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REPORT ON
THE IAEA CROSS SECTION PROCESSING CODE VERIFICATION PROJECT

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Vienna, Austria

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Abstract

The IAEA is presently engaged in a project which is designed to use a step-by-step approach to verifying the accuracy of neutron cross section processing codes. This report presents the results of the first step, or round, of comparisons. The first round of comparisons is intended to test the ability of processing codes to accurately produce, cold (0 Kelvin), unshielded, flat weighted multigroup cross sections; in principle this should be the simplest quantity that can be derived from evaluations. At present contributions to this project have been received from forty-two participants using thirteen different processing codes. In the initial comparisons not one participant has been able to obtain agreement with benchmark results; differences varied from 2% to a factor of over 50. However, this project has already in its initial phase been successful in detecting and correcting problems with a number of cross section processing codes and, in particular, has led to the practical result of identifying accurate codes and of improving the ENDF/B-V dosimetry library as distributed in 620 groups.

Introduction

The International Atomic Energy Agency (IAEA) has begun a project for the intercomparison of neutron cross section processing codes in order to verify their ability to reproduce proven correct numerical benchmark results. In this report this reproducibility aspect is referred to as the "processing accuracy" of a code. This paper will discuss: the scope of this project, the most prominent areas and sources of disagreement between processing codes and the current status of this project concerning improving the reliability of the output from processing codes.

The neutron cross section processing code is merely a link between evaluated data on the one hand and transport or adjustment codes on the other hand. This fact has been used in order to simplify the verification task; specifically, the IAEA project attempts to assure that for a given input of evaluated data and physical assumptions, the output of the cross section processor is accurate. This project does not address the "evaluation accuracy" of the evaluated data (which are used as input to the processor), nor the "model accuracy" of the transport or adjustment code (which uses the output of the processor).

The objectives of this project are: (1.) to test the accuracy of processing codes, (2.) to understand and eliminate the sources of discrepancies, (3.) to arrive at the point where we have a number of cross section processing codes which can be used as safely as possible as

"black boxes", without worry, to accurately process cross section data, for use in a variety of applications. At the present time, this project has been successful in the sense that starting from a variety of processing codes which produced multigroup cross sections which were not the same from any two codes, we have now arrived at the point where a number of the codes produce results which agree with benchmark results.

Background

In 1981 a report was published (1) on a comparison (performed in 1980) between the 620 group (SAND-II structure (2)) averaged cross sections derived from the ENDF/B-V Dosimetry Library (3) at Brookhaven and those derived at ECN Petten, Netherlands. These 620 group cross sections were both derived from the same evaluated data and the group constants corresponded to cold (0 Kelvin), unshielded, flat weighted results. Of the twenty-five materials in the ENDF/B-V Dosimetry Library large differences were found in fourteen reactions. In individual reactions, in specific groups, differences were found of up to a factor of twenty (not twenty per-cent, a factor of twenty). Fig. 1 illustrates the ratio of the 620 group ^{237}Np fission cross sections calculated at Brookhaven to those calculated at Petten (1). From fig. 1, in the unresolved resonance region there appears to be no correspondence between the multigroup results generated by the two codes starting from the same evaluated data. Unfortunately this study (1) could not address the question of which of these two sets of data is correct.

In order to determine which of these two sets is correct the IAEA obtained additional multigroup data sets from a number of laboratories in the United States and Europe. Comparison of data sets generated at eight different laboratories showed general agreement and confirmed that the cross sections generated at Brookhaven were incorrect. In none of these eight sets were differences seen that were anywhere near those found in the Brookhaven/Petten comparison. However, in no case did any two of the data sets agree for all reactions, in all groups to within 6%. This was a very surprising result, since generally these data sets were purported to be accurate to within a small fraction of one per-cent.

IAEA Verification Project

Based upon the disagreement that was seen between the output data generated by a variety of cross section processing codes the Nuclear Data Section of the IAEA decided to initiate a project to methodically examine and compare the output of cross section processing codes in order to determine the current accuracy of these codes. These comparisons could then be used to improve the codes in order to reach the ultimate goal of this project, which is to identify those processing codes which can be reliably used to process evaluated cross section data. Potential users of cross section processing codes would be periodically informed by an IAEA publication specifying those codes which have been tested and in particular those that have passed a set of benchmark tests and can be recommended for reliable use.

This verification project is based on asking one simple question "Given a set of evaluated data can the existing cross section processing codes reliably produce output to some specified accuracy for use in applications?" Based upon the initial comparisons performed at the beginning of this project the answer to this question was a resounding NO! Fortunately this project has demonstrated that by intercomparing codes it is possible to greatly improve the reliability of results.

It is important to understand that this verification project is not designed to examine the quality of evaluated data which is used as input to processing codes, nor is it designed to examine the transport methods that use the output from these codes. It should be realized that since the results of transport calculations are often used in an attempt to improve evaluated data (e.g. sensitivity calculations), the evaluated data, cross section processing and transport calculations are not completely independent. However, this verification is only designed to guarantee the accuracy of the output from cross section processing codes. If this can be achieved, then any differences between the results of transport calculations and experimental measurements can be truly identified as due to either the evaluated data, transport model or both. In this case the result of transport calculations can be used to improve evaluations and/or transport methods. However, as long as processing codes introduce large uncertainties into the multigroup data, any differences between calculated and measured results may be due to error in processing, which would prevent any attempt to improve evaluations or transport methods.

Establishing Benchmark Results

In order to verify the accuracy of the results provided by cross section processing codes it is necessary to establish benchmark results which can be used as a standard for comparison. Because of the complexity and volume of data included in modern evaluations, cross section processing codes have become correspondingly complex making it difficult, if not impossible, to verify that any given processing code will produce accurate results for all combinations of cross section representations encountered in modern evaluations. To give but one example, ENDF/B format cross sections may be represented by a combination of tabulated data and resonance parameters. The tabulated data may use up to five different types of interpolation laws. Both resolved and unresolved resonance parameters may be given. Resolved parameters may be given in terms of one of four representations and unresolved parameters in terms of one of three representations. In addition the ENDF/B formats and conventions which specify how to interpret resonance parameters are not the same for all versions of the ENDF/B library. From this one example one can appreciate the difficulty of attempting to verify that a processing code can accurately process all possible combinations of tabulated data and resonance parameters, let alone all of the other data required for a transport calculation.

In the past attempts have been made to establish idealized evaluations which would be simple to process and compare results. Generally these efforts have failed because (1.) the evaluations were too idealized and although they tested basic representations of evaluated

data they did not correspond to or simulate the complexity of modern evaluations, (2.) since the evaluations were idealized the results were not of practical interest which made it difficult to generate enthusiastic support from code designers and made it equally difficult for code designers to justify spending their time, efforts and computer expense involved in processing these idealized data.

For this project it was decided to take a more pragmatic approach in which real evaluations would be used to generate results. Establishing benchmark results by this approach presented a problem since as pointed out earlier initial comparisons of the results generated by a variety of processing codes demonstrated that no two codes initially generated the same results.

In order to establish benchmark data the results of comparisons were returned to each processing code designer. Each code designer was asked to independently examine the comparisons, investigate the sources of observed differences, implement code improvements and submit improved results. Even the initial code comparisons made it possible to identify a number of generic problems that existed in most or all codes and allowed the code designers to focus on the source of problems and to improve their codes. Using this approach it was possible to arrive at the point where a number of processing codes can now each produce the same multigroup results to within a small fraction of 1% for all reactions, in all groups. More important than the absolute differences in the results generated by these codes is the observation that differences in the results are now significantly smaller than the uncertainty in the evaluated data. As such it is now possible to interpret the multigroup data as having the same uncertainty as the evaluated data. Therefore any differences between calculated and experimental results obtained using this data may now be interpreted as due to either the evaluated data or transport method, which in turn may be used to improve the evaluated data and/or transport method.

This benchmark approach does not lead to absolute benchmark results where we can say one or more codes exactly reproduce the standard results. Rather it leads to practical benchmark results which can be reproduced to within a required accuracy. Therefore within this report we will not identify the results obtained by one single code as a standard, nor will we attempt to distinguish between the codes which can reproduce the standard to high accuracy; we will merely present the results of initial and current comparisons and identify those codes which can presently reproduce the benchmark results within an acceptable accuracy.

Problem Areas

The results of initial comparisons indicated large differences in the cross sections generated by various codes, primarily in the resolved and unresolved resonance regions. These differences will affect both the self-shielding and Doppler broadening properties of the cross sections. Similarly, recently Perez (4) has shown an inconsistency in the methods normally used to calculate group averaged cross sections in the unresolved resonance region. By calculating self-shielded cross sections in the resolved resonance region first directly from the resolved data

and then by treating the data as unresolved and using the equivalent average level widths and spacings Perez found differences in excess of 30%. In addition, Perkins (5) has recently investigated the numerical stability of the methods used to generate group-to-group transfer matrices and has found that if extreme care is not used severe round-off problems can occur.

A more subtle problem area is the effect of these inconsistencies on the many relatively new applications which use the uncertainties quoted for the evaluated data in order either to assign confidence limits to calculational results or to improve our knowledge of spectra or cross sections (6) (e.g. unfolding procedures (7)). The results of these calculations can be very sensitive to the uncertainties assigned to the cross sections used. If the cross section processor introduces an error which is large compared to the error assigned to the evaluated data (as occurred in the initial comparisons described above) the results obtained using the processed cross sections and only the uncertainties assigned to the evaluated data, without folding in the errors introduced by the cross section processor, are of questionable validity.

Step by Step Verification

Attempting to eliminate this multitude of deficiencies from processing codes in one fell swoop is too ambitious an undertaking and one that would be almost bound to fail. Therefore the IAEA has decided to begin a step-by-step verification project in an attempt to address first the most glaring areas of disagreement, using the simplest possible test cases. Then more subtle areas of disagreement will be addressed, using progressively more complex test cases.

Following this step-by-step philosophy at present two rounds of comparisons are being performed. In the first round of comparisons the areas of largest disagreement, which is the calculation of cross sections in the resolved and unresolved resonance regions, will be investigated. The simplest way to investigate this problem would be to compare the energy dependent point cross section values generated by a variety of processing codes. However, this information is not available from all processing codes. The next best, simple comparison is constant (flat-weighted), cold, unshielded cross sections using a fine group structure.

In the second round of comparisons those processing codes which have passed the first round of tests are asked to calculate complete sets of multigroup data for a variety of representative materials. This second round will allow us to investigate self-shielding, Doppler broadening, transfer matrices, to name but a few areas of interest.

First Round

The first round of comparisons is being coordinated directly by the IAEA Nuclear Data Section and anyone interested in participating or obtaining more information should contact

D.E. Cullen
Nuclear Data Section
International Atomic Energy Agency
P.O. Box 100, Wagramerstrasse 5
A-1400 Vienna, Austria

The first round is directed toward testing data which is used in general applications.

For the first round of comparisons the IAEA Nuclear Data Section is asking all those interested in participating in this exercise to use the same evaluated neutron data: ENDF/B-V Dosimetry Library (mod. 1), to calculate flat weighted, 0^{o} Kelvin, unshielded cross sections using the SAND-II 620 group structure. Those who use energy-dependent cross sections (e.g. in continuous energy Monte Carlo calculations) will be asked to send energy-dependent cross sections and IAEA Nuclear Data Section will convert them to multigroup form for comparison. Anyone who uses neutron cross sections is encouraged to participate in this study.

Results should be sent to D.E. Cullen at the IAEA in the ENDF/B format (each reaction as a section of file 3 using the histogram interpolation law) (3).

The results of each comparison will be reported back to the participants. If there are any differences, participants will be asked to investigate and eliminate the sources of these differences and to then re-submit their results.

Second Round

Within the United States

The second round of comparisons is being coordinated within the United States by

N.M. Greene
Union Carbide Corporation
Nuclear Division
P.O. Box X, Oak Ridge, TN. 37830
U.S.A.

For the second round of comparisons within the United States all those interested in participating should use ENDF/B-V data for H (MAT 1301), Fe (MAT 1326) and ^{238}U (MAT 1398). Two separate sets of comparisons will be performed, first involving neutron cross sections and second involving photon production cross sections.

For the neutron cross section comparison participants are asked to use a 100 group set of boundaries consisting of the GAM-II structure with one thermal group. This group structure has 49 groups equally spaced in lethargy between 14.91825 MeV and 110.9 keV, 50 groups equally spaced in lethargy between 110.9 keV and 0.414 eV and one thermal group from 0.414eVto 10^{-5}eV. Participants should use room temperature (293 K) and two different weighting spectra, one flat-weighted and the other fully shielded, i.e. $1/E\sigma_T$ weighted.

Participants are asked to submit,

1. Group-averaged values of as many processes (e.g. total, elastic, (n,2n)....etc.) as can be conveniently supplied.

2. Scattering matrices separated by process (if at all possible) with P_3 Legendre fits of processes with angular dependence.

3. A short description of any special treatments which the code may have used in generating the numbers. For example, the code could have used an analytic treatment for hydrogen elastic scattering which assumes the cross sections are isotropic in the center-of-mass system (as AMPX does), or within-group terms may have been transport-corrected, etc.

For the photon production cross section comparison participants are asked to use the same 100 group set for neutrons, described above, and a 20-group structure with 1 MeV increments from 20 MeV to 1 MeV and the bottom group extending to 25 keV. In this case participants are asked to submit scattering matrices separated by process for all gamma producing interactions. A P_3 Legendre fit should be used for those processes with angular dependence. If the matrices are in "yield" units, the average neutron cross sections of the processes should be supplied.

Results should be sent to N.M. Greene at Oak Ridge on magnetic tape in a BCD format which can be read on an IBM-computer, e.g. blocked in 80-character records in ASCII or EBCDIC, preferably labelled and written at 1600 or 6250 bpi.

As yet benchmark results for these materials have not yet been established.

Outside United States

The second round of comparison is being coordinated outside the United States by,

P. Vertes
Central Research Institute
for Physics
Hungarian Academy of Sciences
P.O. Box 49
H-1525 Budapest, Hungary

For the second round of comparisons outside the United States the Nuclear Data Section of the IAEA will make available evaluated data in the ENDF/B format for the following materials, H, C, Fe, ^{232}Th, ^{235}U, ^{238}U, ^{237}Np, and ^{239}Pu (note, since the ENDF/B-V library is only available within the United States, these materials will be in the ENDF/B-V format, but not from the ENDF/B-V library). Only neutron data will be compared.

For this comparison participants are asked to use the ABBN 26 group structure, a flat weighting function and the following constants are to be submitted:

1. "Cold" (not Doppler broadened), self-shielded (i.e. $1/(\sigma_T+\sigma_0)$ weighted), group averaged cross-sections and/or self-shielding factors for each of the processes: total, elastic, (n,γ), (n,f) as can be conveniently supplied. The following self-shielding conditions should be used:

Material	Bondarenko σ_0			
Fe (MAT=1192)	10	10^2	10^3	10^4
^{232}TH (MAT=1296)	10	50	10^2	200
^{235}U (MAT=1261)	10	10^2	10^3	10^4
^{238}U (MAT=1262)	10	50	10^2	200
^{237}Np (MAT=1263)	10	10^2	10^3	10^4
^{239}Pu (MAT=1264)	10	10^2	10^3	10^4

2. Elastic scattering matrices with up to P_3 Legendre fits without self-shielding for the above materials plus for H (MAT=1301) and C (MAT=1306)

3. Group-averaged elastic slowing-down constants:
   - average scattering cosine in laboratory system
   - average lethargy change

   if they are calculated from elastic angular distribution

4. Inelastic scattering matrices for materials in the above table. These may be given either by inelastic processes separately, or in any "summed up" form (total inelastic scattering matrix, total discrete level matrix and matrix for unresolved inelastic levels, separately).

Results should be sent to P. Vertes, Budapest on magnetic tape.

As yet benchmark results for these materials have not yet been established.

Subsequent Rounds

The results of the first two rounds of testing will be used to identify specific problem areas that require additional investigation, e.g. spectrum weighting, Doppler broadening and self-shielding. However, each of these effects will be introduced in a step-by-step manner so that when we see differences we can isolate the cause of the difference, which will simplify the task of remedying the problem.

Each of these areas of verification requires a coordinator and if all areas are to be investigated volunteers are needed to provide leadership in these studies. Anyone interested in leading this verification effort in one or more subject areas is asked to contact D.E. Cullen at the IAEA, Vienna.

Round One Results

To date we have received contributions from forty-two participants using thirteen different processing codes. The thirteen processing codes include,

ENTOSAN - Petten, Netherlands
RESEND/INTEND - Brookhaven National Laboratory, U.S.A.
LINEAR/RECENT/GROUPIE - Nuclear Data Section, IAEA, Austria
FOURACES - Bologna, Italy
RESCAL - Greenwood, Argonne National Laboratory, U.S.A.
RESENDD - JAERI, Japan
FEDGROUP-3 - Central Research Institute for Physics, Budapest, Hungary
FEDGROUP-C - Institut Jozef Stefan, Ljubljana, Yugoslavia
NJOY (CDC) - Los Alamos National Laboratory, U.S.A.
NJOY (IBM) - NEA Data Bank, Saclay, France
AMPX - Oak Ridge National Laboratory, U.S.A.
MINX - Oak Ridge National Laboratory, U.S.A.
GRUCON - Obninsk, U.S.S.R.

As pointed out results have been obtained from forty-two cross section processing code users. Of these results thirteen results were obtained from the actual code designer or laboratory presently responsible for maintenance of the code. Presumably the code designer or maintainer should be the one most familiar with each code and should submit the best results for each code. In addition if we are to focus on the objective of this project, which is not just to detect errors in codes, but rather to improve codes, the most important contributions were from code designers and maintainers, since in general they are the only ones in a position to use the initial comparisons to improve their codes.

Therefore in this report we will only present detailed results of the initial and current status of the results obtained from the thirteen code designers or maintainers. The results obtained from other participants will only be briefly summarized.

In the initial comparison of data of those who submitted complete results not even one participant has obtained agreement with our benchmark results within every group, for every reaction; the closest agreement was 2% and the worst disagreement was more than a factor of 50 (that is a factor of 50, not 50%). However, the verification project has led to positive results in the sense that once differences in the multigroup cross sections are located it has been fairly easy to identify the source of the differences, eliminate problem areas and end up with improved processing codes. This has been demonstrated by improved results obtained from participants which show greatly improved agreement with our benchmark results. The initial and current maximum differences found in the results submitted by each code designer or maintainer are presented in Table I.

Table I

Summary of initial and current maximum per-cent differences for each code

(results are presented in the chronological order in which they were received from code authors)

code	initial maximum difference	current maximum difference or status
RESEND	2018 %	abandoned
ENTOSAN	2 %	agreement
LINEAR/RECENT/GROUPIE	6 % *	agreement
FOURACES	2692 %	agreement
RESCAL	113 %	87 % *
RESENDD	5488 %	agreement
FEDGROUP-3	188 % **	16 % **
FEDGROUP-C	2482 % **	agreement
NJOY(CDC)	19 % *	agreement *
NJOY(IBM)	100 % *	19 % *
AMPX	24 %	1.7 %
MINX	2018 % **	no additional results
GRUCON	2.5 % **	no additional results

* - this ignores large per-cent differences for small cross sections near thresholds

** - comparison based on only a portion of ENDF/B-V dosimetry library

Problem Areas

Our initial round of comparisons identified a variety of problem areas in the participating cross section processing codes. Since most of these problems occurred in more than one code they will be discussed in detail here, rather than separately for each code. For each code it will merely be mentioned which problems existed initially or currently. The problem areas identified included,

1. Programming errors

which lead to large differences, as illustrated in fig. 1. The complexity of modern processing codes makes it difficult to locate such errors without resorting to intercomparison of the results generated by a variety of codes. For example, the major cause of the programming error illustrated in fig. 1 was found to be due to switching two arguments in the subroutine in RESEND which interpolates unresolved parameters. Since RESEND is the father or grandfather of many processing codes it is possible to intercompare the results from several codes which are based on RESEND and to obtain agreement, even though all are generating the same wrong answer. Only by comparing the results from several codes, which are developed independently, is it possible to find such programming errors.

2. Inadequate representation of narrow resonances

leading to large differences in the resolved resonance region, as illustrated in fig. 2. Most of the codes which participated in this study first convert the resolved parameters to energy dependent cross sections and then group average the energy dependent cross sections. Even if cross sections are accurately calculated within a computer, when a code outputs the cross sections reconstructed from resonances in the ENDF/B BCD format the normal E11.4 format can be totally inadequate to represent energies (e.g. 1234.56789 eV is output as either 1.2346E+3 or 0.1234E+3 depending on the computer). Extension of the format to six digit accuracy, as used in many codes, improves the accuracy (e.g., by not outputting "E" it is possible to output the above energy as 1.23457+3). However for heavy even-even isotopes which have milli-eV capture widths in the KeV energy range even six digits are inadequate to represent the shape of narrow resonances; the result can be to randomly either over- or underestimate the integral of narrow resonances. This effect has been avoided in several codes by either recognizing that energies are always positive and only require at most a one digit exponent, which allows energies to be output with up to nine digits of accuracy (e.g. the above energy can be output as 1.23456789+3) or by simply outputting energies in F format (e.g. output the above energy without an exponent in the form 1234.56789). Either of these representation is more than adequate to represent the energy well beyond the accuracy required. The magnitude of the error which results when the energy is output in the ENDF/B BCD format has been investigated (by the author) by using the entire ENDF/B-V dosimetry library. Internal to the computer all calculations were performed to the same accuracy, but the results were output to a different number of digits accuracy in the energy. Each result was then group averaged to 640 groups and results were compared. The maximum differences occurred, as expected, in ^{232}Th and ^{238}U capture due to narrow resonances. When compared to the

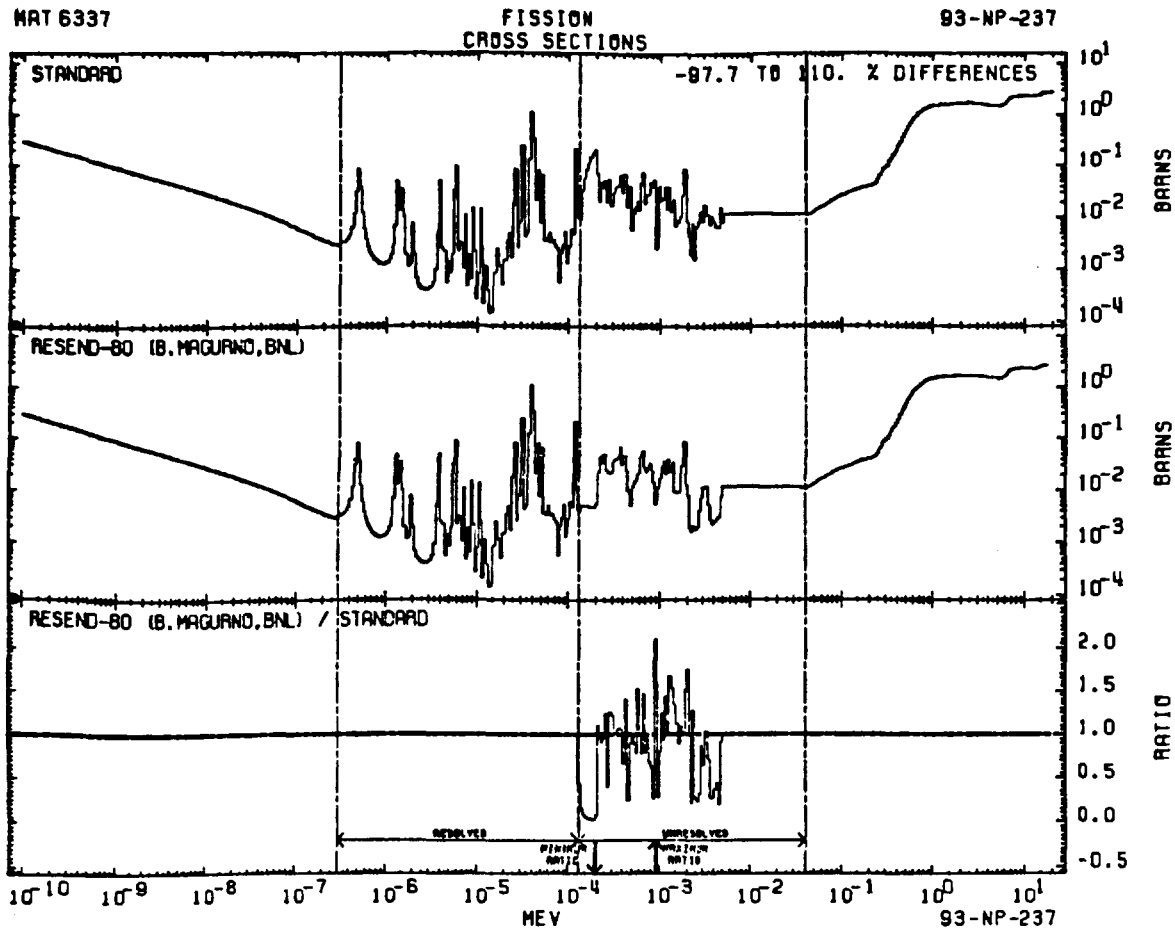

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-97.7 TO 110. % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
93-NP-237

Fig.1

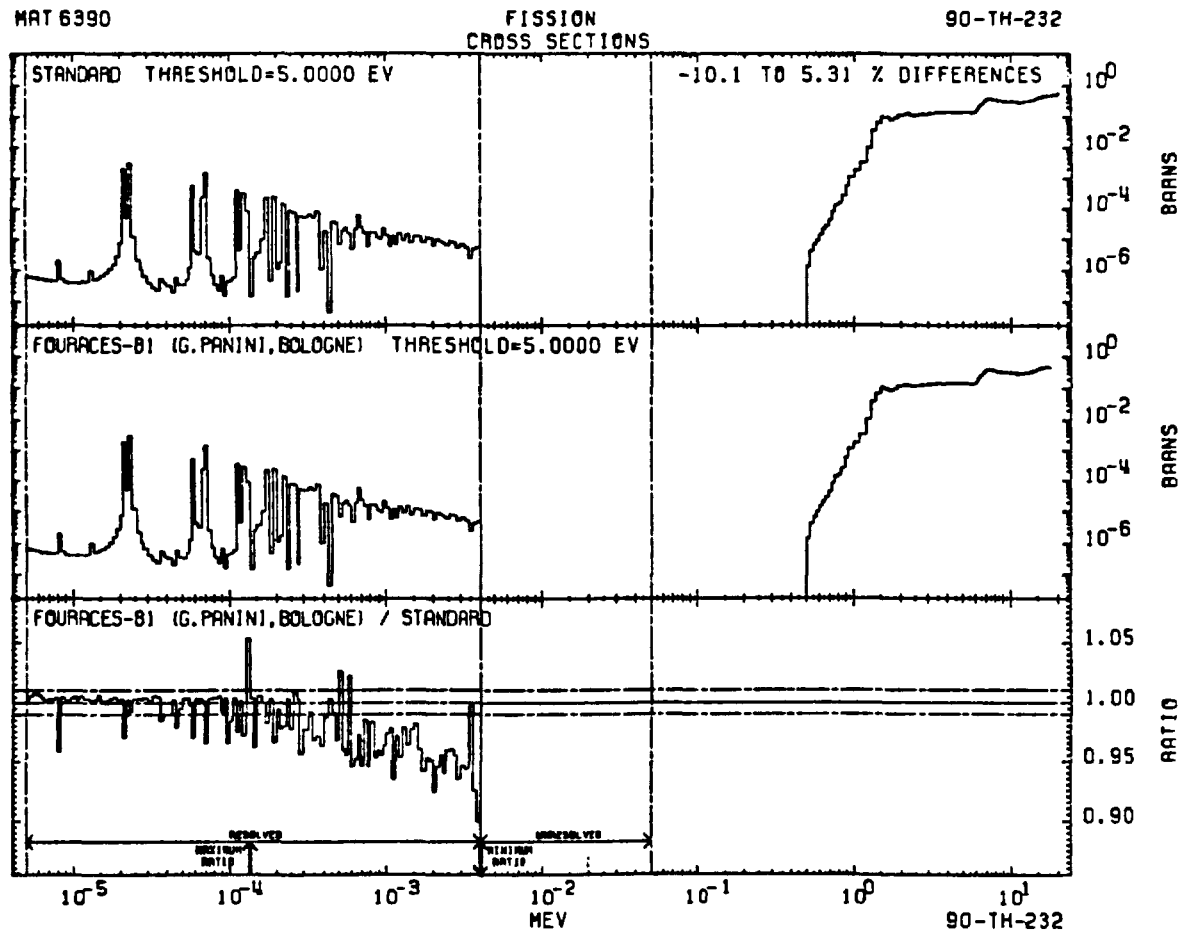

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-10.1 TO 5.31 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE) THRESHOLD=5.0000 EV
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
90-TH-232

Fig. 2

results based on energies output to nine digits accuracy the following maximum differences were found in one or more group averaged cross sections,

5 digit energy - 72%

6 digit energy - 6%

7 digit energy - 0.3%

8 digit energy - 0.0%

Some codes have completely avoided this problem by simply using the ENDF/B binary format for intermediate storage between the resonance reconstruction and the multi-group calculation; this approach will maintain the complete accuracy of the internal representation of the cross section. Logically this is the simplest approach to avoid the problem. However, it may be difficult to implement in existing codes and impractical to implement in existing code systems where a number of codes are each designed to use the ENDF/B BCD format for a variety of different applications.

3. Failure to consider the competitive width

In earlier versions of ENDF/B the total width for each resonance was defined as the sum of the elastic, capture and fission widths. In more recent versions of ENDF/B the competitive width is defined as the difference between the total width and the sum of the elastic, capture and fission widths and the threshold for the competitive reaction is defined by a Q-value. This has led to two problems: (a) some codes were not updated to consider the competitive width, which effectively ignore the competitive width and underestimate the strength of each resonance, (b) several codes which consider the competitive width fail to consider the competitive reaction Q-value. To correctly consider the intended effect of the competitive width it is necessary to use the available energy (incident energy minus competitive reaction threshold) in calculating the penetration factor for the competitive reaction. If this is done properly the effective competitive width reduces to zero below the threshold of the competitive reactions and smoothly increases above the threshold.

4. Interpolation in the unresolved resonance region

as illustrated in fig. 3. In all versions of ENDF/B three possible representations have been available within the ENDF/B format for unresolved resonance parameters: (a) all parameters energy independent (i.e. all parameters constant over a given energy range), (b) fission widths energy dependent with an implied interpolation law and all other widths energy independent, (c) all widths energy dependent with a given interpolation law. Until ENDF/B-IV the convention was that between the energies at which unresolved parameters are tabulated unresolved parameters should be interpolated to each energy and cross sections should be calculated at each energy based on the interpolated parameters. This was a scheme which was applicable to all three representations of unresolved parameters and which resulted in a unique representation of the unresolved parameters at each energy.

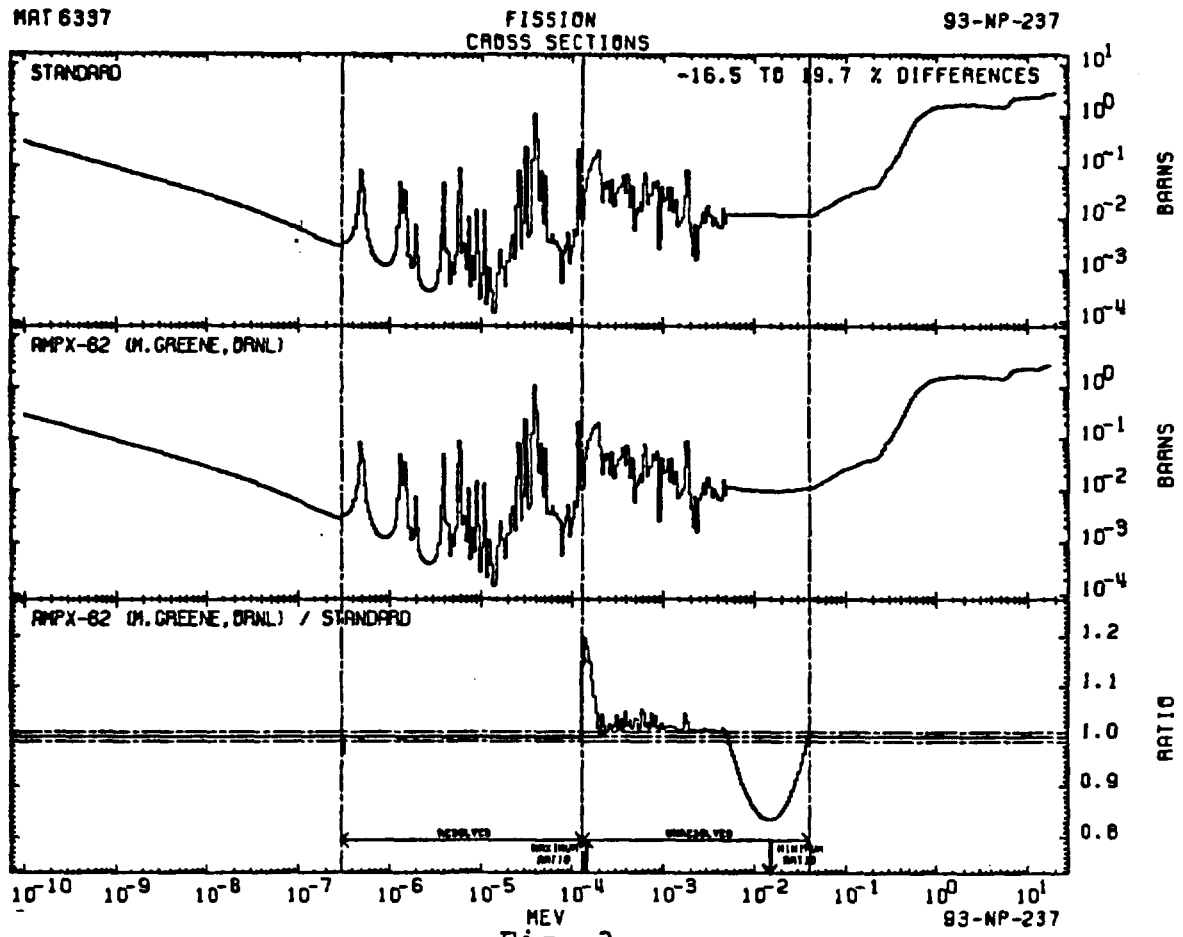

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-16.5 TO 19.7 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
93-NP-237

Fig. 3

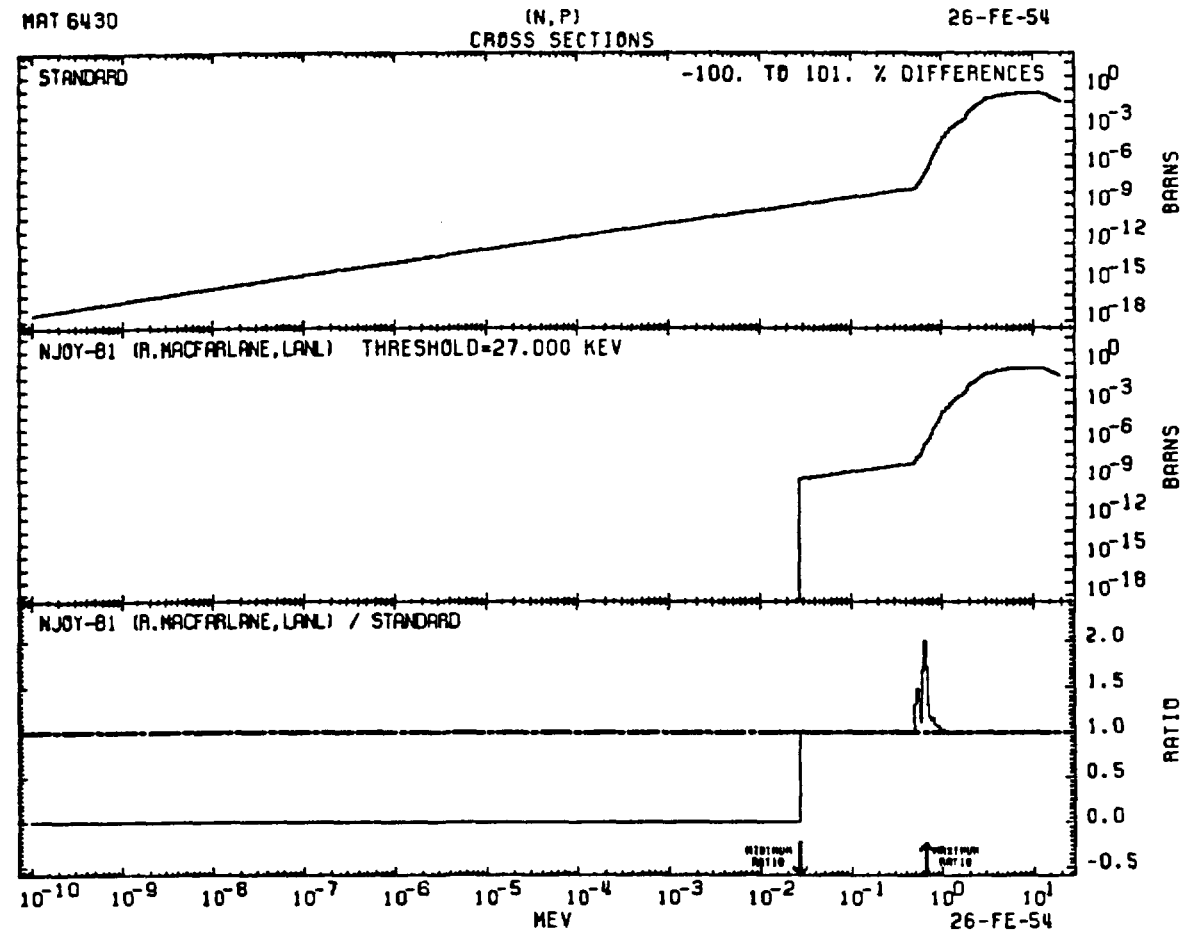

MAT 6430
(N,P)
CROSS SECTIONS
26-FE-54
STANDARD
-100. TO 101. % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=27.000 KEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
26-FE-54

Fig. 4

Starting with ENDF/B-V it was decided that for practical reasons in applications since it is the cross sections rather than the parameters that are actually used-it would be simpler to adopt the convention, for a set of parameters tabulated at a given set of energies, to calculate cross sections at the energies at which parameters are given and define the cross sections at all other energies by interpolating the cross sections rather than the parameters.

Therefore starting with ENDF/B-V it was decided that the convention should be that in the unresolved resonance region one should interpolate cross sections rather than parameters. In addition in going from ENDF/B-IV to V it was decided, again for practical use in applications, that the implied interpolation law for the fission width energy dependent, all other widths energy independent representation should be changed from log-log (ENDF/B-IV) to lin-lin (ENDF/B-V) interpolations.

At the time these appeared to be minor changes which should have minimal, if any, impact on the evaluated data files. In practice this has resulted in introducing major uncertainties into the cross sections calculated by processing codes. If we examine the three possible representations of unresolved parameters and the equations that describe the cross sections that result at any energy from a given set of unresolved parameters we can see that the effect of a set of energy independent parameters is to produce a basically 1/v cross section.

It quickly became obvious to processing code designers that since the energy independent representation of unresolved parameters can represent parameters as constant over a number of energy decades the all parameters energy independent representation of unresolved parameters did not lend itself to simply calculating the cross section at both ends of the energy interval and linearly interpolating between these two points to define the cross section at all intermediate energies. For example, using exactly the same evaluations which appeared in ENDF/B-IV and which were carried forward without modification to ENDF/B-V if one uses the ENDF/B-IV or V conventions one can obtain differences in the cross section based on parameter vs. cross section interpolation of over 300%. Linearly interpolating the cross section leads to non-realistic, non-1/v variation. Therefore most code designers who implemented the ENDF/B-V conventions decided that for the all parameters energy independent representation interpolating cross sections is "nonsense" or rationalized that since parameters are not energy dependent, there is nothing to interpolate and the constant parameters should simply be used at each energy to define the cross section.

When we examine the fission width energy dependent, all other widths energy independent representation in ENDF/B we run into another problem. According to the ENDF/B-IV convention where cross sections were based on interpolating parameters this representation resulted in basically 1/v behavior for the elastic and capture cross sections and, due to the implied log-log interpolation of the fission widths, variations from 1/v based on the variation in the fission width. If one follows the ENDF/B-V convention of interpolating cross sections one obtains elastic and capture cross sections which are linearly interpolable over the entire unresolved region, which are non-realistic and fission cross sections which vary linearly with energy between the energies at which fission parameters are given, which are equally unrealistic. This situation was

not as simple to address by code designers as the all energy parameters energy independent case. On the one hand to obtain realistic elastic and capture cross sections it seemed obvious that one should treat them as identical to the all parameters energy independent representation (to which logically and physically they are identical) and merely calculate the cross sections at each energy based on the constant elastic and capture widths. However, if one does this and at the same time follows the ENDF/B-V convention to only calculate fission cross sections at the energies at which fission widths are given and then linearly interpolates the fission cross section to define the fission cross section at all other energies one obtains non-realistic capture to fission ratios. For example, using exactly the same evaluations which appeared in ENDF/B-IV and which were carried forward without modification to ENDF/B-V if one uses the ENDF/B-IV or V conventions one can obtain differences in the capture to fission ratio of over a factor of two (i.e. 200%). It should be noted that this effect would not have been nearly as large if the ENDF/B-IV convention of using an implied log-log interpolation law for this representation had been carried forward to ENDF/B-V; the log-log interpolation law reproduced a 1/v variation (similar to the capture) and produces reasonable capture to fission ratios. In contrast the ENDF/B-V convention of using an implied linear interpolation law for this representation leads to non-realistic capture to fission ratios. To reproduce realistic 1/v cross sections and capture to fission ratios requires interpolation of parameters, which violates the ENDF/B-V convention. The results in the uncertainty of how to treat this representation of unresolved parameters have led to confusion among code designers which has resulted in each designer implementing ad hoc conventions to obtain the results which each designer considered to be the most realistic.

