENDF/B-V CROSS SECTIONS
0 0 0
0 0 0

27-CO-59 ENDF/B-V CROSS SECTIONS
1.00000+ 7 2.00000+ 7 0 0 0
0 0 0

NOTE, TO OBTAIN PLOTS ONLY COMPARING (N,N') AND (N,2N) (I.E.,
IGNORE (N,3N)) ONE CAN CHANGE COLUMNS 1-11 OF THE FIRST INPUT
LINE FROM -3 TO -2 AND USE THE ABOVE INPUT.

EXAMPLE NO. 4 UNIT 2 INPUT

IF WE HAVE PHOTON INTERACTION DATA FOR THE ENTIRE PERIODIC TABLE
WITH 5 CURVES FOR EACH ELEMENT (TOTAL, COHERENT, INCOHERENT,
PHOTOELECTRIC AND PAIR PRODUCTION) WE CAN PUT THE DATA ON THE
CURVE FILE IN ELEMENT ORDER (I.E., HYDROGEN FIRST) AND IDENTIFY
EACH CURVE BY REACTION. TO OBTAIN A SERIES OF PLOTS 1 FOR EACH
ELEMENT THE FOLLOWING INPUT MAY BE USED.

Example Input:

(0.0 13.5 0.0 10.0 1 1)
(5 0 0 0 1 0)

INCIDENT ENERGY MEV
CROSS SECTION BARNES
HYDROGEN ENDL
PHOTON INTERACTION CROSS SECTIONS
0 0 0
0 0 0

HELUM ENDL
PHOTON INTERACTION CROSS SECTIONS
0 0 0
0 0 0
LITHIUM ENDL
PHOTON INTERACTION CROSS SECTIONS

0 0 0
0 0 0

(3 LINES FOR EACH ELEMENT TO THE END OF THE PERIODIC TABLE)

EXAMPLE NO. 5 UNIT 2 INPUT

ASSUMING WE HAVE ALL OF THE DATA DESCRIBED IN EXAMPLE NO. 3, BUT WE ONLY HAVE EXPERIMENTAL DATA FOR (N,3N) AND WE WOULD LIKE TO PLOT (N,N') AND (N,2N) SEPARATELY WITHOUT EXPERIMENTAL DATA AND THEN WE WOULD LIKE TO PLOT (N,3N) COMPARED TO EXPERIMENTAL DATA OVER THE ENTIRE ENERGY RANGE FOLLOWED BY A PLOT OF 10 TO 20 MEV WE MAY USE THE FOLLOWING INPUT TO RE-DEFINE THE GLOBAL PARAMETERS AFTER THE FIRST TWO PLOTS TO OBTAIN THE DESIRED PLOTS.

0.0 13.5 0.0 10.0 1 1
1 0 0 0 1 0

INCIDENT ENERGY EV
CROSS SECTION BARNS ENDF/B-V
27-CO-59 CROSS SECTIONS

1 0 0
1 0 0

(IF THIS LINE IS BLANK NEXT 4 LINES = PLOTTER/GLOBAL PARAMETERS)

0.0 13.5 0.0 10.0 1 1
-1 -30 0 0 1 0

INCIDENT ENERGY EV
CROSS SECTION BARNS ENDF/B-V
27-CO-59 CROSS SECTIONS

1 0 0
1 0 0

27-CO-59 CROSS SECTIONS

1.00000+7 2.00000+7 1 0 0
1 0 0

CURVE DATA (ON I/O UNIT 10)

LINE COLUMNS FORMAT DESCRIPTION
---------------------------------------------
1 1-26 26A1 TITLE FOR CURVE
2-N 1-11 E11.4 X VALUE
12-22 E11.4 Y VALUE

EACH CURVE IS TERMINATED BY BLANK (NOT 0.0). THE SEQUENCE OF TITLE FOLLOWED BY TABULATED POINTS MAY BE REPEATED ANY NUMBER OF TIMES. THE CURVE FILE MAY CONTAIN DATA FOR ANY NUMBER OF CURVES AND ANY NUMBER OF DATA POINTS. EACH PLOT MAY CONTAIN UP TO 200000 POINTS (IF MORE ARE PRESENT ONLY THE FIRST 200000 WILL BE USED).
EXAMPLE UNIT 10 INPUT

------------------------------------------------------------------

IF UNIT 10 CONTAINS THE 27-CO-59 (N,2N) EVALUATIONS FROM ENDF/B-IV
JENDL-II AND ENDL84 THE DATA COULD LOOK LIKE,

**ENDF/B-IV**

<table>
<thead>
<tr>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.10000+ 7 0.00000+ 0</td>
<td>1.20000+ 7 1.20000- 3</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>2.00000+ 7 3.00000- 2</td>
</tr>
</tbody>
</table>

(NOTE, BLANK CARD TERMINATES CURVE).

**JENDL-II**

<table>
<thead>
<tr>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.07000+ 7 0.00000+ 0</td>
<td>1.16000+ 7 1.13000- 3</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>2.00000+ 7 2.80000- 2</td>
</tr>
</tbody>
</table>

(NOTE, BLANK CARD TERMINATES CURVE).

**ENDL84**

<table>
<thead>
<tr>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
<th>E11.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.12000+ 7 0.00000+ 0</td>
<td>1.22000+ 7 1.27000- 3</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>2.00000+ 7 2.90000- 2</td>
</tr>
</tbody>
</table>

(NOTE, BLANK CARD TERMINATES CURVE).

NOTE, FOR IDENTIFICATION ON EACH PLOT THE PROGRAM WILL ONLY READ
AND USE THE FIRST 40 CHARACTERS OF THE TITLE. THE USER MAY USE
THE REMAINDER OF THE TITLE LINE TO FURTHER PHYSICALLY IDENTIFY
THE DATA (AS IN THE ABOVE EXAMPLE WHERE THE DATA IS FURTHER
IDENTIFIED AS 27-CO-59 (N,2N)).

NOTE, THE ABOVE DATA IS FOR ILLUSTRATION PURPOSES ONLY AND DOES
NOT CORRESPOND TO THE ACTUAL DATA FROM THESE EVALUATED LIBRARIES.

POINT DATA (ON I/O UNIT 11)

=================================================================

<table>
<thead>
<tr>
<th>LINE</th>
<th>COLUMNS</th>
<th>FORMAT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-26</td>
<td>26A1</td>
<td>TITLE FOR CURVE</td>
</tr>
<tr>
<td>2-N</td>
<td>1-11</td>
<td>E11.4</td>
<td>X VALUE</td>
</tr>
<tr>
<td>12-22</td>
<td>E11.4</td>
<td>POSITIVE X UNCERTAINTY</td>
<td></td>
</tr>
<tr>
<td>23-33</td>
<td>E11.4</td>
<td>NEGATIVE X UNCERTAINTY</td>
<td></td>
</tr>
<tr>
<td>34-44</td>
<td>E11.4</td>
<td>Y VALUE</td>
<td></td>
</tr>
<tr>
<td>45-55</td>
<td>E11.4</td>
<td>POSITIVE Y UNCERTAINTY</td>
<td></td>
</tr>
<tr>
<td>55-66</td>
<td>E11.4</td>
<td>NEGATIVE Y UNCERTAINTY</td>
<td></td>
</tr>
</tbody>
</table>

EACH SET OF POINTS IS TERMINATED BY BLANK (NOT 0.0). THE SEQUENCE
TITLE FOLLOWED BY TABULATED POINTS MAY BE REPEATED ANY NUMBER OF TIMES.
THE POINT FILE MAY CONTAIN DATA FOR ANY NUMBER OF SETS
AND ANY NUMBER OF DATA POINTS. EACH PLOT MAY CONTAIN UP TO 100000 POINTS
(IF MORE ARE PRESENT ONLY THE FIRST 100000 WILL BE USED).

UNCERTAINTIES

UNCERTAINTIES MUST BE IN THE SAME UNITS AS THE DATA (E.G., EV OR
BARNS). THE UNCERTAINTIES WILL BE INTERPRETED TO DEFINE THE ERROR
BARS RELATIVE TO THE DATA POINT. THE ERROR BARS FOR A POINT WILL
EXTEND FROM THE POINT MINUS THE NEGATIVE ERROR TO THE POINT PLUS
THE POSITIVE ERROR (E.G., 10 BARNS +/- 2 BARNS DEFINES AN ERROR
BAR FROM 8 TO 12 BARNS). NEVER TRY TO USE THE UNCERTAINTIES TO
DIRECTLY DEFINE THE ERROR BARS (E.G., IN THE ABOVE EXAMPLE YOU
CANNOT DEFINE THE UNCERTAINTIES AS 8 AND 12 BARNS). NEVER SPECIFY
ERRORS IN PER-CENT (E.G., 10 BARNS +/- 5 PER-CENT WILL BE TREATED
AS 10 BARNS +/- 5 BARNS, SINCE THE PROGRAM KNOWS NOTHING ABOUT THE
REAL UNITS OF THE DATA).

THE UNCERTAINTIES CAN BE SYMMETRIC OR NON-SYMMETRIC AND CAN BE
GIVEN OR SIMPLY LEFT BLANK (NO UNCERTAINTY GIVEN). NOTE, FOR A
SYMMETRIC UNCERTAINTY YOU MUST ENTER BOTH A POSITIVE AND NEGATIVE
UNCERTAINTIES.

IT DOES NOT MATTER WHETHER YOU DEFINE THE UNCERTAINTIES TO BE
POSITIVE OR NEGATIVE ON UNIT 11 (YOU CAN USE ANY CONVENTION THAT
YOU LIKE). INTERNALLY THE PROGRAM WILL DEFINE ALL UNCERTAINTIES TO
BE POSITIVE NUMBERS AND USE THE UNCERTAINTIES TO DEFINE A POSITIVE
ERROR BAR (EXTENDING FROM THE POINT TO THE POINT PLUS THE POSITIVE
ERROR) AND A NEGATIVE ERROR BAR (EXTENDING FROM THE POINT TO THE
POINT MINUS THE NEGATIVE ERROR).

EXAMPLE UNIT 11 INPUT
====================================================================
IF UNIT 11 CONTAINS THE EXPERIMENTAL MEASURED DATA 27-CO-59 (N,2N)
The data could look like,

L.R.VEESER, ET AL. (77) 27-CO-59 (N,2N)
1.10000+ 7 1.10000+ 6 1.10000+ 6 1.10000- 4 2.30000- 4 1.10000- 4
1.20000+ 7 1.20000- 3
...
2.00000+ 7 2.20000+ 6 2.20000+ 6 3.00000- 2
(NO, BLANK CARD TERMINATES DATA SET).
S.OKAMURA (67) 27-CO-59 (N,2N)
1.07000+ 7 1.07000+ 6 1.07000+ 6 1.30000- 4 3.40000- 4 1.10000- 4
1.16000+ 7 1.40000- 3
...
2.00000+ 7 2.20000+ 6 2.20000+ 6 3.10000- 2
(NO, BLANK CARD TERMINATES DATA SET).
A.PAULSEN, ET AL (65) 27-CO-59 (N,2N)
1.13000+ 7 1.13000+ 6 1.13000+ 6 1.80000- 4 3.40000- 4 1.10000- 4
1.37000+ 7 2.80000- 3
...
2.00000+ 7 2.20000+ 6 2.20000+ 6 3.30000- 2
(NO, BLANK CARD TERMINATES DATA SET).

(NOTE, ANY NUMBER OF REFERENCES MAY FOLLOW)

NOTE, FOR IDENTIFICATION ON EACH PLOT THE PROGRAM WILL ONLY READ
AND USE THE FIRST 40 CHARACTERS OF THE TITLE. THE USER MAY USE
THE REMAINDER OF THE TITLE LINE TO FURTHER PHYSICALLY IDENTIFY
THE DATA (AS IN THE ABOVE EXAMPLE WHERE THE DATA IS FURTHER
IDENTIFIED AS 27-CO-59 (N,2N)).

NOTE, THE ABOVE DATA IS FOR ILLUSTRATION PURPOSES ONLY AND DOES
NOT CORRESPOND TO THE ACTUAL DATA FROM THESE REFERENCES.

REPORTING ERRORS
=================================================================
IN ORDER TO IMPROVE THIS CODE AND MAKE FUTURE VERSIONS MORE
COMPATIBLE FOR USE ON AS MANY DIFFERENT TYPES OF COMPUTERS AS
POSSIBLE PLEASE REPORT ALL COMPILER DIAGNOSTICS AND/OR OPERATING
PROBLEMS TO THE AUTHOR AT THE ABOVE ADDRESS.

PLEASE REMEMBER IF YOU SIMPLY REPORT 'I'VE GOT A PROBLEM' AND DO
NOT ADEQUATELY DESCRIBE EXACTLY HOW YOU WERE USING THE PROGRAM
IT WILL BE IMPOSSIBLE FOR THE AUTHOR TO HELP YOU. WHEN A PROBLEM
ARISES PLEASE WRITE TO THE AUTHOR, DESCRIBE THE PROBLEM IN AS MUCH
DETAIl AS POSSIBLE, IDENTIFY THE VERSION OF THE PROGRAM THAT YOU
ARE USING (E.G. VERSION 90-1) AND SEND THE FOLLOWING INFORMATION
ON MAGNETIC TAPE TO THE AUTHOR,

(1) A COPY OF THE FORTRAN PROGRAM YOU ARE USING
(2) A COPY OF COMPILER DIAGNOSTICS (IF ANY)
(3) A COPY OF YOUR JCL AND INPUT OPTIONS (UNIT 2)
(4) A COPY OF YOUR CURVE DATA (UNIT 10)
(5) A COPY OF YOUR POINT DATA (UNIT 11)
(6) A COPY OF SOFTWARE CHARACTER TABLE (UNIT 12)
(7) A COPY OF SOFTWARE SYMBOL AND LINE TYPE TABLE (UNIT 14)
(8) A COPY OF THE OUTPUT REPORT FROM THE PROGRAM (UNIT 6)
(9) A COPY OF THE PLOTS FROM THE PROGRAM

WITHOUT ALL OF THIS INFORMATION IT IS IMPOSSIBLE TO EXACTLY
SIMULATE THE PROBLEM THAT YOU RAN AND TO DETERMINE THE SOURCE
OF YOUR PROBLEM.

C***** PLOTTER/GRAPHICS TERMINAL INTERFACE ****************************

PLOTTING
---------
THIS PROGRAM USES A SIMPLE CALCOMP LIKE INTERFACE INVOLVING
ONLY 7 SUBROUTINES,

STARPLOT - INITIALIZE PLOTTER
NEXTPLOT - END OF A PLOT - CLEAR SCREEN FOR NEXT
ENDPLOTS - END OF PLOTTING

PLOT(X,Y,IPEN) - DRAW OR MOVE FROM LAST LOCATION TO (X,Y),
                 END OF CURRENT PLOT OR END OF PLOTTING.
IPEN = 2 - DRAW
      = 3 - MOVE

PEN(IPEN) - SELECT COLOR.
IPEN = COLOR = 1 TO N (N = ANY POSITIVE INTEGER)

BOXCOLOR(X,Y,IFILL,IBORDER) - FILL A RECTANGLE WITH COLOR
X,Y = DEFINES THE CORNERS OF THE BOX
IFILL = COLOR TO FILL BOX WITH
IBORDER = COLOR OF THE BORDER OF THE BOX
IN ORDER TO INTERFACE THIS PROGRAM FOR USE ON ANY PLOTTER WHICH
DOES NOT USE THE ABOVE CONVENTIONS IT IS MERELY NECESSARY FOR THE
USER TO WRITE 7 SUBROUTINES WITH THE NAMES AND ARGUMENTS
DESCRIBED ABOVE AND TO THEN CALL THE LOCAL EQUIVALENT ROUTINES.

INTERACTION
----------
THIS PROGRAM USES 2 SUBROUTINES TO CONTROL INTERACTION,

INTERACT(MYACTION) - INDICATE WHETHER OR NOT PROGRAM
            IS IN ITS INTERACTIVE MODE
            MYACTION = 0 - NO INTERACTION
            = 1 - INTERACTION
            (MYACTION IS RETURNED BY INTERACT)
MOUSEY(IWAY,X,Y,IWAY1,IWAY2) - READ MOUSE AND/OR KEYBOARD
            IWAY = 0 - NO INPUT
            = 1 TO 3 - MOUSE INPUT
            = 4 - KEYBOARD INPUT
            X,Y = COORDINATES FOR MOUSE INPUT
            IWAY1 = LOWEST VALUE OF IWAY ALLOWED
            IWAY2 = HIGHEST VALUE OF IWAY ALLOWED

FOR NON-INTERACTIVE INPUT YOUR GRAPHIC INTERFACE SHOULD CONTAIN
ROUTINES INTERACT AND MOUSEY. WHEN CALLED INTERACT SHOULD RETURN
MYACTION = 0. MOUSEY CAN THEN BE A DUMMY THAT SIMPLY RETURNS.

AVAILABLE PLOTTER INTERFACES
---------------------------------
THIS PROGRAM HAS AVAILABLE PLOTTER INTERFACES TO OPERATE AS
FOLLOWS,
(1) MAINFRAME - HARDCOPY PLOTS IN BLACK AND WHITE.
(2) MAINFRAME - SCREEN PLOTS IN 7 COLORS ON IBM GRAPHICS TERMINAL.
(3) IBM-PC - HARDCOPY PLOTS IN 6 COLORS ON A HEWLETT-PACKARD
            7475A PLOTTER.
(4) IBM-PC - SCREEN PLOTS IN 16 COLORS - REQUIRES LAHEY
            FORTRAN COMPILER.
(5) SUN - HARDCOPY PLOTS IN BLACK AND WHITE.
(6) SUN - SCREEN PLOTS IN BLACK AND WHITE.
(7) SUN - X-WINDOWS SCREEN PLOTS IN 256 COLORS.

CONTACT THE AUTHOR TO OBTAIN COPIES OF ANY OF THE ABOVE PLOTTER
INTERFACES.

COLOR PLOTS
------------
TO SELECT PLOTTING COLORS SUBROUTINE PEN (DESCRIBED ABOVE) IS USED
TO SELECT ONE OF THE AVAILABLE COLORS. WHEN RUNNING ON A MAINFRAME
USING AN IBM GRAPHICS TERMINAL OR ON AN IBM-PC USING A HEWLETT-
PACKARD PLOTTER THE GRAPHICS INTERFACE (DESCRIBED ABOVE) WILL
PRODUCE COLOR PLOTS.

BLACK AND WHITE PLOTS
----------------------
WHEN PRODUCING BLACK AND WHITE HARDCOPY ON A MAINFRAME THE USER
SHOULD ADD A DUMMY SUBROUTINE PEN TO THE END OF THE PROGRAM TO
IGNORE ATTEMPTS TO CHANGE COLOR. ADD THE FOLLOWING SUBROUTINE,

SUBROUTINE PEN(IPEN)
RETURN
END

SIMILARLY FOR BOXCOLOR,

SUBROUTINE BOXCOLOR(X,Y,IFILL,IBORDER)
RETURN
END

CHARACTER SET

------------------------------------------------------------------

THIS PROGRAM USES COMPUTER AND PLOTTER DEVICE INDEPENDENT SOFTWARE
CHARACTERS. THIS PROGRAM COMES WITH A FILE THAT DEFINES THE PEN
STROKES REQUIRED TO DRAW ALL CHARACTERS ON AN IBM KEYBOARD (UPPER
AND LOWER CASE CHARACTERS, NUMBERS, ETC.) PLUS AN ALTERNATE SET OF
ALL UPPER AND LOWER CASE GREEK CHARACTERS AND ADDITIONAL SPECIAL
SYMBOLS.

THE SOFTWARE CHARACTER TABLE CONTAINS X AND Y AND PEN POSITIONS TO
DRAW EACH CHARACTER. IF YOU WISH TO DRAW ANY ADDITIONAL CHARACTERS
OR TO MODIFY THE FONT OF THE EXISTING CHARACTERS YOU NEED ONLY
MODIFY THIS TABLE.

CONTROL CHARACTERS

------------------------------------------------------------------

IN THE SOFTWARE CHARACTER TABLE ALL CHARACTERS TO BE PLOTTED WILL
HAVE PEN POSITION = 2 (DRAW) OR = 3 (MOVE). IN ADDITION THE TABLE
CURRENTLY CONTAINS 4 CONTROL CHARACTERS,

PEN POSITION = 0

-------------

SHIFT THE NEXT PRINTED CHARACTER BY X AND Y. 3 CONTROL CHARACTERS
ARE PRESENTLY INCLUDED IN THE SOFTWARE CHARACTER TABLE TO ALLOW
SHIFTING.

{ = SHIFT UP (FOR SUPERSCRIPts............X= 0.0, Y= 0.5)
} = SHIFT DOWN (FOR SUBSCRIPTS............X= 0.0, Y=-0.5)
\ = SHIFT LEFT 1 CHARACTER (FOR BACKSPACE...X=-1.0, Y= 0.0)

PEN POSITION =-1

----------

SELECT THE NEXT PRINTED CHARACTER FROM THE ALTERNATE CHARACTER
SET. AT PRESENT THIS CONTROL CHARACTER IS,

] = SWITCH TO ALTERNATE CHARACTER SET

THESE 4 CONTROL CHARACTERS ARE ONLY DEFINED BY THE VALUE OF THE
PEN POSITION IN THE SOFTWARE CHARACTER TABLE (I.E., THEY ARE NOT
HARD WIRED INTO THIS PROGRAM). AS SUCH BY MODIFYING THE SOFTWARE
CHARACTER TABLE THE USER HAS THE OPTION OF DEFINING ANY CONTROL
CHARACTERS TO MEET SPECIFIC NEEDS.