Finally we come to the all unresolved parameters energy dependent representation which in principle should be the easiest to consider. For this representation at first glance the ENDF/B-V convention seems to be straightforward: in the ENDF/B formats and procedures manual it states that for ENDF/B-V one should calculate the cross sections at the energies at which parameters are given and define the cross sections at all other energies by interpolating cross sections, not parameters, according to the explicitly given interpolation law (what could be simpler). However, if one reads further into the ENDF/B formats and procedures manual one discovers that the situation is not that straightforward and clear. Specifically, in the manual it is stated that even though the new convention is to interpolate cross sections, not parameters, evaluators should provide parameters on a "dense enough" energy grid to insure that the differences in the cross sections obtained by parameter vs. cross section interpolation are small. The question arises as to what is "dense enough" and what should the code designer do if the evaluator does not provide parameters on a "dense enough" energy grid (as occurs in many ENDF/B-V evaluations). On the one hand one could assume that the evaluator knows best and whatever energy grid the evaluator provides for the unresolved parameters is "dense enough". In the other extreme the code designer could assume that the convention is that evaluators should interpolate their parameters to a "dense enough" energy grid to insure that subsequent interpolation to a finer energy grid yields essentially the same cross sections, regardless of whether parameter or cross section interpolation is used to interpolate to the finer energy grid. If this is the convention then code designers can automatically determine if

an energy grid is "dense enough" by simply interpolating parameters to a fine enough grid such that subsequent interpolation of cross sections or parameters yields essentially the same cross section at all energies. If this procedure is followed it is obviously equivalent to using the ENDF/B-IV convention of interpolating parameters (since one interpolates parameters to a fine enough energy grid such that it is irrelevant how one interpolates to a finer energy grid). Besides the two extremes of assuming the evaluator has provided a "dense enough" energy grid or the code designer insuring a "dense enough" energy grid by parameter interpolation, the code designer can merely insure that parameters are not given on too sparse an energy grid by insisting that the successive energies at which parameters are given not be more than a certain multiple of one another (e.g. 2 or 3, etc.). By considering different possible multiples from very large to very small one ends up with an infinite number of possible interpretations of the unresolved parameters extended from the two extremes of using the evaluator's energy grid (equivalent to using a very large multiplier) to interpolating parameters (equivalent to using a multiplier close to one).

How much difference does it make if one interpolates cross sections or parameters for actual ENDF/B-V evaluations? In the ENDF/B-V dosimetry library there is an excellent example which can be used to illustrate both the magnitude of the differences that result and the problem of trying to uniquely define a "dense enough" energy grid. For ^{237}Np unresolved parameters are given over the energy range 130 ev to 40 Kev. Between 130 ev and 4.954 KeV parameters are given on a very fine energy grid that would pass most multiplier tests (e.g. 130, 198, 208, 231, 240, 249, 259, 278, 288, 330, 340 ev, etc.). Between 4.954 and 40 KeV parameters are only given at the two end points of this energy interval. An additional complication which effects results is that even though in the energy range 130 ev to 4.954 KeV the parameters are given on a very fine energy grid the fission widths vary dramatically between tabulated energies, by up to two orders of magnitude, e.g.

E (ev)	$\Gamma_{n,f}$ (ev)
130	5.4391E-6
198	3.0718E-4
208	2.8031E-6
231	9.1923E-5

From fig. 3 we can see that the effect of using the ENDF/B-V convention of interpreting cross sections (STANDARD result) or the ENDF/B-IV convention of interpolating parameters (AMPX result) results in almost a 20% difference in the fission cross section in the energy range between 130 ev and 4.954 KeV, where the parameters are given on a very fine energy grid. The maximum difference occurs near 140 ev. This indicates that it is impractical to attempt to eliminate the difference between the cross sections obtained by parameter or cross section interpolation by simply insuring that the successive energies at which parameters are specified are within a given multiple of one another. In the case of ^{237}Np fission this would require a multiple very close to one, which would require the cross section to be calculated at an enormously large number of energies; far more energies than would be required by simply interpolating parameters.

For ^{237}Np in the energy interval 4.954 to 40 KeV where unresolved parameters are only given at the ends of this energy interval the fission widths increase almost exactly by v over the interval and the net effect is that the fission cross section calculated at 4.954 KeV is almost exactly equal to the fission cross section calculated at 40 KeV. Obviously in this case interpolation of the fission cross section over this energy interval will result in a constant fission cross section (see fig. 3 STANDARD results). In contrast interpolation of the fission parameters over this energy interval results in a fission cross section which decreases by about 18% over this energy interval.

To summarize the status of unresolved resonance parameter calculations,

1. At the beginning of this study very few codes had implemented cross section interpolation (ENDF/B-V convention) and almost all codes were still using parameter interpolation (ENDF/B-IV convention).

2. During the course of this study virtually all codes were converted to use cross section interpolation (ENDF/B-V convention).

3. Examination of the results obtained using strictly cross section interpolation indicates that for the three possible representations of unresolved parameters available in the ENDF/B system the results are often physically unrealistic. This has resulted in code designers implementing ad hoc methods in an attempt to make their results more physically acceptable, e.g. resorting to purely parameter interpolation or interpolating parameters to an energy grid where successive energies cannot exceed some multiple of one another.

4. The case of ^{237}Np fission in the energy range 130 eV to 4.954 KeV indicates that it is impractical to insure that there will not be differences between the cross section obtained by parameter vs. cross section interpolation to a finer grid by simply starting from parameters which have been interpolated to an initial energy grid where the energies at which parameters are given are simply multiples of one another. If one attempts to find such a multiple which can be uniformly used for all ENDF/B-V evaluations, obviously the ^{237}Np case indicates that a multiple very close to one would have to be used to obtain a fine enough starting grid to eliminate significant differences between the cross sections obtained by subsequent cross section vs. parameter interpolation to a finer energy grid. The result of attempting to find a fine enough starting grid which can be used for all ENDF/B-V evaluations results in the situation where (a) since parameters are interpolated to define the fine enough starting grid this approach is physically equivalent to using the ENDF/B-IV convention of simply interpolating parameters, (b) defining a multiplier for use with all ENDF/B-V evaluations results in the situation where for most evaluations cross sections are calculated at far more energies than if one simply interpolates parameters. As such use of a multiplier offers no advantage over simply resorting to parameter interpolation.

5. The seemingly simple change in ENDF/B conventions between parameter interpolation (ENDF/B-IV) and cross section interpolation (ENDF/B-V)

has resulted in the situation where a variety of cross section processing codes can obtain completely different results and yet code designers can all claim that they are following the ENDF/B-V conventions. The differences that have been found in the unresolved region cross sections calculated in this study cannot be blamed on the code designers; rather the differences should be blamed on the ambiguity and impracticality of the current ENDF/B-V conventions concerning interpolation of unresolved data.

6. Many evaluations were carried forward from the ENDF/B-IV to the ENDF/B-V library without being modified. If one uses exactly the same evaluations from the ENDF/B-IV library or the ENDF/B-V library and the conventions associated with each of the two ENDF/B versions one can obtain a difference of a factor of three (i.e. 300%) in the cross sections derived from the unresolved parameters. Which is correct?

7. If one is given a single set of energy independent unresolved parameters and codes them into the ENDF/B format using each of the three possible representations of unresolved parameters available in ENDF/B (all of which can accommodate energy independent unresolved parameters) one can obtain three completely different unresolved cross sections. Which is the physically most acceptable? Obviously the 1/v cross sections obtained using parameter interpolation.

8. In the author's view, the change in ENDF/B conventions between ENDF/B-IV and V, which was designed to simplify use of the unresolved data, has led to a more complicated situation involving ad hoc assumptions and procedures which can introduce large differences in the cross sections derived from unresolved parameters using different combinations of assumptions and procedures. The only procedure which is applicable to all three representations of unresolved parameters available in ENDF/B and leads to a unique averaged unresolved cross section is to interpolate parameters and not cross sections.

5. Treating small cross sections as zero and/or not using the ENDF/B interpolation law

as illustrated in fig. 4. For use in transport calculations when the cross sections for any reaction become small (e.g. in fig. 4 less than 10^{-6} barns) it is practical to ignore the ENDF/B interpolation law and assume that the cross section is linearly interpolable. This leads to the differences seen in fig. 4 in the energy range 500 Kev - 1 MeV. In addition when the cross section becomes very small (in fig. 4 less than 10^{-8} barns) the cross section may be considered to be zero. This leads to the differences seen in fig. 4 below 28 KeV.

Introducing either or both of these assumptions will have no effect on the flux or other reaction rates obtained from a transport calculation. As such it is a practical approach to reducing the complexity of transport calculations by minimizing the number of reactions that must be considered in any energy range. Therefore the differences seen here should not be considered to be due to errors in the code, but are rather the result of introducing a practical, physically acceptable approximation.

The only point that the user should be aware of is that even though the flux in any transport calculation will not be affected, the reaction rate obtained using the calculated flux and the approximate cross section may be in error. For example, from fig. 4 we may see that any flux spectrum which has a peak at low energies (e.g. thermal reactor spectrum) and is essentially zero above 28 KeV will yield a small reaction rate using the standard cross section, but a zero reaction rate using the approximate cross section. It should be pointed out that the use of essentially threshold reactions for such purposes is inappropriate, but if the user insists on performing such calculations one can still obtain the appropriate reaction rate by using the calculated flux and the cross sections from a standard library, such as the ENDF/B dosimetry library.

6. Numerical instabilities near discontinuities in the cross section

as at resonance region boundaries, as illustrated in fig. 5. This problem is introduced by codes which calculate multigroup cross sections from energy dependent cross sections. In order to illustrate the source of this problem consider trying to integrate a linearly interpolable cross section over a small energy interval,

$$\int_{E}^{E+\delta E} (A+BE)\,dE$$

where A is the zero energy intercept cross section and B is the slope. This appears to be a trivial calculation to perform, but unfortunately in the resonance region A and B can be enormous numbers, generally of opposite signs, which leads to round-off problems. The result on short word length computers (e.g., IBM) is to generate essentially random results. For example, from fig. 5 we can see that in the one group which spans the resolved-unresolved resonance region boundary the calculated cross section is over 20 times too large. Admittedly this effect only occurs in the group where the discontinuity is located, but such large differences can affect both calculated fluxes and reaction rates if the flux spectrum is strongly peaked in the vicinity of this group.

This problem can be avoided by simply re-writing the above equation in a form which avoids numerical instabilities. For example defining the energy and cross section at the mid-point of the energy interval; $\langle E \rangle$ and $\langle \sigma \rangle$ and the change in cross section across the energy interval $\delta\sigma$ the equation can be written in the form.

$$\int_{\langle E \rangle - \frac{1}{2}\delta E}^{\langle E \rangle + \frac{1}{2}\delta E} \left[\langle \sigma \rangle + \frac{1}{2}\delta\sigma \left(E - \langle E \rangle \right) \right] dE = \delta E \langle \sigma \rangle$$

This approach also works where the integrand is the cross section times a flux and for logarithmic variation.

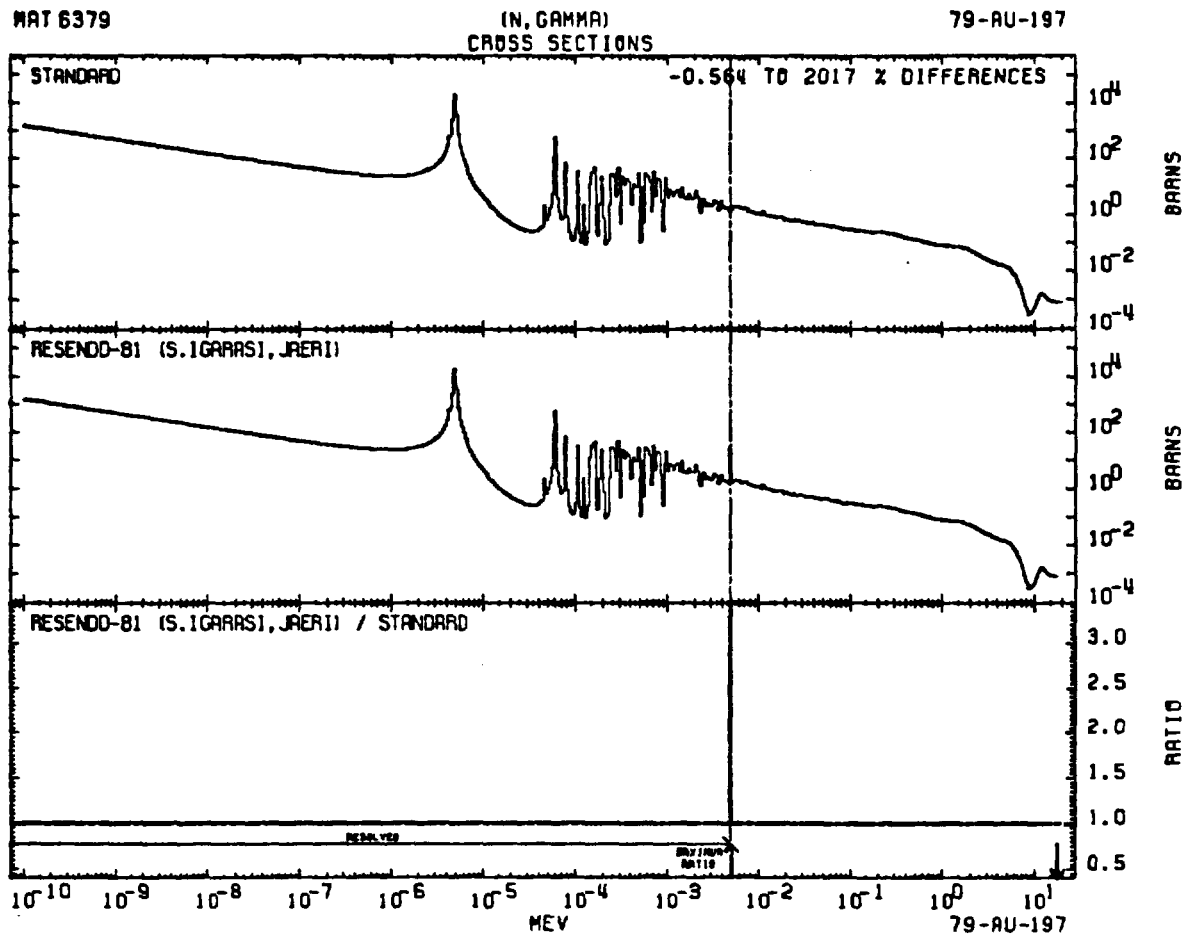

MAT 6379
(N, GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-0.564 TO 2017 % DIFFERENCES
RESEND-81 (S.IGARASI, JAERI)
RESEND-81 (S.IGARASI, JAERI) / STANDARD
BARNS
BARNS
RATIO
MEV
79-AU-197

Fig. 5

Note, that even when δE is very small, which leads to instability in the original equation, the result of using the re-formulated equation is still stable and leads to the average cross section times the width of the energy interval.

7. Different results based on different input operations

Modern cross section processing codes have many input options, generally to select one of a number of possible routes through the codes, specify processing accuracy or the use of certain approximations. Therefore it was not surprising to find that the results submitted by code users differed from the results submitted by code designers, even though both used the same code and evaluated data.

At the beginning of this study it was assumed that since the code designers should be the ones most familiar with their own codes they would submit the best results for each code. Therefore it was surprising to find that based on the initial round of comparisons four code designers stated that they used the wrong input options on their own codes and could have obtained better results simply by selecting a more appropriate set of input options.

These results indicate that code designers should attempt to make their codes more "user friendly" by recommending standard input options and documenting the range of validity and the influence of input parameters on calculated results.

Summary of problem areas

An important point to realize is that because of the complexity of modern evaluations, modern cross section processing codes are equally complex and the large volume of data output by these codes would have made it impossible to identify these problem areas without intercomparison of the results generated by a variety of codes.

A second point is that the author considers the designers of the cross section processing codes which participated in this project to be some of the best code designers in the world, yet in every case the participating codes were found to have one or more errors. This illustrates that the complexity of modern cross section processing codes makes it impossible for even experienced code designers to insure the accuracy of the results generated by their codes without intercomparison.

In this study once initial comparisons were performed it was fairly easy to identify and isolate problem areas in each code and for the code designers to improve their codes.

Based on the results of this study, since problems were found in every participating code, it is fair to ask: how accurate are the results generated by codes which did not participate in this study? In an attempt to answer this question and to help improve as many codes as possible, all code designers who have not participated in this study to date are still encouraged to participate in this study by sending results for the first round of comparisons.

Benchmark results

All participants were asked to use the ENDF/B-V dosimetry library to generate cold (0 Kelvin), unshielded, flat weighted 620 group (SAND-II group structure) averaged cross sections in the ENDF/B format and to submit their results to the Nuclear Data Section, IAEA, Vienna for comparison to the benchmark results.

This study has extended over a number of years and during this time several versions of the ENDF/B-V dosimetry library were distributed by Brookhaven National Laboratory, namely: Mods. 0,1 and 2. In an attempt to insure that any differences in the results submitted by participants are due to the codes used, rather than the evaluated data, benchmark results have been established for each of the three mods. of the library. The following plots document the differences that are to be expected based on use of any mod. of the ENDF/B-V dosimetry library, specifically, the benchmark results for mod. 1 were compared to the results for mod. 0 and the mod. 2 results were compared with mod. 1 results. The following plots indicate those reactions for which differences in excess of 1% were found in the group averaged cross sections in one or more groups.

Mod. 0 vs. Mod. 1

The only differences between the cross sections in the ENDF/B-Dosimetry libraries mod. 0 and 1 is that for ^{238}U fission and ^{58}Fe capture two tabulated data points which were incorrect in mod. 0 have been corrected in mod. 1.

Mod. 1 vs. Mod. 2

Between mod. 1 and mod. 2 eight reactions were modified as follows,

^{237}Np fission - Resonance region is 10^{-5} to 300 ev in mod. 2 (it was 0.3 - 130 ev in mod. 1) and new resonance parameters.

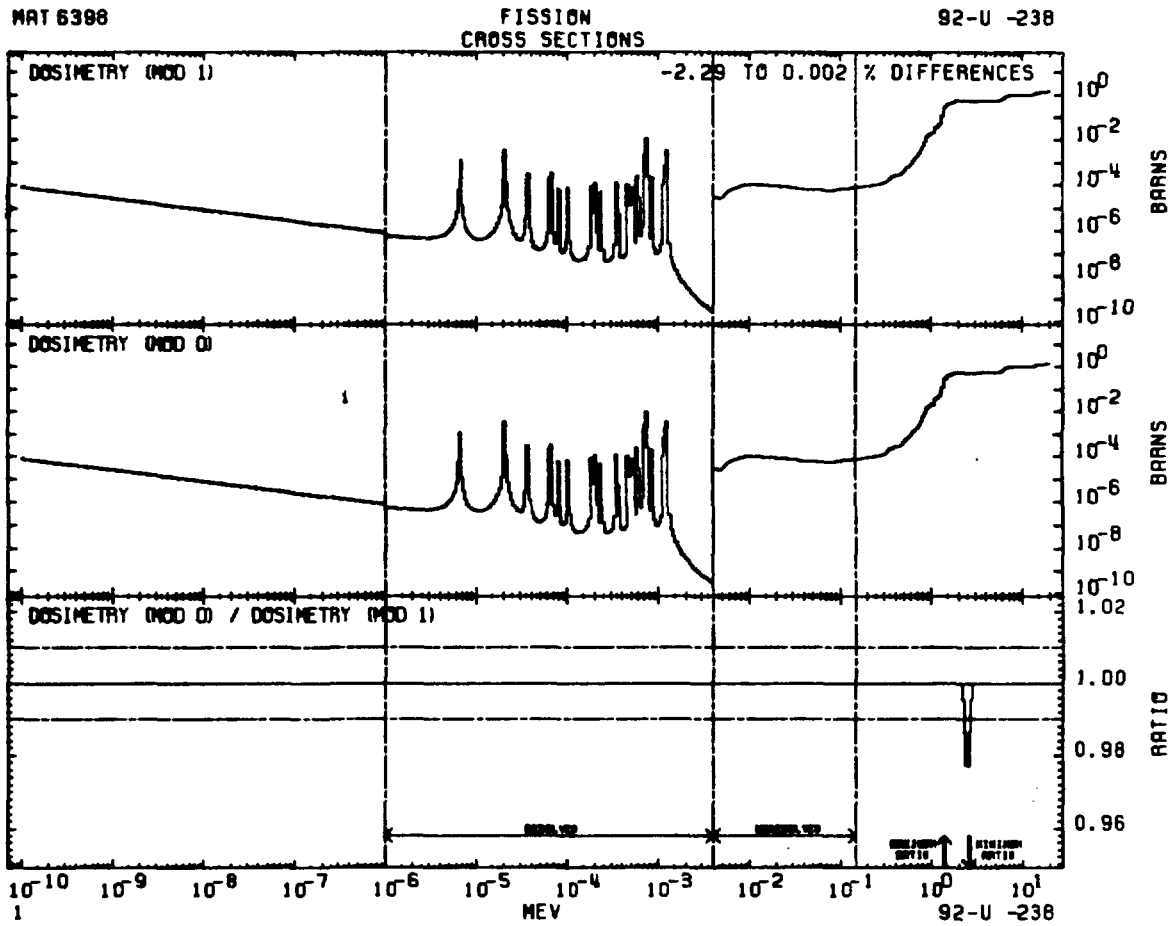
^{197}Au capture - The resonance region is 10^{-5} to 5 KeV in mod. 2 (it was 10^{-5} to 4.827 Kev in mod. 1). The extension of the resonance region to 5 KeV without additional resonances causes the cross section in mod. 2 to be considerable lower in the energy range 4.827 to 5 KeV (resulting in the 80% difference seen in the following figures).

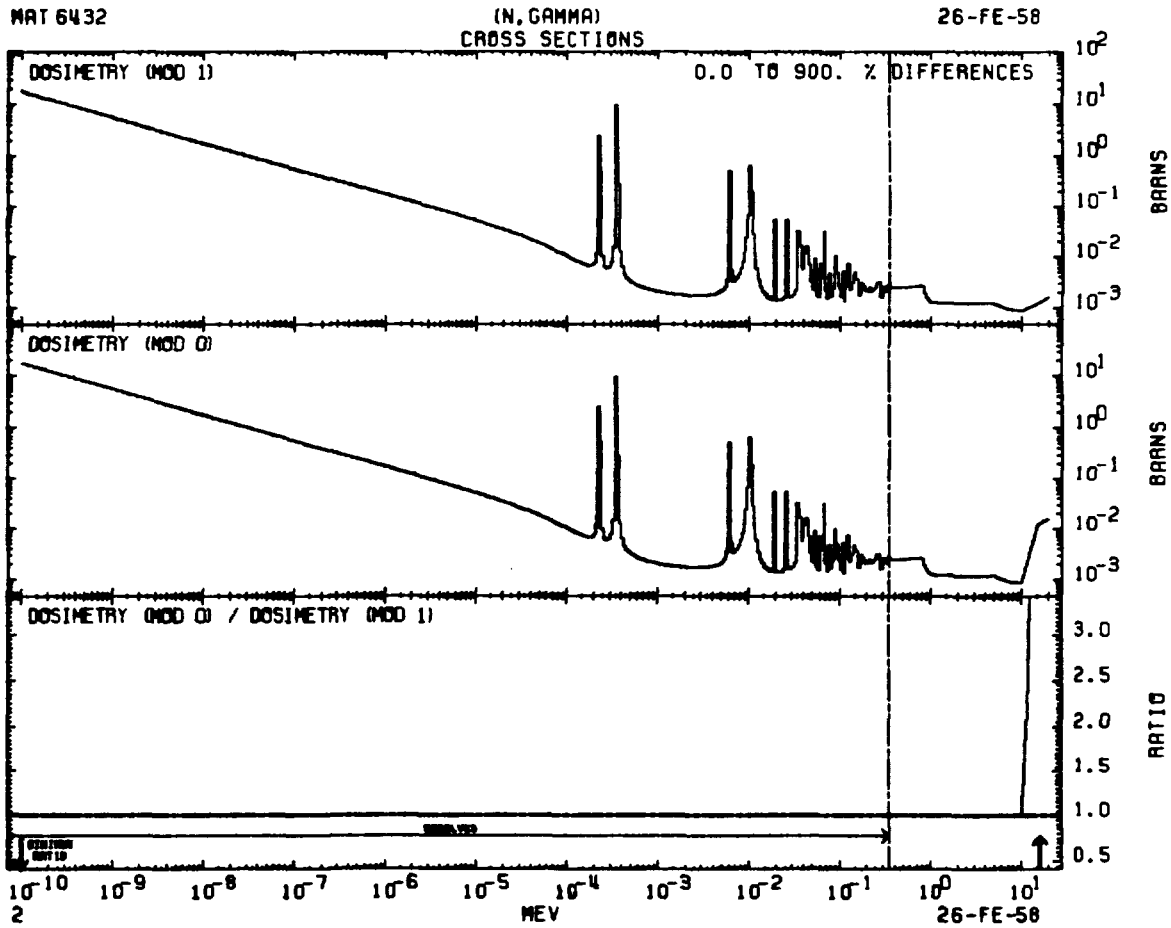
^{232}Th fission - For mod. 2 all resolved fission widths are zero (in mod. 1 they were small, but non-zero)

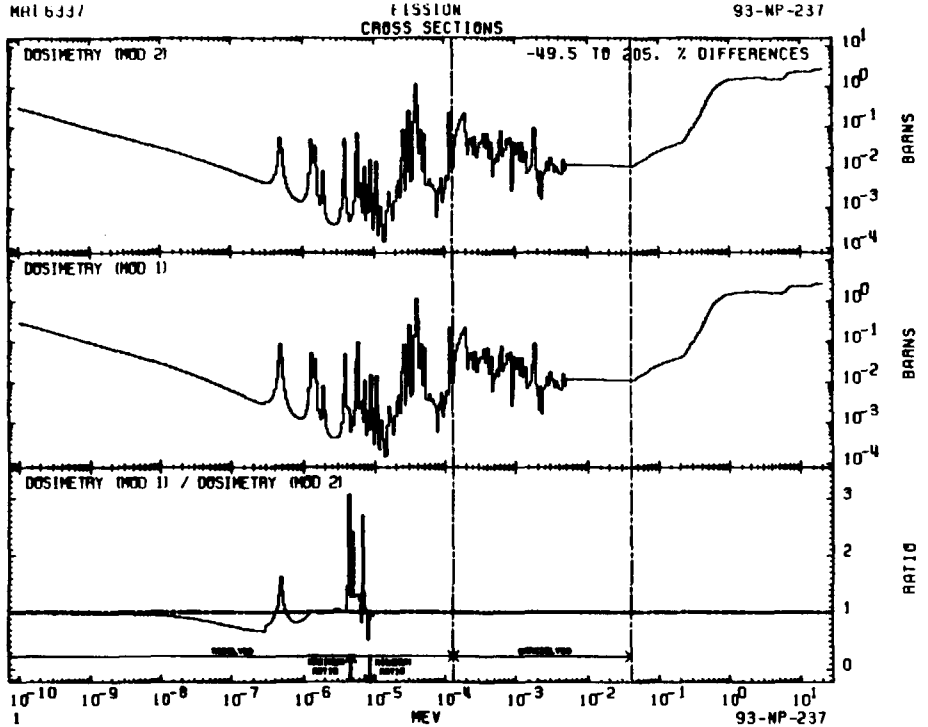
^{232}Th capture - Resonance parameters have been slightly modified. The biggest effect is seen near 70 ev where slightly shifting overlapping resonances between mod. 1 and 2 leads to a 216% difference in the cross section.

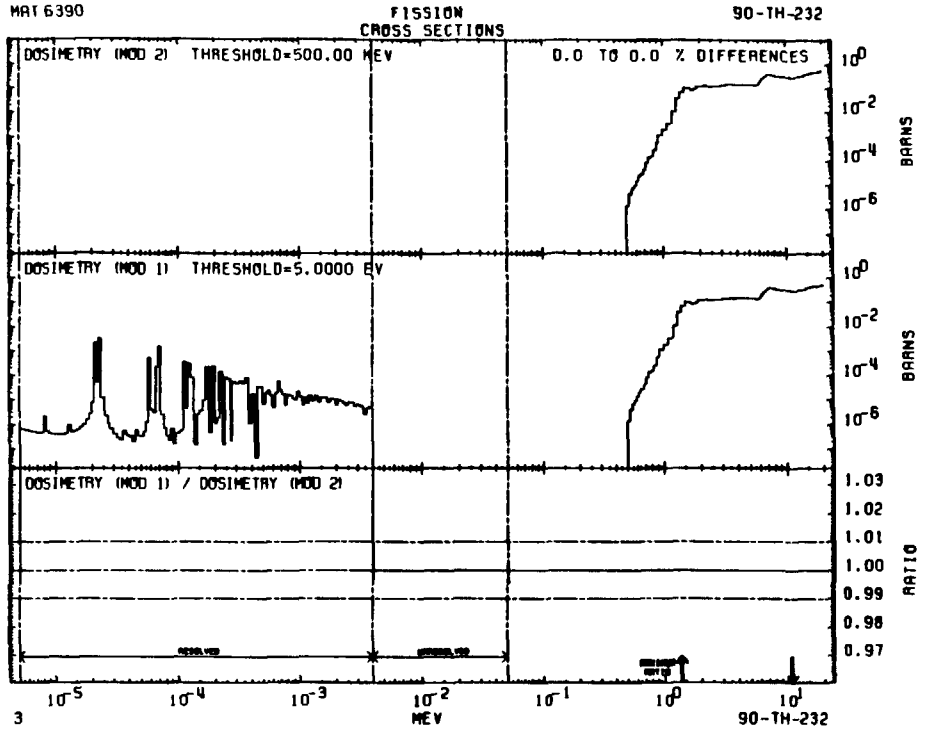
$^{47}Ti(n,p)$, $^{54}Fe(n,p)$, $^{58}Ni(n,p)$ - For mod. 2 the cross sections have been modified to have an effective threshold once the cross section falls to a low value. In mod. 1 these reactions were continued to low energies with very small, but non-zero cross sections.

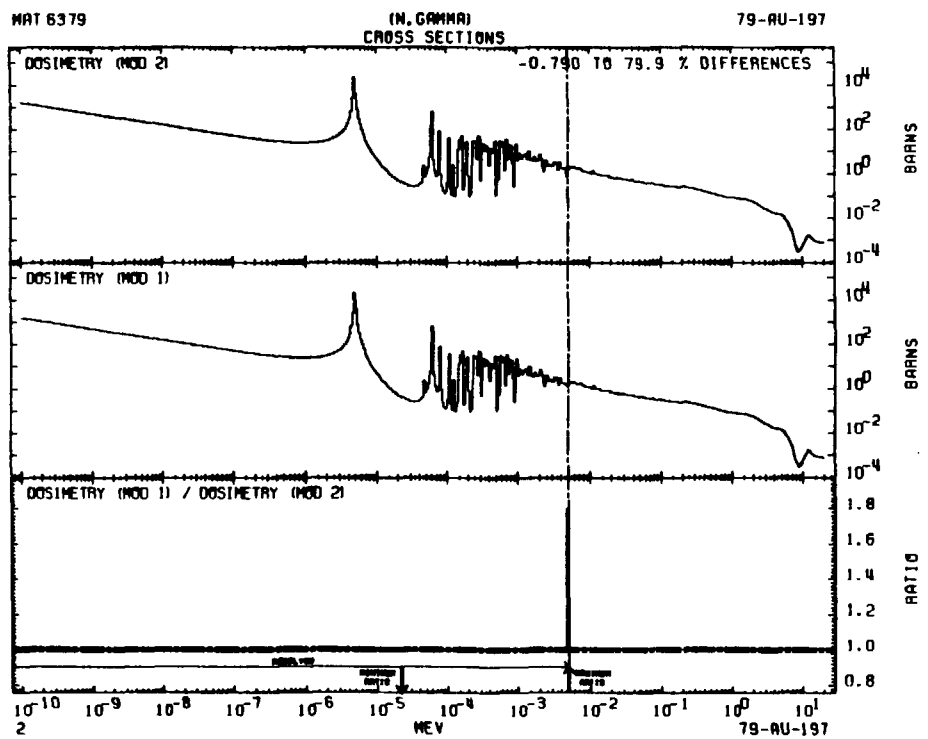
^{115}In capture - mod. 2 has a completely new set of resolved resonance parameters.

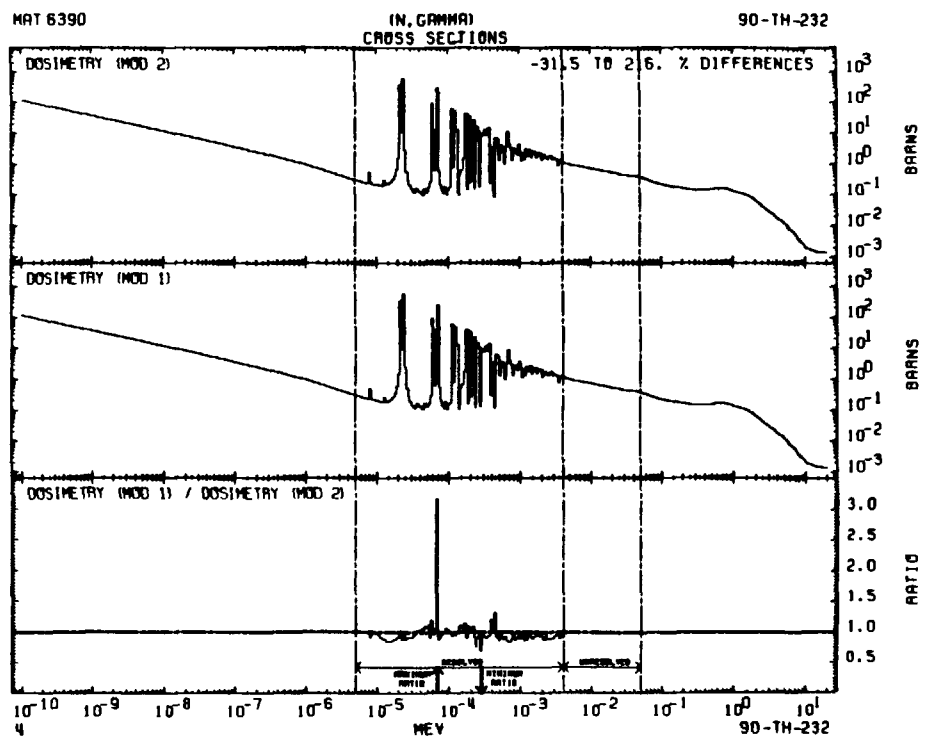

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
DOSIMETRY (MOD 1)
-2.29 TO 0.002 % DIFFERENCES
DOSIMETRY (MOD 0)
DOSIMETRY (MOD 0) / DOSIMETRY (MOD 1)
BARNS
RATIO
MEV
1
92-U -238

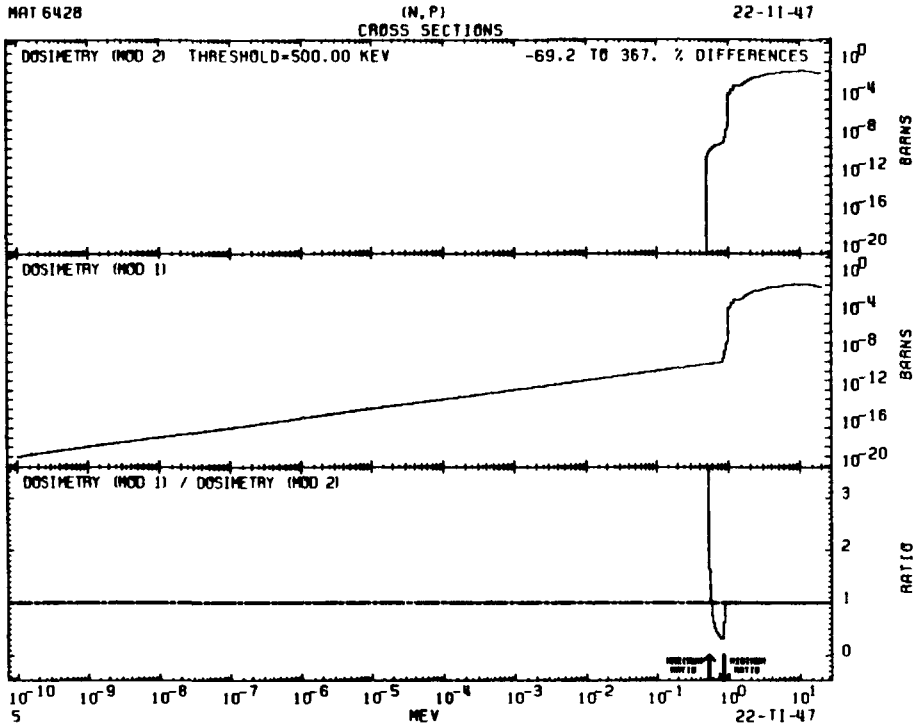

MAT 6432
(N,GAMMA)
CROSS SECTIONS
26-FE-58
DOSIMETRY (MOD 1)
0.0 TO 900. % DIFFERENCES
DOSIMETRY (MOD 0)
DOSIMETRY (MOD 0) / DOSIMETRY (MOD 1)
BARNS
RATIO
MEV
2
26-FE-58

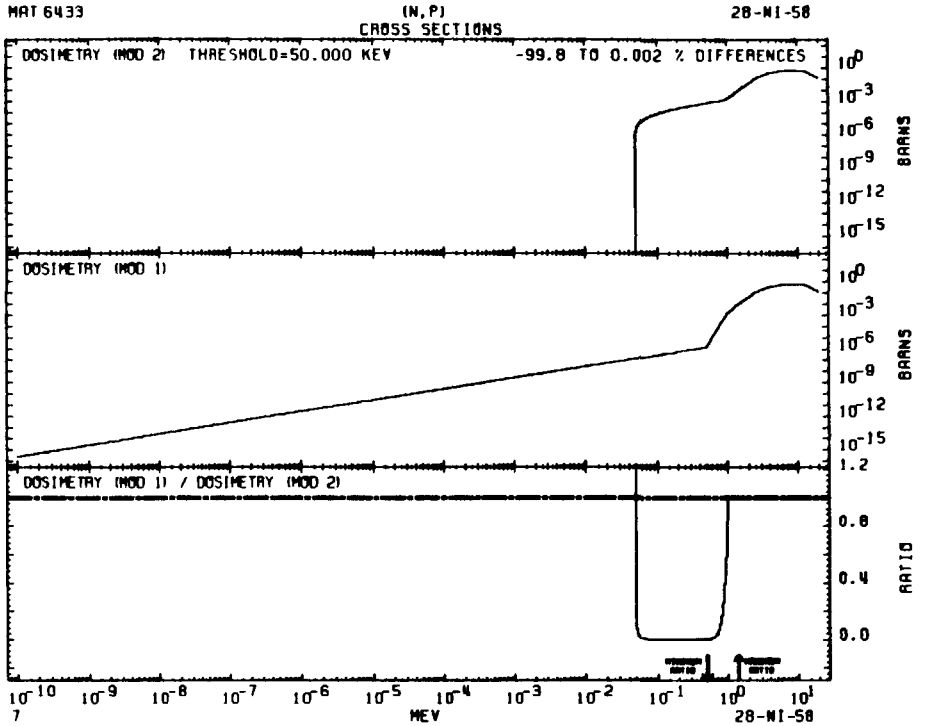

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
DOSIMETRY (MOD 2)
-49.5 TO 205. % DIFFERENCES
DOSIMETRY (MOD 1)
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
1
93-NP-237

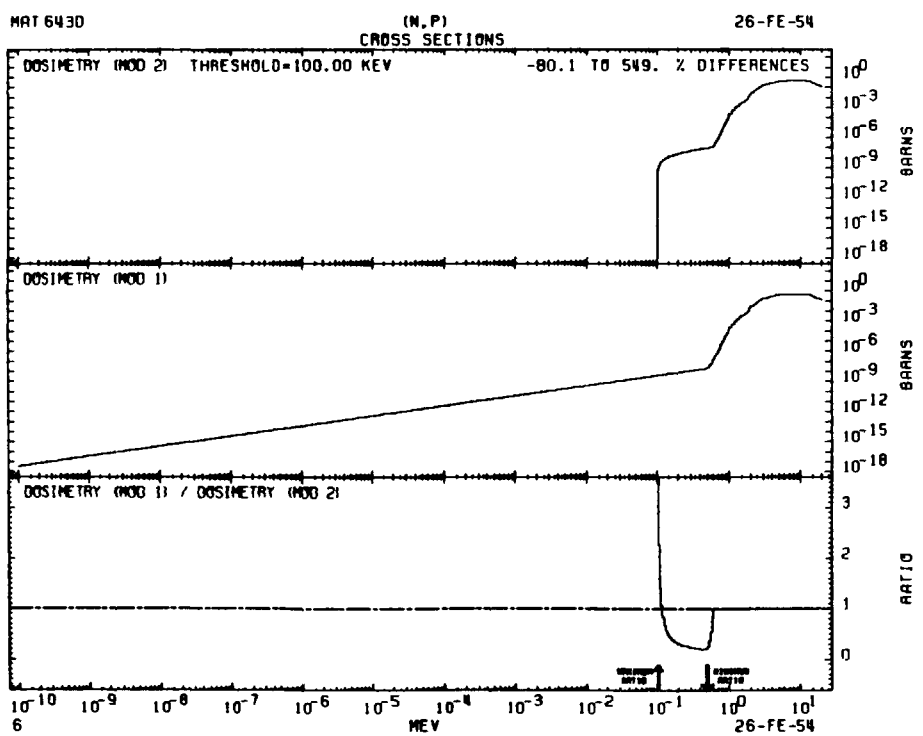

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
DOSIMETRY (MOD 2) THRESHOLD=500.00 MEV
0.0 TO 0.0 % DIFFERENCES
DOSIMETRY (MOD 1) THRESHOLD=5.0000 EV
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
3
90-TH-232

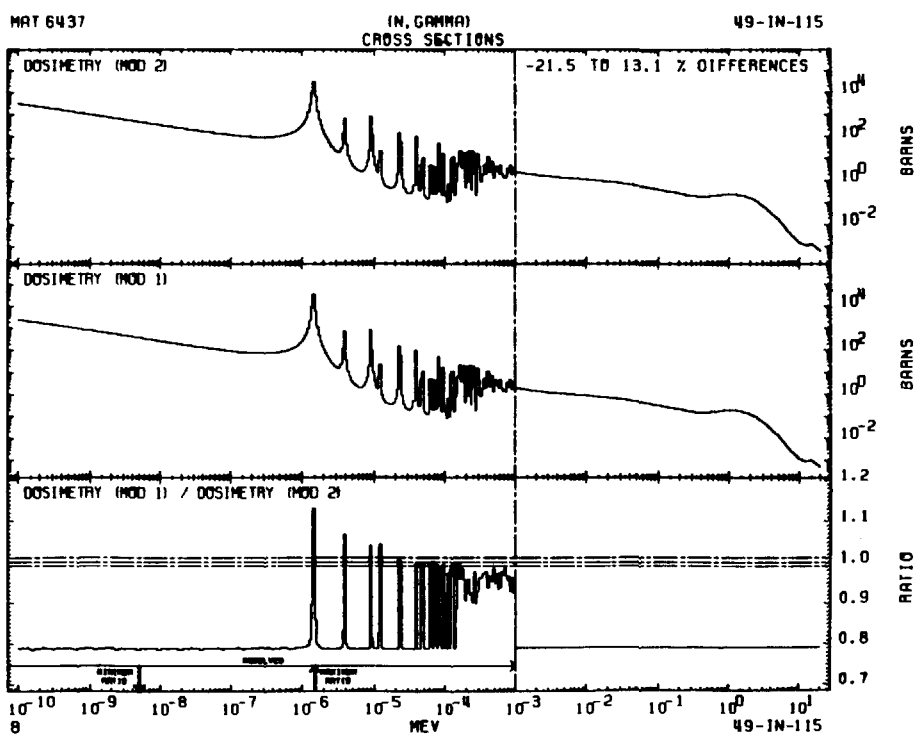

MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
DOSIMETRY (MOD 2)
-0.790 TO 79.9 % DIFFERENCES
DOSIMETRY (MOD 1)
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
2
79-AU-197


MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
DOSIMETRY (MOD 2)
-31.5 TO 216. % DIFFERENCES
DOSIMETRY (MOD 1)
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
4
90-TH-232


MAT 6428
(N,P)
CROSS SECTIONS
22-11-47
DOSIMETRY (MOD 2) THRESHOLD=500.00 KEV
-69.2 TO 367. % DIFFERENCES
DOSIMETRY (MOD 1)
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
5
22-11-47


MAT 6433
(N,P)
CROSS SECTIONS
28-NI-58
DOSIMETRY (MOD 2) THRESHOLD=50.000 KEV
-99.8 TO 0.002 % DIFFERENCES
DOSIMETRY (MOD 1)
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
7
28-NI-58


MAT 6430
(N,P)
CROSS SECTIONS
26-FE-54
DOSIMETRY (MOD 2) THRESHOLD=100.00 KEV
-80.1 TO 549. % DIFFERENCES
DOSIMETRY (MOD 1)
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
6
26-FE-54


MAT 6437
(N,GAMMA)
CROSS SECTIONS
49-IN-115
DOSIMETRY (MOD 2)
-21.5 TO 13.1 % DIFFERENCES
DOSIMETRY (MOD 1)
DOSIMETRY (MOD 1) / DOSIMETRY (MOD 2)
BARNS
RATIO
MEV
8
49-IN-115

Cross Section Processing Code Results

The following sections document the initial and latest results generated by each participating code compared to our benchmark results. In each case the submitted results have been compared to the benchmark results for the corresponding mod. of the ENDF/B-V dosimetry library. Therefore all differences presented in the following sections are due to the processing codes and not due to differences in the evaluated data.