THESE CHARACTERS MAY BE USED IN CHARACTER STRINGS TO PRODUCE
SPECIAL EFFECTS. FOR EXAMPLE, TO PLOT SUBSCRIPT 5, B, SUPERSCRIPT
10 USE THE STRING,

)5B(1{0
TO PLOT B, SUBSCRIPT 5 AND SUPERSCRIPT 10 WITH THE 5 DIRECTLY
BELOW THE 1 OF THE 10 WE CAN USE THE BACKSPACE CHARACTER TO
POSITION THE 1 DIRECTLY ABOVE THE 5 USING THE STRING,

B)5\{1{0

TO PLOT UPPER CASE GREEK GAMMA FOLLOWED BY THE WORD TOTAL (I.E.,
RESONANCE TOTAL WIDTH) USE THE STRING.

]\G TOTAL

NOTE, WHEN THESE CONTROL CHARACTERS ARE USED THEY ONLY EFFECT THE
NEXT 1 PRINTED CHARACTER (SEE, ABOVE EXAMPLE OF PLOTTING SUPER-
SCRIPT 10 WHERE THE SHIFT UP CONTROL CHARACTER WAS USED BEFORE THE
1 AND THEN AGAIN BEFORE THE 0 AND THE BACKSPACE AND SHIFT UP
CONTROL CHARACTERS WERE USED IN COMBINATION).

IF THESE 4 CONTROL CHARACTERS ARE NOT AVAILABLE ON YOUR COMPUTER
YOU CAN MODIFY THE SOFTWARE CHARACTER TABLE TO USE ANY OTHER 4
CHARACTERS THAT YOU DO NOT NORMALLY USE IN CHARACTER STRINGS (FOR
DETAILS SEE THE SOFTWARE CHARACTER TABLE).

STANDARD/ALTERNATE CHARACTER SETS

THE SOFTWARE CHARACTER TABLE CONTAINS 2 SETS OF CHARACTERS WHICH
ARE A STANDARD SET (ALL CHARACTERS ON AN IBM KEYBOARD) AND AN
ALTERNATE SET (UPPER AND LOWER CASE GREEK CHARACTERS AND SPECIAL
CHARACTERS). TO DRAW A CHARACTER FROM THE ALTERNATE CHARACTER SET
PUT A RIGHT BRACKET CHARACTER (]) BEFORE A CHARACTER (SEE THE
ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS
CONTROL CHARACTER WILL ONLY EFFECT THE NEXT 1 PLOTTED CHARACTER.

SUB AND SUPER SCRIPTS

TO DRAW SUBSCRIPT PRECEDE A CHARACTER BY }. TO DRAW SUPERSCRIPT
PRECEDE A CHARACTER BY { (SEE THE ABOVE EXAMPLE AND THE SOFTWARE
CHARACTER TABLE FOR DETAILS). THESE CONTROL CHARACTER WILL ONLY
EFFECT THE NEXT 1 PLOTTED CHARACTER.

BACKSPACING

TO BACKSPACE ONE CHARACTER PRECEDE A CHARACTER BY \ (SEE, THE
ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS
CONTROL CHARACTER WILL PERFORM A TRUE BACKSPACE AND WILL EFFECT
ALL FOLLOWING CHARACTERS IN THE SAME CHARACTER STRING.

PLOT DIMENSIONS

ARE DEFINED BY USER INPUT. INTERNALLY THE PROGRAM WILL CREATE A
PLOT IN APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. DURING
OUTPUT THE PLOT IS TRANSFORMED TO THE UNITS (INCHES, CENTIMETERS,
MILLIMETERS, WHATEVER) OF THE PLOTTER BEING USED AND OUTPUT.

DEFINING THE DIMENSIONS OF YOUR PLOTTER

WHEN IMPLEMENTING THIS CODE FOR USE ON ANY PLOTTER THE FIRST THING
TO DO IS DETERMINE THE PHYSICAL SIZE OF THE PLOT TO SPECIFY ON
THE FIRST INPUT LINE. ONCE YOU HAVE DETERMINED THE APPROPRIATE
X AND Y DIMENSIONS YOU WILL NEVER HAVE TO CHANGE THEM AGAIN.

TO DEFINE THE APPROPRIATE DIMENSIONS YOU CAN USE THE FIRST PLOT
GENERATED BY THIS CODE. THE FIRST PLOT IS A SIMPLE PLOT MERELY
TO IDENTIFY THE CODE AND VERSION, E.G., 90-1. USE THE INPUT
PARAMETERS TO TURN ON THE BORDER FOR PLOTS (SEE, DESCRIPTION
OF INPUT PARAMETERS ABOVE) – THE BORDER DEFINES THE EXTREME
X AND Y LIMITS OF THE PLOTTING AREA. BY CHANGING THE X AND Y
PHYSICAL LIMITS THAT YOU SPECIFY ON THE FIRST INPUT LINE YOU
WILL BE ABLE TO RAPIDLY POSITION THE PLOT AND DEFINE ITS SIZE
FOR YOUR PLOTTER.

REMEMBER THE BORDER DEFINES THE EXTREME X AND Y LIMITS OF THE
PLOT – THERE IS A PLOTTING AREA WHICH IS SURROUNDED BY TITLE
INFORMATION AT TOP, BOTTOM AND LEFT OF THE PLOT – THEREFORE
YOU MUST TURN ON THE BORDER FOR THE FIRST PLOT AND INSURE
THAT THE ENTIRE BORDER APPEARS ON YOUR PLOTTING SURFACE –
FAILURE TO FOLLOW THESE INSTRUCTIONS MAY CAUSE YOU TO loose
A PORTION OF SOME PLOTS, I.E., THEY MAY NOT BE WITHIN THE
PHYSICAL LIMITS OF YOUR PLOTTING SURFACE.

***** PLOTTER/GRAPHICS TERMINAL INTERFACE ****************************

ACKNOWLEDGEMENTS

THE AUTHORS ACKNOWLEDGES THE CONTRIBUTION OF JIM SMITH, NUCLEAR
DATA SECTION, IAEA, VIENNA, FOR SUGGESTING MANY OF THE OPTIONS
WHICH ARE NOW INCORPORATED IN THIS CODE AS WELL AS FOR TESTING
THE CODE EXTENSIVELY DURING ITS DEVELOPMENT PHASE.

THE AUTHOR ACKNOWLEDGES THE CONTRIBUTION OF DAVE RESLER, LAWRENCE
LIVERMORE NATIONAL LABORATORY FOR PROVIDING THE GRAPHICS INTERFACE
WHICH ALLOWS THIS PROGRAM TO BE USED ON A SUN TERMINAL
PROGRAM PLOTTAB:
A Code Designed to Plot
Continuous and/or Discrete Physical Data
(Version 2013-1)
Part B: Examples

by
Dermott E. Cullen
University of California (retired)
1466 Hudson Way
Livermore, CA 94550

Tele: 925-443-1911
E.Mail redcullen1@comcast.mnet
Website: http://home.comcast.net/~redcullen1

November 22, 2013

Abstract

PLOTTAB is designed as a general purpose plotting utility code to plot continuous and/or discrete physical data for use in almost any application. It is designed to be easily used by your application codes to produce your output results in a form that can be immediately used by PLOTTAB to allow you to see your results.

It produces on screen graphics as well as Postscript formatted output files that can be viewed or printed on any Postscript printer. The code is designed to be easily used on any computer - not only today's computers, but also anything that comes along in the future. So you can be assured that once you start using PLOTTAB your graphics problems are over - not just today, but well into the future.

Part A of this report documents the basic features of PLOTTAB.

Part B is designed to aid users in using the code, by describes a variety of applications, including listings of input parameters and output plots.
PROGRAM PLOTTAB:
Continuous and/or Discrete Physical Data
(Version 2013-1)
Part B: Examples

A Code Designed to Plot

by
Dermott E. Cullen
University of California (retired)
1466 Hudson Way
Livermore, CA 94550

Tele: 925-443-1911
E.Mail redcullen1@comcast.mnet
Website: http://home.comcast.net/~redcullen1

November 22, 2013

Introduction

The code PLOTTAB is designed as a simple plotting code which can be used on virtually any computer and graphics device to plot continuous and/or discrete physical data. To date this code has been successfully interfaced and used on a wide variety of computers as simple as IBM-PCs and as advanced as CRAY supercomputers.

In order to use this code on any given computer all you have to be able to do is turn your plotting device on or off and draw a line from one (X,Y) position to another. That’s all you have to be able to do to interface this code to any plotting device; for details see below.

Although the graphics interface used by this code is very simple, it can still take advantage of many features of individual plotting devices in order to produce either hardcopy or images on screens, either in black and white or in full color.

This code can be used with plotting devices of any physical size, whose size is defined in any set of units. This code allows you to define the physical size of your plotting device in whatever dimensions you are used to using, e.g., inches, millimeters, centimeters - anything; so that you can properly size the plots for use with any plotting device.

The formats of the continuous and discrete physical data read by this code are designed to be extremely simple, so that virtually any computer code can be simply modified to produce output results in the input format required by this code. The continuous data includes a one title line, followed by a series of (X,Y) coordinates, one per line. Each “curve” of continuous data is terminated by a blank line. One curve can be followed by another, starting with the one line title line. The input to this code may include any number of such “curves”. The format of the discrete data is very similar to the continuous data: each set of discrete points starts with a one line title and ends with a blank line. Each point is defined by an (X,Y) value plus uncertainties in both X and Y; each point is defined by up to six values X, DX, +DX, Y, -DY, +DY, one point per input line. The input to this code may include any number of such sets of discrete points. See below for details of the continuous and discrete data formats.
This code has been designed to meet the needs of a wide variety of users. The code has been designed to allow the casual user to simply produce plots without becoming familiar with all of the options available in this code. This design feature allows some users to concentrate on applications and still produce meaningful graphic results without having to become an expert in graphics. At the same time this code includes many options which may be used to produce customized plots to meet most needs, varying from very simple and fast plots which can be quickly produced and used, to complicated, detailed figures of a quality suitable for publications (for examples of the latter see the below list of publications).

For extensive examples of the results produced by this code see,

"Tables and Graphs of Photon-Interaction Cross Sections from 10 eV to 100 GeV Derived from the LLNL Evaluated Photon Data Library (EPDL), Part A: Z = 1 to 50, Part B: Z = 51 to 100", UCRL-50400, Vol. 6, Rev. 4, Oct. 1989, Lawrence Livermore National Laboratory.


Software Character Sets

In order to make this code as computer independent as possible it uses an input file (PLOT.CHR) to define the strokes necessary to plot each character - this is called a software character set. Using this method the interface for each computer and plotting device need only be able to draw lines from one (X,Y) coordinate to another - and all character sizes and aspect ratios will be plotted identically on all plotters.