Explanation of Results

Results for each code are presented in the chronological order in which the initial results were received from participants. Each code is identified by a name and a year (e.g. RESEND-80). The year identifies the year in which the comparison was performed; the year is not a version number for the code. For each code tabulated and graphical results are presented.

The tabulated results present a one line summary of the comparison for each reaction. Each line indicates whether or not the reaction was compared (i.e., all participants did not submit results for the entire ENDF/B-V dosimetry library). If compared, the line summarizes maximum negative and positive per-cent differences found in any group and the value of the average cross sections for the two sets of data in the group where the maximum negative and positive per-cent differences were found. An asterisk (*) following the per-cent difference indicates a difference in excess of 1%. The results for each reaction in which differences in excess of 1% were found are presented in graphical form following the tabulated results. For any reaction in which the per-cent difference could not be defined because the standard result is zero in a group where the other result is not, the tabulated results contain a warning and the reaction is plotted; this occurred for several threshold reactions.

The graphical results are presented as a series of plots, one per reaction. Each plot presents the standard (i.e. benchmark) results, the submitted results and the ratio of the submitted result to the standard. As in the case of the tabulated results each code is identified by name and the year in which the comparison was performed. The maximum negative and positive per-cent differences are listed in the upper right hand corner of each plot. The position (in energy) where these differences occurred are identified at the bottom of the plot by an up arrow (↑) for the maximum ratio and a down arrow (↓) for the minimum ratio. In order to assist in identifying the source of errors in each code the resolved and unresolved resonance regions (if any) are identified by vertical dashed lines at the region boundaries and the word RESOLVED or UNRESOLVED at the bottom of the plot.

For each code up to two sets of results may appear: the initial and latest comparison results. If the latest comparison results for any code agree with the benchmark results to within 1% for every reaction, in every group the latest comparison results are not presented; it is merely stated that the results generated by the code agree with the benchmark results.

Since all of the problem areas found in this study have been discussed in a preceding section, they will not be discussed in detail for each code. For each code it will merely be stated which problems were found and whether or not the problem has been eliminated.

RESEND
======

The RESEND code was designed to convert resonance parameters and background cross sections to energy dependent cross sections in the ENDF/B format. The RESEND results obtained in 1980 indicate that RESEND has major problems in the resolved and unresolved resonance regions. The differences found indicate that in the resolved region the energy grid used is inadequate to accurately represent narrow resonances, which leads to appreciable errors even in the average cross sections (see, ^{23}Na-capture, ^{232}Th-fission and capture). The differences in the unresolved region (see, ^{237}Np-fission) have been traced to a programming error which resulted in incorrect interpolation of the unresolved parameters. Another programming error which incorrectly interpolated background cross sections led to the differences seen in ^{58}Fe-capture and ^{63}Cu-capture. Another error is due to outputting the linearly interpolable resonance contribution using the interpolation law of the background cross section (e.g., a zero background with histogram interpolation leads to a resonance contribution in histogram form). Another error was introduced by the code which was used to convert the RESEND energy dependent cross sections to multigroup form. For ^{197}Au-capture we can see that this code introduces a numerical instability due to the discontinuity in the cross section at the upper energy limit of the resolved resonance region. The result is an average cross section in one group which is a factor of over twenty (i.e. 2000%) too high.

As a result of these comparisons it was decided that the problems with RESEND were too extensive to remedy and the code has been abandoned.

The author would like to point out that the RESEND code was one of the first codes which was designed to process ENDF/B data into energy dependent form and it has now been in use for almost fifteen years. As the father or grandfather of many currently used cross section processing codes RESEND has made a significant contribution over this time period toward improving our ability to process ENDF/B data. Certainly without the existence of RESEND as a starting point half of the processing codes which participated in this project would not have been able to generate pointwise cross sections. As such even though RESEND was eventually found to contain errors its contributions toward processing ENDF/B data should be recognized and the author for one will mourn its passing on to computer code heaven.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=RESEND-80 (B.MAGURNO,BNL)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2=RESEND OUTPUT...ENDF/B-V DOSIMETRY LIBRARY (B.MAGURNO, BNL, 1980) 803

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-0.103	16.001 *			2.62310- 5	3.04281- 5
13-AL- 27	103	6313	6313	365	325	1.8000+ 6	2.0000+ 7	-0.152	0.074				
13-AL- 27	107	6313	6313	337	297	3.2000+ 6	2.0000+ 7	-0.122	0.001				
25-MN- 55	16	6325	6325	193	153	1.0400+ 7	2.0000+ 7	-0.072	0.081				
27-CO- 59	16	6327	6327	189	149	1.0600+ 7	2.0000+ 7	-0.000	0.000				
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-1.208 *	6.271 *	5.99952- 2	5.92706- 2	2.46276- 2	2.61720- 2
27-CO- 59	107	6327	6327	291	253	5.4000+ 6	2.0000+ 7	0.0	0.042				

WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 5.40000+ 6 EV.

93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-97.656 *	109.727 *	2.07430- 1	4.86301- 3	2.55572- 3	5.36003- 3
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-0.193	2017.552 *			1.22906+ 0	2.60260+ 1
90-TH-232	18	6390	6390	861	1240	1.0000- 4	2.0000+ 7	-0.836	23.662 *			2.54758- 6	3.15038- 6

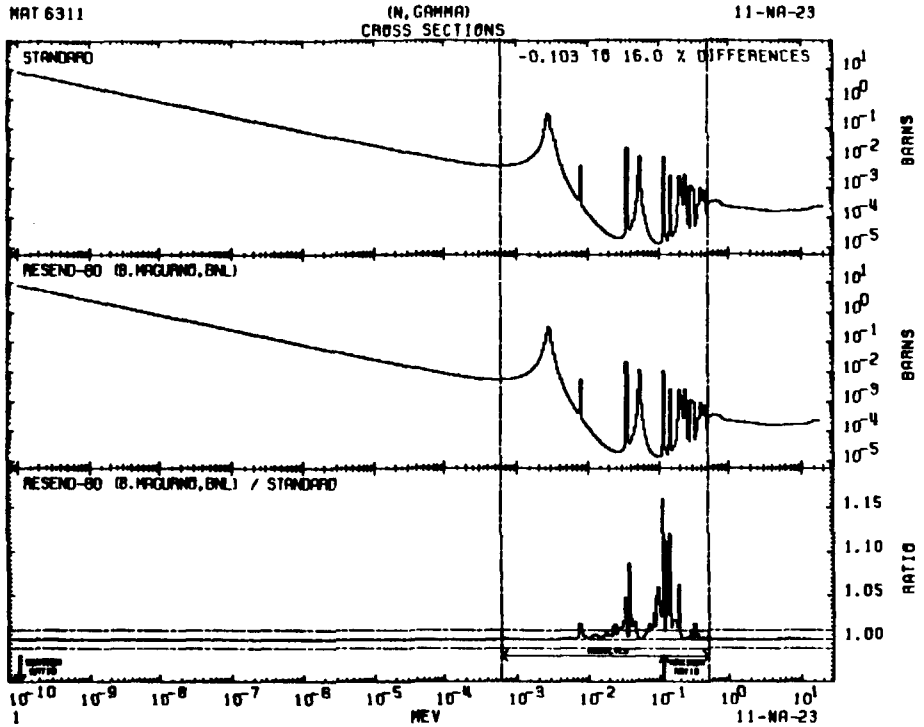
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 422 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 1.00000- 4 EV.

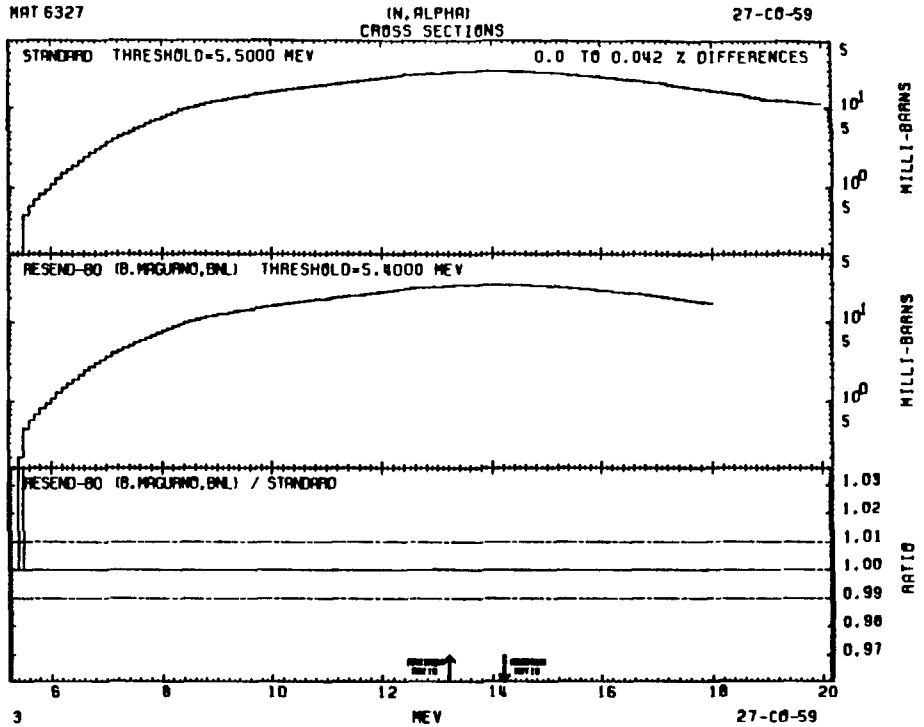
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-0.619	12.629 *			7.73382- 1	8.71052- 1
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-2.545 *	9.123 *	2.79848+ 0	2.72727+ 0	2.70950+ 0	2.95668+ 0
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-0.375	5.151 *			3.56413- 3	3.74771- 3
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-4.184 *	9.616 *	7.11360- 1	6.81597- 1	1.11774+ 0	1.22522+ 0
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-0.658	0.886				
3-LI- 6	207	6424	6424	1280	1240	1.0000- 4	2.0000+ 7	-0.098	0.091				
5-B - 10	207	6425	6425	1280	1240	1.0000- 4	2.0000+ 7	-0.098	0.053				
21-SC- 45	102	6426	6426	1280	1240	1.0000- 4	2.0000+ 7	-0.251	2.524 *			2.91846- 2	2.99211- 2
22-TI- 46	103	6427	6427	369	329	1.6000+ 6	2.0000+ 7	0.0	0.001				
22-TI- 47	28	6428	6428	189	149	1.0600+ 7	2.0000+ 7	-0.088	0.000				
22-TI- 47	103	6428	6428	1280	1240	1.0000- 4	2.0000+ 7	0.0	0.002				
22-TI- 48	28	6429	6429	169	129	1.1600+ 7	2.0000+ 7	-0.099	0.042				
22-TI- 48	103	6429	6429	337	297	3.2000+ 6	2.0000+ 7	0.0	0.001				
26-FE- 54	103	6430	6430	1280	1240	1.0000- 4	2.0000+ 7	-0.101	0.085				
26-FE- 56	103	6431	6431	343	303	2.9000+ 6	2.0000+ 7	-0.070	0.001				
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.379	9.936 *			4.66373- 3	5.12711- 3
28-NI- 58	16	6433	6433	153	113	1.2400+ 7	2.0000+ 7	0.0	0.000				
28-NI- 58	103	6433	6433	1280	1240	1.0000- 4	2.0000+ 7	-0.095	0.074				
28-NI- 60	103	6434	6434	351	311	2.5000+ 6	2.0000+ 7	-0.101	0.032				
29-CU- 63	102	6435	6435	1280	1240	1.0000- 4	2.0000+ 7	-0.104	94.058 *			1.07784- 2	2.09163- 2
29-CU- 63	107	6435	6435	367	327	1.7000+ 6	2.0000+ 7	-0.095	0.070				
29-CU- 65	16	6436	6436	201	161	1.0000+ 7	2.0000+ 7	0.0	0.000				
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.065	0.001				
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-0.104	3.951 *			2.29952- 1	2.39037- 1
53-I -127	16	6438	6438	217	177	9.2000+ 6	2.0000+ 7	-0.056	0.096				
16-S - 32	103	6439	*** NO COMPARISON ***										

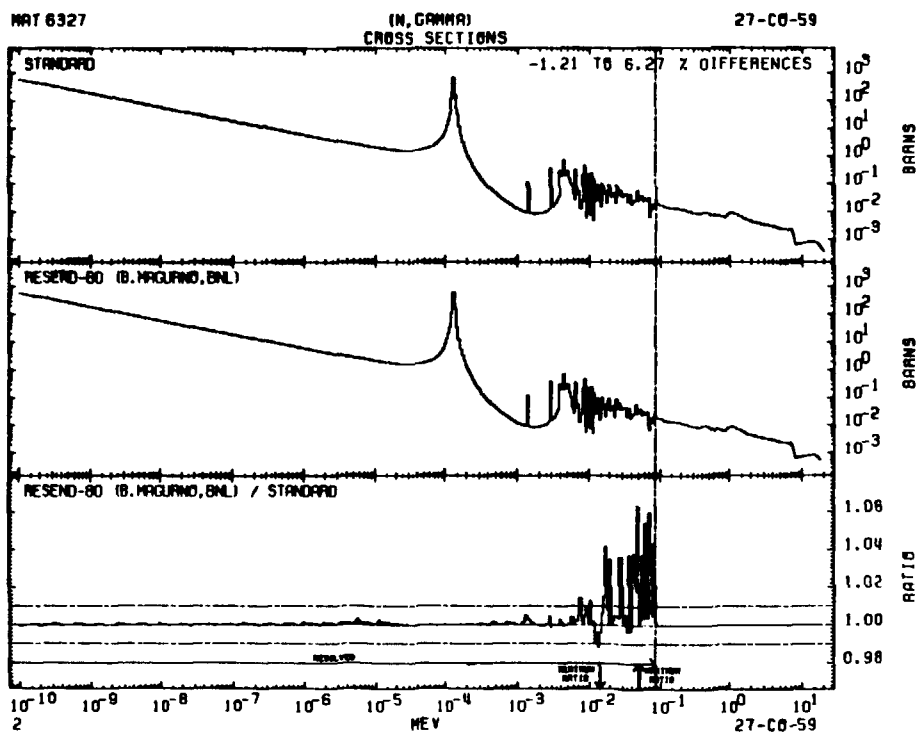
14 PLOTS GENERATED

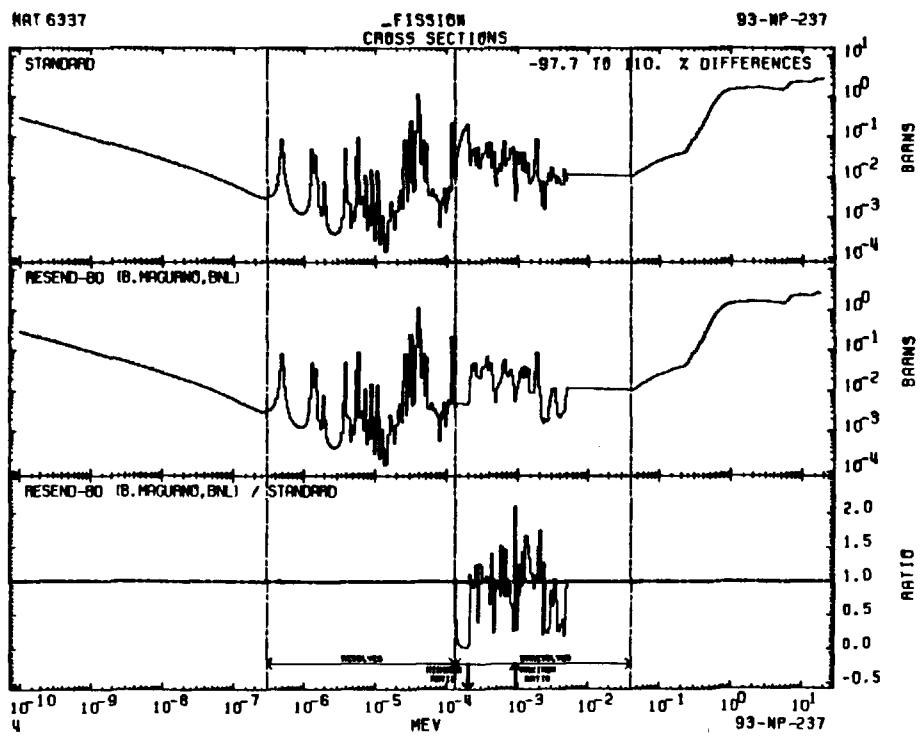
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

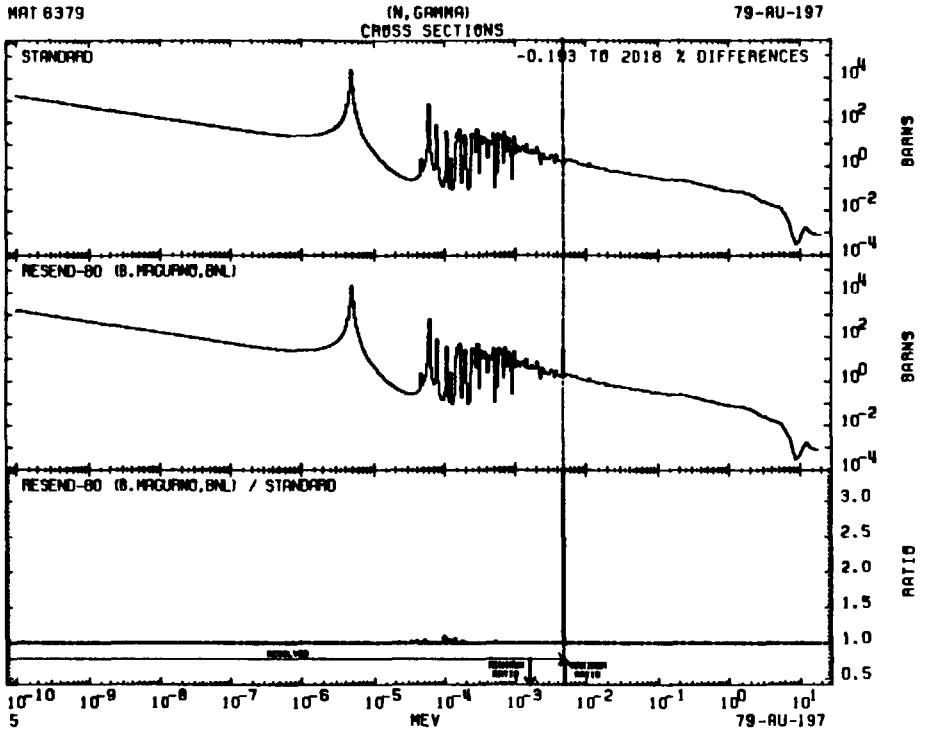
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

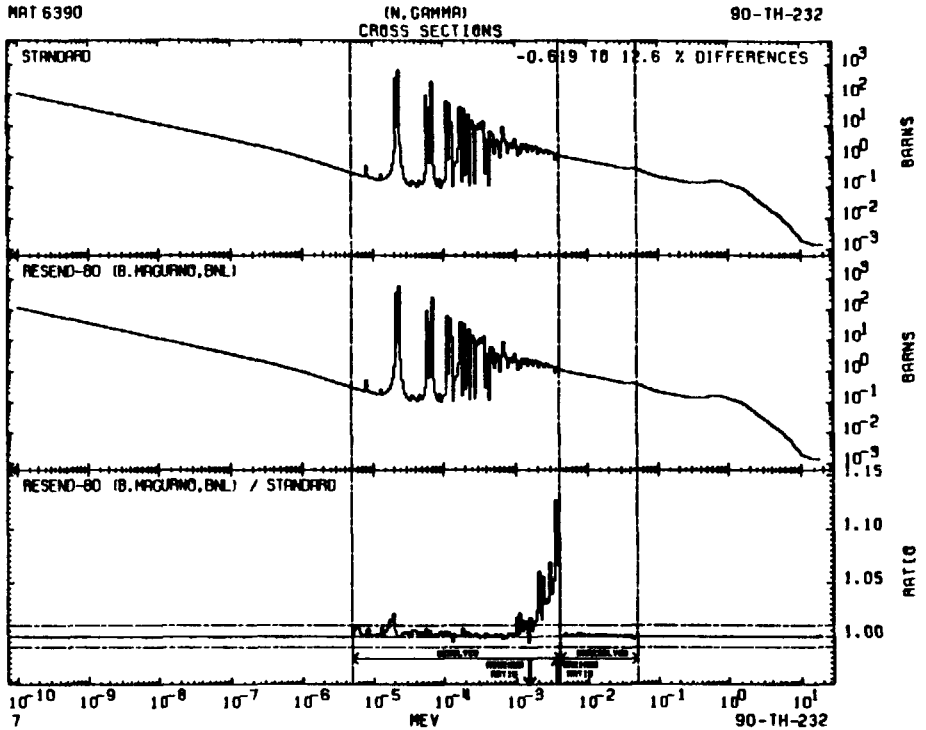

MAT 6311
(N,GAMMA)
CROSS SECTIONS
11-NA-23
STANDARD
-0.103 TO 16.0 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
1
11-NA-23

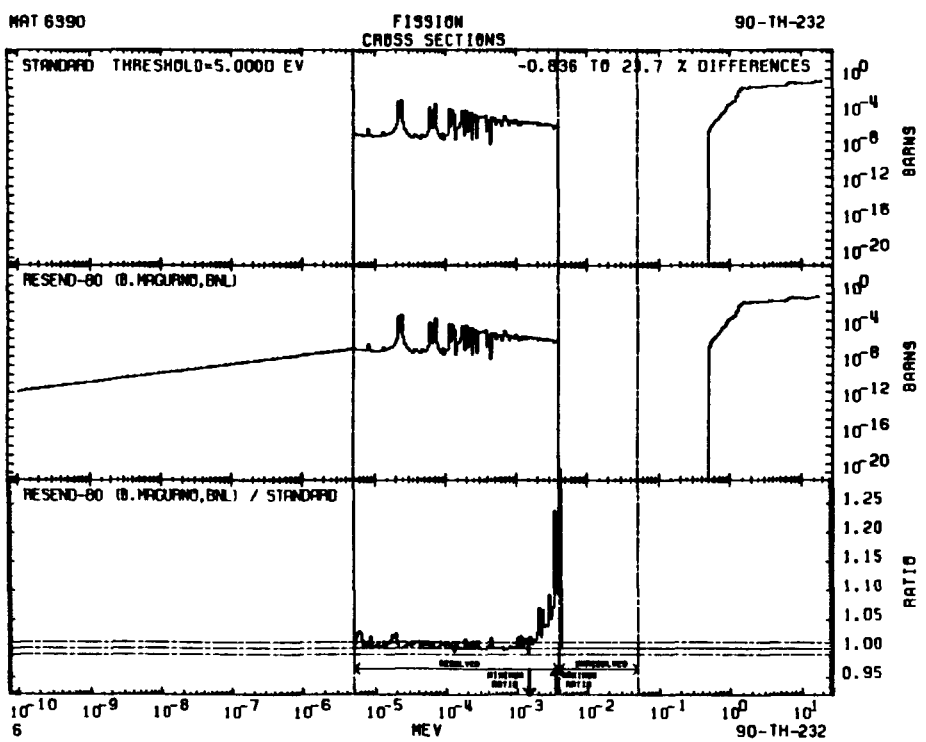

MAT 6327
(N,ALPHA)
CROSS SECTIONS
27-CO-59
STANDARD THRESHOLD=5.5000 MEV
0.0 TO 0.042 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL) THRESHOLD=5.4000 MEV
RESEND-80 (B.MAGURNO,BNL) / STANDARD
MILLI-BARNS
RATIO
MEV
3
27-CO-59

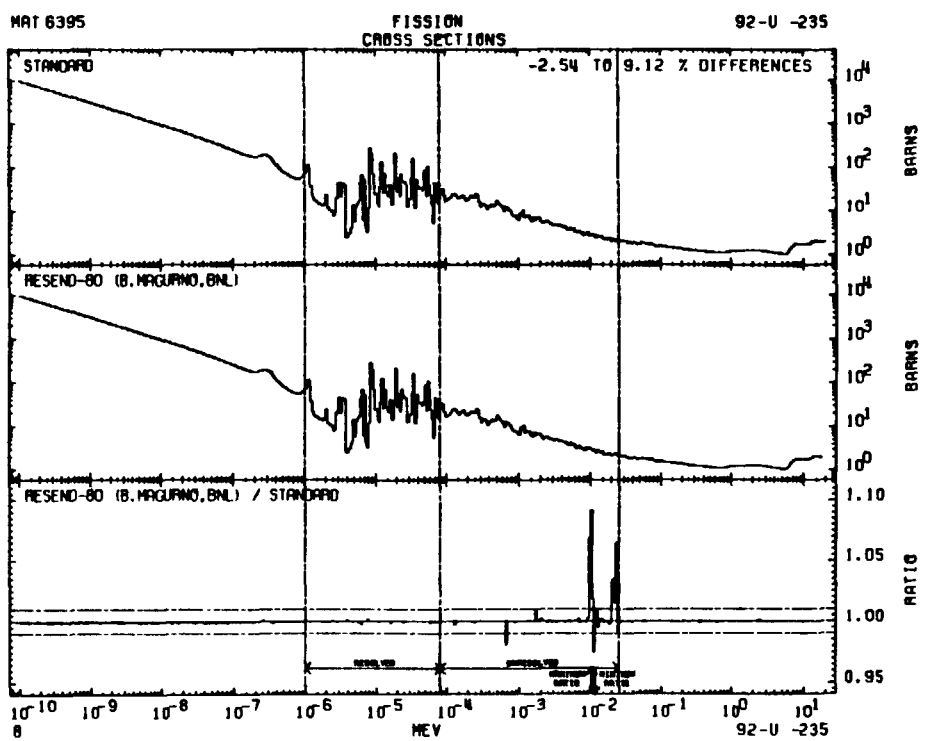

MAT 6327
(N,GAMMA)
CROSS SECTIONS
27-CO-59
STANDARD
-1.21 TO 6.27 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
2
27-CO-59

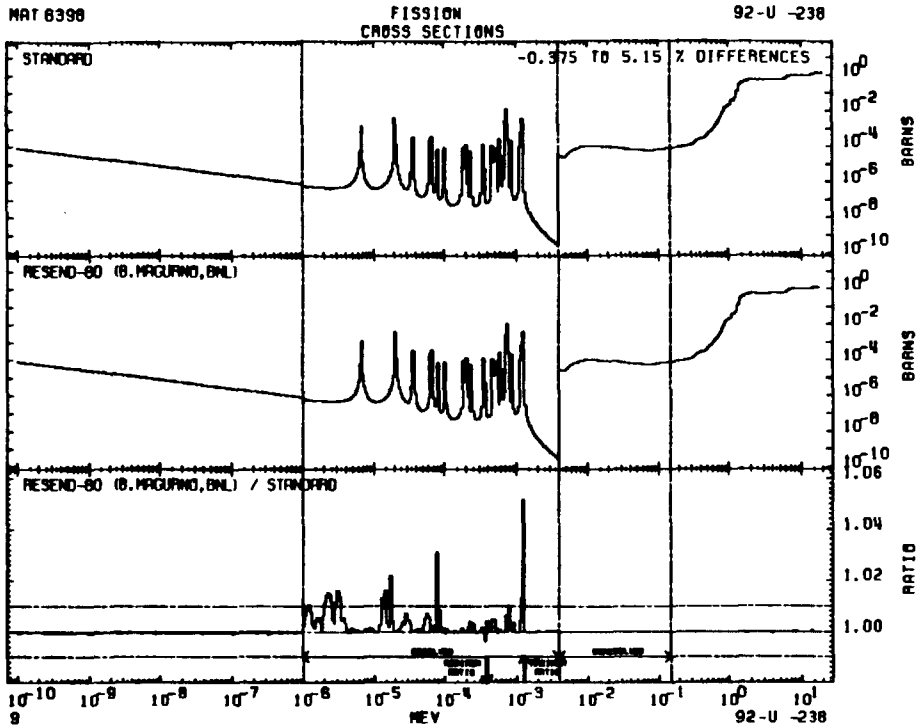

MAT 6337
_FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-97.7 TO 110. % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
4
93-NP-237

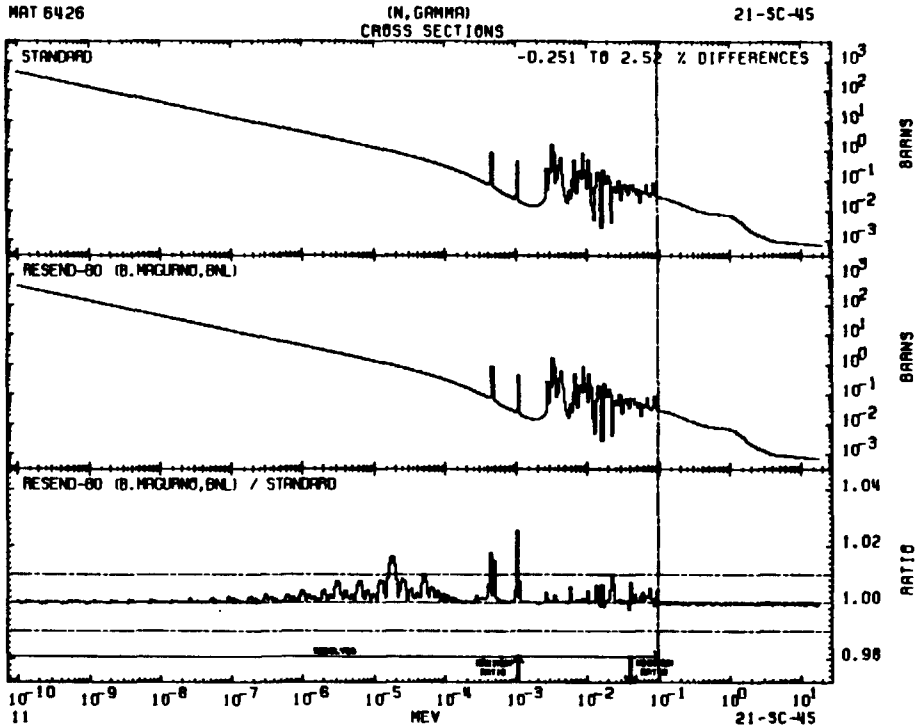

MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-0.193 TO 2018 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
5
79-AU-197

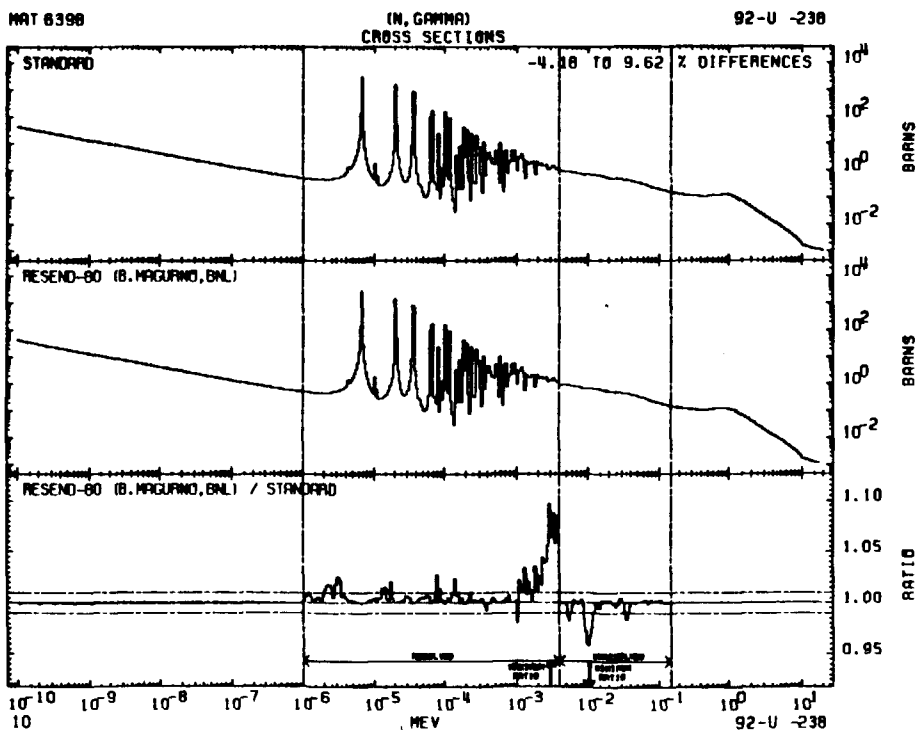

MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-0.619 TO 12.6 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
7
90-TH-232

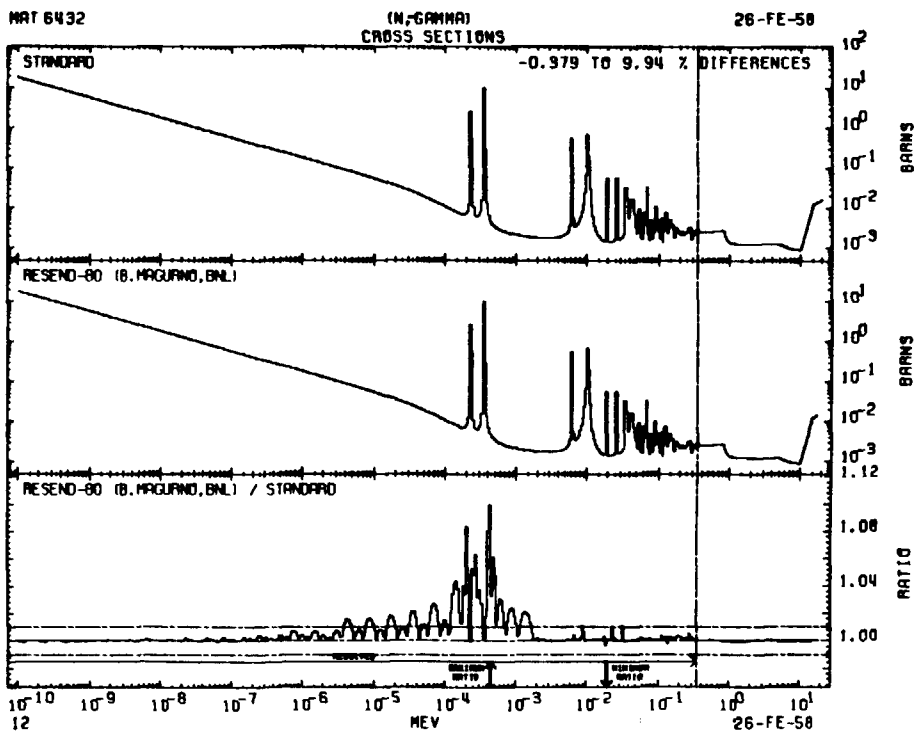

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-0.836 TO 29.7 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
6
90-TH-232

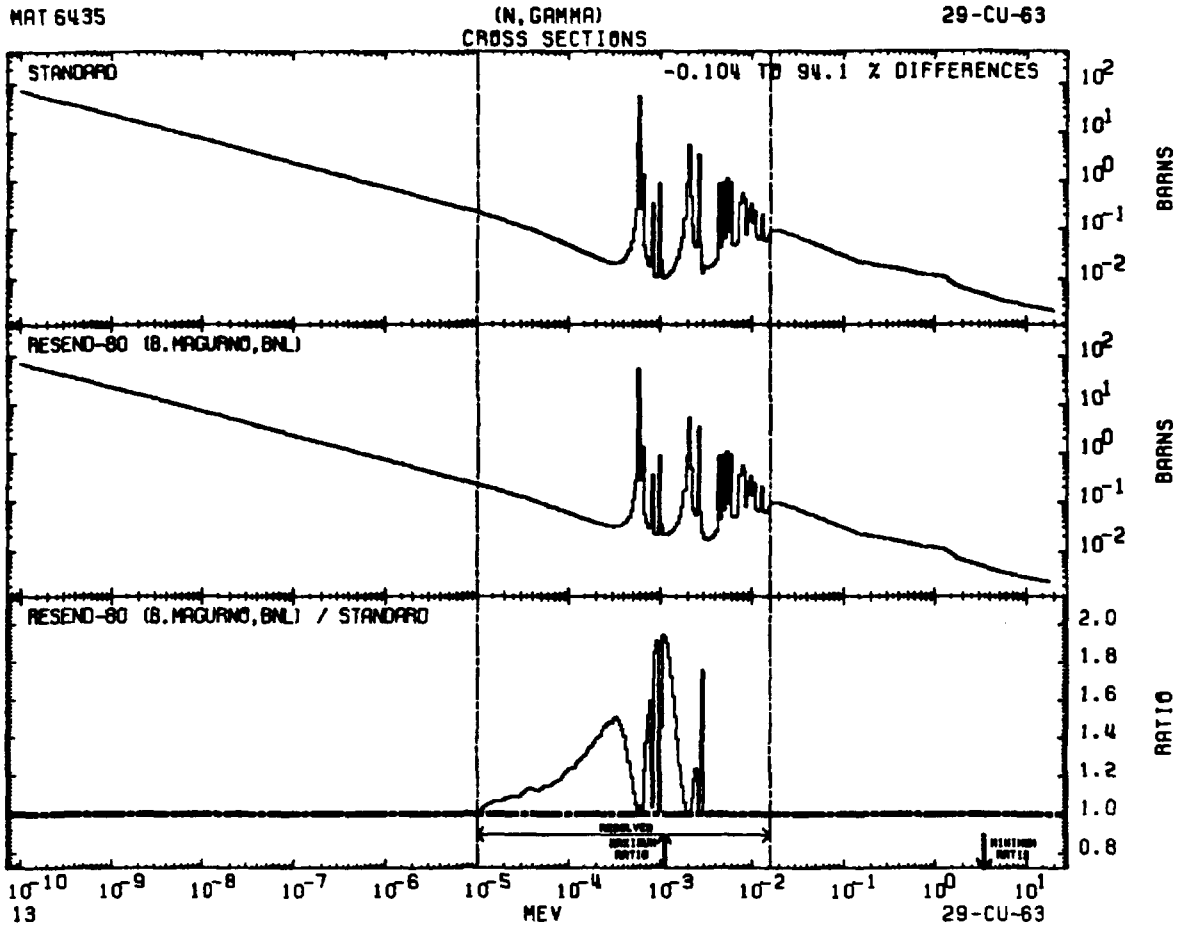

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-2.54 TO 9.12 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
8
92-U -235

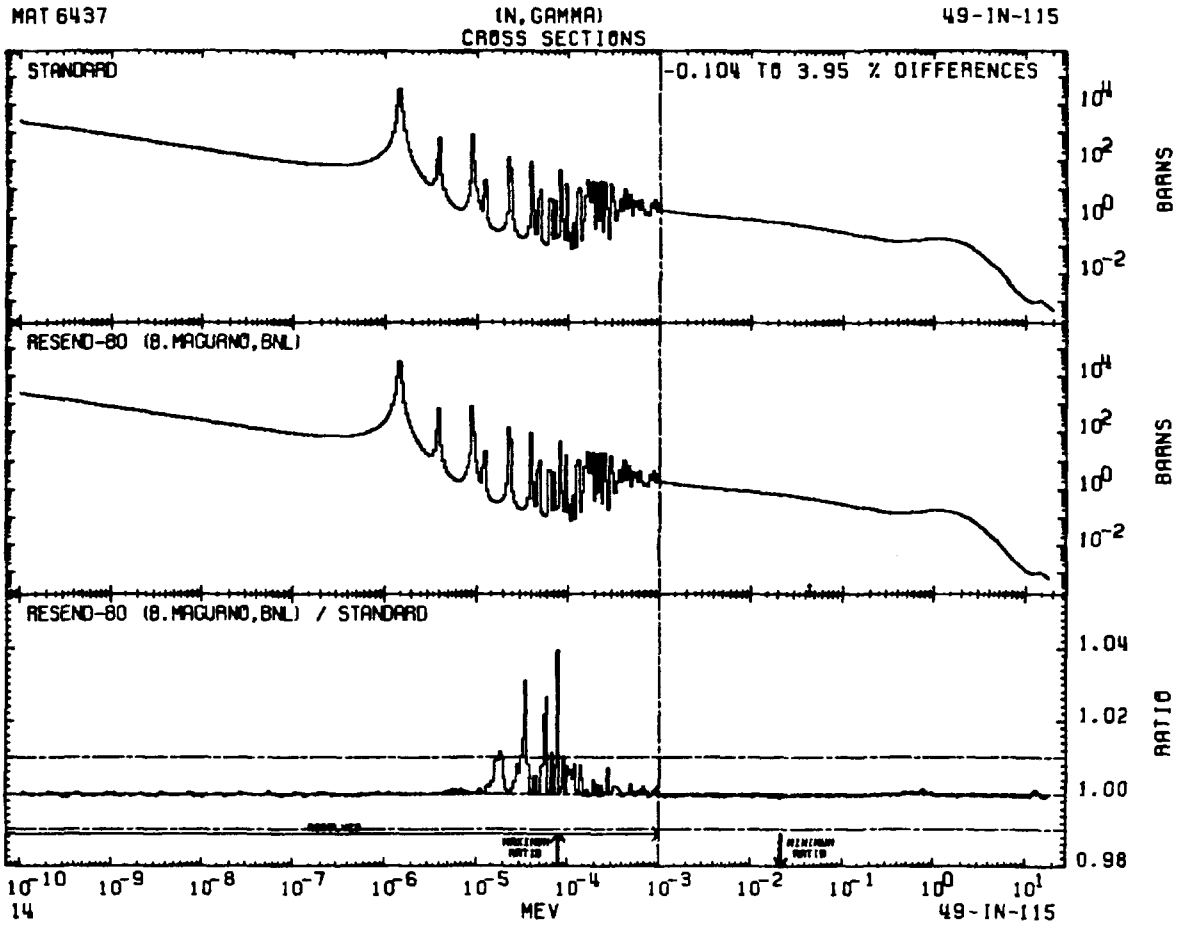

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-0.375 TO 5.15 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
9
92-U -238


MAT 6426
(N,GAMMA)
CROSS SECTIONS
21-SC-45
STANDARD
-0.251 TO 2.52 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
11
21-SC-45


MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-4.18 TO 9.62 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
10
92-U -238


MAT 6432
(N,GAMMA)
CROSS SECTIONS
26-FE-58
STANDARD
-0.979 TO 9.94 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
RATIO
MEV
12
26-FE-58


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-0.104 TO 94.1 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
BARNS
RATIO
2.0
1.8
1.6
1.4
1.2
1.0
0.8
13
MEV
29-CU-63


MAT 6437
(N,GAMMA)
CROSS SECTIONS
49-IN-115
STANDARD
-0.104 TO 3.95 % DIFFERENCES
RESEND-80 (B.MAGURNO,BNL)
RESEND-80 (B.MAGURNO,BNL) / STANDARD
BARNS
BARNS
RATIO
1.04
1.02
1.00
0.98
14
MEV
49-IN-115

ENTOSAN

The ENTOSAN code was designed to convert resonance parameters and background cross sections directly into unshielded multigroup cross sections, without the intermediate step of reconstructing energy dependent cross sections. As pointed out earlier in this work, the ENTOSAN-RESEND results published by Petten were instrumental in initiating this verification project.

The ENTOSAN comparisons performed in 1980 indicated that ENTOSAN had no major problems. Only minor differences were found in the resolved resonance region and these were easily eliminated by the code designers by using more stringent convergence criteria in calculating integrals.

The latest ENTOSAN results agree with the benchmark results. It is worth noting that comparison of the initial results submitted by all codes indicates that of all the processing codes which submitted results for the entire ENDF/B-V dosimetry library the initial ENTOSAN results were eventually found to be closest to the benchmark results.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=ENTOSAN-80 (W.ZIJP,PETTEN)

ENDF/B TAPE LABELS

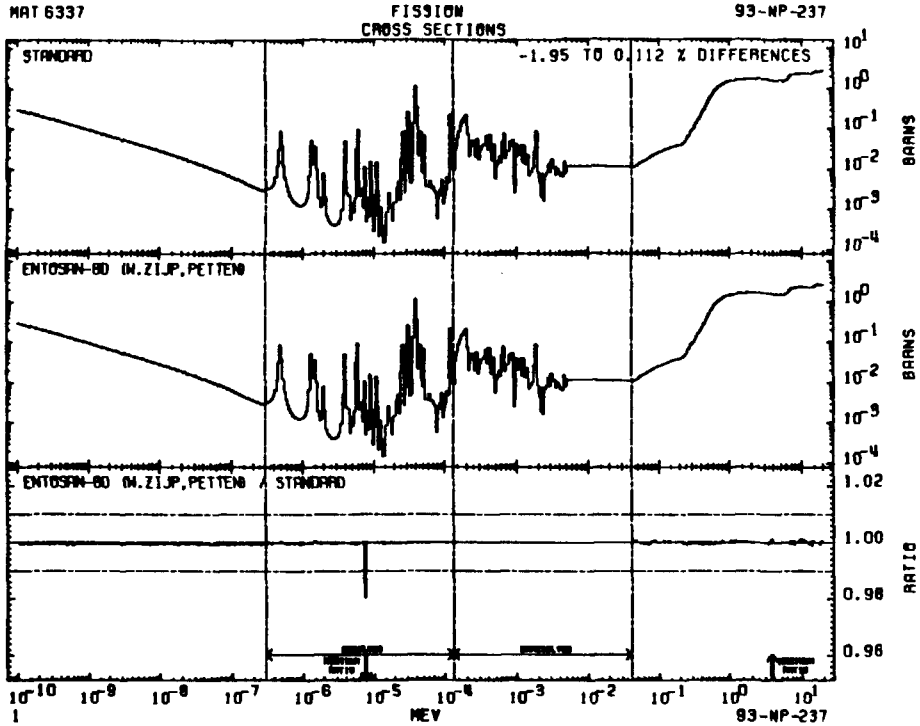
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2= ENTOSAN...ENDF/B-V DOSIMETRY LIBRARY (W.ZIJP,PETTEN,1980) 800

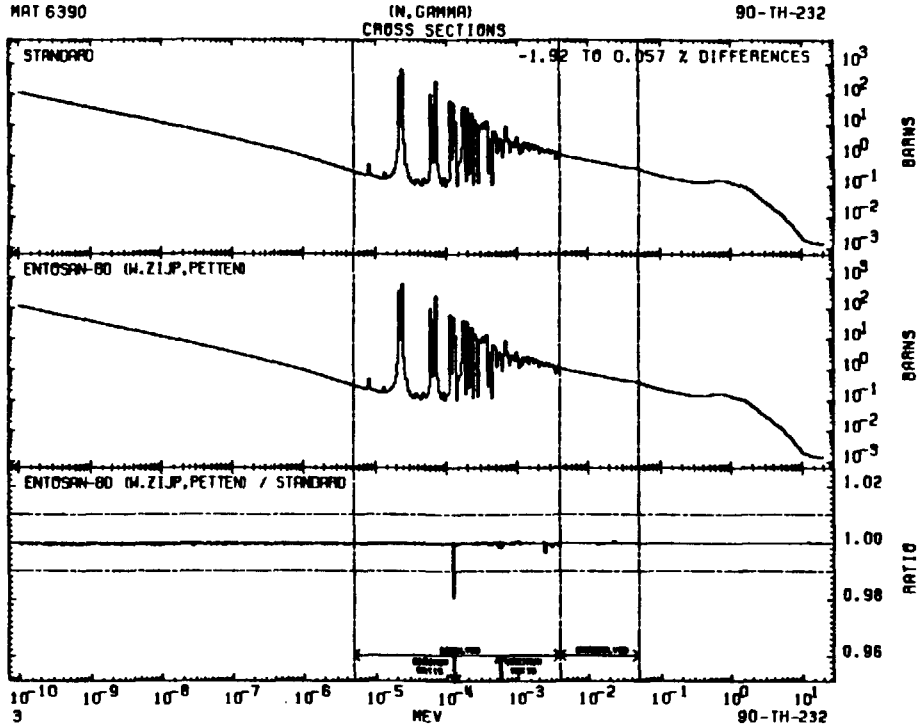
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE		MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2
11-NA- 23	102	6311	3	1280	1280	1.0000- 4	2.0000+ 7	-0.155		0.099		
13-AL- 27	103	6313	4	365	365	1.8000+ 6	2.0000+ 7	-0.152		0.074		
13-AL- 27	107	6313	4	337	337	3.2000+ 6	2.0000+ 7	-0.122		0.005		
25-MN- 55	16	6325	9	193	193	1.0400+ 7	2.0000+ 7	-0.080		0.081		
27-CO- 59	16	6327	13	189	189	1.0600+ 7	2.0000+ 7	-0.001		0.003		
27-CO- 59	102	6327	13	1280	1280	1.0000- 4	2.0000+ 7	-0.253		0.060		
27-CO- 59	107	6327	13	291	291	5.5000+ 6	2.0000+ 7	-0.003		0.042		
93-NP-237	18	6337	27	1280	1280	1.0000- 4	2.0000+ 7	-1.948	*	0.112	1.08239- 2	1.06130- 2
79-AU-197	102	6379	23	1280	1280	1.0000- 4	2.0000+ 7	-0.075		0.054		
90-TH-232	18	6390	24	861	861	5.0000+ 0	2.0000+ 7	-1.920	*	0.056	3.06708- 4	3.00820- 4
90-TH-232	102	6390	24	1280	1280	1.0000- 4	2.0000+ 7	-1.918	*	0.057	4.96248+ 1	4.86730+ 1
92-U -235	18	6395	25	1280	1280	1.0000- 4	2.0000+ 7	-0.093		0.086		
92-U -238	18	6398	26	1280	1280	1.0000- 4	2.0000+ 7	-0.096		0.040		
92-U -238	102	6398	26	1280	1280	1.0000- 4	2.0000+ 7	-0.726		0.071		
94-PU-239	18	6399	28	1280	1280	1.0000- 4	2.0000+ 7	-1.783	*	0.125	3.31479+ 1	3.25570+ 1
3-LI- 6	207	6424	1	1280	1280	1.0000- 4	2.0000+ 7	-0.098		0.090		
5-B - 10	207	6425	2	1280	1280	1.0000- 4	2.0000+ 7	-0.098		0.053		
21-SC- 45	102	6426	5	1280	1280	1.0000- 4	2.0000+ 7	-0.108		0.031		
22-TI- 46	103	6427	6	369	369	1.6000+ 6	2.0000+ 7	-0.002		0.004		
22-TI- 47	28	6428	7	189	189	1.0600+ 7	2.0000+ 7	-0.095		0.001		
22-TI- 47	103	6428	7	1280	1280	1.0000- 4	2.0000+ 7	-0.003		0.005		
22-TI- 48	28	6429	8	169	169	1.1600+ 7	2.0000+ 7	-0.099		0.041		
22-TI- 48	103	6429	8	337	337	3.2000+ 6	2.0000+ 7	-0.004		0.002		
26-FE- 54	103	6430	10	1280	1280	1.0000- 4	2.0000+ 7	-0.103		0.085		
26-FE- 56	103	6431	11	343	343	2.9000+ 6	2.0000+ 7	-0.072		0.005		
26-FE- 58	102	6432	12	1280	1280	1.0000- 4	2.0000+ 7	-0.130		0.093		
28-NI- 58	16	6433	14	153	153	1.2400+ 7	2.0000+ 7	0.0		0.000		
28-NI- 58	103	6433	14	1280	1280	1.0000- 4	2.0000+ 7	-0.094		0.074		
28-NI- 60	103	6434	15	351	351	2.5000+ 6	2.0000+ 7	-0.102		0.032		
29-CU- 63	102	6435	16	1280	1280	1.0000- 4	2.0000+ 7	-0.110		0.009		
29-CU- 63	107	6435	16	367	367	1.7000+ 6	2.0000+ 7	-0.102		0.070		
29-CU- 65	16	6436	17	201	201	1.0000+ 7	2.0000+ 7	-0.003		0.005		
49-IN-115	51	6437	21	427	427	3.2000+ 5	2.0000+ 7	-0.062		0.004		
49-IN-115	102	6437	21	1280	1280	1.0000- 4	2.0000+ 7	-0.123		0.111		
53-I -127	16	6438	22	217	217	9.2000+ 6	2.0000+ 7	-0.055		0.099		
16-S - 32	103	6439	*** NO COMPARISON ***									

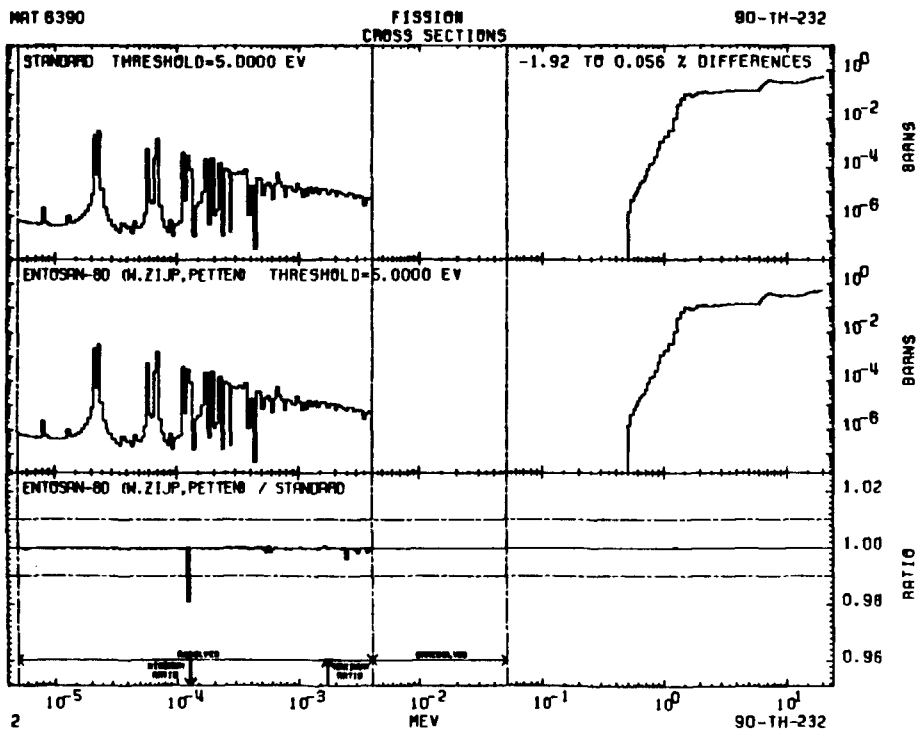
4 PLOTS GENERATED

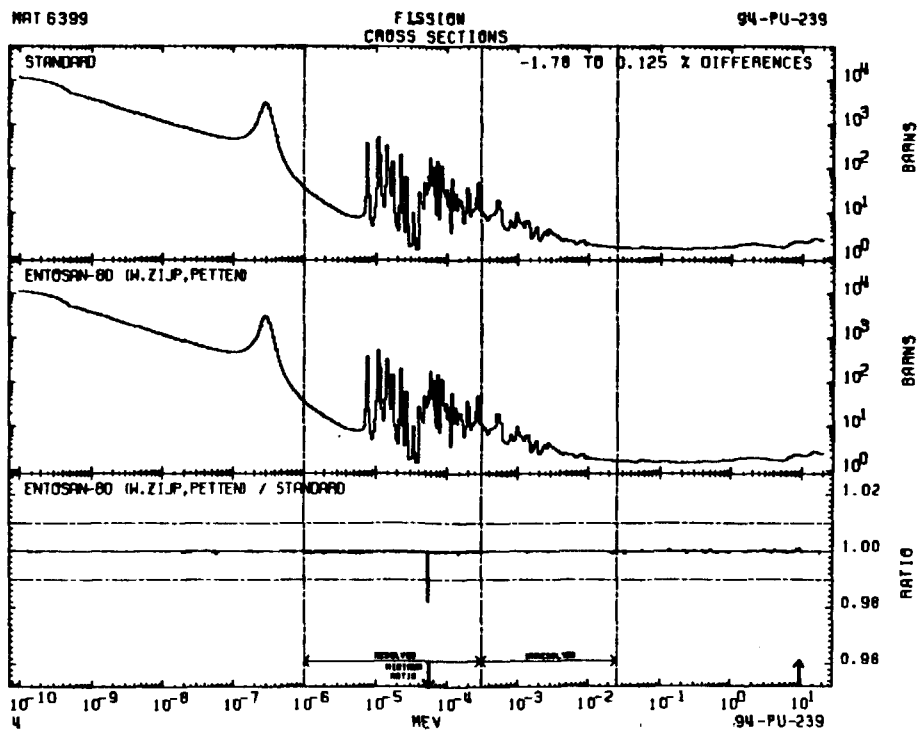
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS


MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-1.95 TO 0.112 % DIFFERENCES
ENTOSAN-80 (W.ZIP,PETTEN)
ENTOSAN-80 (W.ZIP,PETTEN) / STANDARD
BARNS
RATIO
MEV
1
93-NP-237


MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-1.92 TO 0.057 % DIFFERENCES
ENTOSAN-80 (W.ZIP,PETTEN)
ENTOSAN-80 (W.ZIP,PETTEN) / STANDARD
BARNS
RATIO
MEV
3
90-TH-232


MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-1.92 TO 0.056 % DIFFERENCES
ENTOSAN-80 (W.ZIP,PETTEN) THRESHOLD=5.0000 EV
ENTOSAN-80 (W.ZIP,PETTEN) / STANDARD
BARNS
RATIO
MEV
2
90-TH-232


MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-1.78 TO 0.125 % DIFFERENCES
ENTOSAN-80 (W.ZIP,PETTEN)
ENTOSAN-80 (W.ZIP,PETTEN) / STANDARD
BARNS
RATIO
MEV
4
94-PU-239

RECENT

The RECENT code was designed to convert resonance parameters and background cross sections into energy dependent cross sections.

The RECENT initial comparisons which were performed in 1980 identified two problem areas with the code. Failure to follow the ENDF/B interpolation law for small cross sections led to large errors for small cross sections close to thresholds (e.g., ^{27}Al-(n,alpha)). The program had an input option to allow energies to be output in the ENDF/B format to six or nine digit accuracy. The initial results were generated using the six digit option, which resulted in differences in the average cross section of up to 6% (e.g. ^{59}Co-capture). The author must admit that this is an example of using the wrong input option with his own code.

RECENT was modified to use the ENDF/B interpolation law all the way to threshold. This did not lead to any numerical instability, nor did it cause significantly more energy points to be generated. The six-nine digit input option was eliminated; all energies are now output to nine digit accuracy. With these two modifications the current version of RECENT can now reproduce the benchmark results.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=RECENT-80 (D.CULLEN,IAEA)

ENDF/B TAPE LABELS

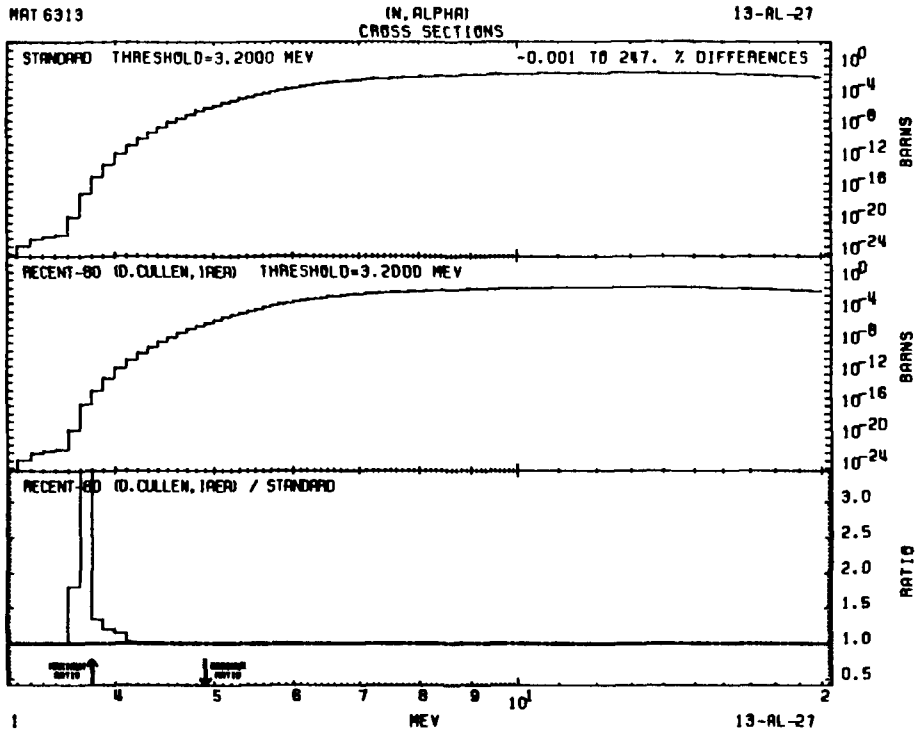
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2=ENDF/B-V DOSIMETRY LIBRARY FROM RECENT-80 (IAEA,VIENNA) 9000

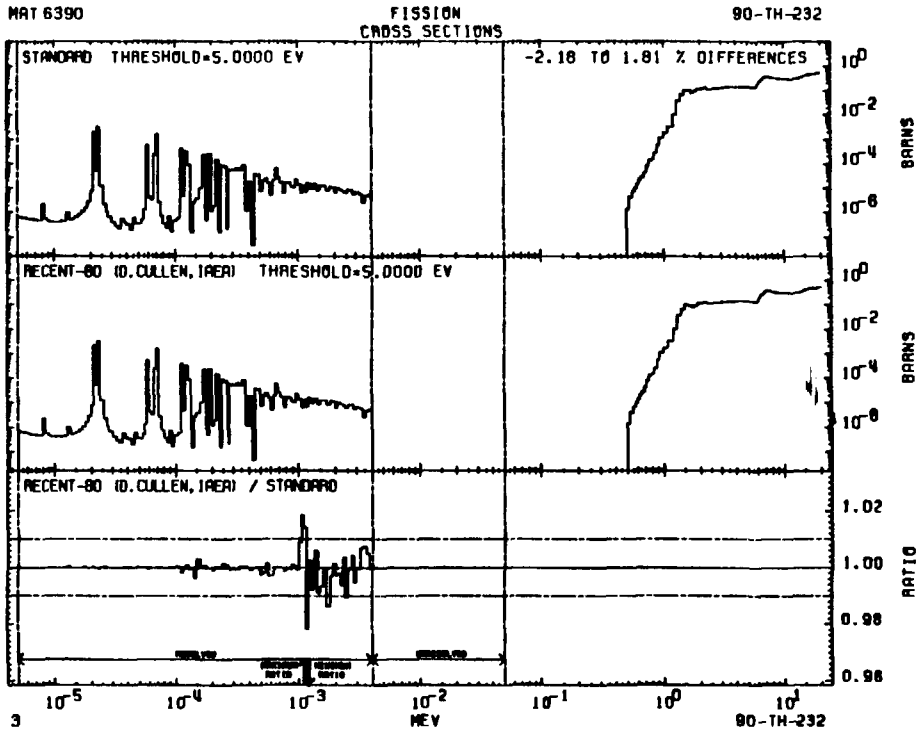
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2		DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1280	1.0000- 4	2.0000+ 7	-0.194	0.364						
13-AL- 27	103	6313	6313	365	365	1.8000+ 6	2.0000+ 7	-0.003	0.003						
13-AL- 27	107	6313	6313	337	337	3.2000+ 6	2.0000+ 7	-0.001	247.098	*				4.83039-17	1.67662-16
25-MN- 55	16	6325	6325	193	193	1.0400+ 7	2.0000+ 7	-0.009	0.007						
27-CO- 59	16	6327	6327	189	189	1.0600+ 7	2.0000+ 7	0.0	0.0						
27-CO- 59	102	6327	6327	1280	1280	1.0000- 4	2.0000+ 7	-2.190	5.569	*	1.97407- 2	1.93083- 2		2.42248- 2	2.55739- 2
27-CO- 59	107	6327	6327	291	291	5.5000+ 6	2.0000+ 7	0.0	0.0						
93-NP-237	18	6337	6337	1280	1280	1.0000- 4	2.0000+ 7	-0.072	0.082						
79-AU-197	102	6379	6379	1280	1280	1.0000- 4	2.0000+ 7	-0.211	0.219						
90-TH-232	18	6390	6390	861	861	5.0000+ 0	2.0000+ 7	-2.182	1.809	*	7.00047- 6	6.84769- 6		6.02101- 6	6.12992- 6
90-TH-232	102	6390	6390	1280	1280	1.0000- 4	2.0000+ 7	-1.948	1.545	*	1.33445+ 0	1.30846+ 0		1.13697+ 0	1.15454+ 0
92-U -235	18	6395	6395	1280	1280	1.0000- 4	2.0000+ 7	-0.057	0.039						
92-U -238	18	6398	6398	1280	1280	1.0000- 4	2.0000+ 7	-0.126	0.067						
92-U -238	102	6398	6398	1280	1280	1.0000- 4	2.0000+ 7	-0.191	0.093						
94-PU-239	18	6399	6399	1280	1280	1.0000- 4	2.0000+ 7	-0.073	0.063						
3-LI- 6	207	6424	6424	1280	1280	1.0000- 4	2.0000+ 7	-0.063	0.051						
5-B - 10	207	6425	6425	1280	1280	1.0000- 4	2.0000+ 7	-0.001	0.001						
21-SC- 45	102	6426	6426	1280	1280	1.0000- 4	2.0000+ 7	-0.055	0.016						
22-TI- 46	103	6427	6427	369	369	1.6000+ 6	2.0000+ 7	0.0	0.0						
22-TI- 47	28	6428	6428	189	189	1.0600+ 7	2.0000+ 7	-0.002	0.005						
22-TI- 47	103	6428	6428	1280	1280	1.0000- 4	2.0000+ 7	0.0	0.0						
22-TI- 48	28	6429	6429	169	169	1.1600+ 7	2.0000+ 7	-0.003	0.002						
22-TI- 48	103	6429	6429	337	337	3.2000+ 6	2.0000+ 7	0.0	0.0						
26-FE- 54	103	6430	6430	1280	1280	1.0000- 4	2.0000+ 7	-0.001	0.001						
26-FE- 56	103	6431	6431	343	343	2.9000+ 6	2.0000+ 7	-0.001	0.002						
26-FE- 58	102	6432	6432	1280	1280	1.0000- 4	2.0000+ 7	-0.099	0.007						
28-NI- 58	16	6433	6433	153	153	1.2400+ 7	2.0000+ 7	0.0	0.0						
28-NI- 58	103	6433	6433	1280	1280	1.0000- 4	2.0000+ 7	-0.004	0.007						
28-NI- 60	103	6434	6434	351	351	2.5000+ 6	2.0000+ 7	-0.004	0.002						
29-CU- 63	102	6435	6435	1280	1280	1.0000- 4	2.0000+ 7	-0.058	0.006						
29-CU- 63	107	6435	6435	367	367	1.7000+ 6	2.0000+ 7	-0.001	0.001						
29-CU- 65	16	6436	6436	201	201	1.0000+ 7	2.0000+ 7	0.0	0.0						
49-IN-115	51	6437	6437	427	427	3.2000+ 5	2.0000+ 7	-0.001	0.000						
49-IN-115	102	6437	6437	1280	1280	1.0000- 4	2.0000+ 7	-0.082	0.066						
53-I -127	16	6438	6438	217	217	9.2000+ 6	2.0000+ 7	0.0	0.0						
16-S - 32	103	6439	*** NO COMPARISON ***												

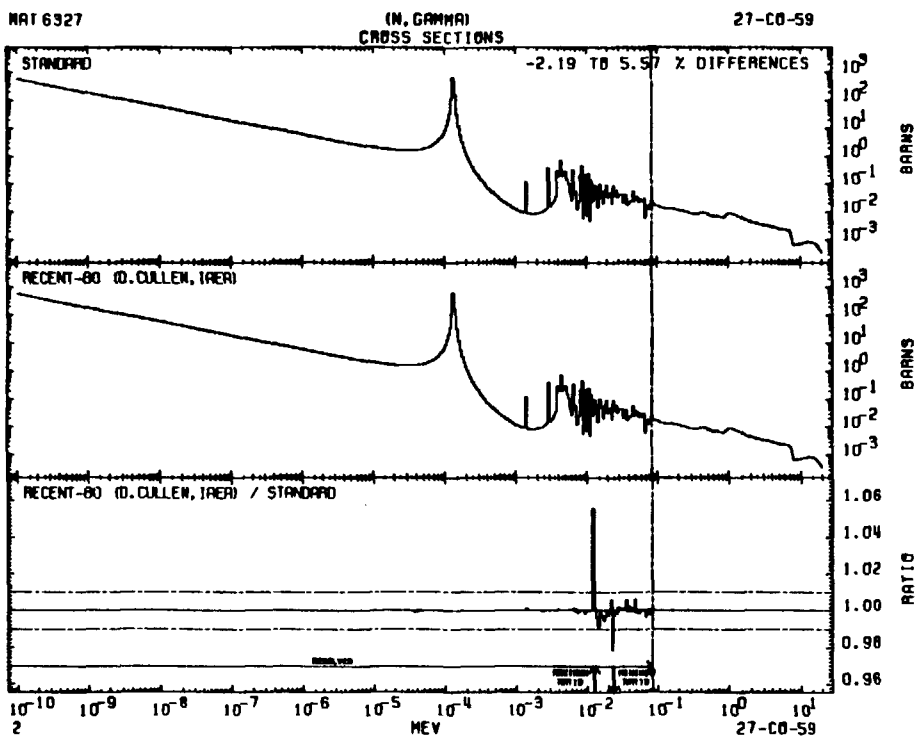
4 PLOTS GENERATED

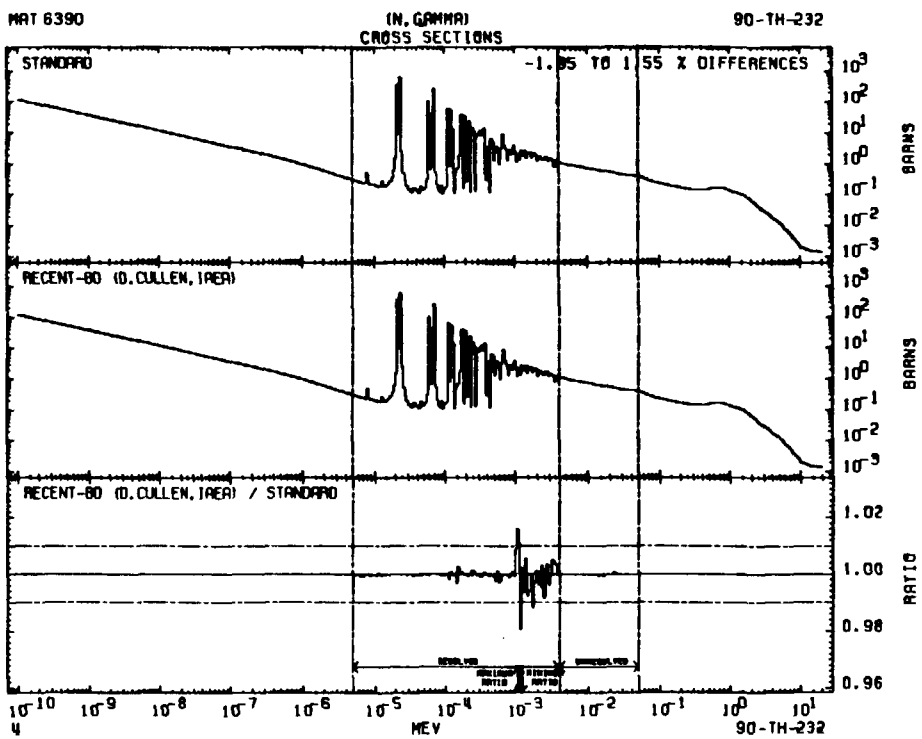
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS


MAT 6313
(N,ALPHA)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=3.2000 MEV
-0.001 TO 247. % DIFFERENCES
RECENT-80 (D.CULLEN,IAEA) THRESHOLD=3.2000 MEV
RECENT-80 (D.CULLEN,IAEA) / STANDARD
BARNS
RATIO
MEV
13-AL-27


MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-2.18 TO 1.81 % DIFFERENCES
RECENT-80 (D.CULLEN,IAEA) THRESHOLD=5.0000 EV
RECENT-80 (D.CULLEN,IAEA) / STANDARD
BARNS
RATIO
MEV
90-TH-232


MAT 6327
(N,GAMMA)
CROSS SECTIONS
27-CO-59
STANDARD
-2.19 TO 5.57 % DIFFERENCES
RECENT-80 (D.CULLEN,IAEA)
RECENT-80 (D.CULLEN,IAEA) / STANDARD
BARNS
RATIO
MEV
27-CO-59


MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-1.95 TO 1.55 % DIFFERENCES
RECENT-80 (D.CULLEN,IAEA)
RECENT-80 (D.CULLEN,IAEA) / STANDARD
BARNS
RATIO
MEV
90-TH-232

FOURACES
========

FOURACES is a multigroup processing system (unlike the codes previously described which only produce cross sections) designed to produce complete multigroup sets for use in calculations, starting from evaluated data in any of a variety of evaluated data formats (e.g., ENDF/B, KEDAK, UKNDL).

The initial FOURACES comparisons indicated major problems in the resolved region and some problems in the unresolved resonance region. Resolved region results indicated that the energy grid used was inadequate for isolated resonances (e.g., ^{58}Fe-capture-2400% error) and for narrow resonances at higher energy (e.g. ^{197}Au-capture, ^{232}Th-capture, ^{238}U-capture). The unresolved region results for ^{237}Np-fission, ^{235}U-fission and ^{239}Pu-fission indicated that FOURACES was using the ENDF/B-IV convention of parameter interpolation and that there was an error in the calculation of the fluctuation integrals.

FOURACES has been modified to use an improved energy grid in the resolved resonance region. In the unresolved resonance region FOURACES is now using the ENDF/B-V convention of cross section interpolation and the problem in calculating the fluctuation integral has been eliminated. The latest FOURACES results agree with the benchmark results.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=FOURACES-81 (G.PANINI,BOLOGNE)

ENDF/B TAPE LABELS

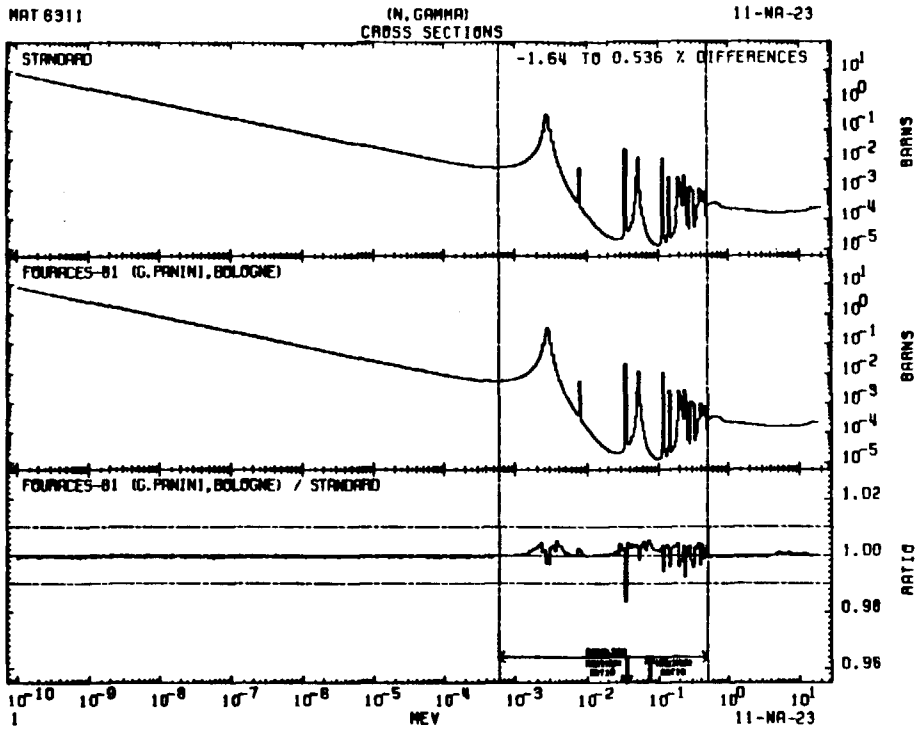
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2= FOURACES...ENDF/B-V DOSIMETRY LIBRARY (G.PANINI,BOLOGNE,1981) 8000

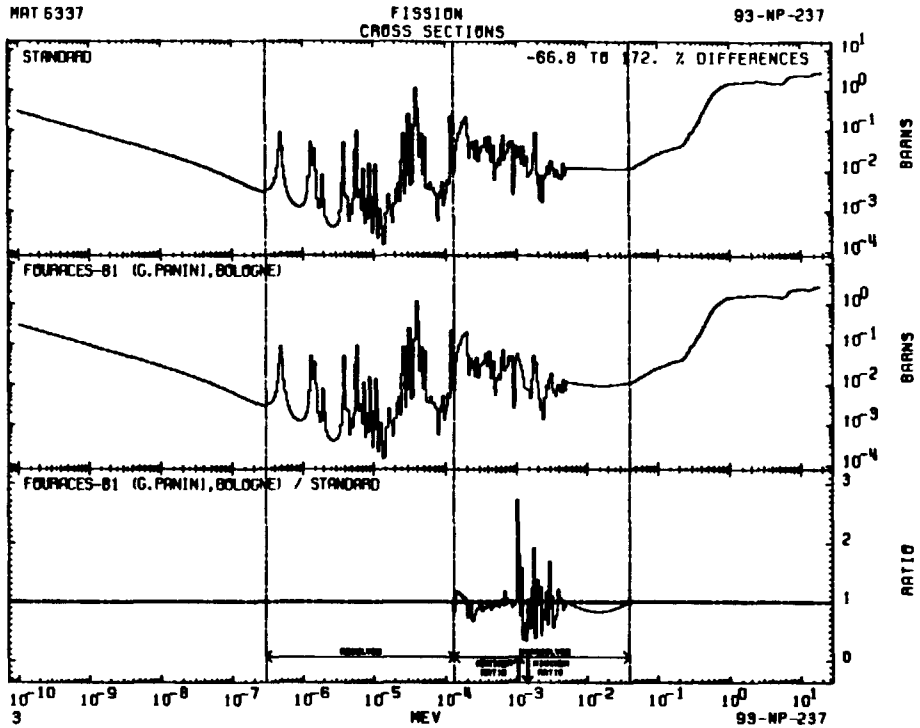
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-1.638 *	0.536	2.05039- 2	2.01680- 2		
13-AL- 27	103	6313	6313	365	325	1.8000+ 6	2.0000+ 7	-0.141	0.074				
13-AL- 27	107	6313	6313	337	297	3.2000+ 6	2.0000+ 7	-0.114	0.007				
25-MN- 55	16	6325	6325	193	153	1.0400+ 7	2.0000+ 7	-0.072	0.081				
27-CO- 59	16	6327	6327	189	149	1.0600+ 7	2.0000+ 7	-0.001	0.003				
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-5.478 *	97.777 *	5.95111+ 2	5.62510+ 2	1.07758- 1	2.13120- 1
27-CO- 59	107	6327	6327	291	251	5.5000+ 6	2.0000+ 7	-0.003	0.042				
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-66.819 *	172.375 *	2.28005- 2	7.56550- 3	2.11165- 2	5.75160- 2
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-6.222 *	2.208 *	5.65247+ 2	5.30080+ 2	3.87084+ 3	3.95630+ 3
90-TH-232	18	6390	6390	861	821	5.0000+ 0	2.0000+ 7	-10.056 *	5.315 *	5.50765- 6	4.95380- 6	8.62973- 5	9.08840- 5
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-6.997 *	5.267 *	1.28684+ 0	1.19680+ 0	1.25908+ 1	1.32540+ 1
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-19.767 *	13.949 *	1.01748+ 1	8.16350+ 0	6.28265+ 0	7.15900+ 0
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-100.000 *	97.797 *	1.07190- 2	0.0 + 0	2.82507-10	5.58790-10
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-8.067 *	1.901 *	1.09308+ 0	1.00490+ 0	1.97888- 1	2.01650- 1
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-14.382 *	18.324 *	4.60839+ 0	3.94560+ 0	4.51516+ 0	5.34250+ 0
3-LI- 6	207	6424	6424	1280	1240	1.0000- 4	2.0000+ 7	-0.098	0.090				
5-B - 10	207	6425	6425	1280	1240	1.0000- 4	2.0000+ 7	-0.098	0.053				
21-SC- 45	102	6426	6426	1280	1240	1.0000- 4	2.0000+ 7	-4.204 *	29.320 *	4.83496- 1	4.63170- 1	4.35881- 1	5.63680- 1
22-TI- 46	103	6427	6427	369	329	1.6000+ 6	2.0000+ 7	-0.002	0.004				
22-TI- 47	28	6428	6428	189	149	1.0600+ 7	2.0000+ 7	-0.091	0.005				
22-TI- 47	103	6428	6428	1280	1240	1.0000- 4	2.0000+ 7	-0.003	0.005				
22-TI- 48	28	6429	6429	169	129	1.1600+ 7	2.0000+ 7	-0.099	0.041				
22-TI- 48	103	6429	6429	337	297	3.2000+ 6	2.0000+ 7	-0.002	0.004				
26-FE- 54	103	6430	6430	1280	1240	1.0000- 4	2.0000+ 7	-0.102	0.085				
26-FE- 56	103	6431	6431	343	303	2.9000+ 6	2.0000+ 7	-0.072	0.003				
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.988	2691.591 *			2.85837- 1	7.97940+ 0
28-NI- 58	16	6433	6433	153	113	1.2400+ 7	2.0000+ 7	0.0	0.000				
28-NI- 58	103	6433	6433	1280	1240	1.0000- 4	2.0000+ 7	-0.094	0.074				
28-NI- 60	103	6434	6434	351	311	2.5000+ 6	2.0000+ 7	-0.102	0.032				
29-CU- 63	102	6435	6435	1280	1240	1.0000- 4	2.0000+ 7	-1.416 *	0.532	8.01181- 2	7.89840- 2		
29-CU- 63	107	6435	6435	367	327	1.7000+ 6	2.0000+ 7	-0.096	0.070				
29-CU- 65	16	6436	6436	201	161	1.0000+ 7	2.0000+ 7	-0.003	0.002				
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.067	0.004				
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-5.823 *	0.844	5.42183+ 1	5.10610+ 1		
53-I -127	16	6438	6438	217	177	9.2000+ 6	2.0000+ 7	-0.057	0.093				
16-S - 32	103	6439	*** NO COMPARISON ***										