This code is distributed with three sets of software characters, which in the order of character detail are called SIMPLEX, DUPLEX and COMPLEX. Each of these sets is distributed as a separate computer file and to use any one of them you need merely copy it to PLOT.CHR before executing this code. The three files of strokes are completely compatible and this code will simply use whichever set you have in PLOT.CHR.

Each of these sets can be used in given situations. The SIMPLEX set is a fairly simple set of characters, each of which may be drawn with a minimum number of strokes; this makes using this set very economical. At the other extreme the COMPLEX set included detailed characters, each of which may require a large number of strokes to draw; this set can be expensive to use, but it can produce finished plots suitable for use in publications.

The following page illustrates all available characters for each of the three software character sets. For each set the upper two lines illustrate the standard characters and the lower two lines illustrate the alternate character set.
<table>
<thead>
<tr>
<th>Complex</th>
<th>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/)$/()=abcdefgihjklmnopqrstuvwxyz,..!?&gt;&lt;%~@#$&amp;_!&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABXΔΕΦΓΗΙ ΚΑΜΝΟΠΘΡΣΤΤΤ ΩΞΨΖ</td>
<td></td>
</tr>
<tr>
<td>αβχδεφγηι κλμνοπθρστυ ωξψζ ( \rightarrow \uparrow \downarrow \neq \equiv \leq \geq \infty \in \partial \nabla \sqrt{f[\ ]} )</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duplex</th>
<th>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/)$/()=abcdefgihjklmnopqrstuvwxyz,..!?&gt;&lt;%~@#$&amp;_!&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABXΔΕΦΓΗΙ ΚΑΜΝΟΠΘΡΣΤΤΤ ΩΞΨΖ</td>
<td></td>
</tr>
<tr>
<td>αβχδεφγηι κλμνοπθρστυ ωξψζ ( \rightarrow \uparrow \downarrow \neq \equiv \leq \geq \infty \in \partial \nabla \sqrt{f[\ ]} )</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Simplex</th>
<th>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/)$/()=abcdefgihjklmnopqrstuvwxyz,..!?&gt;&lt;%~@#$&amp;_!&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABXΔΕΦΓΗΙ ΚΑΜΝΟΠΘΡΣΤΤΤ ΩΞΨΖ</td>
<td></td>
</tr>
<tr>
<td>αβχδεφγηι κλμνοπθρστυ ωξψζ ( \rightarrow \uparrow \downarrow \neq \equiv \leq \geq \infty \in \partial \nabla \sqrt{f[\ ]} )</td>
<td></td>
</tr>
</tbody>
</table>
Standard vs. Alternate Character Set

To use the standard character set as input to this code one need merely type the desired character; all of the standard characters are available on most computer keyboards.

To use the alternate character set you should consult the following equivalence table and precede each character by \). For example, to plot \((n, \text{Greek alpha})\), you should type \((n,)a\) \) indicates that the next character is from the alternate character set and the following equivalence table indicates that \(-a-\) is equivalence to a lower case Greek alpha.
## Alternate Character Equivalences

<table>
<thead>
<tr>
<th>A = A</th>
<th>M = M</th>
<th>Y = Ψ</th>
<th>k = κ</th>
<th>w = ω</th>
<th>8 = ∞</th>
</tr>
</thead>
<tbody>
<tr>
<td>B = B</td>
<td>N = N</td>
<td>Z = Z</td>
<td>l = λ</td>
<td>x = ξ</td>
<td>9 = ε</td>
</tr>
<tr>
<td>C = X</td>
<td>O = O</td>
<td>a = α</td>
<td>m = μ</td>
<td>y = ψ</td>
<td>+ = ∞</td>
</tr>
<tr>
<td>D = Δ</td>
<td>P = Π</td>
<td>b = β</td>
<td>n = ν</td>
<td>z = ζ</td>
<td>− = δ</td>
</tr>
<tr>
<td>E = E</td>
<td>Q = Θ</td>
<td>c = χ</td>
<td>o = o</td>
<td>0 = →</td>
<td>* = ∇</td>
</tr>
<tr>
<td>F = Φ</td>
<td>R = P</td>
<td>d = δ</td>
<td>p = π</td>
<td>1 = ↑</td>
<td>/ = √</td>
</tr>
<tr>
<td>G = Γ</td>
<td>S = Σ</td>
<td>e = ε</td>
<td>q = ϑ</td>
<td>2 = ←</td>
<td>$ = f</td>
</tr>
<tr>
<td>H = H</td>
<td>T = T</td>
<td>f = φ</td>
<td>r = ρ</td>
<td>3 = ↓</td>
<td>( = [</td>
</tr>
<tr>
<td>I = I</td>
<td>U = Υ</td>
<td>g = γ</td>
<td>s = σ</td>
<td>4 = ≠</td>
<td>) = ]</td>
</tr>
<tr>
<td>J =</td>
<td>V =</td>
<td>h = η</td>
<td>t = τ</td>
<td>5 = ≡</td>
<td></td>
</tr>
<tr>
<td>K = K</td>
<td>W = Ω</td>
<td>i = i</td>
<td>u = u</td>
<td>6 = ≤</td>
<td></td>
</tr>
<tr>
<td>L = Λ</td>
<td>X = Ξ</td>
<td>j =</td>
<td>v =</td>
<td>7 = ≥</td>
<td></td>
</tr>
</tbody>
</table>
Character Thicknesses

All lines on a plot, except the grid, may be drawn using a specified line thickness. This option may be used to good advantage to insure that data can be properly and easily distinguished from the background grid.

As input you can specify that all lines should be of thickness between 0 (only draw each line once) up to 5 (with thickness 5 each line is drawn and then slightly offset to either side of the line and drawn 5 times - each line is drawn 11 times). Using line thickness can be very effective as far as improving the end product plots, but it can be very expensive if not properly used. For example, with thickness 5 each line is drawn 11 times and between drawing the beam or pen must be returned to the start of the line. Therefore plots with thickness 5 will contain 20 times as many strokes as a plot with thickness 0, and as such will take 20 times as long to create.

For most plots it is sufficient to have thickness for curves and points, but generally it is not necessary to have thickness for characters; the basic COMPLEX characters already contain an intrinsic thickness. In order to allow this option you can specify as input thickness 0 through 5, which indicates thickness for all lines, except the grid, on each plot, or -1 through -5 which indicates thickness only for curves and set of data points - but not for characters. Using the latter option can significant decrease the time required to produce plots, and this option is recommended.

For reference purposes the following pages illustrate each of the three software character sets in the order COMPLEX, DUPLEX and SIMPLEX, using line thickness 0 through 5. As stated above, the recommended procedure is not to use a line thickness for characters, and this recommendation will be followed in all of the examples included in this report.
<table>
<thead>
<tr>
<th>0 Thick</th>
<th>1 Thick</th>
<th>2 Thick</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=</td>
<td>abcdefghijklmnopqrstuvwxyz,..!:?!&lt;&gt;%',~@#&amp;_1&quot;</td>
<td>ABXΔΕΦΓΗΙΚΑΜΝΟΠΘΡΣΣΤΤΤΩΨΨΖ</td>
</tr>
<tr>
<td>αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ]</td>
<td>αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ]</td>
<td>αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ]</td>
</tr>
<tr>
<td>2 Thick</td>
<td>1 Thick</td>
<td>0 Thick</td>
</tr>
</tbody>
</table>

| ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()= | abcdefghijklmnopqrstuvwxyz,..!:?!<>%',~@#&_1" | ABXΔΕΦΓΗΙΚΑΜΝΟΠΘΡΣΣΤΤΤΩΨΨΖ |
| αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ] | αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ] | αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ] |

<p>| 2 Thick | 1 Thick | 0 Thick |
| ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()= | abcdefghijklmnopqrstuvwxyz,..!:?!&lt;&gt;%',~@#&amp;_1&quot; | ABXΔΕΦΓΗΙΚΑΜΝΟΠΘΡΣΣΤΤΤΩΨΨΖ |
| αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ] | αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ] | αβχδεφγηικλμνοπυρστυωξψζ→↑↓≠≡≤≥∞∈α∂∇ʃ[ ] |</p>
<table>
<thead>
<tr>
<th>3 Thick</th>
<th>4 Thick</th>
<th>5 Thick</th>
</tr>
</thead>
</table>
| \( ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/\$()= \)  
\( a\beta\chi\delta\epsilon\phi\gamma\eta\kappa\lambda\mu\nu\pi\rho\sigma\tau\upsilon\omega\xi\psi\zeta \rightarrow \uparrow \downarrow \neq \equiv \Rightarrow \leq \in \alpha \partial \sqrt[ ]{ f } \) |
| \( ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/\$()= \)  
\( a\beta\chi\delta\epsilon\phi\gamma\eta\kappa\lambda\mu\nu\pi\rho\sigma\tau\upsilon\omega\xi\psi\zeta \rightarrow \uparrow \downarrow \neq \equiv \Rightarrow \leq \in \alpha \partial \sqrt[ ]{ f } \) |
| \( ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/\$()= \)  
\( a\beta\chi\delta\epsilon\phi\gamma\eta\kappa\lambda\mu\nu\pi\rho\sigma\tau\upsilon\omega\xi\psi\zeta \rightarrow \uparrow \downarrow \neq \equiv \Rightarrow \leq \in \alpha \partial \sqrt[ ]{ f } \) |
<table>
<thead>
<tr>
<th>Thick Level</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=abcdefghijklmnopqrstuvwxyz,:;!&lt;&gt;%'@#$&amp;_1''</td>
</tr>
<tr>
<td>1</td>
<td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=abcdefghijklmnopqrstuvwxyz,:;!&lt;&gt;%'@#$&amp;_1''</td>
</tr>
<tr>
<td>2</td>
<td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=abcdefghijklmnopqrstuvwxyz,:;!&lt;&gt;%'@#$&amp;_1''</td>
</tr>
<tr>
<td>3. Thick</td>
<td>4. Thick</td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>$ ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+,*_/()= $</td>
<td>$ ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+,*_/()= $</td>
</tr>
<tr>
<td>$ abcdefghijklmnopqrstuvwxyz,,:;!?$%'#@&amp;_1'' $</td>
<td>$ abcdefghijklmnopqrstuvwxyz,,:;!?$%'#@&amp;_1'' $</td>
</tr>
<tr>
<td>$ \alpha\beta\gamma\delta\varepsilon\eta\iota\kappa\lambda\mu\nu\xi\psi\varsigma\rightarrow\leftarrow\not\equiv\not\leq\not\geq\not\in\not\partial\not\nabla\not\int[] $</td>
<td>$ \alpha\beta\gamma\delta\varepsilon\eta\iota\kappa\lambda\mu\nu\xi\psi\varsigma\rightarrow\leftarrow\not\equiv\not\leq\not\geq\not\in\not\partial\not\nabla\not\int[] $</td>
</tr>
</tbody>
</table>
\[ \alpha \beta \chi \delta \varepsilon \varphi \gamma \kappa \lambda \mu \nu \omicron \pi \rho \sigma \tau \upsilon \omega \xi \psi \zeta \rightarrow \downarrow \neg \equiv \leq \geq \in \partial \nabla \sqrt{f[\ ]} \]
| 3 Thick | ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=  
|  | abcdefghijklmnopqrstuvwxyz,.;?!<>%~@#&_-l"  
|  | ABXDEFGHI KAMNOPQRSTUVWXYZ  
|  | αβχδεφγηκλμνοπρστυωξψζ  
|  | " \( \alpha \beta \gamma \delta \epsilon \phi \chi \rho \sigma \tau \upsilon \omega \)  
|  | \( \frac{\partial \nabla}{\partial f} \) [ ] |

| 4 Thick | ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=  
|  | abcdefghijklmnopqrstuvwxyz,.;?!<>%~@#&_-l"  
|  | ABXDEFGHI KAMNOPQRSTUVWXYZ  
|  | αβχδεφγηκλμνοπρστυωξψζ  
|  | " \( \alpha \beta \gamma \delta \epsilon \phi \chi \rho \sigma \tau \upsilon \omega \)  
|  | \( \frac{\partial \nabla}{\partial f} \) [ ] |

| 5 Thick | ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=  
|  | abcdefghijklmnopqrstuvwxyz,.;?!<>%~@#&_-l"  
|  | ABXDEFGHI KAMNOPQRSTUVWXYZ  
|  | αβχδεφγηκλμνοπρστυωξψζ  
|  | " \( \alpha \beta \gamma \delta \epsilon \phi \chi \rho \sigma \tau \upsilon \omega \)  
|  | \( \frac{\partial \nabla}{\partial f} \) [ ] |
Software Symbols and Line Types