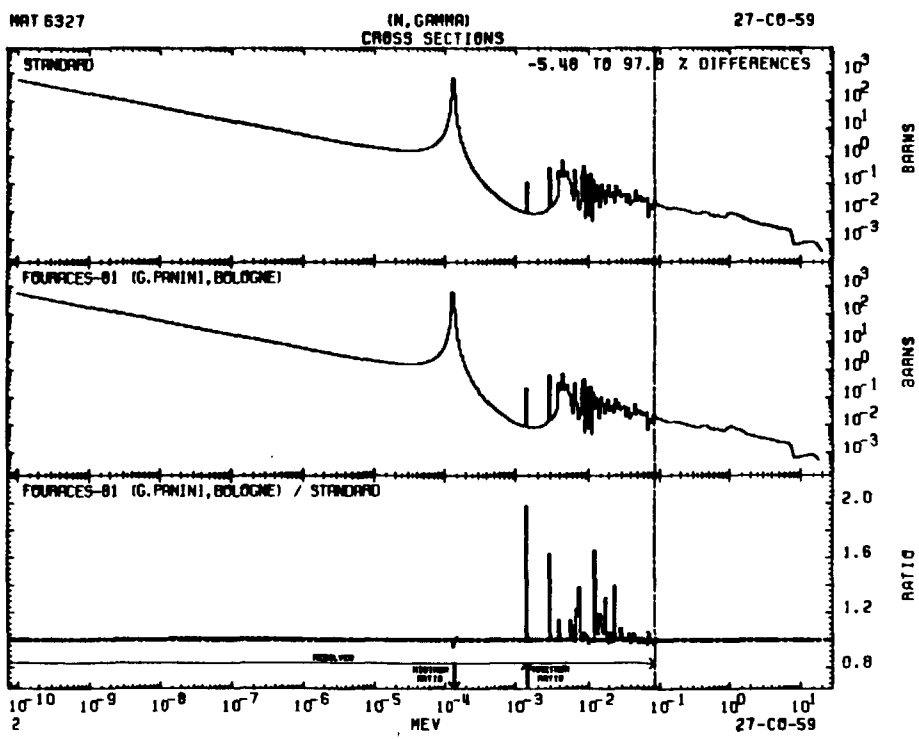
14 PLOTS GENERATED

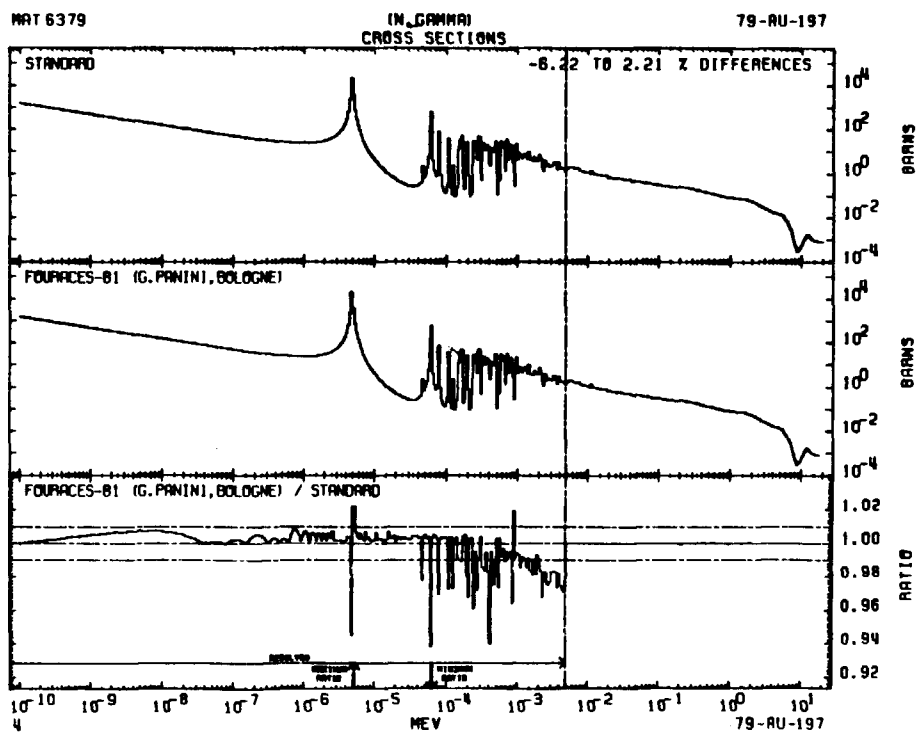
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

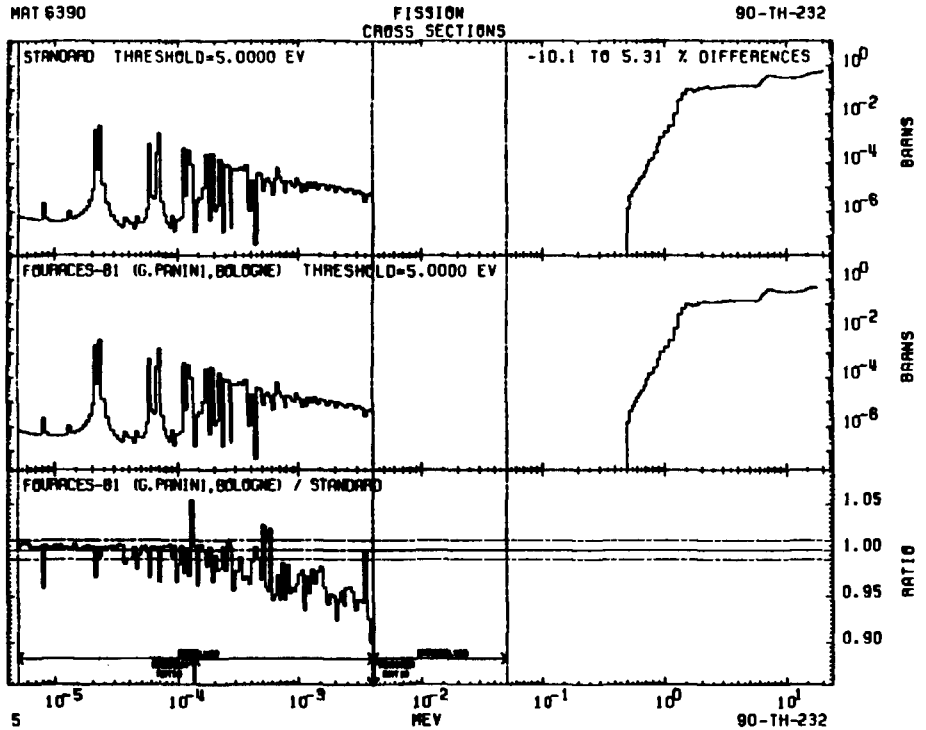
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

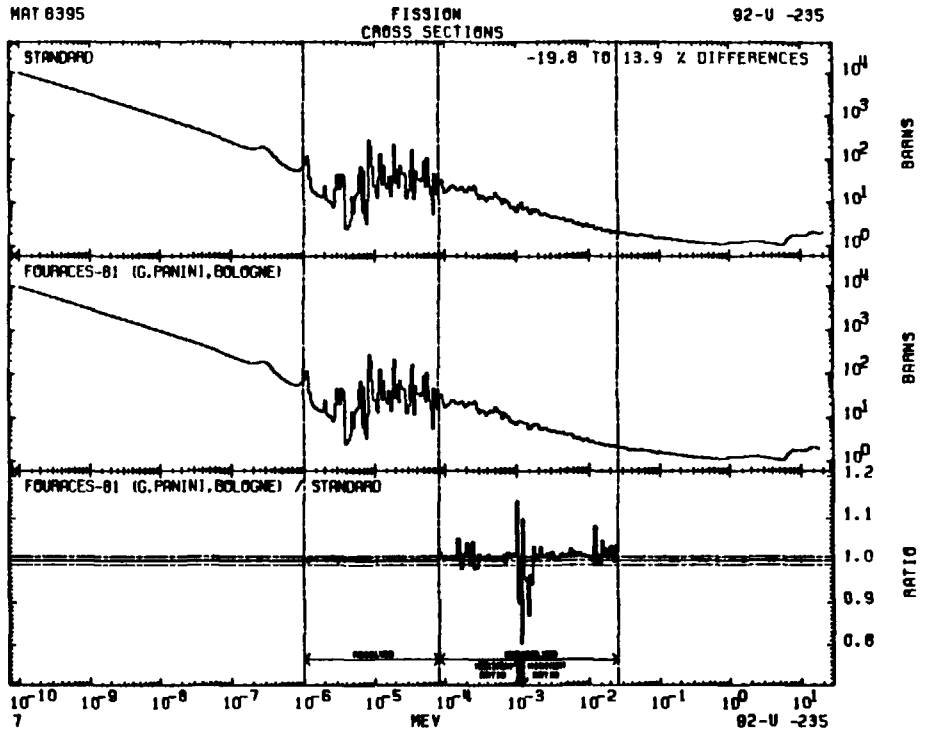

MAT 6311
(N,GAMMA)
CROSS SECTIONS
11-NA-23
STANDARD
-1.64 TO 0.536 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
1
11-NA-23

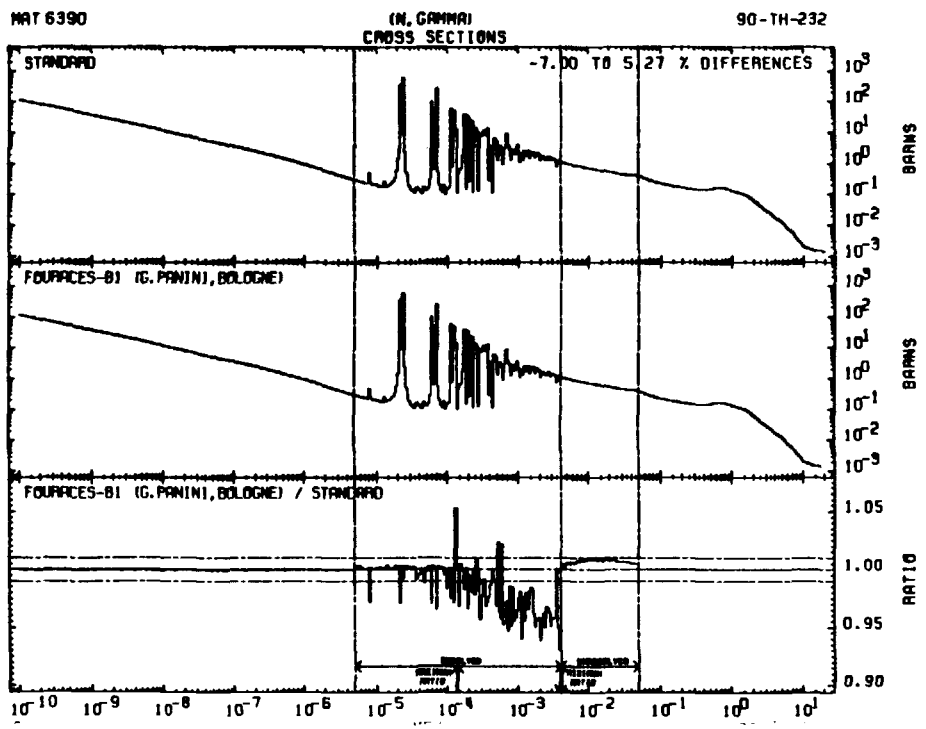

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-66.8 TO 172. % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
3
93-NP-237

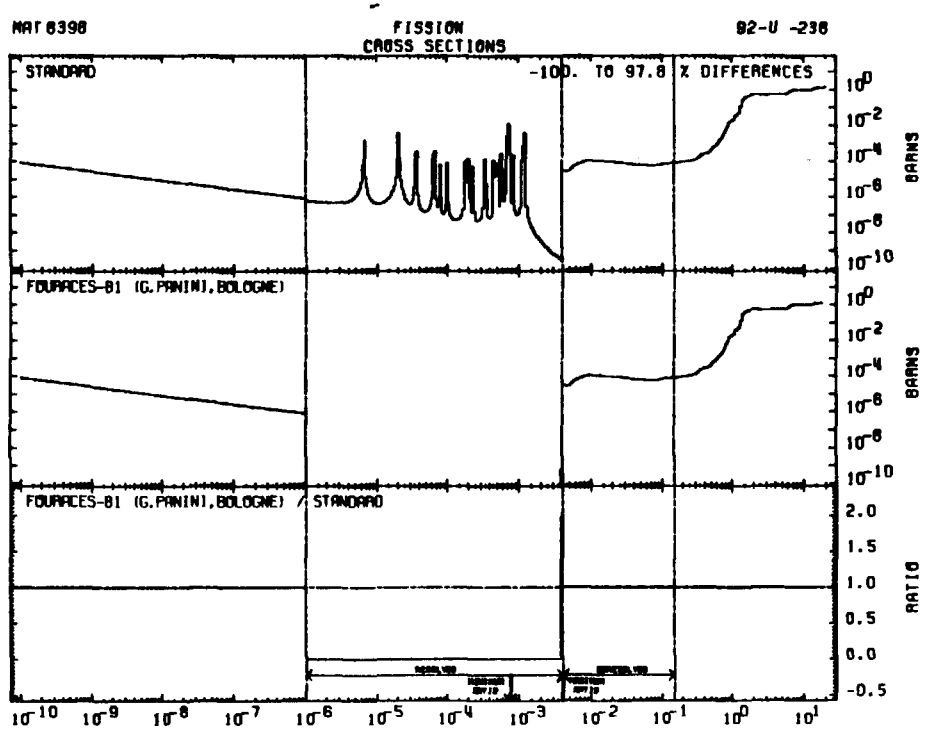

MAT 6327
(N,GAMMA)
CROSS SECTIONS
27-CO-59
STANDARD
-5.48 TO 97.8 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
2
27-CO-59

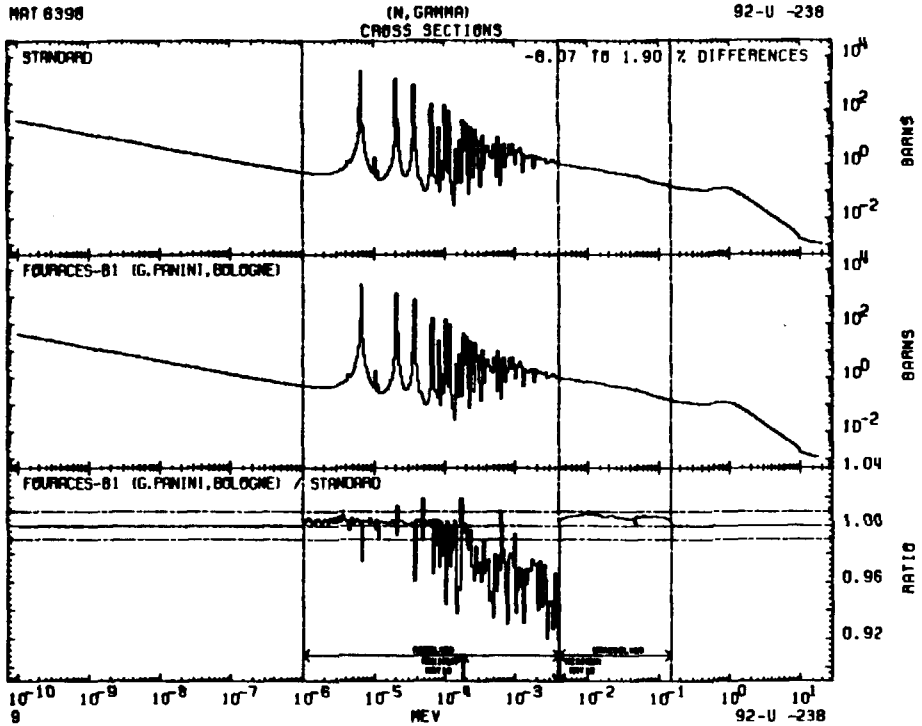

MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-6.22 TO 2.21 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
4
79-AU-197

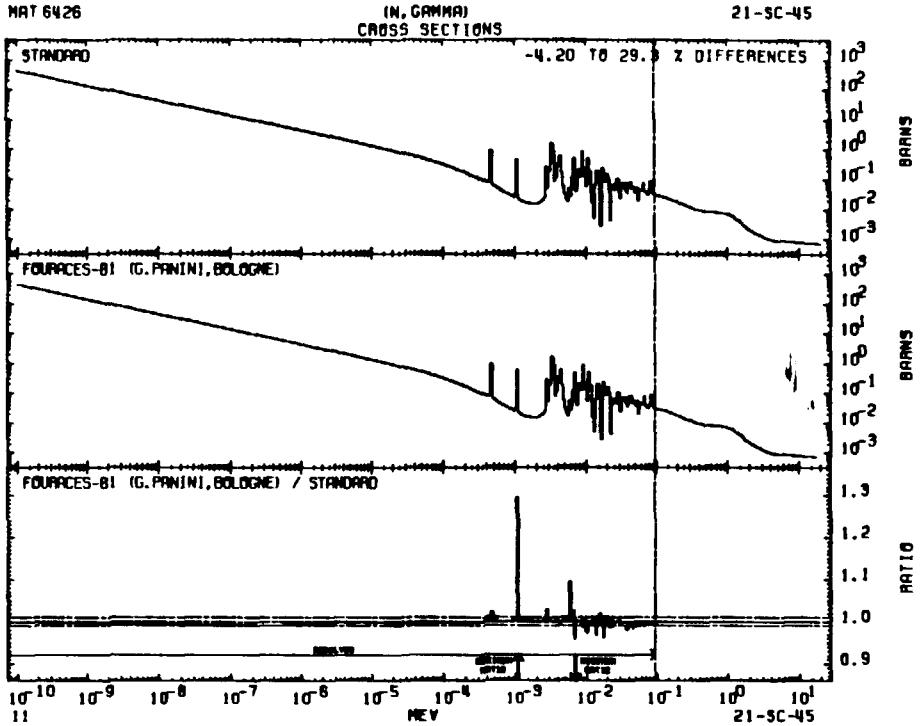

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-10.1 TO 5.31 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE) THRESHOLD=5.0000 EV
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
90-TH-232

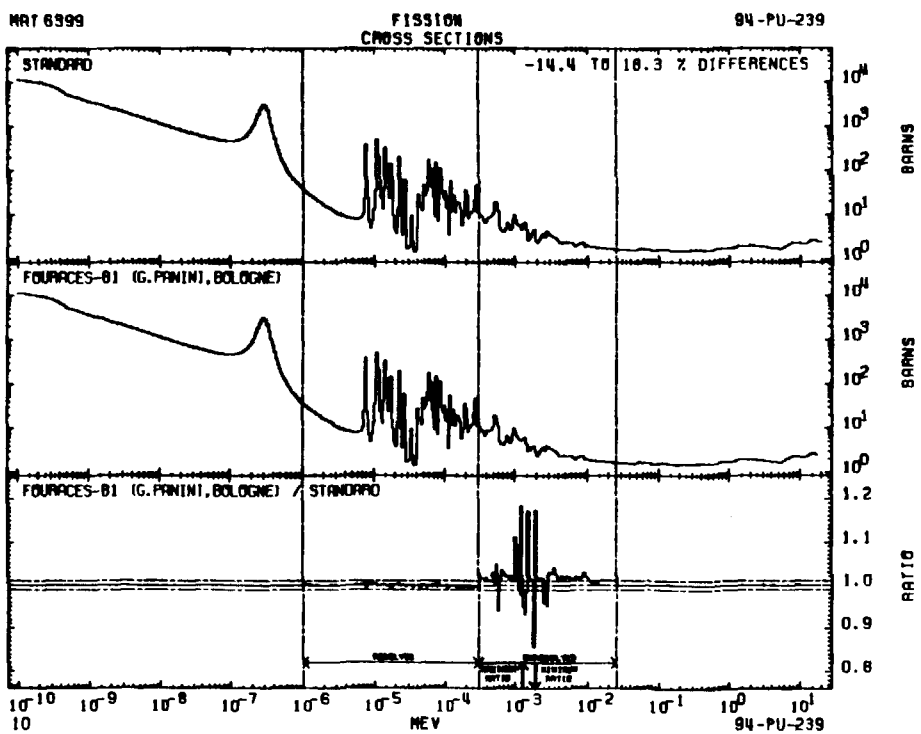

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-19.8 TO 13.9 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
92-U -235

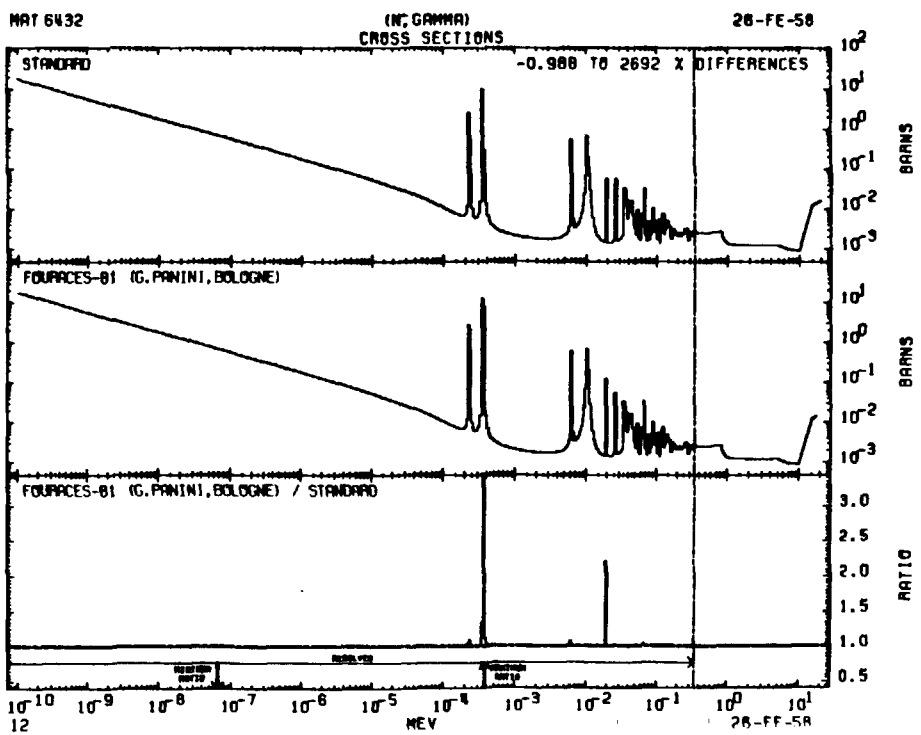

MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-7.00 TO 5.27 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO

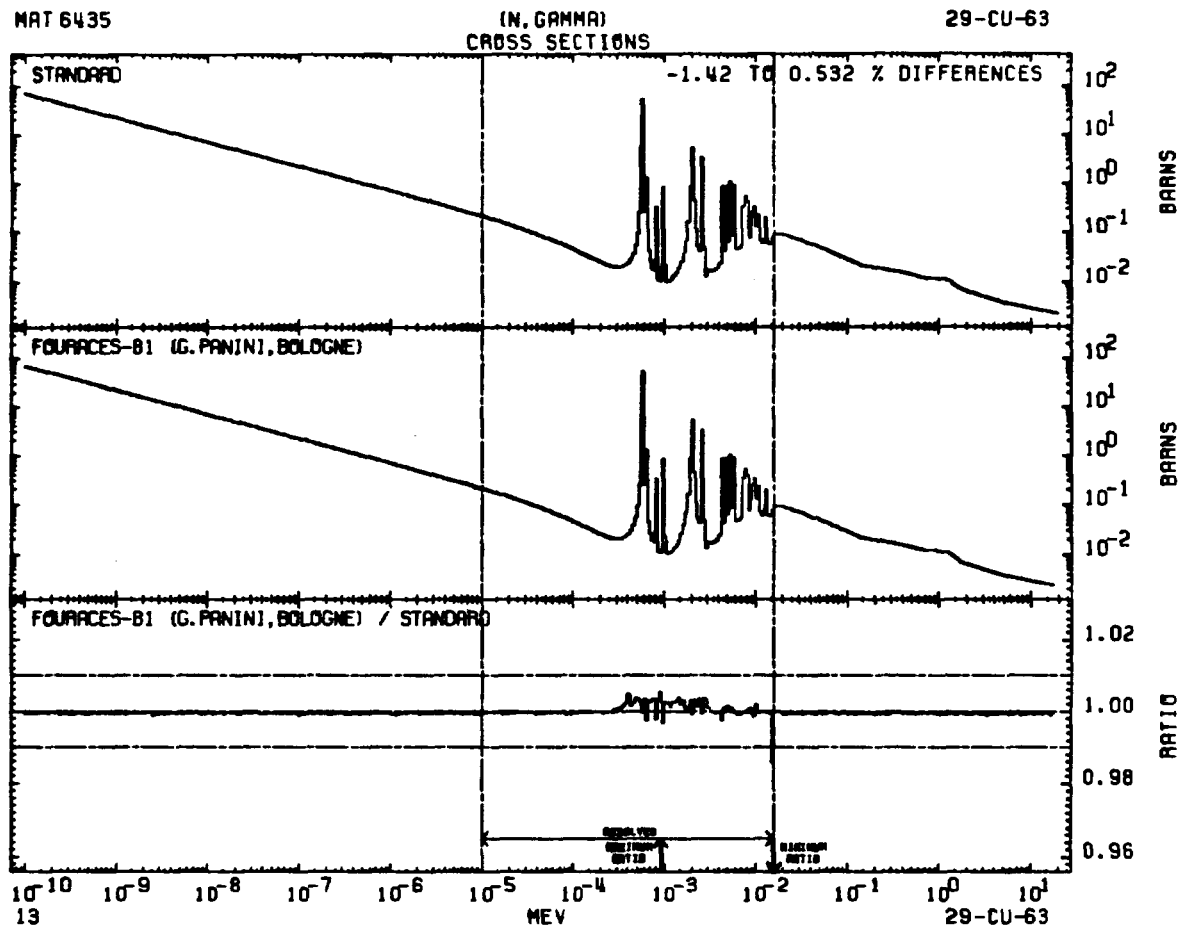

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-100. TO 97.8 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO

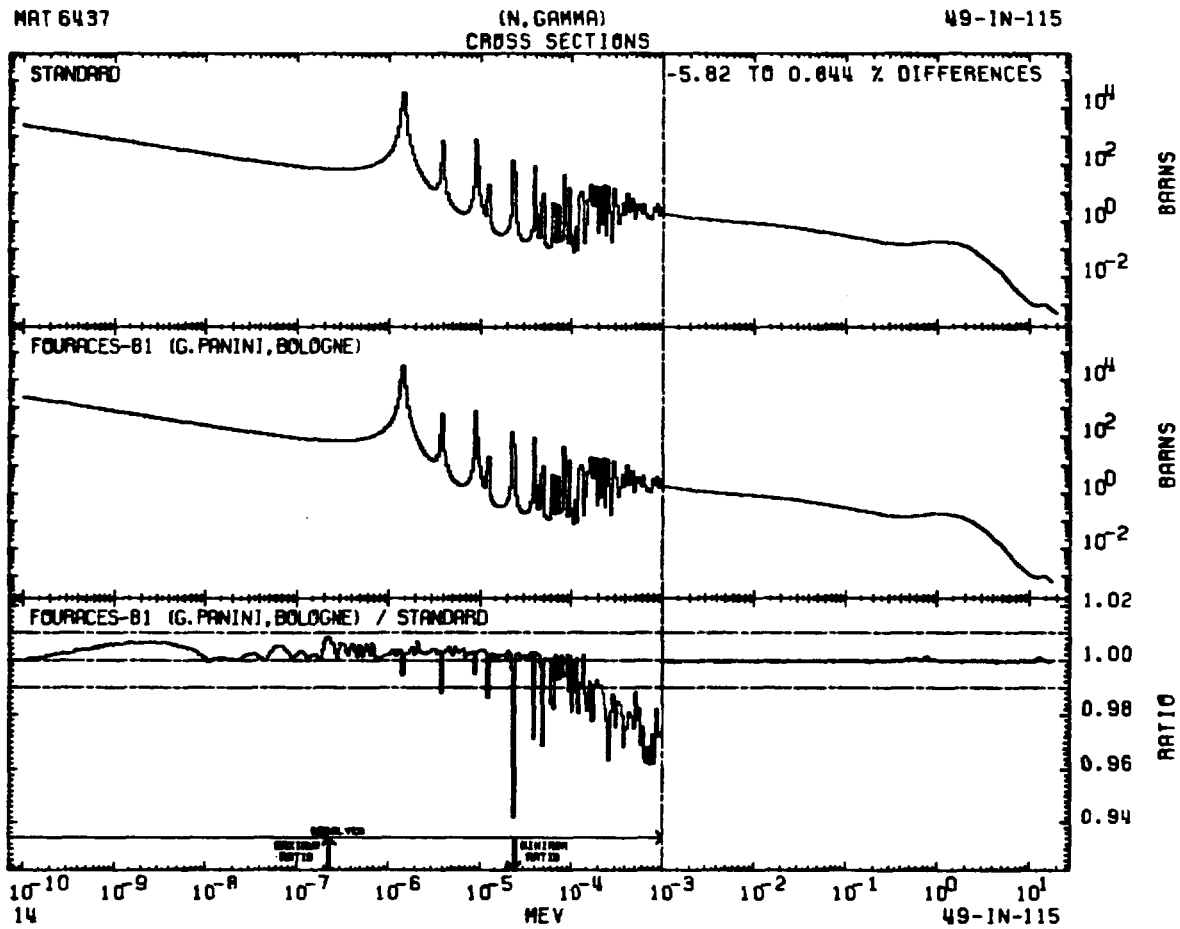

MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-8.07 TO 1.90 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
9
92-U -238


MAT 6426
(N,GAMMA)
CROSS SECTIONS
21-SC-45
STANDARD
-4.20 TO 29.
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
11
21-SC-45


MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-14.4 TO 18.3 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
10
94-PU-239


MAT 6432
(N,GAMMA)
CROSS SECTIONS
26-FE-58
STANDARD
-0.988 TO 2692 % DIFFERENCES
FOURACES-81 (G.PANINI,BOLOGNE)
FOURACES-81 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
12
26-FE-58


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-1.42 TO 0.532 % DIFFERENCES
FOURACES-B1 (G.PANINI,BOLOGNE)
FOURACES-B1 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
13
29-CU-63


MAT 6437
(N,GAMMA)
CROSS SECTIONS
49-IN-115
STANDARD
-5.82 TO 0.644 % DIFFERENCES
FOURACES-B1 (G.PANINI,BOLOGNE)
FOURACES-B1 (G.PANINI,BOLOGNE) / STANDARD
BARNS
RATIO
MEV
14
49-IN-115

RESCAL
======

The RESCAL code is designed to calculate unshielded multigroup cross sections from resonance parameters and background cross sections. As an intermediate step the code calculates energy dependent cross sections on a dense fixed energy grid and then group averages the cross sections.

The initial RESCAL comparisons performed in 1980 indicate that the fixed energy grid leads to surprisingly good results in the resolved region (e.g. a maximum difference of about 2% for ^{23}Na-capture and ^{238}U-fission). The ^{237}Np-fission and ^{238}U-capture results indicated that RESCAL was using the ENDF/B-IV convention of interpolating parameters and there was an error in the calculation of the fluctuation integral. The peaks or holes in the average cross sections at resonance region boundaries (e.g., ^{59}Co-capture, ^{197}Au-capture, ^{235}U-fission, ^{238}U-fission, ^{45}Sc-capture and ^{58}Fe-capture) indicates a numerical instability in the group averaging algorithm used by RESCAL. From the ^{47}Ti(n,p), ^{54}Fe(n,p) and ^{58}Ni(n,p) results it can be seen that RESCAL treats all cross sections which are less than 10^{-9} barns as if they are zero. For ^{63}Cu(n,alpha) results indicate that RESCAL may not be following the ENDF/B interpolation law.

The latest RESCAL comparisons performed in 1982 included results for the entire ENDF/B-V dosimetry library. Most of the problems described above for the 1980 comparisons were still present in the 1982 comparisons. In addition a curious new phenomen was seen in the results for a number of reactions (e.g. ^{23}Na-capture, ^{59}Co-capture, ^{238}U-fission, etc.) where periodic, inexplicable peaks were observed in the ratio of RESCAL results to the standard.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=RESCAL-80 (L.GREENWOOD,ANL)

ENDF/B TAPE LABELS

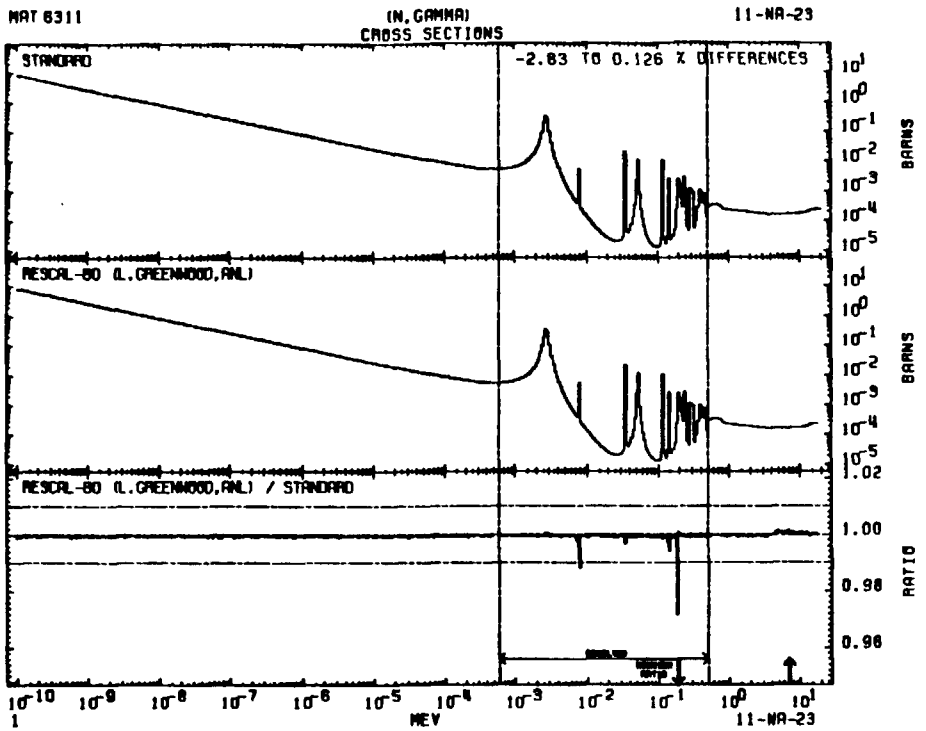
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2=RESCAL...ENDF/B-V DOSIMETRY LIBRARY (L.GREENWOOD,ANL,1980) 800

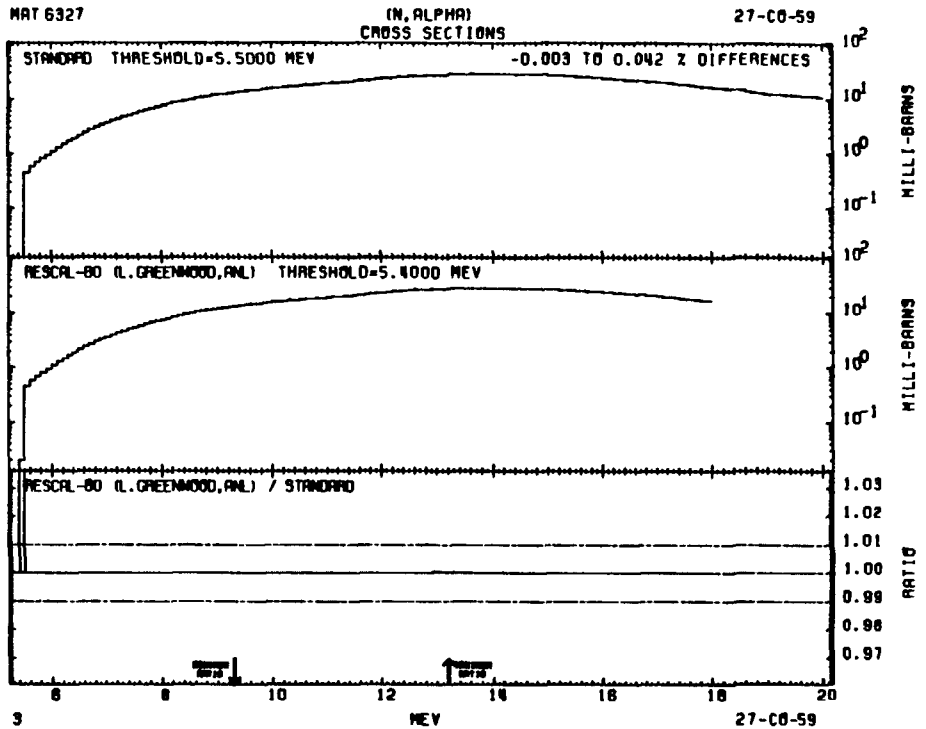
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2
11-NA- 23	102	6311	1	1280	1240	1.0000- 4	2.0000+ 7	-2.826 *	0.126	2.39261- 4	2.32500- 4		
13-AL- 27	103	6313	3	365	325	1.8000+ 6	2.0000+ 7	-0.146	0.068				
13-AL- 27	107	6313	3	337	297	3.2000+ 6	2.0000+ 7	-0.132	0.042				
25-MN- 55	16	6325	8	193	153	1.0400+ 7	2.0000+ 7	-0.078	0.083				
27-CO- 59	16	6327	*** NO COMPARISON ***										
27-CO- 59	102	6327	12	1280	1240	1.0000- 4	2.0000+ 7	-0.834	10.638 *			2.41238- 2	2.66900- 2
27-CO- 59	107	6327	12	291	253	5.4000+ 6	2.0000+ 7	-0.003	0.042				
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.													
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.													
FIRST OCCURRENCE AT 5.40000+ 6 EV.													
93-NP-237	18	6337	22	1280	1240	1.0000- 4	2.0000+ 7	-88.706 *	113.347 *	2.28005- 2	2.57500- 3	7.60732- 3	1.62300- 2
79-AU-197	102	6379	18	1280	1240	1.0000- 4	2.0000+ 7	-47.928 *	0.097	1.22906+ 0	6.40000- 1		
90-TH-232	18	6390	19	861	821	5.0000+ 0	2.0000+ 7	-1.442 *	0.035	1.24089- 5	1.22300- 5		
90-TH-232	102	6390	19	1280	1240	1.0000- 4	2.0000+ 7	-1.319 *	0.036	1.26367+ 0	1.24700+ 0		
92-U -235	18	6395	20	1280	1240	1.0000- 4	2.0000+ 7	-47.805 *	25.821 *	2.50598+ 1	1.30800+ 1	2.14194+ 0	2.69500+ 0
92-U -238	18	6398	21	1280	1240	1.0000- 4	2.0000+ 7	-2.337 *	0.067	2.03865- 4	1.99100- 4		
92-U -238	102	6398	21	1280	1240	1.0000- 4	2.0000+ 7	-4.895 *	8.333 *	1.56985- 1	1.49300- 1	1.52124- 1	1.64800- 1
94-PU-239	18	6399	*** NO COMPARISON ***										
3-LI- 6	207	6424	*** NO COMPARISON ***										
5-B - 10	207	6425	*** NO COMPARISON ***										
21-SC- 45	102	6426	4	1280	1240	1.0000- 4	2.0000+ 7	-0.726	63.883 *			2.77088- 2	4.54100- 2
22-TI- 46	103	6427	5	369	329	1.6000+ 6	2.0000+ 7	-0.002	0.946				
22-TI- 47	28	6428	*** NO COMPARISON ***										
22-TI- 47	103	6428	6	1280	351	1.0000- 4	2.0000+ 7	-100.000 *	0.003	7.98794-10	0.0 + 0		
22-TI- 48	28	6429	*** NO COMPARISON ***										
22-TI- 48	103	6429	7	337	297	3.2000+ 6	2.0000+ 7	-0.002	0.004				
26-FE- 54	103	6430	9	1280	373	1.0000- 4	2.0000+ 7	-100.000 *	0.098	1.75750- 8	0.0 + 0		
26-FE- 56	103	6431	10	343	303	2.9000+ 6	2.0000+ 7	-0.079	0.034				
26-FE- 58	102	6432	11	1280	1240	1.0000- 4	2.0000+ 7	-0.543	3.596 *			2.86690- 3	2.97000- 3
28-NI- 58	16	6433	*** NO COMPARISON ***										
28-NI- 58	103	6433	13	1280	373	1.0000- 4	2.0000+ 7	-100.000 *	0.078	1.29499- 6	0.0 + 0		
28-NI- 60	103	6434	14	351	311	2.5000+ 6	2.0000+ 7	-0.139	0.027				
29-CU- 63	102	6435	*** NO COMPARISON ***										
29-CU- 63	107	6435	15	367	327	1.7000+ 6	2.0000+ 7	-39.072 *	135.467 *	5.38668- 2	3.28200- 2	1.53397- 7	3.61200- 7
29-CU- 65	16	6436	*** NO COMPARISON ***										
49-IN-115	51	6437	16	427	387	3.2000+ 5	2.0000+ 7	-0.092	0.037				
49-IN-115	102	6437	*** NO COMPARISON ***										
53-I -127	16	6438	*** NO COMPARISON ***										
16-S - 32	103	6439	*** NO COMPARISON ***										