In order to identify sets of points or curves this code uses a file defining the strokes required to draw any one of 30 different symbols (to identify sets of points) or any one of 30 types of lines (to identify curves).

This code is distributed with two files: PLOT.SYM containing the strokes required to draw the standard symbol set, and PLOT.ALT containing the strokes required to draw the alternate symbol set. In both cases the types of lines are identical in the two files. In order to use either of these sets of symbols it is merely necessary to insure that the selected set is copied to the file PLOT.SYM prior to executing this code.

The following pages illustrate the standard and alternate symbol sets and the types of lines. The standard symbol set includes 30 different symbols which can be readily distinguished from one another on a plot. When symbols severely overlap on plots it may not be easy to distinguish symbols. Each member of the alternate symbol set is merely a square containing a number (1 through 9) or letter (A through Y). The alternate set is not as elegant as the standard set, but when symbols severely overlap the alternate symbols can be more easily distinguished than the standard symbols.

The types of lines allow for up to 30 different types of lines, but as distributed there are really only 10 different types of lines; line types 11-20 or 21-30 are merely repeats of line types 1-10. Even with only 10 different types of lines it is often difficult to distinguish between them and the author has not been able to define more than this number of different types of lines.
The symbols and line types are used in the order that they are read from the file (PLOT.SYM). The user is free to re-order the symbols and line types in any manner, e.g., if you would like symbols 28-30 to be used for the first 3 sets of points, merely move these symbols to be the beginning of the file. Similarly you are free to modify these symbols and line types to create your own sets. The only restriction to modifying this file is that there MUST BE EXACTLY 30 symbols followed by 30 line types - otherwise the results will be unpredictable.

The files containing the symbols and line types define the strokes required to draw symbols and lines. Each stroke is defined by (X,Y) and either 3 = move (blank) or 2 = draw. For each symbol the first line defines an index (1 to 30 - not used by the code), the number of strokes required to draw the symbol (e.g., for a box, 5 strokes) and the X width of the symbol at the Y midpoint (to allow error bars to be easily and correctly connected to symbols). The first line is then followed by the indicated number of strokes. The first stroke must always include 3 = move, in order to move to the beginning of the symbol without drawing a line from the last location of the beam or pen. Below are the first three symbols from the standard symbol set. See the following page illustrating these symbols.

```
1  5  1.000  BOX
  0.000  0.000  3
  0.000  1.000  2
  1.000  1.000  2
  1.000  0.000  2
  0.000  0.000  2
2  5  1.000  DIAMOND
  0.500  0.000  3
  0.000  0.500  2
  0.500  1.000  2
  1.000  0.500  2
  0.500  0.000  2
3  4  0.500  UP TRIANGLE
  0.000  0.000  3
  0.500  1.000  2
  1.000  0.000  2
  0.000  0.000  2
```

Similarly, each line type is defined by a series of strokes. The first line defines an index (1 to 30 - not used by this code) and the number of strokes. The following field is not used by this code. The following lines define each stroke as either 3 = drawn or 2 = blank. Once the pattern has been used it is merely repeated. Below are the first three line types. See the following page illustrating these line types.

```
1  1  1.000  SOLID
  1.000  0.000  2
2  2  1.000  LONG DASH-SPACE
  0.180  0.000  2
  0.045  0.000  3
3  2  1.000  SHORT DASH-SPACE
  0.060  0.000  2
  0.045  0.000  3
```
<table>
<thead>
<tr>
<th>Standard</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>C</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>P</td>
<td>R</td>
<td>S</td>
<td>T</td>
<td>U</td>
<td>V</td>
<td>W</td>
<td>X</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>
A Basic Series of Plots

The following four plots illustrate the simplest use of the code to plot four curves on each of a series of plots. The X and Y axis labels will be identical on all four plots. Only the titles at the top of each plot will be different from one plot to the next.

In this case you need only define the physical size of each page (in this case 13.5 by 10.0) and the number of plots per page (in this case 1 by 1), the number of curves to read and plot on each plot (4) and the X and Y axis labels; all of these will be the same for all plots and these first four lines of input need only appear once.

Next there are four input lines for each plot. The first two lines define a two line title to appear at the top of the plot. The next two lines define options for the X and Y dimensions of the plot. Note in this case these lines are completely blank or 0, in which case the code will use all of the standard options; this illustrates that in most cases the user need not be familiar with all of the options available, since generally acceptable results can be obtained using the standard code options.

These four lines for a plot can be immediately followed by another four lines for the next plot. This cycle can be repeated any number of times and each four lines will produce one plot, e.g., in this case the cycle is repeated four times to produce the following four plots.

```
0.00000 13.50000 0.00000 10.0 1 1 1.0
4 0 0 0 0 0 0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Hydrogen
0 0 0 0
0 0 0 0
Comparison of Stopping Powers
for Helium
0 0 0 0
0 0 0 0
Comparison of Stopping Powers
for Lithium
0 0 0 0
0 0 0 0
Comparison of Stopping Powers
for Beryllium
0 0 0 0
0 0 0 0
```
Comparison of Stopping Powers for Hydrogen

- 1-H Bethe
- 1-H Collision
- 1-H Ionization
- 1-H Excitation
Comparison of Stopping Powers for Helium

Incident Electron Energy (MeV)

Stopping Power - dE/dx (MeV-barns)
Comparison of Stopping Powers for Beryllium

Stopping Power - dE/dx (MeV-barns)

Incident Electron Energy (MeV)
Multiple Plots per Page

When you have a series of similar plots and each does not contain too much information this code can be used to plot a number of plots on each page.

For example, the preceding four pages of plots could have been condensed onto a single page. The only change in the input parameters would be to specify 2 by 2 plots per page (cols. 45-66 on line 1).

Note, that in this case there is an advantage in presenting the results in this form, since it allows us to see the atomic number (Z) dependence of the stopping power, without having to consult a number of different pages.

\[
\begin{array}{cccccc}
0.00000 & 13.50000 & 0.00000 & 10.0 & 2 & 2 1.0 \\
4 & 0 & 0 & 0 & 0 & 0 \\
\end{array}
\]

Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Hydrogen

\[
\begin{array}{cccc}
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
\end{array}
\]

Comparison of Stopping Powers
for Helium

\[
\begin{array}{cccc}
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
\end{array}
\]

Comparison of Stopping Powers
for Lithium

\[
\begin{array}{cccc}
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
\end{array}
\]

Comparison of Stopping Powers
for Beryllium

\[
\begin{array}{cccc}
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
\end{array}
\]

A second page of four plots are presented here. The second page contains exactly the same data as on the first page. The only difference is that for the second page a character size multiplier of 1.5 (cols. 67-70 on first input line) has been used. The basic limitation on the number of plots per pages is that with more plots per page the characters become progressively smaller and are eventually impossible to read. This effect can be at least partially offset by using larger characters for multiple plots per page.
Comparison of Stopping Powers for Hydrogen

Comparison of Stopping Powers for Helium

Comparison of Stopping Powers for Lithium

Comparison of Stopping Powers for Beryllium
Zoom and Ratios

Two of the most important capabilities of this code are the ability,

1) to select any X and/or Y ranges which you wish to "see" - this is called ZOOMING. This option allows you to examine data in any detail that you consider to be necessary.

2) to define the ratio of all other curves and all sets of data points to the first (standard) curve, and to quantitatively define the position and magnitude of the maximum difference between the first curve and all the other data. In comparing data, plots can be extremely misleading in making different sets of data appear to be very similar - particularly when log scaling scaling is used in the Y dimension. By presenting the ratio one can not only quantitatively define differences, but one can also more clearly "see" trends in differences.

The following example input will produce the three plots which follow this page. The plots include,

1) 4 curves and 2 sets of points are read and kept in core for all plots. The first plot is of the entire X and Y range of data using a log-log plot and including Y error bars for the sets of points.

2) The second plot is of the X range up to 0.01; otherwise all of the parameters are the same as the first plot. This is an example of specifying the X and/or Y range to create a ZOOMED plot of a portion of the data.

3) The third plot uses all of the same parameters as for the second plot, except that the RATIO option has been turned on to show the ratio of everything to the first curve. In order to do this it was necessary to insert a blank line after the lines for the second plot and to then start all over again defining the plot layout, etc.

```
0.00000 13.50000 0.00000 10.0
-4 -2 0 0 0 0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Aluminium
0 0 0 0
1 1 1 1.0

Comparison of Stopping Powers
for Aluminium
1.00000 - 2 0 0 0 0
1 1 1 0

0.00000 13.50000 0.00000 10.0
-4 -2 0 0 0 0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Aluminium
1.00000 - 2 0 0 0 0
1 1 1 0
```
Comparison of Stopping Powers for Aluminium

Incident Electron Energy (MeV)

Stopping Power - $dE/dX$ (MeV·barns)

- Collision
- Bethe
- Ionization
- Excitation

Ashley (76)
Ashley (79)
Comparison of Stopping Powers for Aluminium

Incident Electron Energy (MeV)

Stopping Power - dE/dX (MeV-barns)

- Collision
- Bethe
- Ionization
- Excitation

Ashley (76)
Ashley (79)
Comparison of Stopping Powers for Aluminium

Incident Electron Energy (MeV) vs. Stopping Power - dE/dX (MeV-barns)

- Collision
- Bethe
- Ionization
- Excitation

Ashley (76)
Ashley (79)

Maximum Difference 90.91% at X = 1.000-5

Incident Electron Energy (MeV)

Ratios

10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4}
Rotate Plots and Multiple Plots per Page

The following example uses exactly the same data that appeared on the preceding three plots. The only difference is in the presentation of the data.