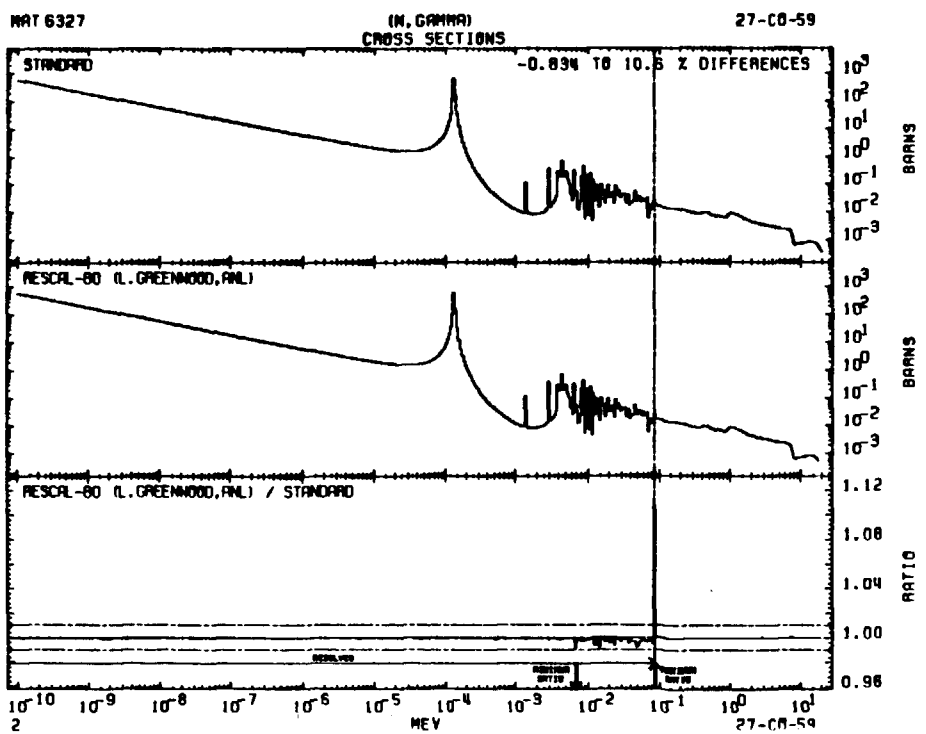
16 PLOTS GENERATED

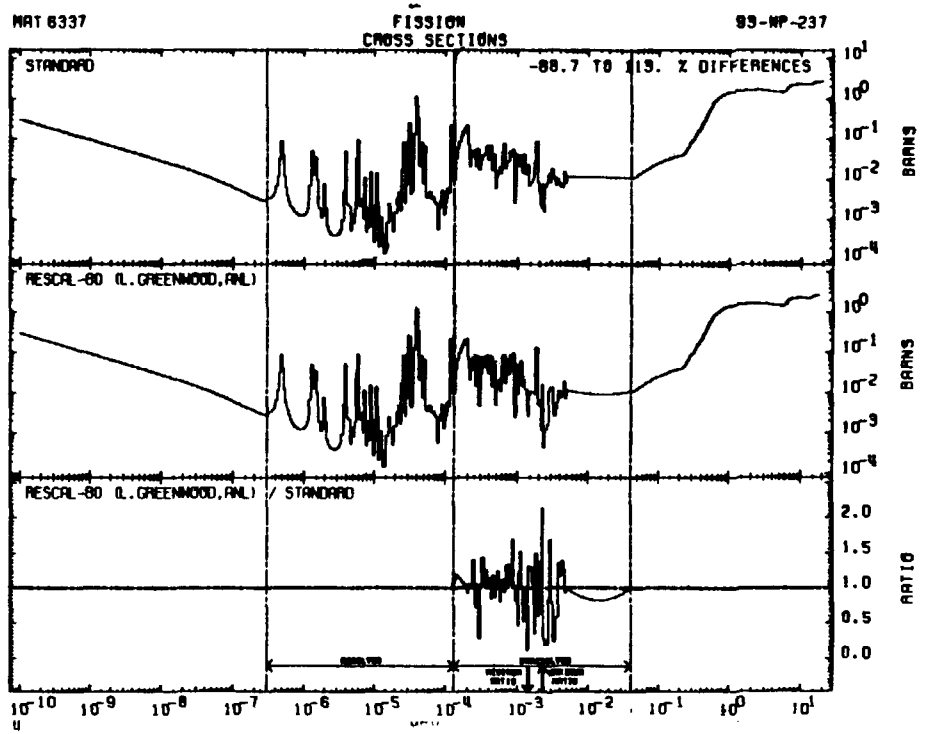
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

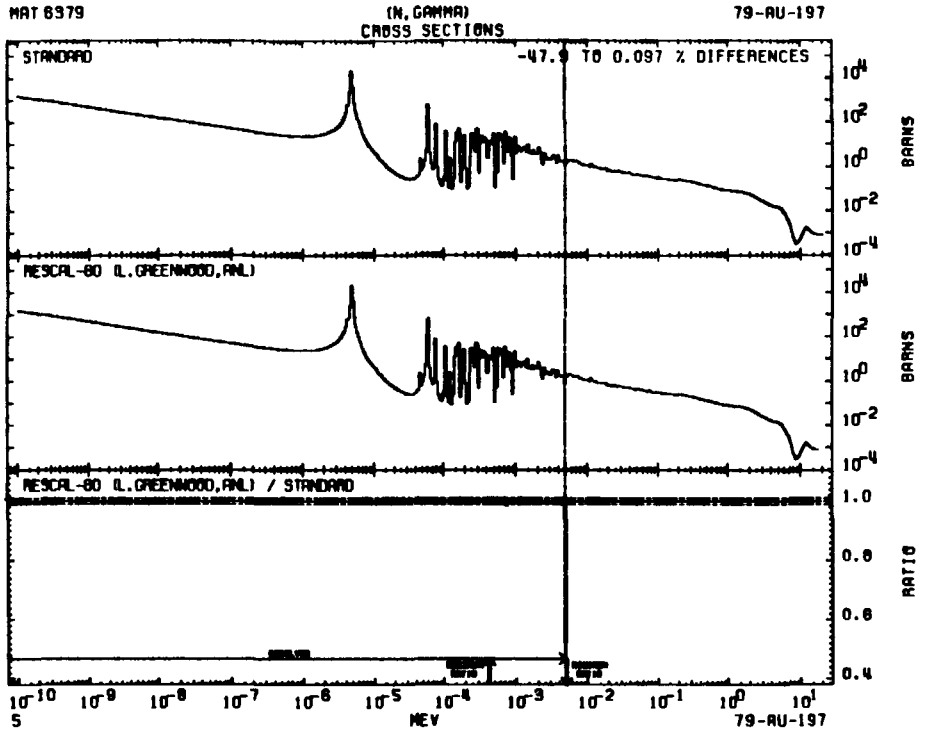
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

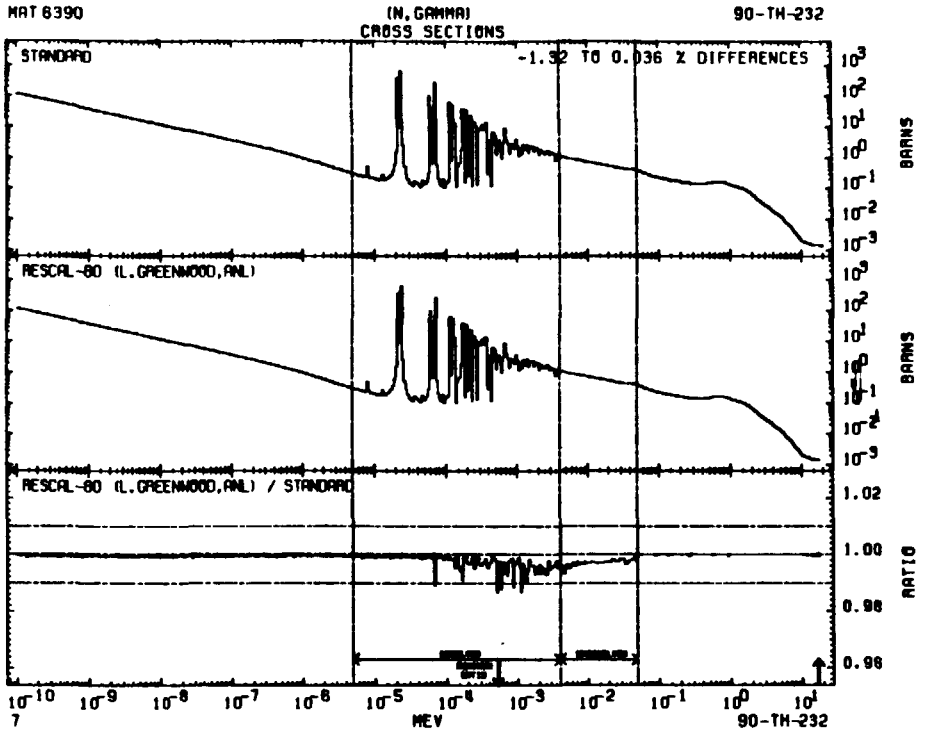

MAT 6311
(N,GAMMA)
CROSS SECTIONS
11-MR-23
STANDARD
-2.83 TO 0.126 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
1
11-MR-23

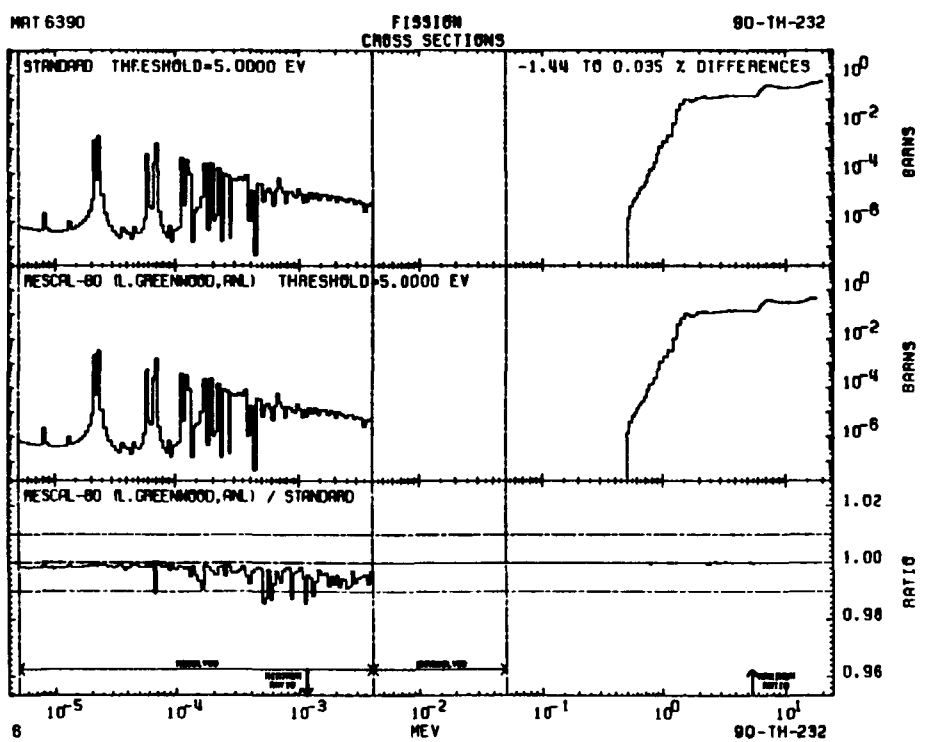

MAT 6327
(N,ALPHA)
CROSS SECTIONS
27-C0-59
STANDARD THRESHOLD=5.5000 MEV
-0.003 TO 0.042 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL) THRESHOLD=5.4000 MEV
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
MILLI-BARNS
RATIO
MEV
3
27-C0-59

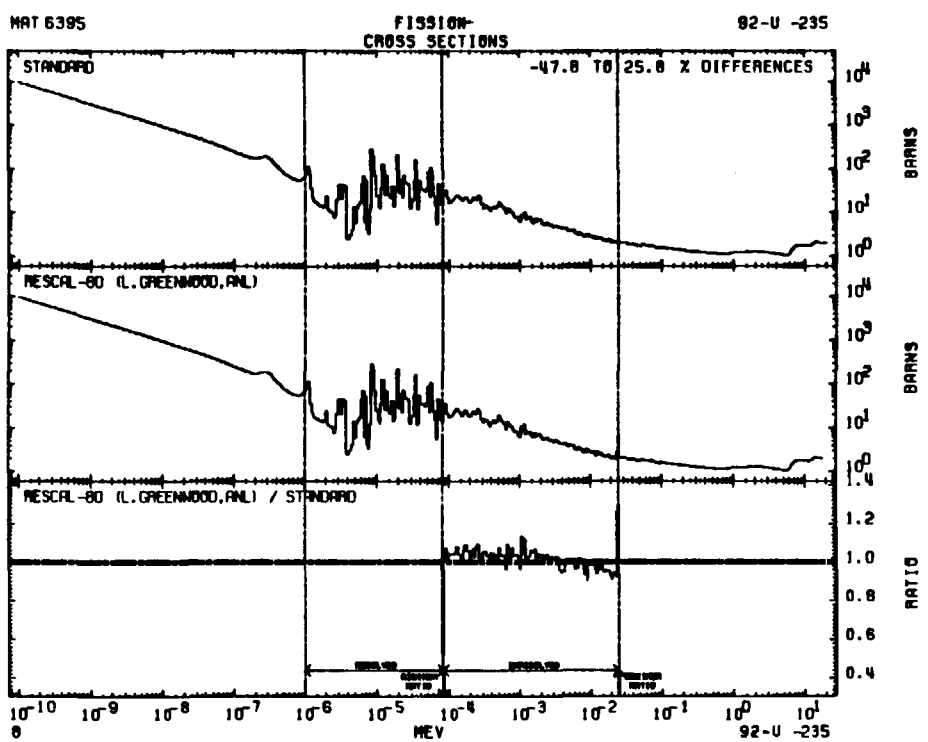

MAT 6327
(N,GAMMA)
CROSS SECTIONS
27-C0-59
STANDARD
-0.89% TO 10.6 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
2
27-C0-59

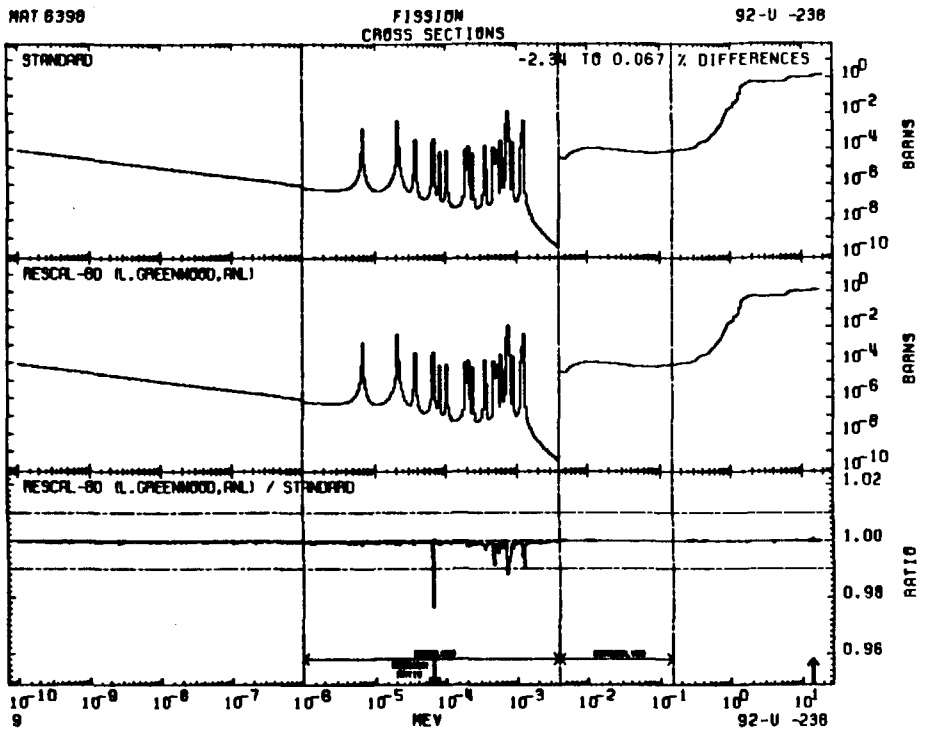

MAT 6337
FISSION
CROSS SECTIONS
99-MP-237
STANDARD
-88.7 TO 119. % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
4

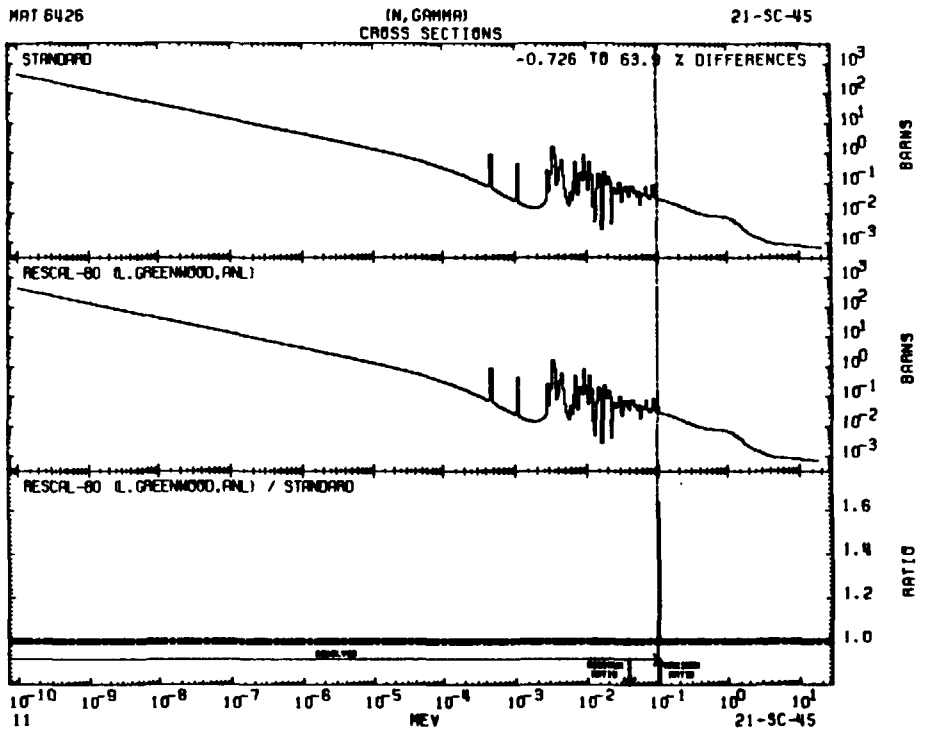

MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-47.9 TO 0.097 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
79-AU-197

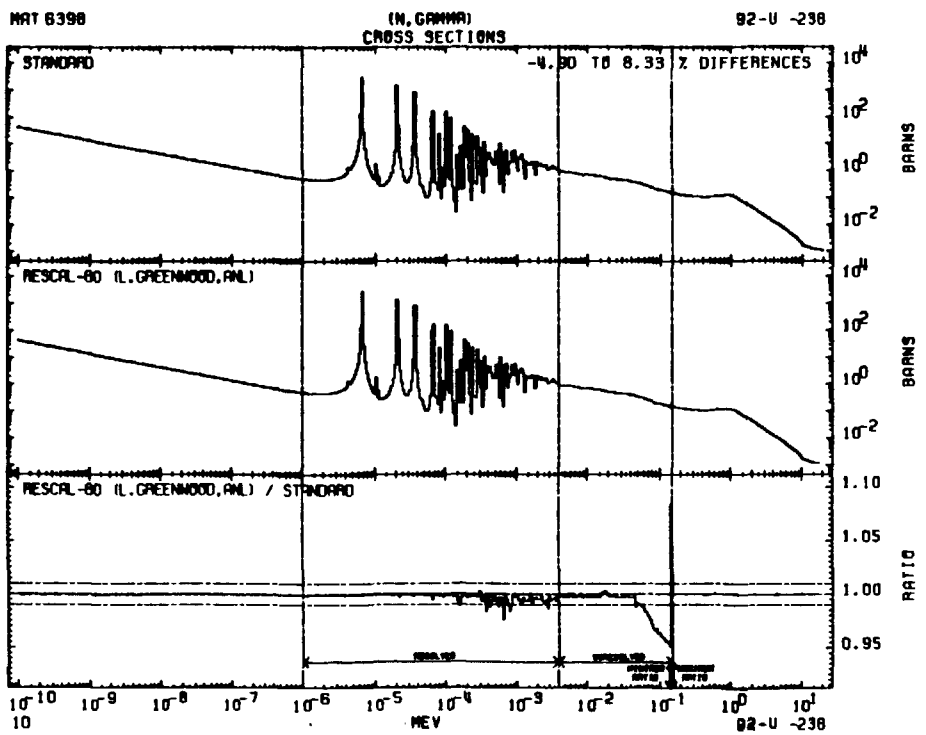

MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-1.32 TO 0.036 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
90-TH-232

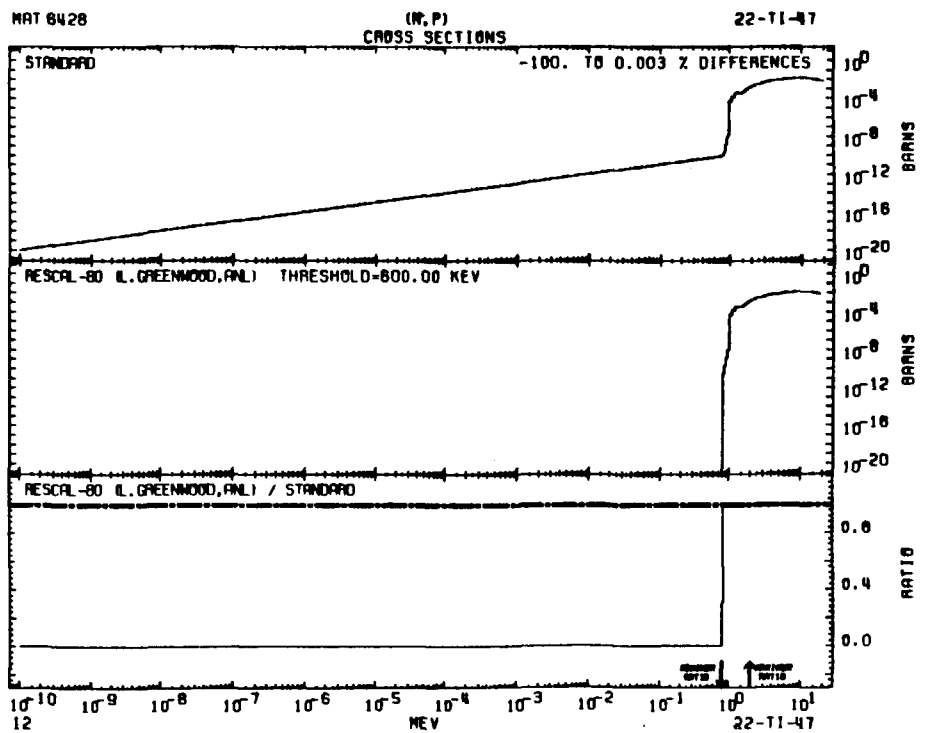

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-1.44 TO 0.035 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL) THRESHOLD=5.0000 EV
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
90-TH-232

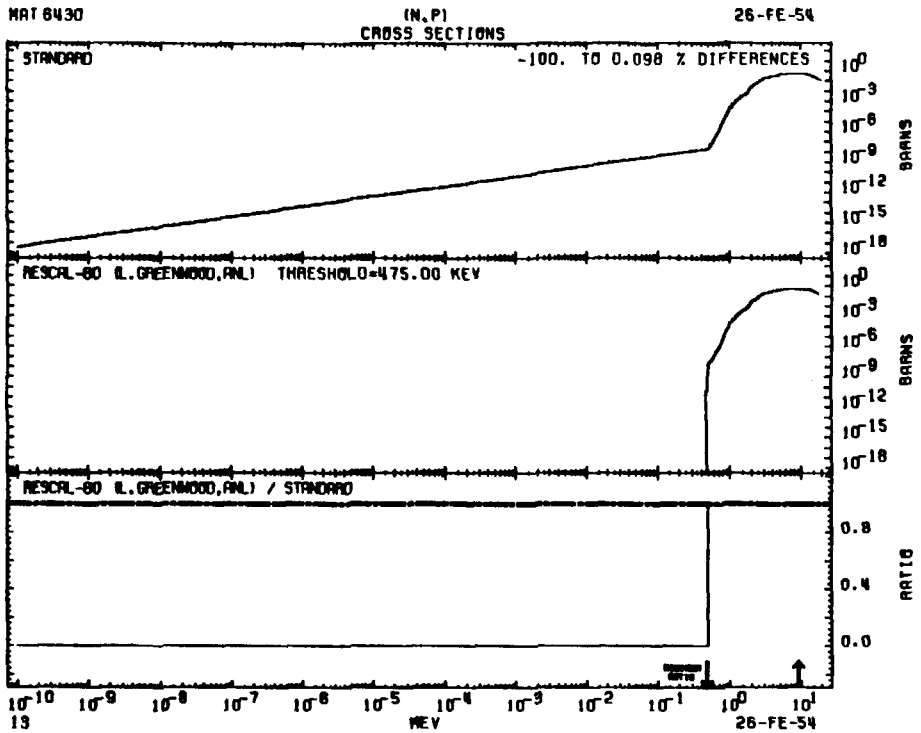

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-47.8 TO 25.8 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
92-U -235

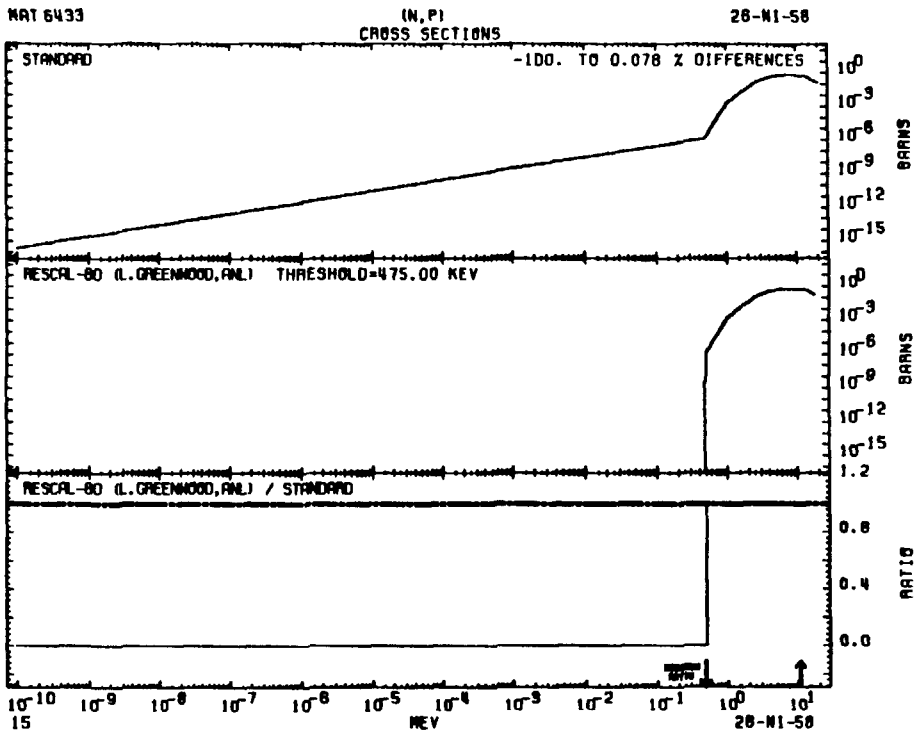

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-2.34 TO 0.067 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
9
92-U -238

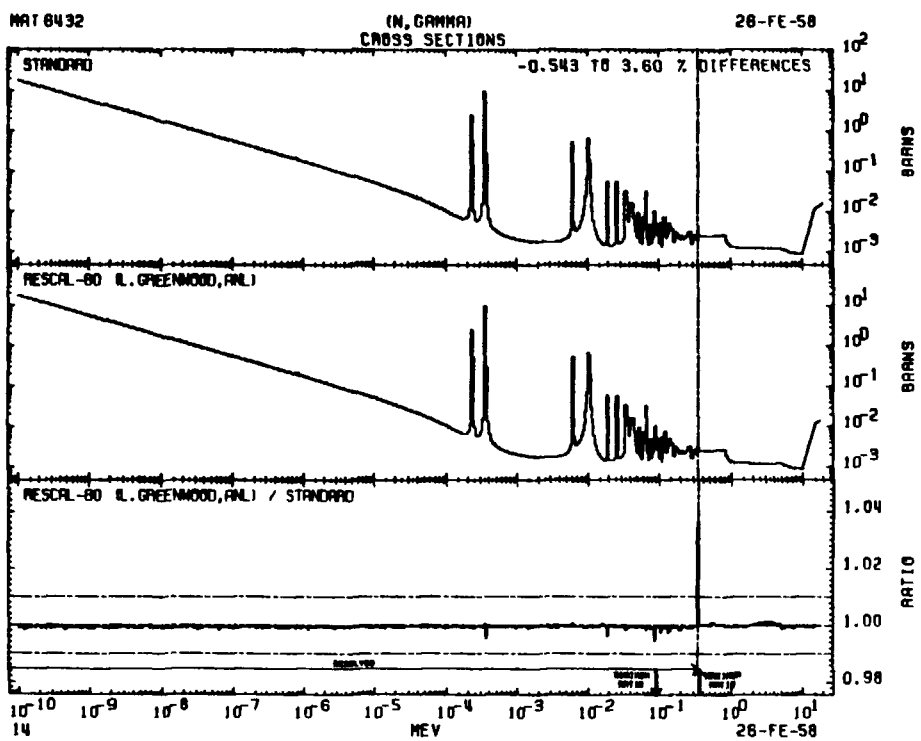

MAT 6426
(N,GAMMA)
CROSS SECTIONS
21-SC-45
STANDARD
-0.726 TO 63.9 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
11
21-SC-45

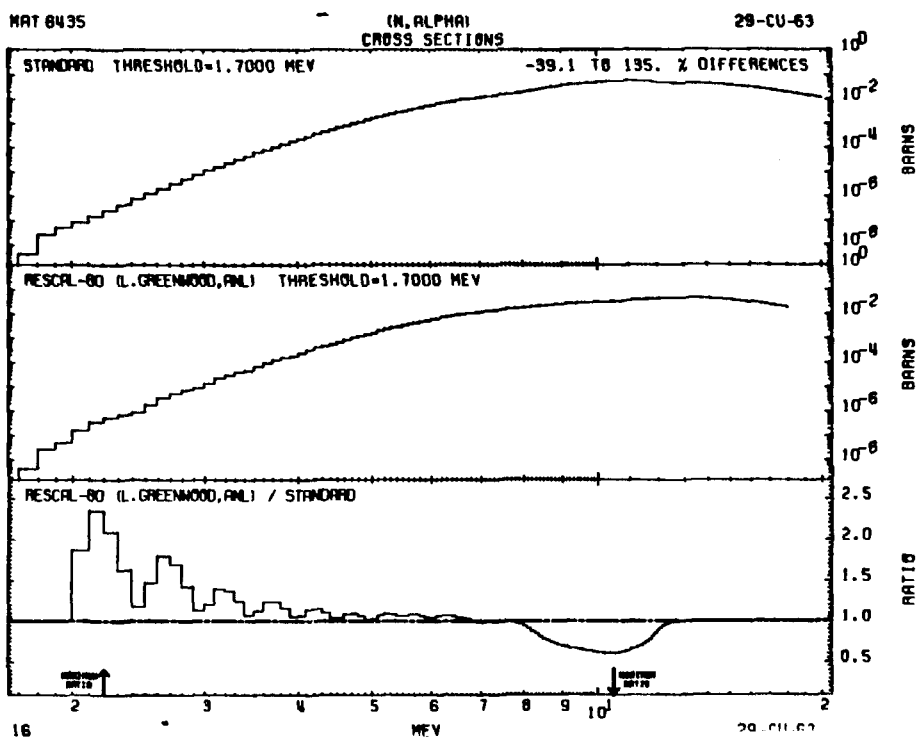

MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-4.30 TO 8.33 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
10
92-U -238


MAT 6428
(N,P)
CROSS SECTIONS
22-TI-47
STANDARD
-100. TO 0.003 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL) THRESHOLD=800.00 KEV
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
12
22-TI-47


MAT 6430
(N,P)
CROSS SECTIONS
26-FE-54
STANDARD
-100. TO 0.098 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL) THRESHOLD=475.00 KEV
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
19
26-FE-54


MAT 6433
(N,P)
CROSS SECTIONS
28-NI-58
STANDARD
-100. TO 0.078 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL) THRESHOLD=475.00 KEV
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
15
28-NI-58


MAT 6432
(N,GAMMA)
CROSS SECTIONS
28-FE-58
STANDARD
-0.543 TO 3.60 % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL)
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
14
26-FE-58


MAT 6435
(N,ALPHA)
CROSS SECTIONS
29-CU-63
STANDARD THRESHOLD=1.7000 MEV
-39.1 TO 135. % DIFFERENCES
RESCAL-80 (L.GREENWOOD,ANL) THRESHOLD=1.7000 MEV
RESCAL-80 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
16

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=RESCAL-82 (L.GREENWOOD,ANL)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2=RESCAL...ENDF/B-V DOSIMETRY LIBRARY (L.GREENWOOD,ANL,1982) 800

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE		MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	39	1280	1240	1.0000- 4	2.0000+ 7	-2.826	*	1.830	*	2.39261- 4	2.32500- 4	9.77016- 2	9.94900- 2
13-AL- 27	103	6313	32	365	325	1.8000+ 6	2.0000+ 7	-1.380	*	2.517	*	5.48877- 2	5.41300- 2	5.56003- 2	5.70000- 2
13-AL- 27	107	6313	32	337	297	3.2000+ 6	2.0000+ 7	-2.289	*	4.482	*	7.85786- 2	7.67800- 2	8.03006- 2	8.39000- 2
25-MN- 55	16	6325	45	193	153	1.0400+ 7	2.0000+ 7	-0.360		0.083					
27-CO- 59	16	6327	17	189	149	1.0600+ 7	2.0000+ 7	-0.057		0.000					
27-CO- 59	102	6327	42	1280	1240	1.0000- 4	2.0000+ 7	-1.529	*	10.638	*	6.53999- 4	6.44000- 4	2.41238- 2	2.66900- 2
27-CO- 59	107	6327	17	291	253	5.4000+ 6	2.0000+ 7	-0.066		0.036					

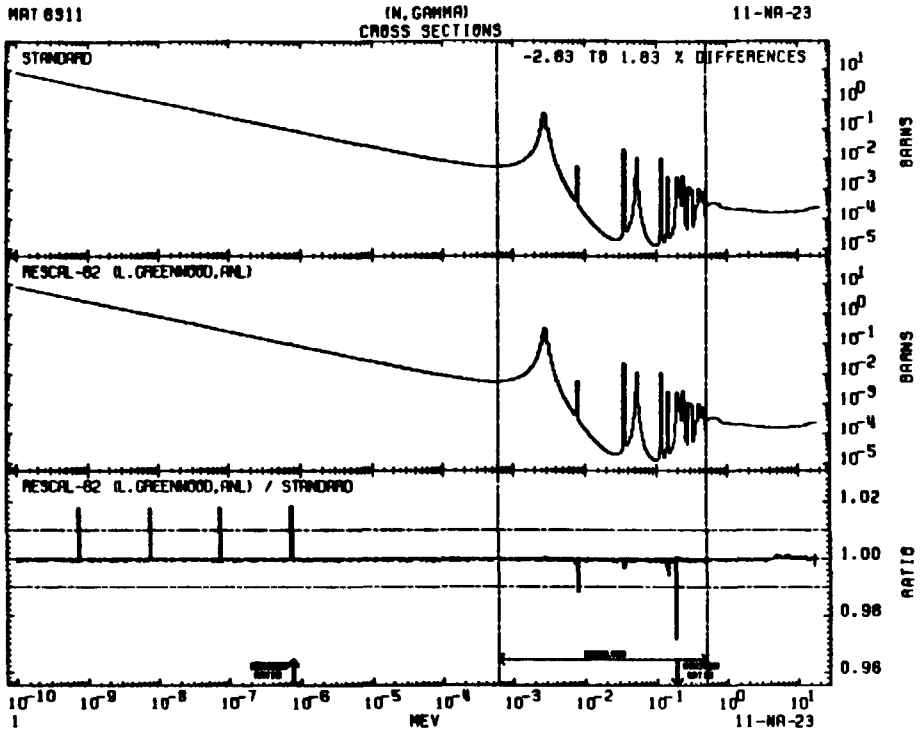
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 5.40000+ 6 EV.

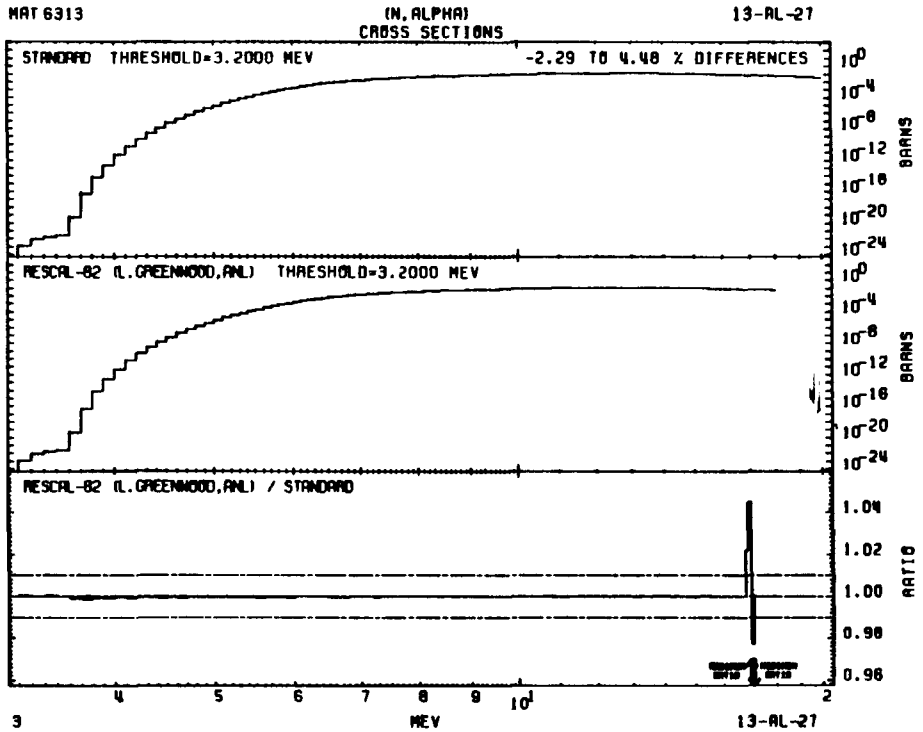
93-NP-237	18	6337	51	1280	1240	1.0000- 4	2.0000+ 7	-17.565	*	24.312	*	1.15679- 2	9.53600- 3	9.35546- 3	1.16300- 2
79-AU-197	102	6379	49	1280	1240	1.0000- 4	2.0000+ 7	-47.928	*	1.759	*	1.22906+ 0	6.40000- 1	5.72136+ 2	5.82200+ 2
90-TH-232	18	6390	55	861	821	5.0000+ 0	2.0000+ 7	-100.000	*	0.536		5.50765- 6	0.0 + 0		
90-TH-232	102	6390	55	1280	1240	1.0000- 4	2.0000+ 7	-1.319	*	19.440	*	1.26367+ 0	1.24700+ 0	1.28684+ 0	1.53700+ 0
92-U -235	18	6395	53	1280	1240	1.0000- 4	2.0000+ 7	-67.399	*	40.025	*	2.14194+ 0	6.98300- 1	2.50598+ 1	3.50900+ 1
92-U -238	18	6398	54	1280	1240	1.0000- 4	2.0000+ 7	-2.288	*	1.785	*	2.03865- 4	1.99200- 4	3.08885- 5	3.14400- 5
92-U -238	102	6398	56	1280	1240	1.0000- 4	2.0000+ 7	-86.859	*	1.822	*	1.52124- 1	1.99900- 2	1.09308+ 0	1.11300+ 0
94-PU-239	18	6399	52	1280	1240	1.0000- 4	2.0000+ 7	-66.748	*	21.058	*	1.64981+ 0	5.48600- 1	8.98743+ 0	1.08800+ 1
3-LI- 6	207	6424	28	1280	1240	1.0000- 4	2.0000+ 7	-1.333	*	1.780	*	3.20979+ 0	3.16700+ 0	1.73119+ 2	1.76200+ 2
5-B - 10	207	6425	29	1280	1240	1.0000- 4	2.0000+ 7	-1.068	*	1.800	*	5.18335- 1	5.12800- 1	2.24459+ 3	2.28500+ 3
21-SC- 45	102	6426	46	1280	1240	1.0000- 4	2.0000+ 7	-0.726		63.883	*			2.77088- 2	4.54100- 2
22-TI- 46	103	6427	18	369	329	1.6000+ 6	2.0000+ 7	-0.036		0.934					
22-TI- 47	28	6428	*** NO COMPARISON ***												
22-TI- 47	103	6428	20	1280	351	1.0000- 4	2.0000+ 7	-100.000	*	0.002		7.98794-10	0.0 + 0		
22-TI- 48	28	6429	*** NO COMPARISON ***												
22-TI- 48	103	6429	22	337	297	3.2000+ 6	2.0000+ 7	-0.037		0.000					
26-FE- 54	103	6430	30	1280	373	1.0000- 4	2.0000+ 7	-100.000	*	3.601	*	1.75750- 8	0.0 + 0	1.95944- 1	2.03000- 1
26-FE- 56	103	6431	33	343	303	2.9000+ 6	2.0000+ 7	-2.040	*	4.006	*	6.86300- 2	6.72300- 2	6.99000- 2	7.27000- 2
26-FE- 58	102	6432	57	1280	1240	1.0000- 4	2.0000+ 7	-38.958	*	1.784	*	2.86690- 3	1.75000- 3	2.12410- 1	2.16200- 1
28-NI- 58	16	6433	24	153	113	1.2400+ 7	2.0000+ 7	-0.025		4.994	*			4.28500- 5	4.49900- 5
28-NI- 58	103	6433	38	1280	373	1.0000- 4	2.0000+ 7	-100.000	*	3.641	*	1.29499- 6	0.0 + 0	2.13911- 1	2.21700- 1
28-NI- 60	103	6434	34	351	311	2.5000+ 6	2.0000+ 7	-1.118	*	2.149	*	8.04999- 2	7.96000- 2	8.14500- 2	8.32000- 2
29-CU- 63	102	6435	43	1280	1240	1.0000- 4	2.0000+ 7	-0.548		1.802	*			8.32397+ 0	8.47400+ 0
29-CU- 63	107	6435	25	367	327	1.7000+ 6	2.0000+ 7	-39.072	*	135.467	*	5.38668- 2	3.28200- 2	1.53397- 7	3.61200- 7
29-CU- 65	16	6436	26	201	161	1.0000+ 7	2.0000+ 7	-0.085		16.053	*			5.41647- 4	6.28600- 4
49-IN-115	51	6437	31	427	387	3.2000+ 5	2.0000+ 7	-0.229		0.454					
49-IN-115	102	6437	44	1280	1240	1.0000- 4	2.0000+ 7	-5.189	*	2.958	*	1.19184+ 2	1.13000+ 2	7.39912- 4	7.61800- 4
53-I -127	16	6438	27	217	177	9.2000+ 6	2.0000+ 7	-0.071		0.115					
16-S - 32	103	6439	*** NO COMPARISON ***												

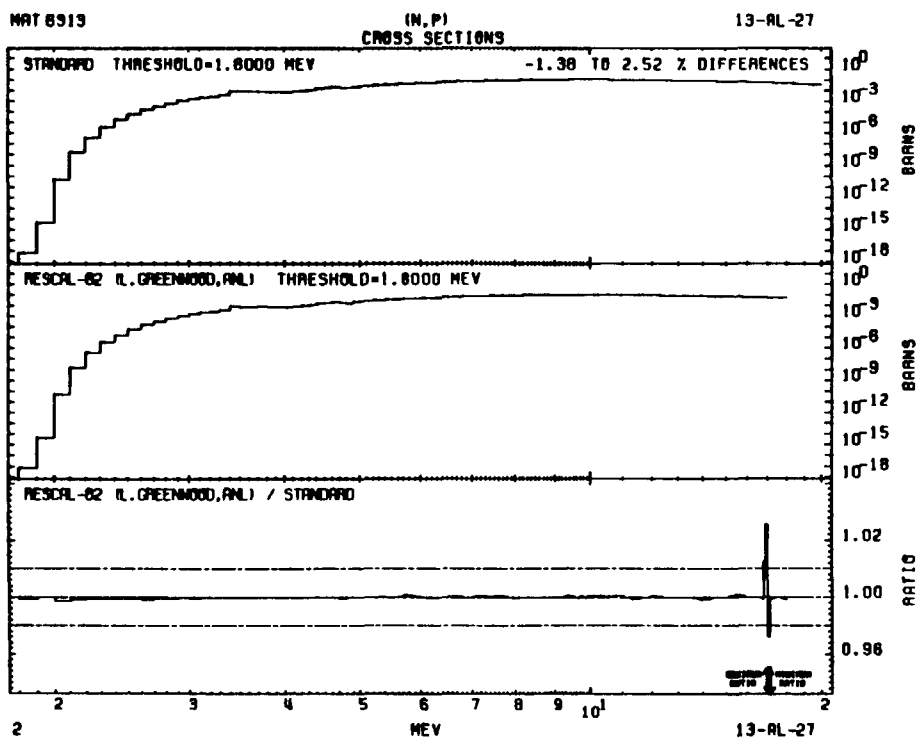
27 PLOTS GENERATED

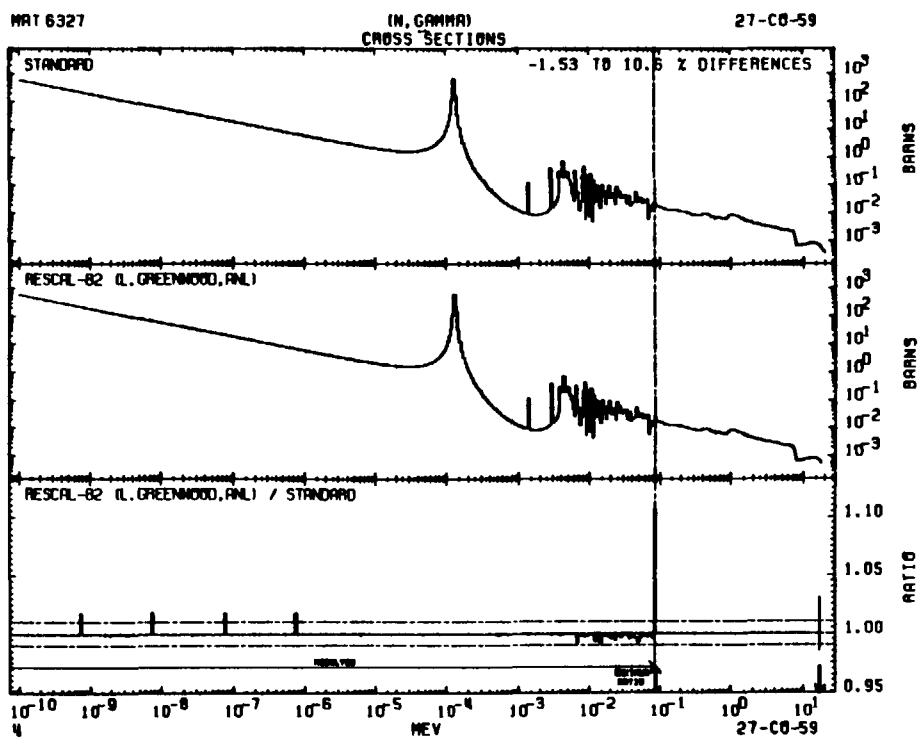
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

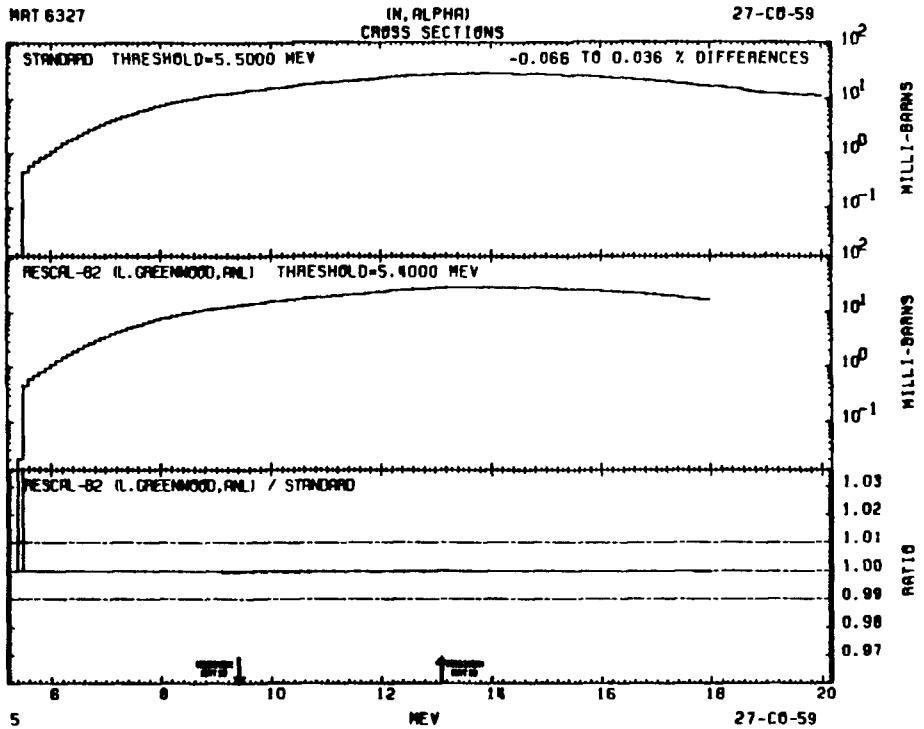
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

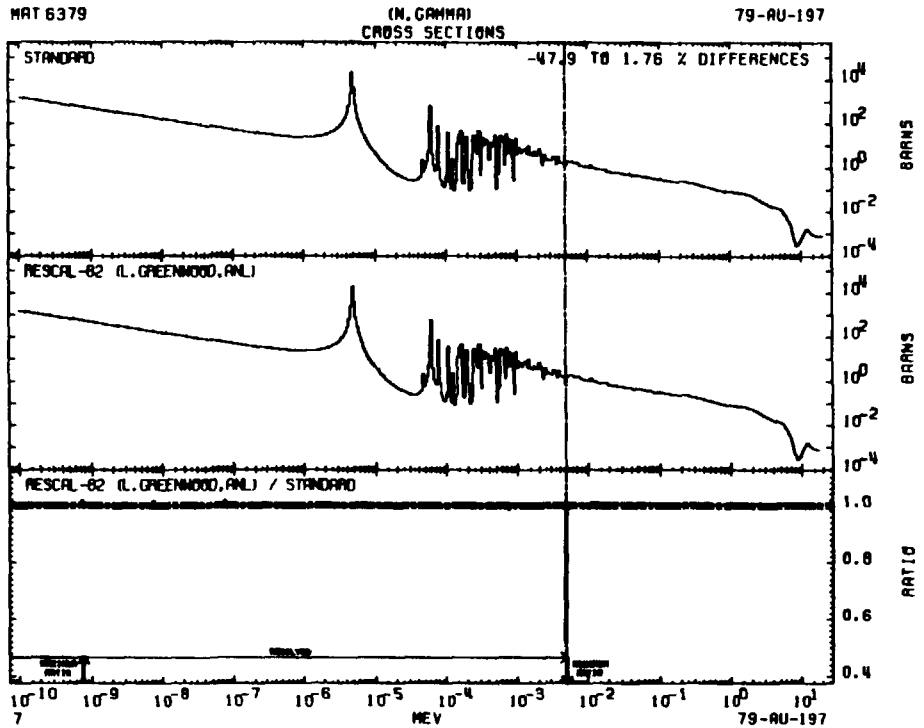

MAT 6911
(N,GAMMA)
CROSS SECTIONS
11-NA-23
STANDARD
-2.83 TO 1.83 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
11-NA-23

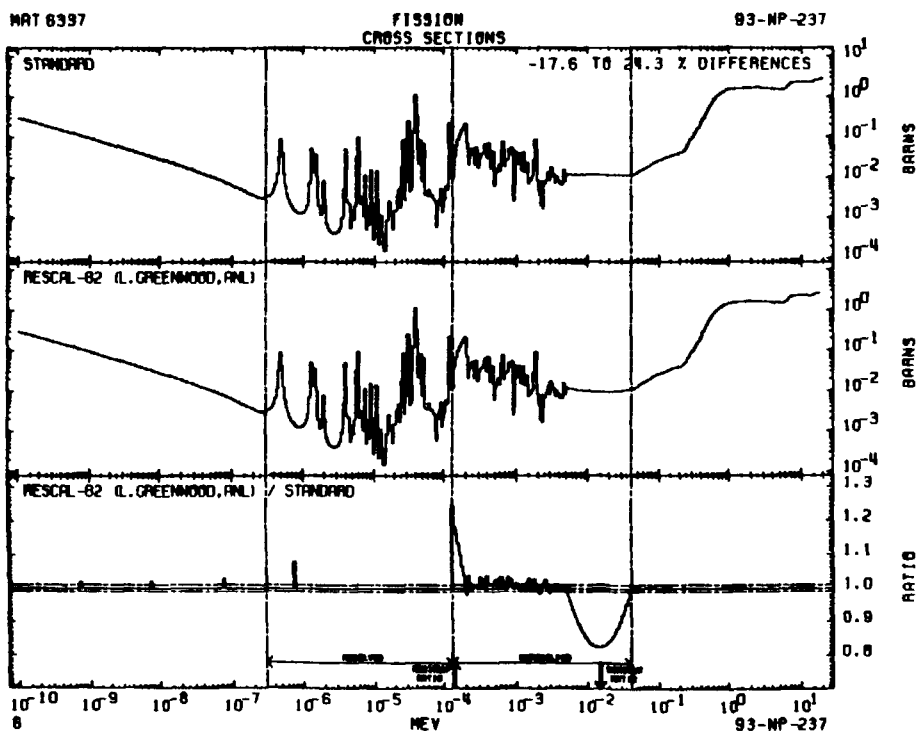

MAT 6313
(N,ALPHA)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=3.2000 MEV
-2.29 TO 4.48 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=3.2000 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
13-AL-27

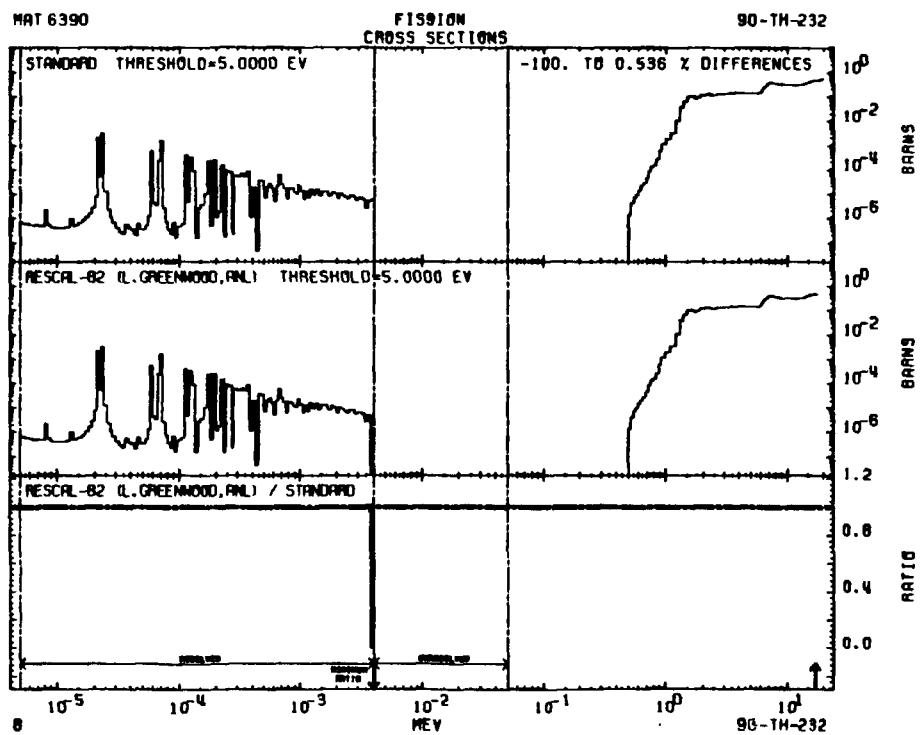

MAT 6913
(N,P)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=1.8000 MEV
-1.38 TO 2.52 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=1.8000 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
13-AL-27

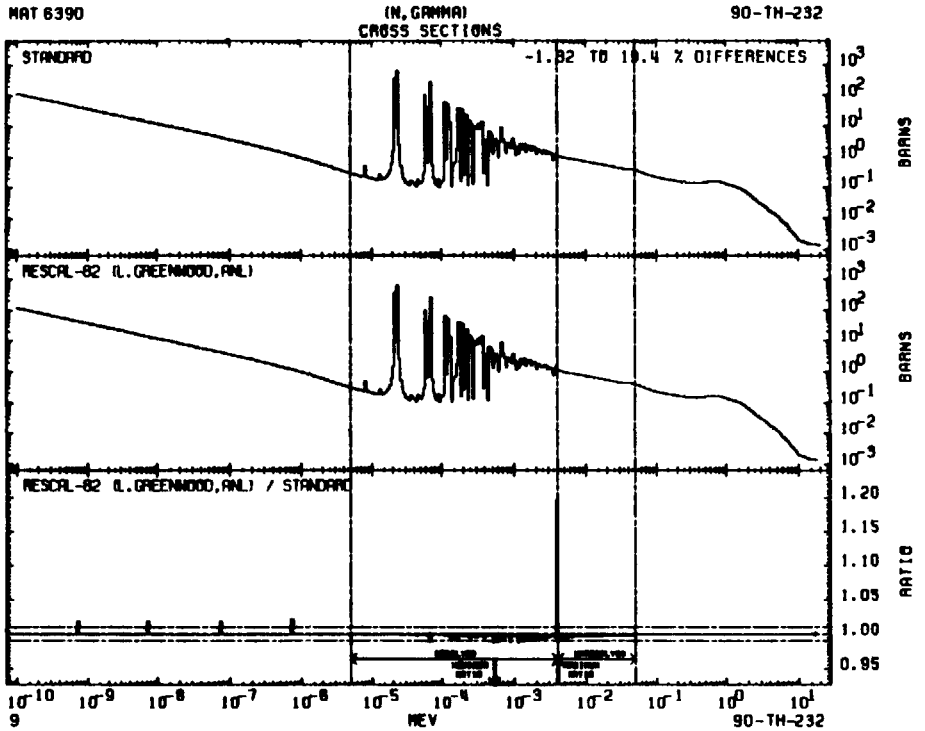

MAT 6327
(N,GAMMA)
CROSS SECTIONS
27-CO-59
STANDARD
-1.53 TO 10.6 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
27-CO-59

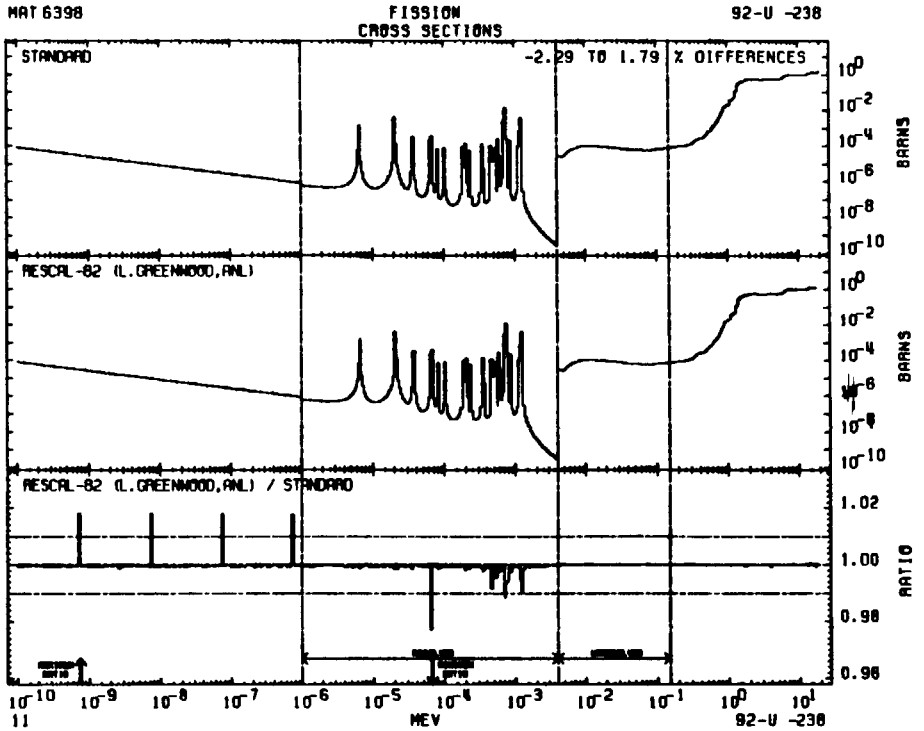

MAT 6327
(N,ALPHA)
CROSS SECTIONS
27-CO-59
STANDARD THRESHOLD=5.5000 MEV
-0.066 TO 0.036 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=5.4000 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
MILLI-BARNS
RATIO
MEV
27-CO-59

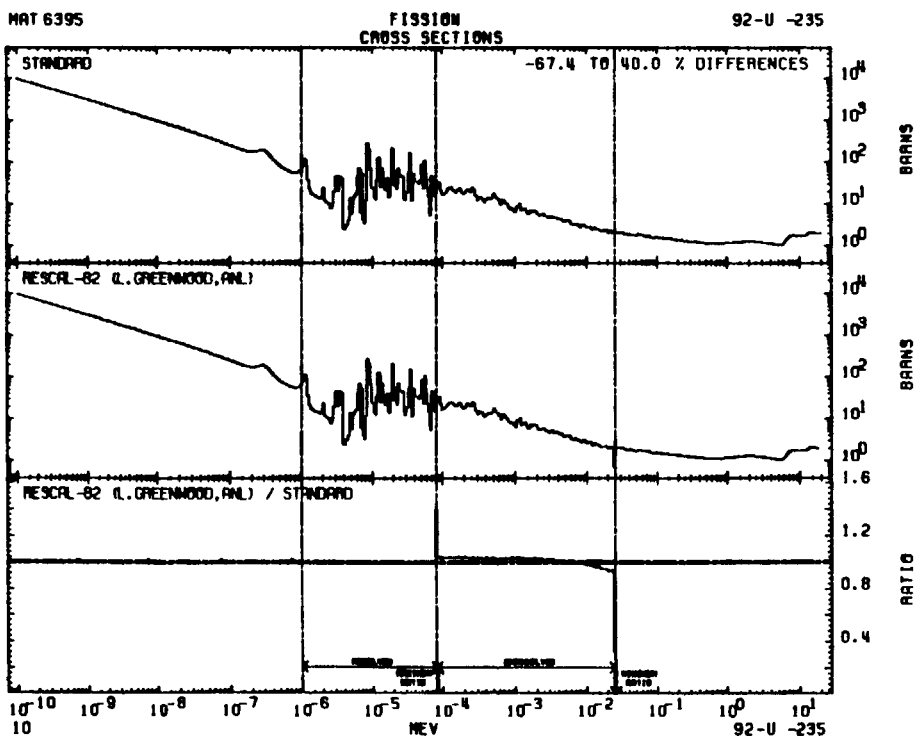

MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-47.9 TO 1.76 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
79-AU-197

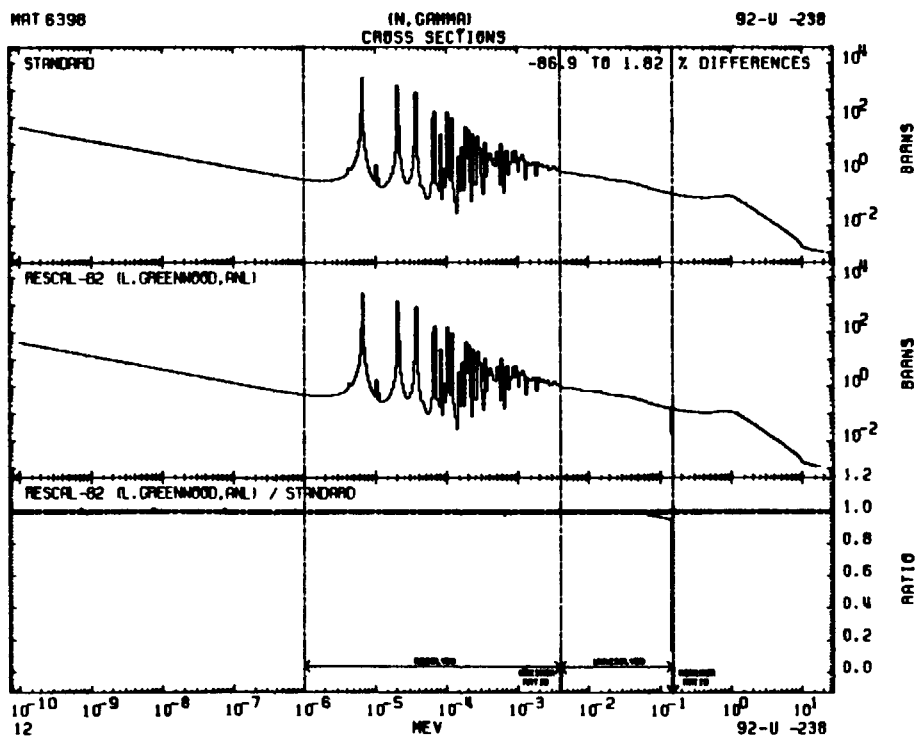

MAT 6397
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-17.6 TO 24.3 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
93-NP-237

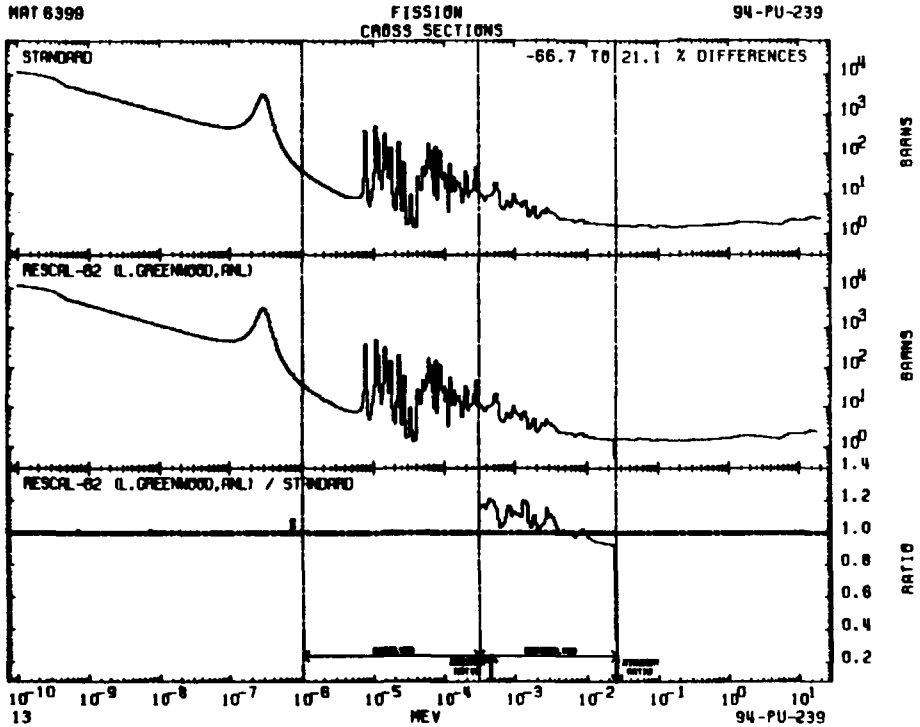

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-100. TO 0.536 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=5.0000 EV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
90-TH-232

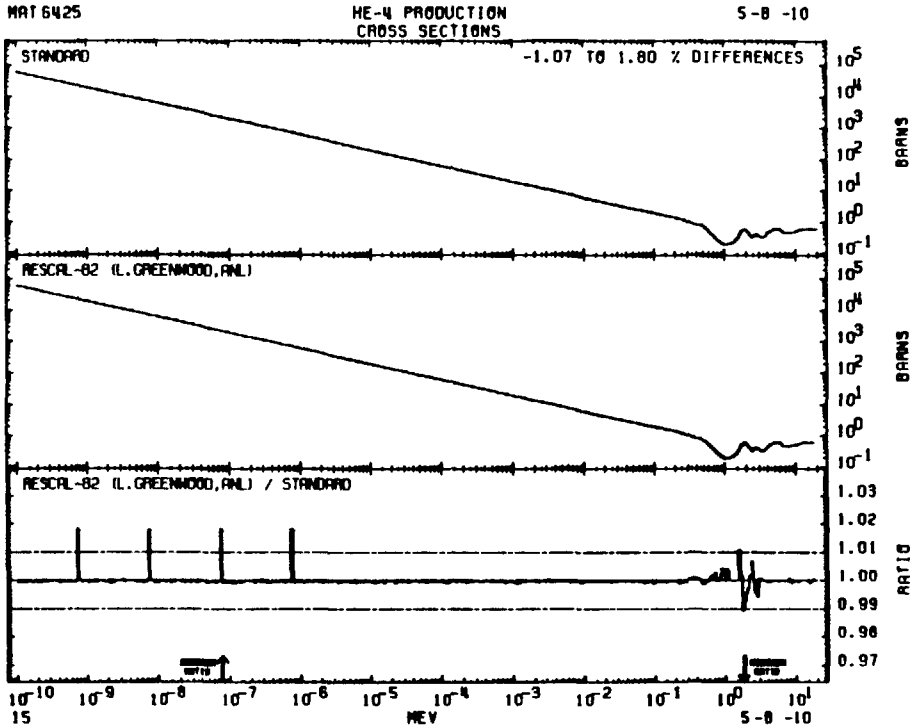

MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-1.82 TO 10.4 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
9
90-TH-232

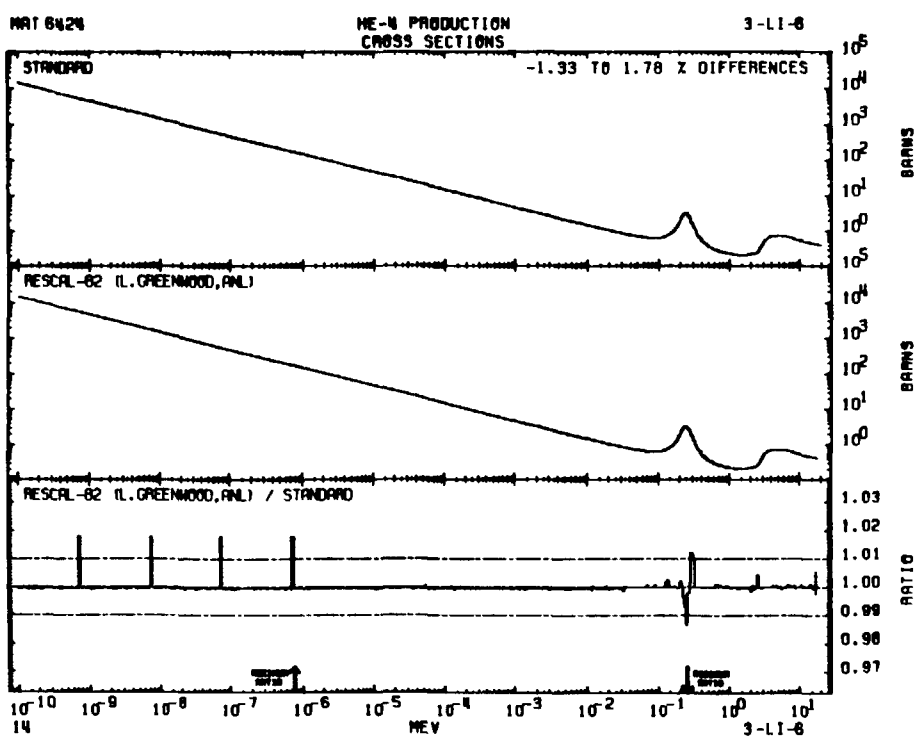

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-2.29 TO 1.79 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
11
92-U -238

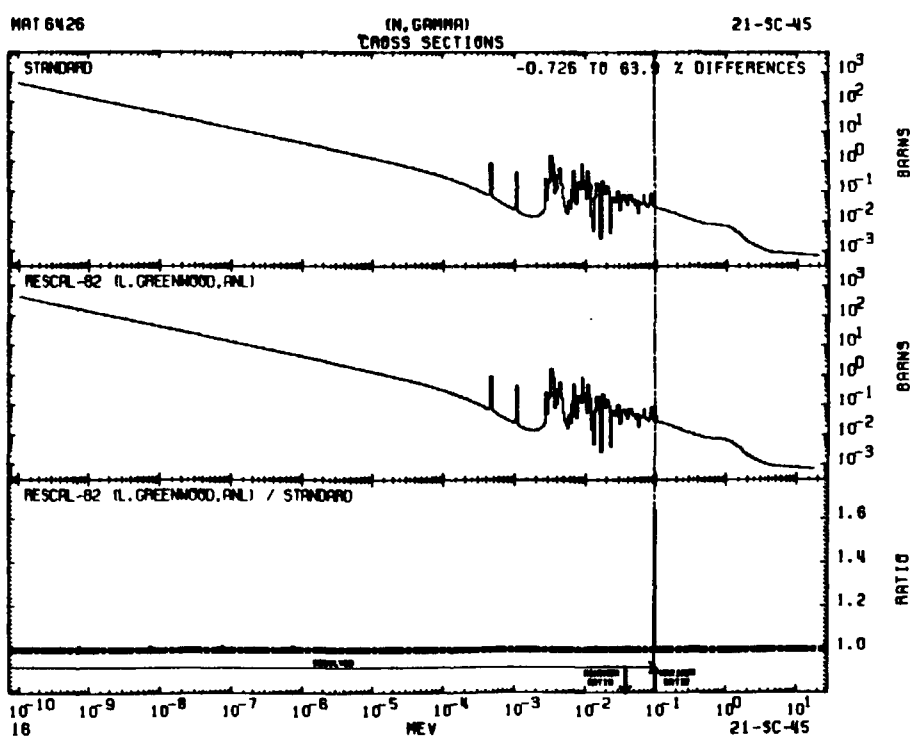

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-67.4 TO 40.0 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
10
92-U -235

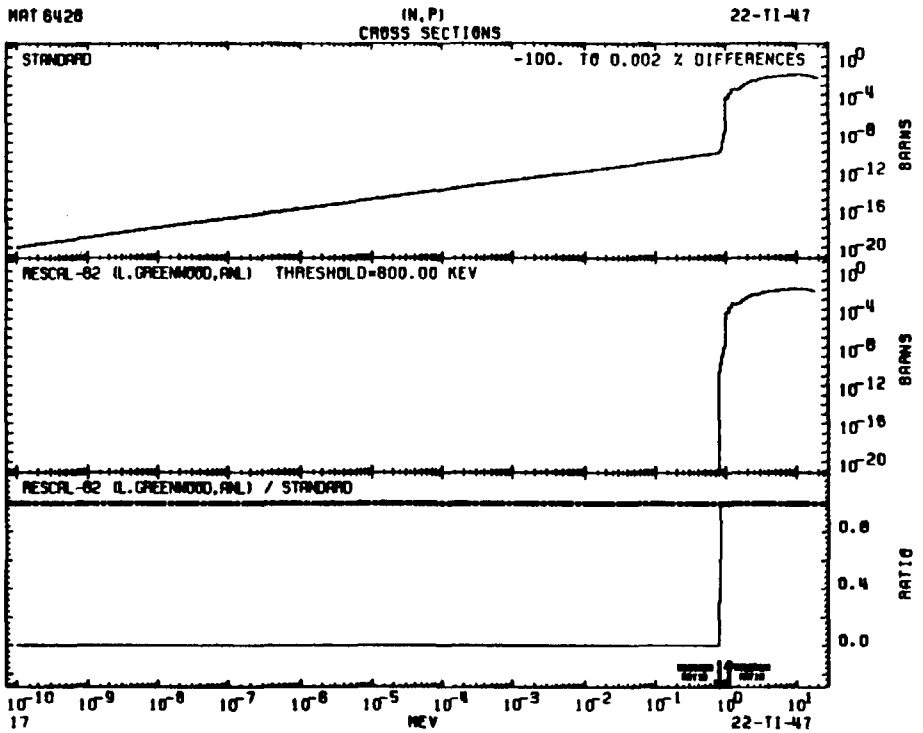

MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-86.9 TO 1.82 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
12
92-U -238

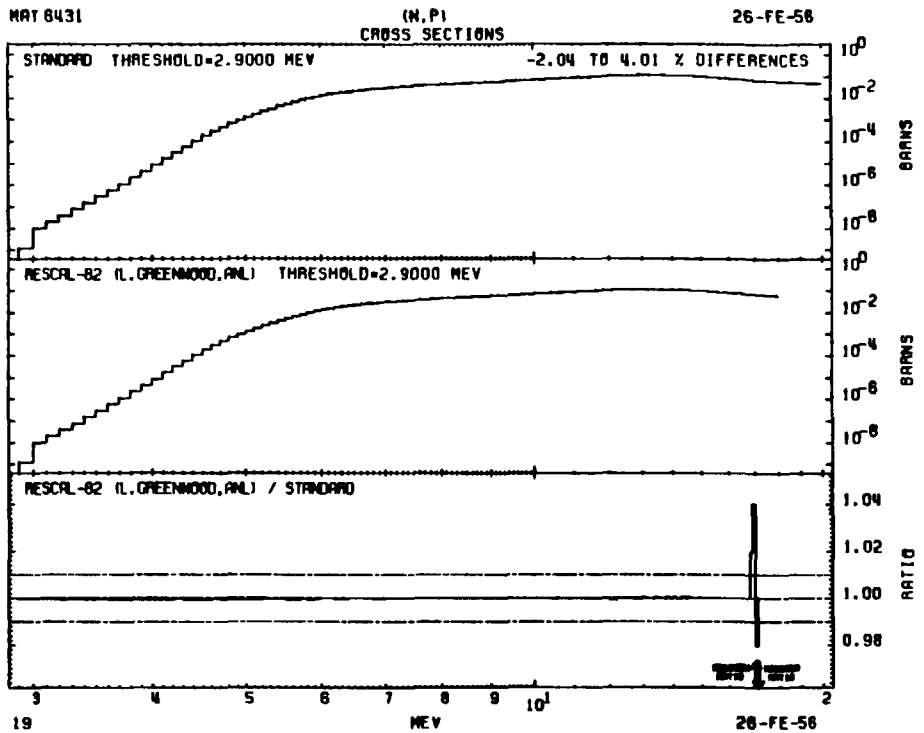

MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-66.7 TO 21.1 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
13
94-PU-239

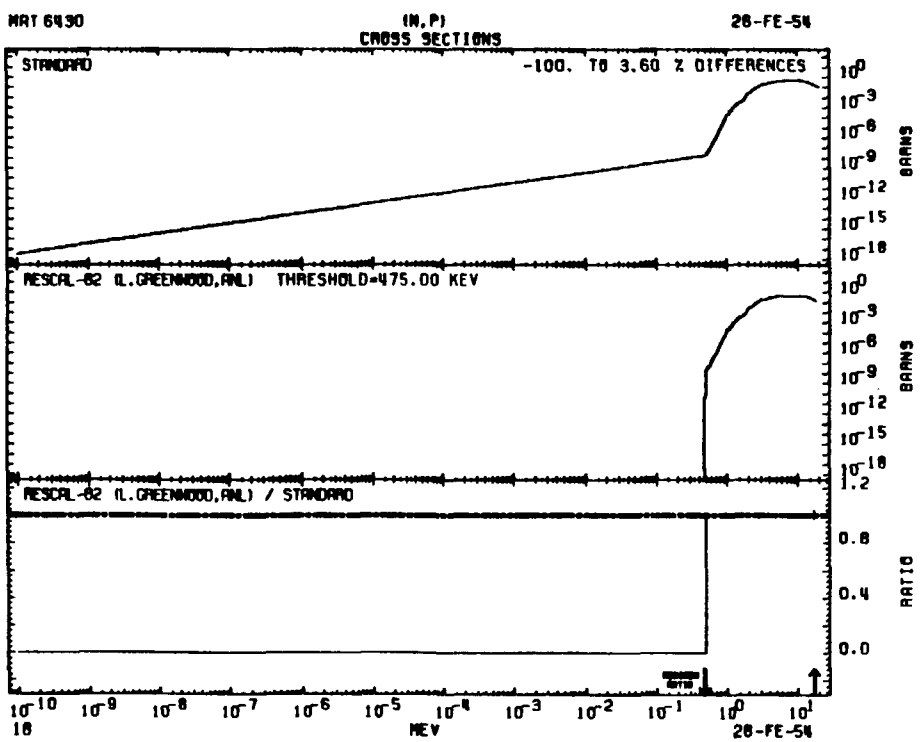

MAT 6425
HE-4 PRODUCTION
CROSS SECTIONS
5-B -10
STANDARD
-1.07 TO 1.80 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
15
5-B -10

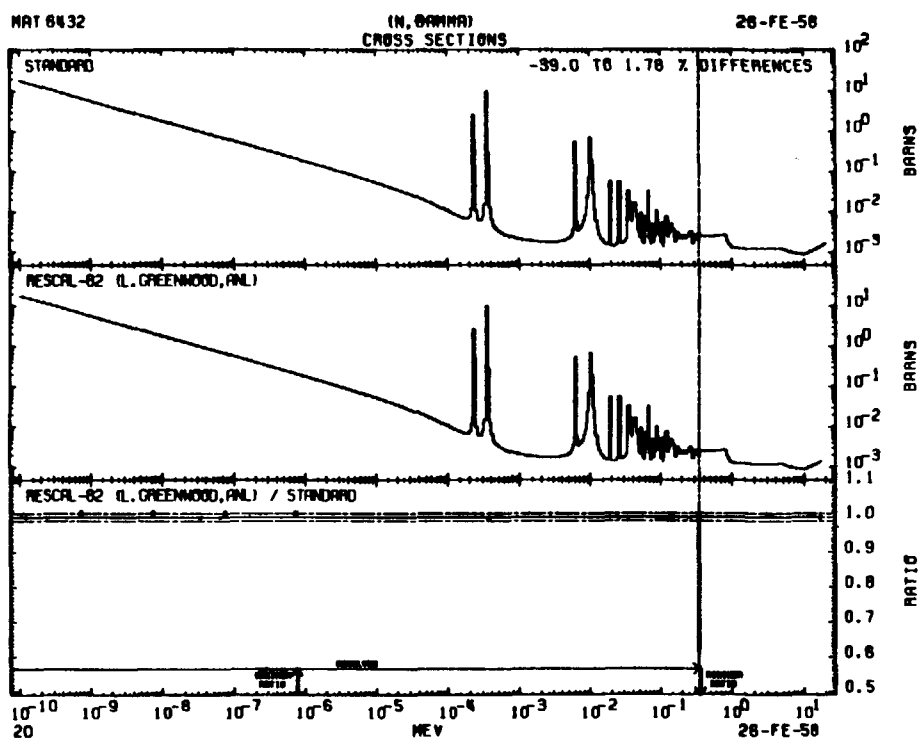

MAT 6424
HE-4 PRODUCTION
CROSS SECTIONS
3-LI-6
STANDARD
-1.33 TO 1.78 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
14
3-LI-6

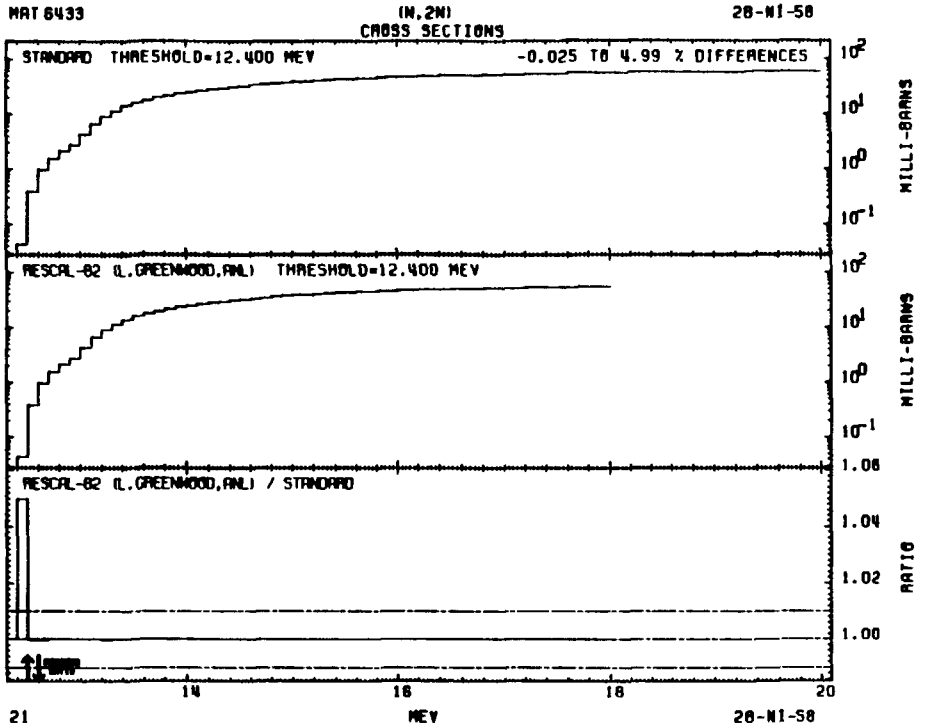

MAT 6426
(N,GAMMA)
CROSS SECTIONS
21-SC-45
STANDARD
-0.726 TO 63.9 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
16
21-SC-45