1) All of the plots have been ROTATED by specifying a negative upper X limit for the size of the plots (cols. 12-22 on first line).

2) The first two plots are presented on a single page by specifying 1 by 2 plots (cols. 45-66 on first line).

3) The third plot is presented as one plot per page.

Except for these modifications the presentation of the plots is identical to that of the preceding three plots.

```
0.00000   -13.50000  0.00000  10.0  1  2  1.0
   -4    -2    0    0    0    0

Incident Electron Energy (MeV)
Stopping Power - dE/dX (MeV*barns)
Comparison of Stopping Powers
for Aluminium

0  2  0  0
1  2  0  0

Comparison of Stopping Powers
for Aluminium

1.00000  -2
0  2  0  0
1  2  0  0

0.00000   -13.50000  0.00000  10.0  1  1  1.0
   -4    -2    0    1    0    0

Incident Electron Energy (MeV)
Stopping Power - dE/dX (MeV*barns)
Comparison of Stopping Powers
for Aluminium

1.00000  -2
0  2  0  0
1  2  0  0
```
Comparison of Stopping Powers for Aluminium

Incident Electron Energy (MeV)

Stopping Power - dE/dx (keV/Å)

- Collision
- Bethe
- Ionization
- Excitation
○ Ashley (70)
○ Ashley (76)
Comparison of Stopping Powers
for Aluminium

- Collision
- Bethe
- Ionization
- Excitation

Maximum Difference
-90.91 %
at X = 1 000-5

Incident Electron Energy (MeV)
Linear vs. Log Scaling

Normally the automatic scaling conventions built into the code are adequate to select either linear or log scaling for the X and Y axis. The automatic scaling convention is extremely simple: if the X or Y range is positive and the maximum of the range is more than ten times the minimum, log scaling is used. Otherwise linear scaling is used. Automatic scaling is indicated by specifying blank or 0 in cols. 34-44 of the third (for X) or fourth (for Y) input line for each plot.

However, occasionally you may wish to force the scaling to be either linear or log. The following page presents four plots to illustrate the results obtained using exactly the same data on each plot and using all combinations of X and Y linear or log scaling.

Note, on the input lines below how the scaling is forced by specifying either 1 (linear) or 2 (log) in cols. 34-44 of the third (for X) or fourth (for Y) input line for each plot. When log scaling is forced by input any non-positive values are ignored and not considered in defining the range of the plot, i.e., log scaling is forced by only considering positive values to plot.

For these plots the character size has been increased by a factor of 1.5 (cols. 67-70 on the first input line) and the upper limit of the X range has been set to 0.001. Note, on the plots for linear scaling the axis annotation will always be in normal form containing numbers in the range 1 to 999. In order to do this the axis labels may have a scale factor added to them, e.g., on the enclosed plot where the Y axis label includes a scale factor of $10^3$ and the X axis label a scale factor of $10^{-3}$.

0.00000 13.50000 0.00000 10.0 2 2 1.5
-4 0 0 0 0 0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Stopping Power for Beryllium
Lin-Lin Scaling
1.00000-3 0 1 0 0
0 1 0 0
Lin-Log Scaling
1.00000-3 0 1 0 0
0 2 0 0
Stopping Power for Beryllium
Log-Lin Scaling
1.00000-3 0 2 0 0
0 1 0 0
Log-Log Scaling
1.00000-3 0 2 0 0
0 2 0 0
Stopping Power for Beryllium

Lin-Lin Scaling

Lin-Log Scaling

Log-Lin Scaling

Log-Log Scaling

Stopping Power - dE/dx (MeV/amu)
Linear vs. Log Interpolation

The preceding example illustrated the effect of presenting exactly the same data using either linear or log scaling in the X and/or Y directions. Here we illustrate the effect of using either linear or log interpolation to define data between the points where it is tabulated.

The ENDL photon interaction cross sections are defined to be log-log interpolable between tabulated values. The plot on the upper half of the following page illustrates the results obtained using log-log interpolation between tabulated values. The input parameters indicate log interpolation for X and Y by using -2 in columns 34-44 of the 7-th (for X) and 8-th (for Y) input lines. At high photon energies the cross sections all follow simple power laws, i.e., vary as E**n. As such, at high energies the cross sections can be represented by just a few widely spaced tabulated energy points with log-log interpolation between tabulated values.

The plot in the lower half of the following page illustrates the results obtained using linear-linear interpolation between tabulated values. Note, the "bumps" or "bubbles" at high energy, due to improperly interpolating between the tabulated values. In this example improperly interpolating can lead to values of the cross section which are an order of magnitude or more too large at some energies; needless to say similar results will occur in integrals.

Hopefully this example clearly illustrates the importance of properly interpolating data, not only in order to obtain acceptable plots using this code, but even more importantly in using data in applications, e.g., in a Monte Carlo transport code linearly interpolating high energy photon interaction cross sections can overestimate the actual cross sections by an order of magnitude or more.

<table>
<thead>
<tr>
<th>Incident Photon Energy (MeV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000-4</td>
<td>0</td>
</tr>
<tr>
<td>-13.50000</td>
<td>0</td>
</tr>
<tr>
<td>0.00000</td>
<td>0</td>
</tr>
<tr>
<td>10.0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1.5</td>
<td>0</td>
</tr>
</tbody>
</table>

(9/2 U ENDL Photon Interaction Cross Sections)

<table>
<thead>
<tr>
<th>Cross Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00000-4</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>-2</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

(9/2 U ENDL Photon Interaction Cross Sections)

<table>
<thead>
<tr>
<th>Cross Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00000-4</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>
$^{92}\text{U ENDL Photon Interaction Cross Sections}$

- Coherent
- Incoherent
- Photoelectric
- Pair Production
- Triplet Production

---

Incident Photon Energy (MeV):

$10^{-5}$ $10^{-4}$ $10^{-3}$ $10^{-2}$ $10^{-1}$ $10^{0}$ $10^{1}$ $10^{2}$

Cross Section (barns):

$10^{-4}$ $10^{-3}$ $10^{-2}$ $10^{-1}$ $10^{0}$ $10^{1}$ $10^{2}$ $10^{3}$ $10^{4}$ $10^{5}$ $10^{6}$ $10^{7}$
Line Thicknesses

The following example illustrates the effect of using line thicknesses 0 through -5 (thick lines, but not characters). Line thickness is controlled by cols. 56-66 of the second input line. This example also includes a border around each plot (cols. 23-33 of the second input line), a solid-dash grid (cols. 34-44 of the second input line) and log-log interpolation between tabulated data points (cols. 34-44 of the 7-th [for X] and 8-th [for Y] input lines — in this case this option is set to -2 to force log scaling and interpolation).

In this example it can be seen that since we decided that we need a grid on the plot, at thickness 0 it is difficult to see the actual curves; this becomes even more true when any portion of a curve approaches being horizontal or vertical. Thickness can be used to make the curves stand out from the background and generally make the plots more acceptable for use in publications.

Line thicknesses should be used carefully, since it can be quite expensive and time consuming to produce plots with thick lines. For low resolution plotting devices (e.g., pen and paper plotters) it can also be a waste of time, since the small offset in strokes used by this code to create line thickness may be less than the resolution of your plotter.

On low resolution plotters line thickness should not be used. On high resolution plotters generally good quality plots can be obtained using line thickness -2. For an illustration of extensive results using a dashed grid and line thickness -2 see UCRL-50400, Vol. 6 and 30, the documentation for the Livermore photon and electron interaction data.
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections

\[
\begin{array}{cccccc}
0.00000 & 13.50000 & 0.00000 & 10.0 & 1 & 1.10 \\
-5 & 0 & 1 & 4 & 0 & 0 \\
\end{array}
\]

Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections

\[
\begin{array}{cccccc}
0.00000 & 13.50000 & 0.00000 & 10.0 & 1 & 1.10 \\
-5 & 0 & 1 & 4 & 0 & -1 0 \\
\end{array}
\]

Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections

\[
\begin{array}{cccccc}
0.00000 & 13.50000 & 0.00000 & 10.0 & 1 & 1.10 \\
-5 & 0 & 1 & 4 & 0 & -2 0 \\
\end{array}
\]

Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections

\[
\begin{array}{cccccc}
0.00000 & 13.50000 & 0.00000 & 10.0 & 1 & 1.10 \\
-5 & 0 & 1 & 4 & 0 & -3 0 \\
\end{array}
\]

Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections

\[
\begin{array}{cccccc}
0.00000 & 13.50000 & 0.00000 & 10.0 & 1 & 1.10 \\
-5 & 0 & 1 & 4 & 0 & -4 0 \\
\end{array}
\]

Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections

\[
\begin{array}{cccccc}
0.00000 & 13.50000 & 0.00000 & 10.0 & 1 & 1.10 \\
-5 & 0 & 1 & 4 & 0 & -5 0 \\
\end{array}
\]
Uranium Photon Interaction
Cross Sections

- Coherent
- Incoherent
- Photoelectric
- Pair Production
- Triplet Production

Incident Neutron Energy (MeV)

Cross Section (barns)
Uranium Photon Interaction
Cross Sections

- Coherent
- Incoherent
- Photoelectric
- Pair Production
- Triplet Production

Incident Neutron Energy (MeV)

Cross Section (barns)
Uranium Photon Interaction
Cross Sections

Incident Neutron Energy (MeV)

Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Uranium Photon Interaction
Cross Sections

- Coherent
- Incoherent
- Photoelectric
- Pair Production
- Triplet Production

Energy (MeV)
Incident Neutron Energy (MeV)
Uranium Photon Interaction
Cross Sections

Incident Neutron Energy (MeV)

Cross Section (barns)
Rounded vs. Non-rounded Limits

The default option for this code is that it will read the data and determine its X and Y limits (i.e., X and Y minimum and maximum). These limits will then be rounded outward from the middle of the plot to insure that all data will be clearly shown away from the border of the plot without any interference from tick marks on the border. For most applications this default option is acceptable.

However, if you wish to absolutely control the X and/or Y limits of a plot you may do so using the rounded vs. non-rounded limits option (cols. 45-55 on input line 7 [for X] and 8 [for Y]). In the following example the X limits are not rounded, so that the X limits of the plot are from the lower X limit of the data (10 eV) up to the specified upper X limit (100 MeV). Only the upper Y limit is rounded, so that the lower Y limit will be the specified Y limit (0.001 barns).

The most frequent use of this option is when the user wishes to fix the lower X and/or Y limits of a plot to exactly zero. For example, for data which is inherently non-negative (e.g., cross sections), but starts with Y = 0.0 at some threshold value, you may want to set the lower Y limit to exactly zero.

```
0.00000 13.50000 0.00000 10.0 1 11.0
-5 0 1 4 0 -2 0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
1.00000+2 0 -2 1 0
1.00000-3 0 -2 3 0
```
Uranium Photon Interaction
Cross Sections

- Coherent
- Incoherent
- Photoelectric
- Pair Production
- Triplet Production

Incident Neutron Energy (MeV)

Cross Section (barns)

\(10^{-5} \rightarrow 10^{2}\)

\(5 \times 10^{-1} \rightarrow 5 \times 10^{1}\)

\(5 \times 10^{-2} \rightarrow 5 \times 10^{2}\)

\(5 \times 10^{-3} \rightarrow 5 \times 10^{3}\)

\(5 \times 10^{-4} \rightarrow 5 \times 10^{4}\)

\(5 \times 10^{-5} \rightarrow 5 \times 10^{5}\)
Master Curve

When a plot contains many curves you may want one curve to stand out from all the others; use of the master curve option (cols. 67-70 of the second input line) will allow you to do this.

In the following example the (n,2n) double differential spectrum due to 14.2 MeV neutrons incident on beryllium is shown at 21 fixed cosine values between -1.0 and +1.0. In addition the spectrum that results when one averages over cosine is also shown.

On the first plot the master curve option is not used and it is very difficult to see the average value. On the second plot the master curve option is used to make the average value stand out from all the other curves.

On a third plot the same data and options are used as were used for the second plot, except that log X scaling is used. This plot is included here merely to once again illustrate the effect that linear vs. log scaling can have on graphic results, i.e., compare the second and third plots.

```
0.00000 13.50000 0.00000 10.0 1 1 1.0
-22 0 0 0 0
Secondary Neutron Energy (MeV)
Spectra (per MeV)
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
0 1 0 0
0 2 0 0
```

```
0.00000 13.50000 0.00000 10.0 1 1 1.0
-22 0 0 0 0 0 22
Secondary Neutron Energy (MeV)
Spectra (per MeV)
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
0 1 0 0
0 2 0 0
```

```
0.00000 13.50000 0.00000 10.0 1 1 1.0
-22 0 0 0 0 0 22
Secondary Neutron Energy (MeV)
Spectra (per MeV)
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
0 2 0 0
0 2 0 0
```
(n,2n) Double Differential and Angular Averaged Spectra due to 14.2 MeV Neutrons Incident on Beryllium
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
(n,2n) Double Differential and Angular Averaged Spectra due to 14.2 MeV Neutrons Incident on Beryllium
Alternate Character Set - Super and Subscripts

The following example illustrates how to use the alternate character set, as well as super and subscripts.

To use the alternate character set each character from the alternate character set is preceded by \]. Using the enclosed table of alternate character set equivalences we can see that \( ]a \) will be plotted as a Greek alpha. In the following example there is a plot of a number of \((n, \alpha)\) cross sections. In order to have this plotted as \((n, \text{Greek character } \alpha)\) the below input parameters include on the second title line \((n,]a)\) - which from the following plot can be seen to be plotted in exactly the form we require.

To use superscripts each character is preceded by \{. Similarly to use subscripts each character is preceded by \}. For the following plot the titles in the curve file (PLOTTAB.CUR) are of the form,

\{6C\}1\}2

which from the following plot we can see is plotted as,

superscript \(6\), \(C\), subscript \(1\), subscript \(2\)

The input parameters used to produce the following plot are listed below.

<table>
<thead>
<tr>
<th>0.00000</th>
<th>13.50000</th>
<th>0.00000</th>
<th>10.0</th>
<th>1</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>-2</td>
</tr>
</tbody>
</table>

Incident Neutron Energy (MeV)
Cross Section (barns)
Comparison of ENDF
\((n,]a)\) Cross Section

<table>
<thead>
<tr>
<th>0</th>
<th>2</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Comparison of ENDL (n,α) Cross Section

Incident Neutron Energy (MeV)

Cross Section (barns)

4He9 (n,α)
6C12 (n,α)
8C13 (n,α)
7N14 (n,α)
Change Character Size

In the following example each of the three plots contains exactly the same data and the only difference between them is that each has a different multiplier for the character size (cols. 67-70 on the first line). The three plots have character size multipliers of 0.7, 1.0 and 1.5, respectively.

These multipliers correspond to roughly increasing the size of the characters to 150% in each successful plot; an increase in the area of the characters (which is what your eye registers) of a factor of roughly 2.25.

From these three plots it can be seen that for plots of this overall size the range of multipliers considered here more or less span the useful range of the character multiplier, i.e. a smaller multiplier would make the characters difficult to read and a larger multiplier would make the characters disproportionately large.

\begin{verbatim}
0.00000 13.50000 0.00000 10.0 1 1 0.7
-1 -1 0 0 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0

0.00000 13.50000 0.00000 10.0 1 1 1.0
-1 -1 0 0 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0

0.00000 13.50000 0.00000 10.0 1 1 1.5
-1 -1 0 0 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0
\end{verbatim}
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium.
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Types of Grids

In the following example each of the six plots contains exactly the same data and the only difference between them is that each has a different type of grid, corresponding to grid types 0 through 5 (cols. 34-44 on the second line).

```
0.00000 13.50000 0.00000 10.0 1 1 1.0
-1 -1 0 0 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0

0.00000 13.50000 0.00000 10.0 1 1 1.0
-1 -1 0 1 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0

0.00000 13.50000 0.00000 10.0 1 1 1.0
-1 -1 0 2 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0

0.00000 13.50000 0.00000 10.0 1 1 1.0
-1 -1 0 3 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0

0.00000 13.50000 0.00000 10.0 1 1 1.0
-1 -1 0 4 0 -2 0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0

Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
0 2 0 0
0 2 0 0
```
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium

Emission Energy (eV)

Emission Probability and Integral

X-Rays 89.5108 %

X-Rays 89.5108 %
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Composition Mode - Non-overlapping Subplots

In composition mode you are free to position any number of plots, anywhere on a page. To enter the composition mode the number of plots per page in the X direction should be a negative integer (cols. 45-55 on the first input line); this is a signal to the code not to advance to the next plotting area at the end of the current plot. The code will stay in this mode until you specify a positive number of plots in the X direction; AFTER this plot is completed the code will advance to the next plotting area.

In the below example four subplots are positioned on a page. For the first three of these the number of plots in the X direction is set to -1 (cols. 45-55 on the first input line). For the fourth (last) subplot the number of plots in the X direction is set to 1 - indicating the end of the page AFTER this plot is completed.

The first subplot occupies the entire upper half of the page (X = 0 to 13.5, Y = 5 to 10 - on the first input line). The following three subplots occupy the lower half of the page (Y = 0 to 5), in three adjacent X ranges (X = 0 to 4.5, 4.5 to 9, 9 to 13.5).

One important restriction on the use of the composition mode - you must only specify one subplot at a time (cols. 45-66 of the first input line) and individually position each subplot.

<table>
<thead>
<tr>
<th>Incident Neutron Energy (MeV)</th>
<th>Cross Section (barns)</th>
<th>ENDL</th>
<th>Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00000 13.50000 5.00000 10.00000</td>
<td>-1 0 0 0</td>
<td>0</td>
<td>2 0 0 0</td>
</tr>
<tr>
<td>0.00000 4.50000 0.00000 5.00000</td>
<td>-1 0 0 0</td>
<td>0</td>
<td>2 0 0 0</td>
</tr>
<tr>
<td>Incident Neutron Energy (MeV)</td>
<td>Cross Section (barns)</td>
<td>ENDL</td>
<td>Cross Section</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------</td>
<td>------</td>
<td>--------------</td>
</tr>
<tr>
<td>1.00000-6 1.00000-5 4.50000 9.00000 0.00000 5.00000</td>
<td>-1 0 0 0</td>
<td>0</td>
<td>2 0 0 0</td>
</tr>
<tr>
<td>Incident Neutron Energy (MeV)</td>
<td>Cross Section (barns)</td>
<td>ENDL</td>
<td>Cross Section</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------</td>
<td>------</td>
<td>--------------</td>
</tr>
<tr>
<td>1.00000-5 1.00000-4 9.00000 13.50000 0.00000 5.00000</td>
<td>-1 0 0 0</td>
<td>0</td>
<td>2 0 0 0</td>
</tr>
<tr>
<td>Incident Neutron Energy (MeV)</td>
<td>Cross Section (barns)</td>
<td>ENDL</td>
<td>Cross Section</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------</td>
<td>------</td>
<td>--------------</td>
</tr>
<tr>
<td>1.00000-4 1.00000-3 0.00000 5.00000</td>
<td>-1 0 0 0</td>
<td>0</td>
<td>2 0 0 0</td>
</tr>
</tbody>
</table>
Composition Mode - Non-overlapping Subplots (continued)

The following plot presents exactly the same data in exactly the same page layout as the preceding plot. The only differences between this plot and the preceding one are,

1) Each subplot has a border around it, to more clearly delineate the subplots. This is accomplished by setting cols. 23-33 of the second input line to 1. This option can be handy when preparing plots which will appear in a report as a part of a page mixed in with text.

2) The legend box has been removed from all subplots. In this case there is only one curve and the information presented in the legend on the preceding plot is redundant in the sense that it merely repeats what is stated in the title lines at the top of the plot. The legend box will not appear on the plot if cols. 56-66 of the seven line are set to 1.

```
0.00000  13.50000  5.00000  10.0       -1       1 1.5
-1       0       1       0       0       0

Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9(2U)2}3 (n,rg)
Cross Section

0.00000    4.50000    0.00000    5.0       -1       1 2.0
-1       0       1       0       0       0

Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9(2U)2}3 (n,rg)
Cross Section

1.00000-  6 1.02000-  5
0       2       0       1
0       2       0       0

4.50000    9.00000    0.00000    5.0       -1       1 2.0
-1       0       1       0       0       0

Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9(2U)2}3 (n,rg)
Cross Section

1.00000-  5 1.00000-  4
0       2       0       1
0       2       0       0

9.00000    13.50000   0.00000    5.0       1       1 2.0
-1       0       1       0       0       0

Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9(2U)2}3 (n,rg)
Cross Section

1.00000-  4 1.00000-  3
0       2       0       1
0       2       0       0
```
Composition Mode - Overlapping Subplots

The preceding examples of the composition mode only considered the case of non-overlapping subplots. In the following example the true power of the composition mode is illustrated in positioning subplots anywhere on a page to create special effects.

In this example there are three subplots. The first subplot occupies the entire page (X = 0 to 13.5 and Y = 0 to 10). The following two subplots are positioned within the same plotting area; one is located in X = 8.5 to 12.5, Y = 5.5 to 9.0, and the another in X = 1.3 to 5.3, Y = 0.85 to 4.35 (in each case a 4 by 3.5 subplot). The positions of these subplots were defined in a trial and error manner using a computer terminal screen; once their positions were defined the following hardcopy was produced.

The restrictions in using overlapping subplots includes the general restriction, described earlier, that each subplot must be positions separately, plus the restriction that only the inner most subplots can contain grids other than simple tick marks on the border. Each subplot is positioned and drawn separately without any knowledge of the other subplots. Therefore if subplots other than the inner most subplot include grids, the grid will overwrite the area occupied by the inner subplot and the results will not be very pleasing.

Note, all three examples of using the composition mode also used the alternate character set - Jg is plotted as a Greek gamma, as well as super and subscripts to identify 92-U-238.

```
0.00000  13.50000  0.00000  10.0           -1   1   1.0
 -1       0         0                 0         0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL (9(2U)2)38 (n,Jg)
Cross Section

0       2         0               1
0       2         0               0
8.50000 12.50000  5.50000  9.0       -1   1   2.0
 -1       0         1                 0         0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL (9(2U)2)38 (n,Jg)
Cross Section
 1.00000- 6 1.03000- 5
   0       2         0               1
   0       2         0               0
1.30000  5.30000  0.85000  4.35         1   1   2.0
 -1       0         1                 0         0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL (9(2U)2)38 (n,Jg)
Cross Section
 1.00000- 5 1.00000- 4
   0       2         0               1
   0       2         0               0
```
Randomly Positioned Titles

For use in special applications this code has the ability to position titles anywhere on the plotting surface. As distributed this option is internally turned off. However, if you wish to use it, it is fairly easy to reactivate this option; use a text edit to search for the word DEBUG and activate all FORTRAN statements between pairs of DEBUG lines.

Once activated this option will read X and Y coordinates followed by a title from a file named TITLES.DAT. There may be up to 30 sets of X and Y coordinates and titles. Each title may be up to 72 characters in length. X and Y coordinates are absolute in the units of the plotter, e.g., inches, centimeters, etc.

The following plot illustrates the results obtained when this option is used to identify the photoelectric edges of lead. In this case the file TITLES.DAT contained the following 12 lines, used to define 6 sets of X and Y coordinates and titles. The X and Y coordinates for these titles were defined in a trial and error manner using a computer terminal screen; once their positions were defined the following hardcopy was produced.

```
1.70000+0 9.00000+0  P
1.90000+0 8.80000+0  O
2.90000+0 8.35000+0  N
4.20000+0 7.80000+0  M
5.00000+0 7.10000+0  L
5.80000+0 6.30000+0  K Edge
```
Lead
Photoelectric Cross Sections

- Total Photoelectric
- K (1s1/2)
- L1 (2s1/2)
- L2 (2p1/2)
- L3 (2p3/2)
- M1 (3s1/2)
- M2 (3p1/2)
- M3 (3p3/2)
- M4 (3d3/2)
- M5 (3d5/2)
- N1 (4s1/2)
- N2 (4p1/2)
- N3 (4p3/2)
- N4 (4d3/2)
- N5 (4d5/2)
- N6 (4f5/2)
- N7 (4f7/2)
- O1 (5s1/2)
- O2 (5p1/2)
- O3 (5p3/2)
- O4 (5d3/2)
- O5 (5d5/2)
- P1 (6s1/2)
- P2 (6p1/2)
- P3 (6p3/2)

Cross Section (barns)

Inincident Photon Energy (MeV)
Comparison of Evaluated and Experimental Data

The following example uses many of the options described so far to produce a series of plots, first comparing two evaluations to all of the available experimental data, and then comparing only the two evaluations.

The first plot is over the energy range 1 keV to 30 MeV, the entire energy range over which both evaluations are defined. This plot really doesn't show us very much, except that: 1) at low energy the two evaluations are quite different and, 2) there are no experimental data below about 10 keV. Usually if these data haven't been "seen" yet a plot such as this is first generated and based on examining the plot energy ranges or options are selected for additional plots, as is done below.

The second plot shows all of the data from 10 keV to 30 MeV. The third through fifth plots show the energy ranges 10-100 keV, 100 keV-1 MeV and 1-30 MeV, including the ratio of everything to the first evaluation. Here by using the ratio we can quantitatively define the actual spread in the evaluated and experimental data. From these plots we can easily see that above 10 keV the two evaluations are very similar, with differences exceeding 10 % only below about 20 keV, and differences of only 6-7 % above 30 keV; these differences are small compared to the spread in the experimental data.

The next two plots compare only the two evaluations over the energy ranges 1 keV-30 MeV and 10 keV-30 MeV. From these plots we can see the importance of interpolation. The tabulated values in the ENDL Old evaluation are quite close to the values in the ENDL New evaluation. However, in the 1-10 keV energy range the ENDL Old evaluation does not contain enough energy points, resulting in the unrealistic "bumps" in the cross section between tabulated points. The result is that between tabulated energies the interpolated values of the cross sections differ by factors of almost 20 (i.e., almost 2000 %). In this energy range there are no experimental values and the cross section is extremely small, i.e., less than 0.1 micro-barns.

The next plot even more dramatically demonstrates the importance of proper interpolation. This plot is exactly the same as the previous plot comparing the two evaluations over the energy range 1 keV-30 MeV, except that the input parameters indicates log-log interpolation between tabulated data points (cols. 34-44 of the 7-th [for X] and 8-th [for Y], input lines). In the previous plot using linear-linear interpolation differences of almost 2000 % were found. Here using exactly the same data but log-log interpolation the differences are less than 60 %, and less than 25 % for all energies above 1.2 keV.

The last two plots illustrate that using the character size multiplier also effects the size of symbols used to define sets of data points. In this case the two plots correspond to previous plots of this series for the energy range 1-30 MeV, but in this case character size multipliers of 1.2 and 1.5, respectively, are used. For plots containing various sets of data points this effect can often be used to more clearly see the individual symbols representing each set of points.
<table>
<thead>
<tr>
<th>Incident Deuteron Energy (MeV)</th>
<th>Cross Section (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENDL (2H (d,n) (3He)</strong></td>
<td><strong>Evaluated and Experimental Cross Sections</strong></td>
</tr>
<tr>
<td>1.00000 -3</td>
<td>0 2 0 0</td>
</tr>
<tr>
<td>1.00000 -2</td>
<td>0 2 0 0</td>
</tr>
<tr>
<td><strong>ENDL (2H (d,n) (3He)</strong></td>
<td><strong>Evaluated Cross Sections</strong></td>
</tr>
<tr>
<td>1.00000 -1</td>
<td>0 2 0 0</td>
</tr>
<tr>
<td>1.00000 0</td>
<td>0 2 0 0</td>
</tr>
<tr>
<td>3.00000 +1</td>
<td>0 2 0 0</td>
</tr>
<tr>
<td>0.00000 13.50000 0.00000 10.0</td>
<td>1 1 1 0</td>
</tr>
<tr>
<td>-2 -30 0</td>
<td>4 0 -2 0</td>
</tr>
</tbody>
</table>

PLOTTAB
ENL $^2$H (d,n) $^3$He
Evaluated and Experimental Cross Sections

Incident Deuteron Energy (MeV)

Cross Section (barns)

10$^{-3}$  10$^{-2}$  10$^{-1}$  10$^0$  10$^1$  10$^2$

10$^{-16}$  10$^{-14}$  10$^{-12}$  10$^{-10}$  10$^{-8}$  10$^{-6}$  10$^{-4}$  10$^{-2}$

ENL New
--- ENL Old

Arnold '54
Blair '48
Booth '66
Brolley '57
Brown '90
Chagnon '56
Dachnick '58
Davidenko '57
Droeg '78
Elliot '53
Erickson '49
Ganev '57
Goldberg '60
Hunter '49
Krauss '87a
Krauss '87b
Manley '46
McNeill '51
Okihama '79
Preston '84
Schulte '72
Thornton '69
ENDL $^2$H (d,n) $^3$He
Evaluated and Experimental Cross Sections

Cross Section (barns)

Incident Deuteron Energy (MeV)

ENDL New
--- ENDL Old

Arnold '54
Blair '48
Booth '56
Brolley '57
Brown '90
Chagnon '56
Daehnick '58
Davidenko '57
Droog '78
Eliot '53
Erickson '49
Ganeev '57
Goldberg '60
Hunter '49
Krauss '87b
Krauss '87a
Manley '46
McNeil '51
Okhman '79
Preston '54
Schulte '72
Thornton '69

PLOTTAB
ENL \(^2\text{H} (d,n)^3\text{He}\)

Evaluated and Experimental Cross Sections

| Maximum Difference | -13.90 % at \(X = 1.285 - 2\) |

---

Incident Deuteron Energy (MeV)
ENL, $^2$H (d,n) $^3$He
Evaluated and Experimental Cross Sections

Maximum Difference
-6.822 %
at $X = 0.029$

Incident Deuteron Energy (MeV)
ENDL $^2$H (d,n) $^3$He
Evaluated and Experimental Cross Sections

Evaluation

- ENDL New
- ENDL Old
- Blair '48
- Brolley '57
- Daehnick '58
- Droeg '78
- Erickson '49
- Goldberg '60
- Hunter '49
- Okihana '79
- Schulte '72
- Thornton '69

Maximum Difference
-6.172 %

at $X=1.171$

Incident Deuteron Energy (MeV)
 ENDL $^2\text{H} \ (d,n) \ ^3\text{He}$

Evaluated Cross Sections

- ENDL New
- ENDL Old

Maximum Difference
1.951±3 %
at $X=1.049-3$

Incident Deuteron Energy (MeV) vs. Cross Section (barns)

Ratios

PLOTTAB
ENDL ²H (d,n) ³He
Evaluated Cross Sections

Cross Section (barns)

Ratios

Incident Deuteron Energy (MeV)

Maximum Difference
-13.90 %
at X= 1.285-2

ENDL New
ENL Old
ENL 2H (d,n) 3He Evaluated Cross Sections

- Cross Section (barns)
  - 10^{-2}
  - 10^{-4}
  - 10^{-6}
  - 10^{-8}
  - 10^{-10}
  - 10^{-12}
  - 10^{-14}

- Incident Deuteron Energy (MeV)
  - 10^{-3}
  - 2
  - 4
  - 6
  - 8
  - 10
  - 2

- Ratios
  - 0.8
  - 0.9
  - 1.0
  - 1.1
  - 1.2
  - 1.3
  - 1.4
  - 1.5
  - 1.6

ENDL New
ENDL Old

Maximum Difference
58.86 %
at X = 1 000 - 3
ENL $^2$H (d,n) $^3$He Evaluated and Experimental Cross Sections

Cross Section (barns)

Ratios

Incident Deuteron Energy (MeV)

Maximum Difference
-6.172 %
at X= 1.171
ENDL $^2$H (d,n) $^3$He
Evaluated and Experimental Cross Sections

- ENDL New
- ENDL Old
  - Blair '48
  - Brolley '57
  - Daehnick '58
  - Drosg '78
  - Erickson '49
  - Goldberg '60
  - Hunter '49
  - Okihana '79
  - Schulte '72
  - Thornton '69

Maximum Difference
6.172 %
at $X = 1.171$

Incident Deuteron Energy (MeV)

Cross Section (barns)

Ratios