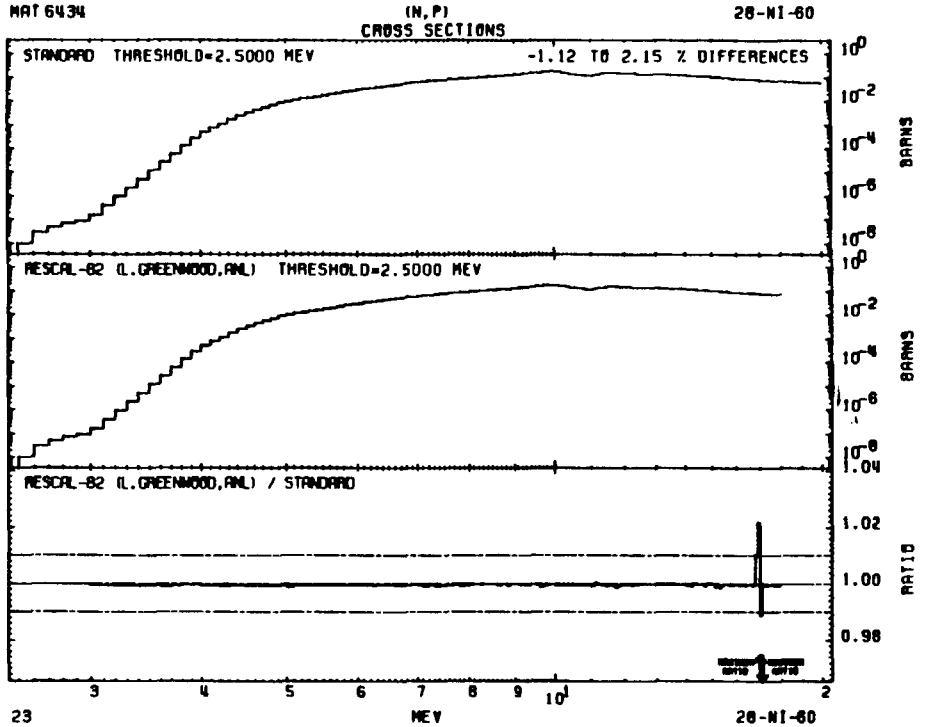

MAT 6428
(N,P)
CROSS SECTIONS
22-TI-47
STANDARD
-100. TO 0.002 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=800.00 KEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
17
22-TI-47

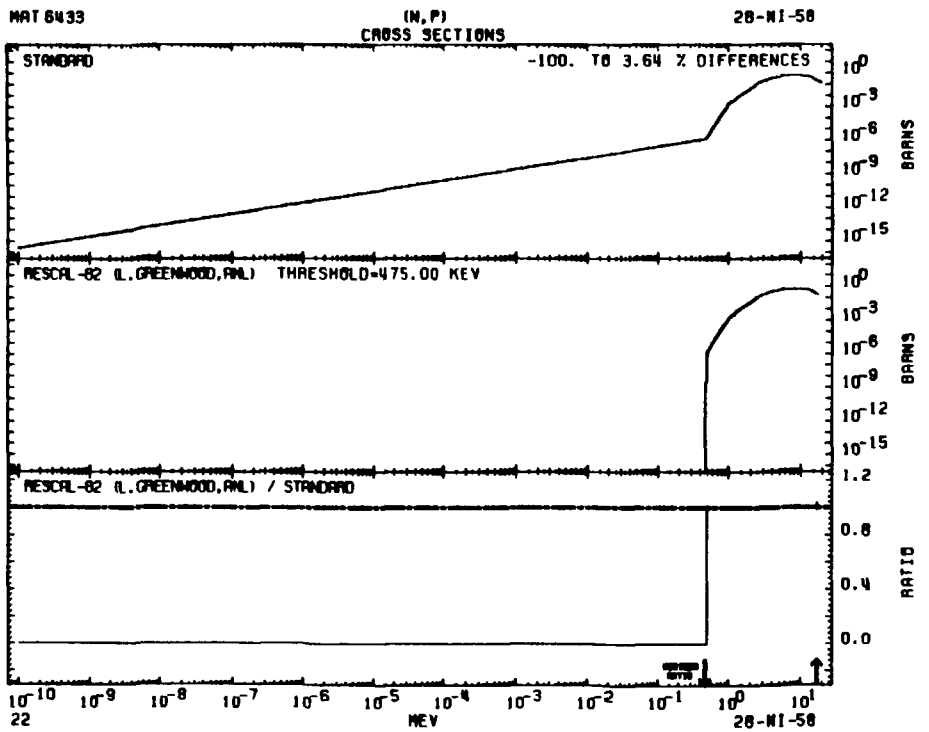

MAT 6431
(N,P)
CROSS SECTIONS
26-FE-56
STANDARD THRESHOLD=2.9000 MEV
-2.04 TO 4.01 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=2.9000 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
19
26-FE-56

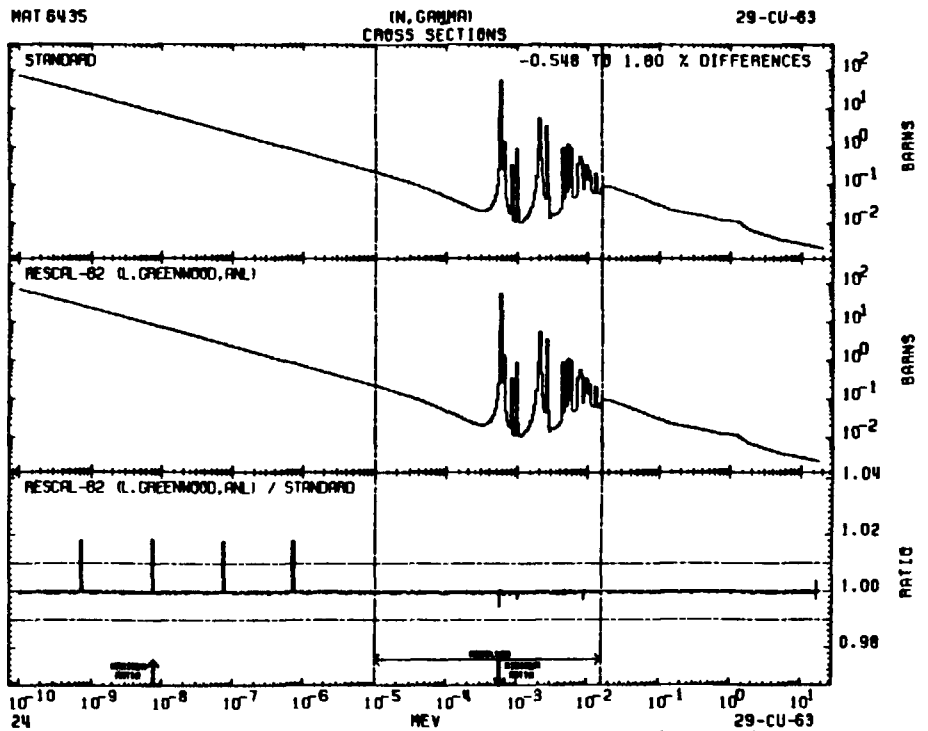

MAT 6430
(N,P)
CROSS SECTIONS
26-FE-54
STANDARD
-100. TO 3.60 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=475.00 KEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
18
26-FE-54

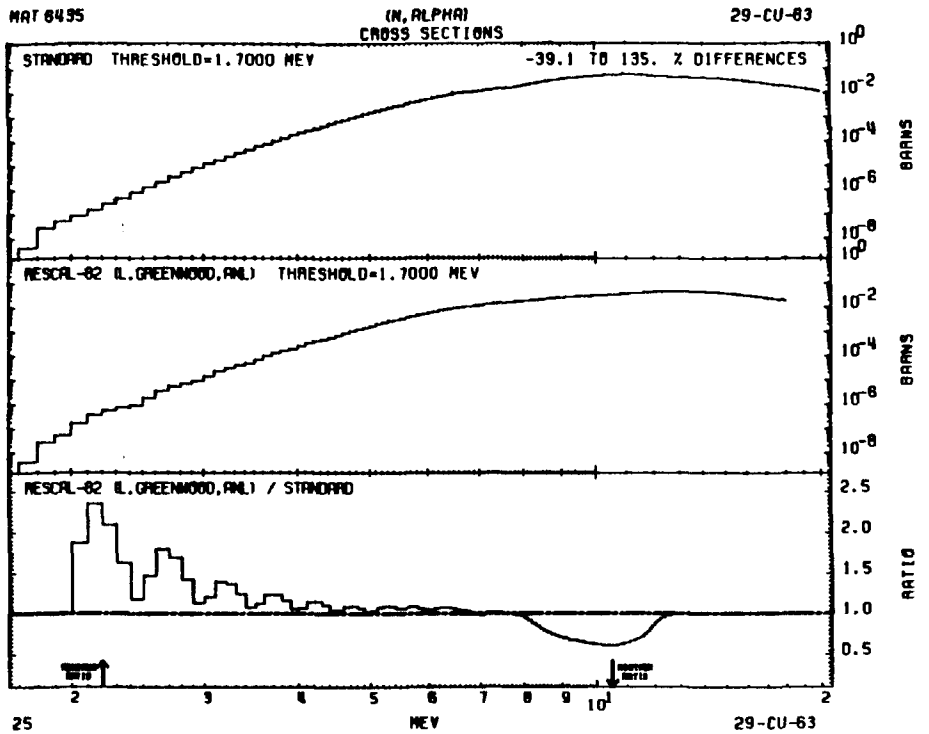

MAT 6432
(N,GAMMA)
CROSS SECTIONS
26-FE-56
STANDARD
-39.0 TO 1.78 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
20
26-FE-56

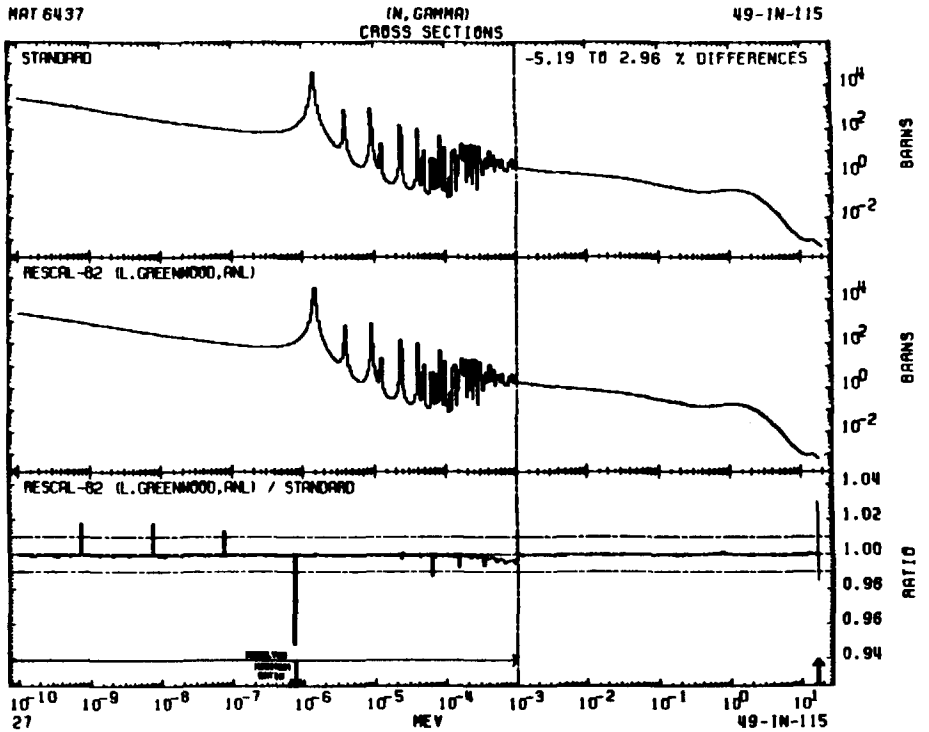

MAT 6433
(N,2N)
CROSS SECTIONS
28-NI-58
STANDARD THRESHOLD=12.400 MEV
-0.025 TO 4.99 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=12.400 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
MILLI-BARNS
RATIO
MEV
21
28-NI-58

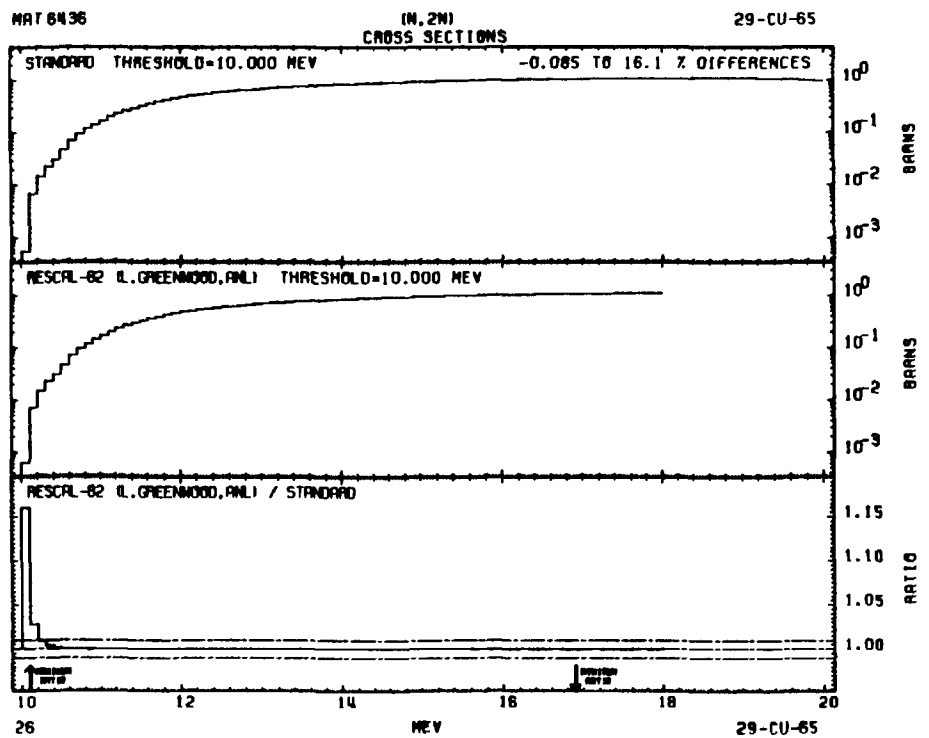

MAT 6434
(N,P)
CROSS SECTIONS
28-NI-60
STANDARD THRESHOLD=2.5000 MEV
-1.12 TO 2.15 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=2.5000 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
23
28-NI-60


MAT 6433
(N,P)
CROSS SECTIONS
28-NI-58
STANDARD
-100. TO 3.64 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=475.00 KEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
22
28-NI-58


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-0.548 TO 1.80 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
24
29-CU-63


MAT 6495
(N,ALPHA)
CROSS SECTIONS
29-CU-63
STANDARD THRESHOLD=1.7000 MEV
-39.1 TO 135. % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=1.7000 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
25
29-CU-63


MAT 6437
(N,GAMMA)
CROSS SECTIONS
49-IN-115
STANDARD
-5.19 TO 2.96 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL)
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
27
49-IN-115


MAT 6436
(N,2N)
CROSS SECTIONS
29-CU-65
STANDARD THRESHOLD=10.000 MEV
-0.085 TO 16.1 % DIFFERENCES
RESCAL-82 (L.GREENWOOD,ANL) THRESHOLD=10.000 MEV
RESCAL-82 (L.GREENWOOD,ANL) / STANDARD
BARNS
RATIO
MEV
26
29-CU-65

RESENDD
=======

The RESENDD code is designed to calculate energy dependent cross sections from resonance parameters and background cross sections in the ENDF/B format.

The RESENDD comparison performed in 1981 indicate a problem in representing narrow resonances in the resolved region (e.g., ^{232}Th-fission and capture, ^{238}U-capture and fission, ^{58}Fe-capture), the use of the ENDF/B-IV convention of interpolating unresolved parameters (e.g., ^{237}Np-fission), an error in interpolating cross sections à la RECENT (e.g., ^{63}Cu-capture) and a numerical instability in the code which was used to calculate multigroup constants from the energy dependent cross sections (e.g., ^{197}Au-capture).

All of the above problems have been eliminated from RESENDD and the latest RESENDD results agree with our benchmark results.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=RESENDD-81 (S.IGARASI,JAERI)

ENDF/B TAPE LABELS

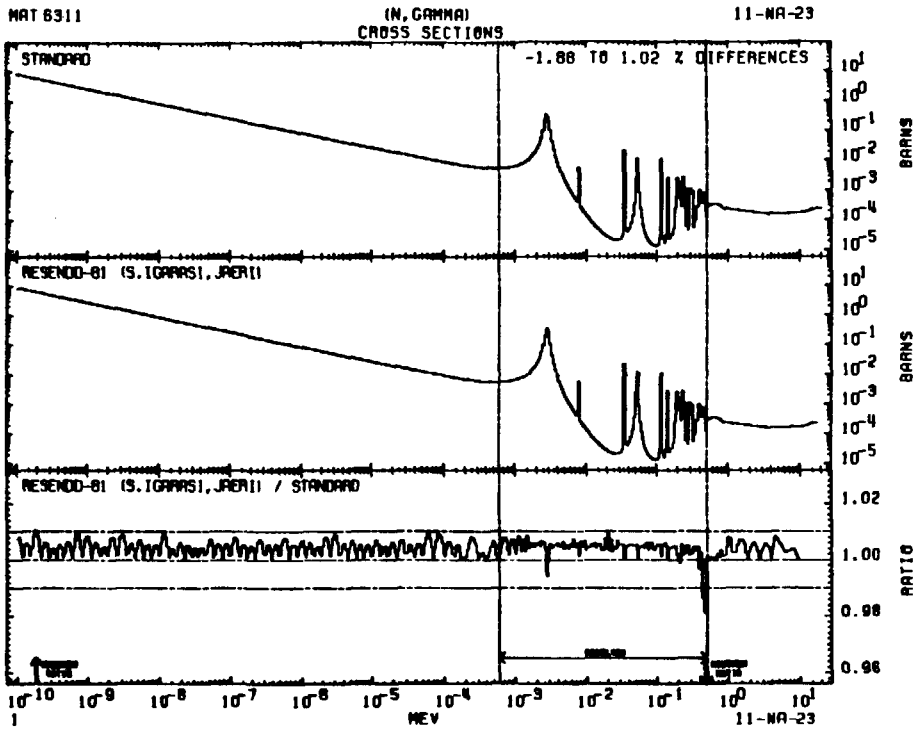
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2= RESENDD...ENDF/B-V DOSIMETRY LIBRARY (S.IGARASI,JAERI,1981) 9000

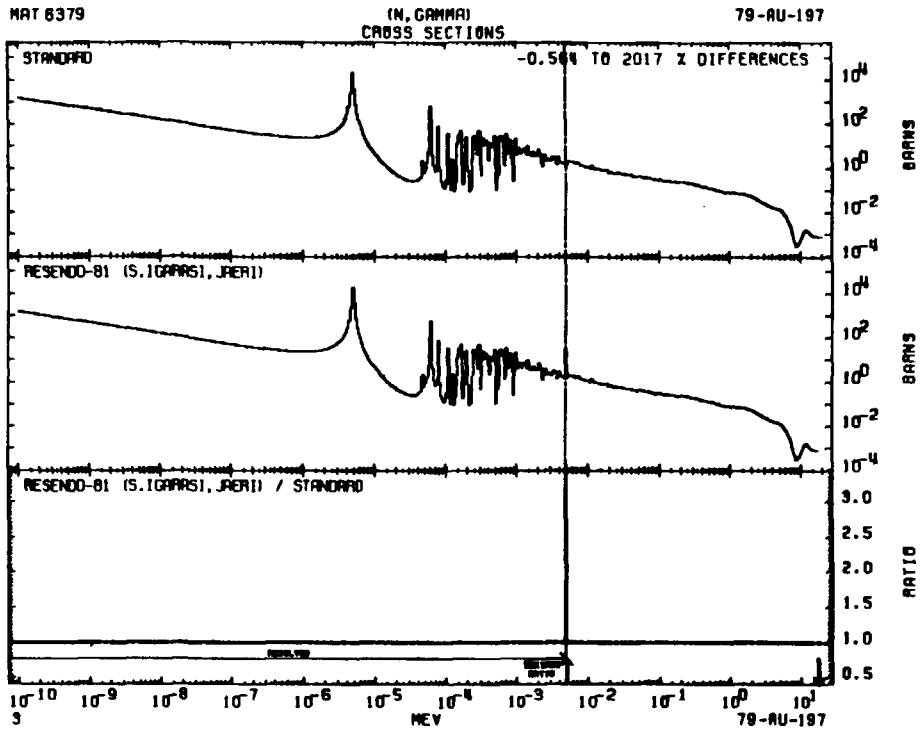
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-1.875 *	1.021 *	3.54688- 4	3.48037- 4	6.17795+ 0	6.24106+ 0
13-AL- 27	103	6313	*** NO COMPARISON ***										
13-AL- 27	107	6313	*** NO COMPARISON ***										
25-MN- 55	16	6325	*** NO COMPARISON ***										
27-CO- 59	16	6327	*** NO COMPARISON ***										
27-CO- 59	102	6327	*** NO COMPARISON ***										
27-CO- 59	107	6327	*** NO COMPARISON ***										
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-17.250 *	18.273 *	1.15840- 2	9.58571- 3	3.29277- 2	3.89445- 2
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-0.564	2017.479 *			1.22906+ 0	2.60251+ 1
90-TH-232	18	6390	6390	861	1240	1.0000- 4	2.0000+ 7	-0.529	20.524 *			2.54758- 6	3.07044- 6
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.													
DATA1 IS ZERO AT 557 ENERGIES WHERE DATA2 IS NON-ZERO.													
FIRST OCCURRENCE AT 1.00000- 4 EV.													
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-0.624	11.743 *			1.14930+ 0	1.28426+ 0
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-1.582 *	1.788 *	1.56412+ 1	1.53937+ 1	2.48513+ 1	2.52956+ 1
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-0.468	5287.039 *			3.20135- 6	1.72458- 4
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-0.761	5488.309 *			7.96262+ 0	4.44976+ 2
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-0.882	1.936 *			3.03207+ 0	3.09076+ 0
3-LI- 6	207	6424	*** NO COMPARISON ***										
5-B - 10	207	6425	*** NO COMPARISON ***										
21-SC- 45	102	6426	6426	1280	1240	1.0000- 4	2.0000+ 7	-0.747	0.968				
22-TI- 46	103	6427	*** NO COMPARISON ***										
22-TI- 47	28	6428	*** NO COMPARISON ***										
22-TI- 47	103	6428	*** NO COMPARISON ***										
22-TI- 48	28	6429	*** NO COMPARISON ***										
22-TI- 48	103	6429	*** NO COMPARISON ***										
26-FE- 54	103	6430	*** NO COMPARISON ***										
26-FE- 56	103	6431	*** NO COMPARISON ***										
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.274	125.297 *			5.30951- 1	1.19622+ 0
28-NI- 58	16	6433	*** NO COMPARISON ***										
28-NI- 58	103	6433	*** NO COMPARISON ***										
28-NI- 60	103	6434	*** NO COMPARISON ***										
29-CU- 63	102	6435	6435	1280	1240	1.0000- 4	2.0000+ 7	-0.039	94.002 *			1.07784- 2	2.09103- 2
29-CU- 63	107	6435	6435	367	327	1.7000+ 6	2.0000+ 7	-0.856	0.889				
29-CU- 65	16	6436	*** NO COMPARISON ***										
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.823	0.920				
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-0.847	1.045 *			8.88480- 4	8.97761- 4
53-I -127	16	6438	*** NO COMPARISON ***										
16-S - 32	103	6439	*** NO COMPARISON ***										

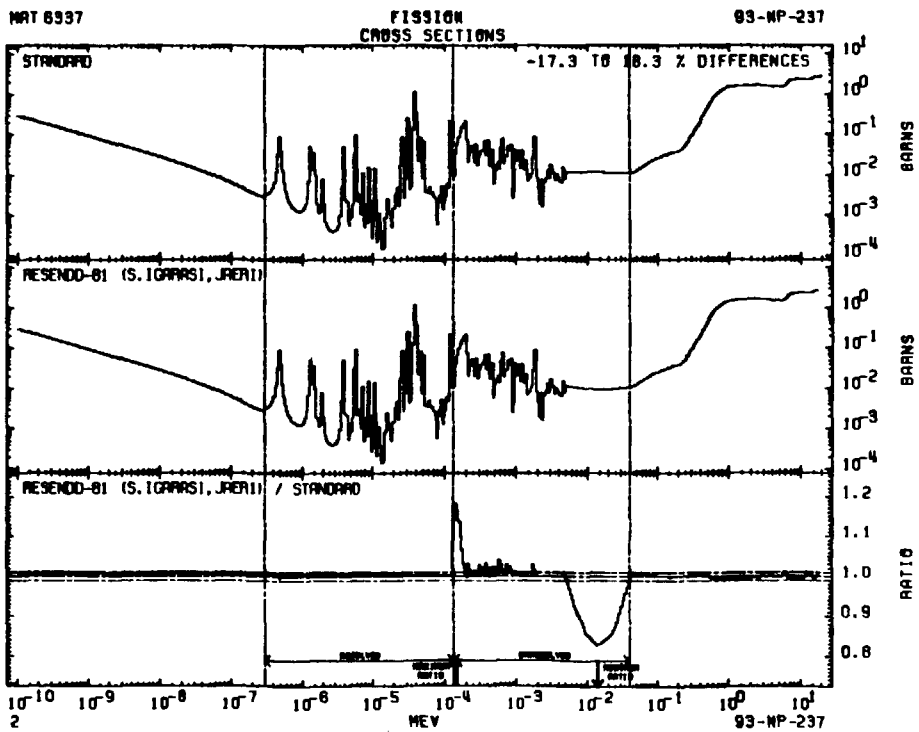
12 PLOTS GENERATED

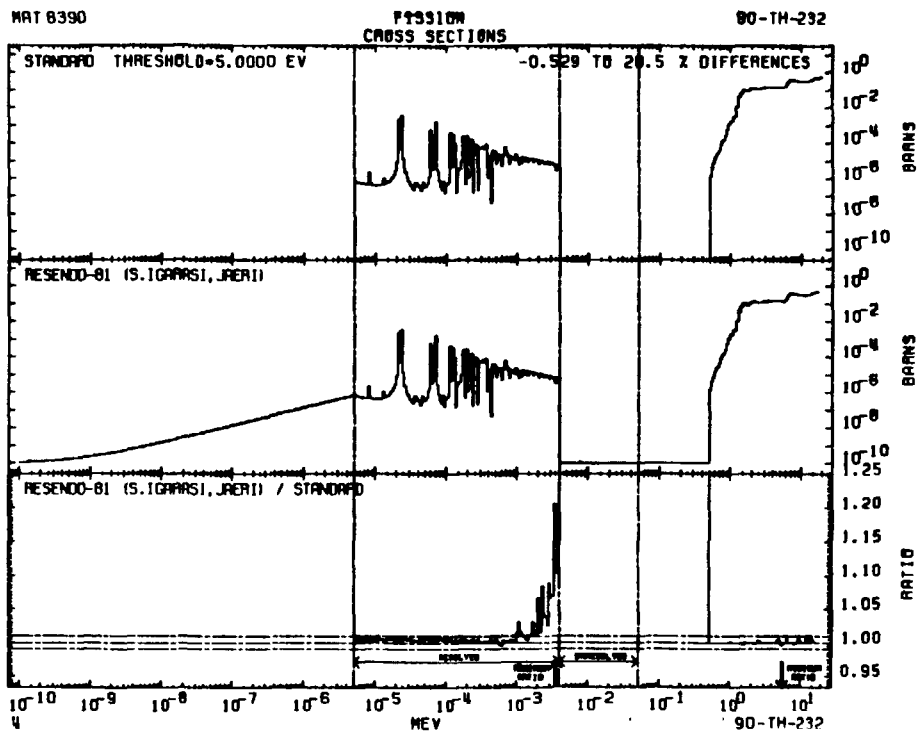
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

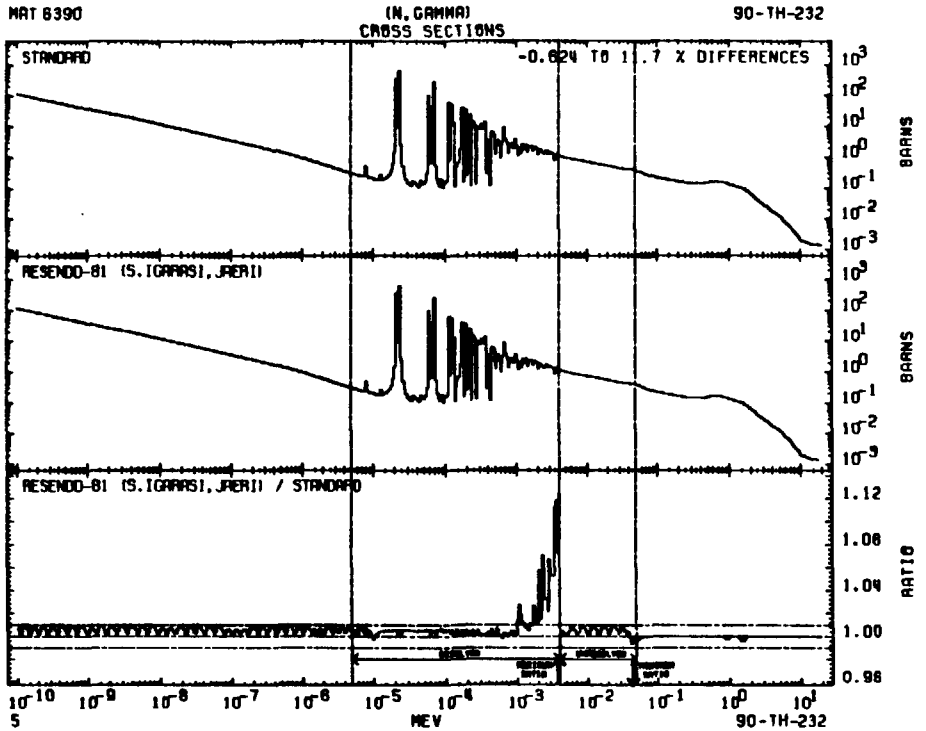
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

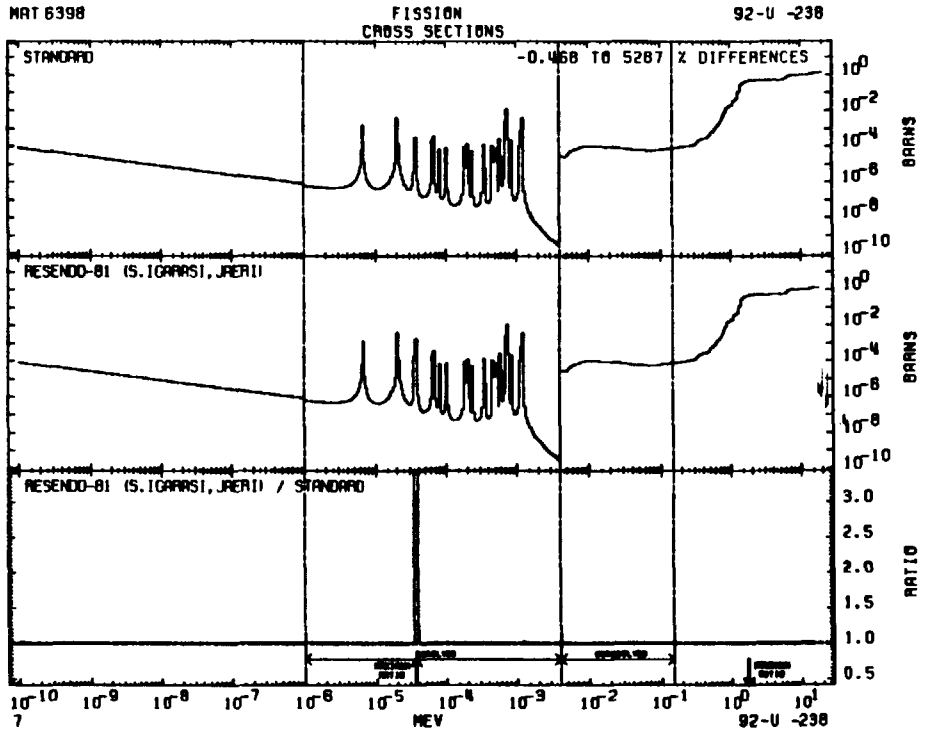

MAT 6311
(N,GAMMA)
CROSS SECTIONS
11-NA-23
STANDARD
-1.88 TO 1.02 % DIFFERENCES
RESEND-81 (S.IGARASI,JAERI)
RESEND-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
1
11-NA-23

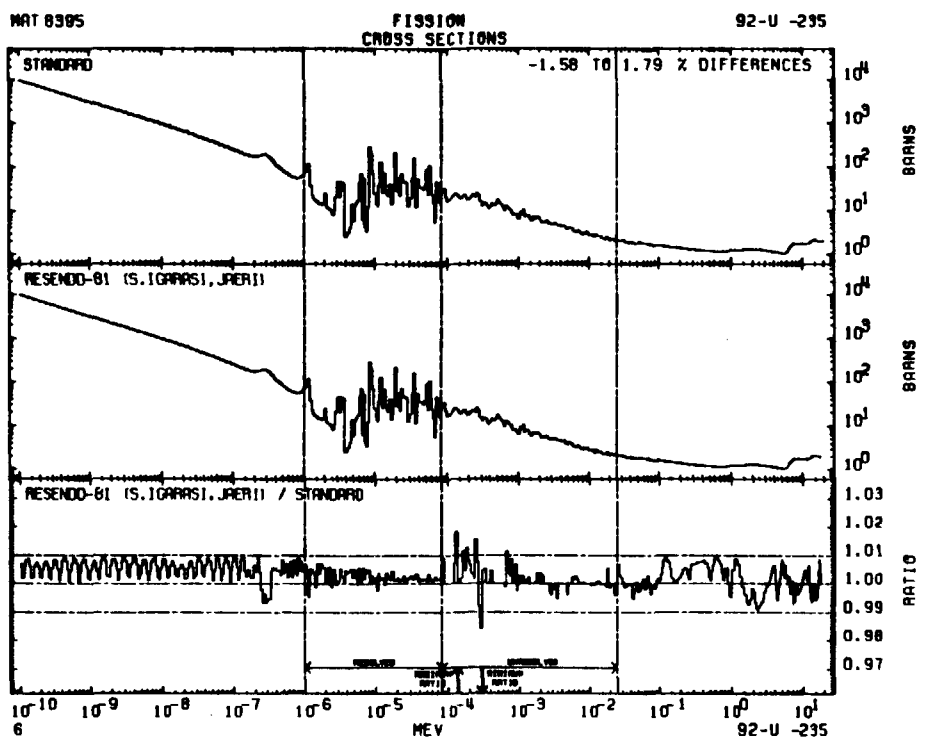

MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-0.564 TO 2017 % DIFFERENCES
RESEND-81 (S.IGARASI,JAERI)
RESEND-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
3
79-AU-197

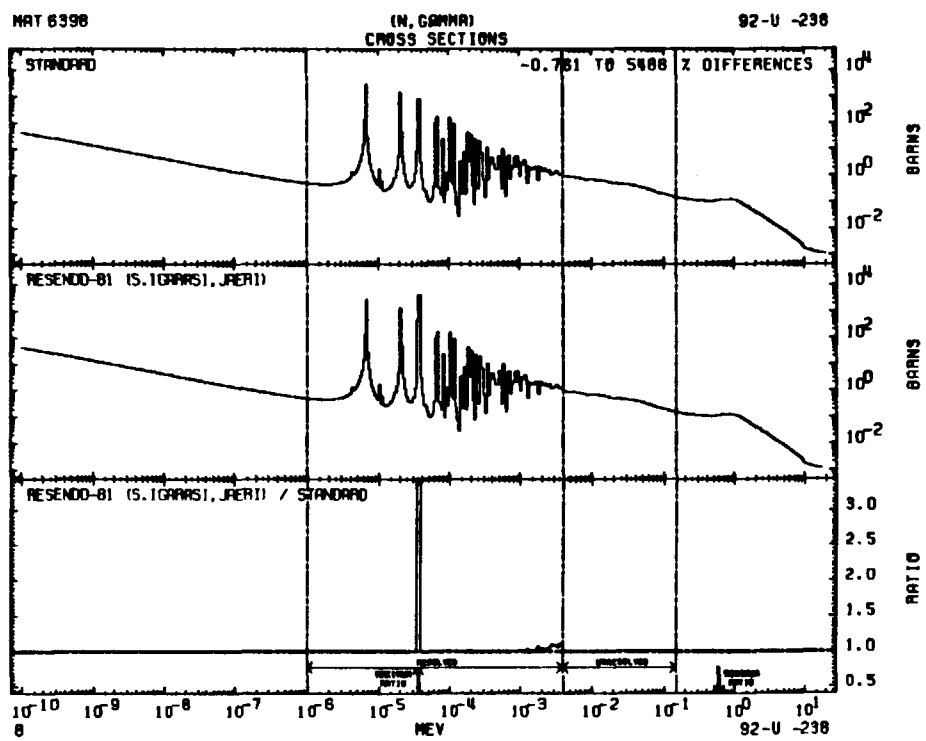

MAT 6937
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-17.3 TO 18.3 % DIFFERENCES
RESEND-81 (S.IGARASI,JAERI)
RESEND-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
2
93-NP-237

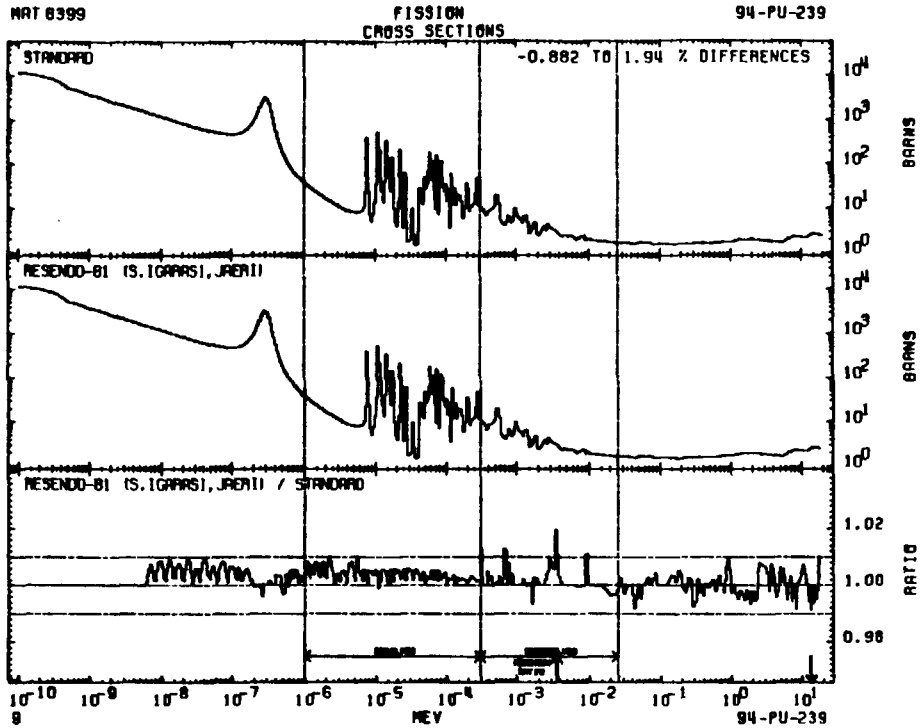

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-0.529 TO 20.5 % DIFFERENCES
RESEND-81 (S.IGARASI,JAERI)
RESEND-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
4
90-TH-232

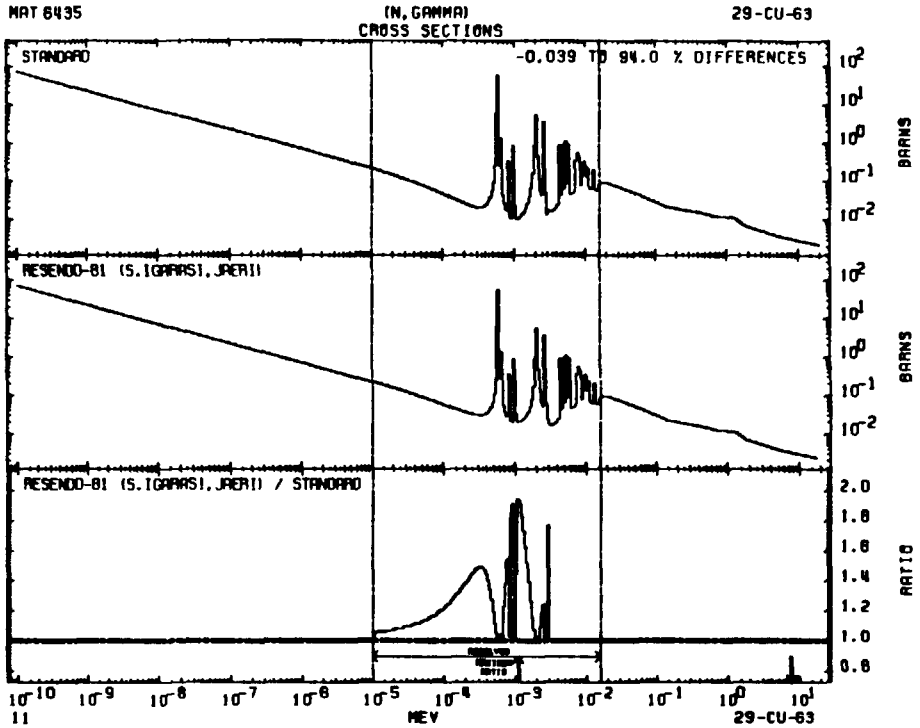

MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-0.624 TO 11.7 % DIFFERENCES
RESENDD-81 (S.IGARASI,JAERI)
RESENDD-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
90-TH-232

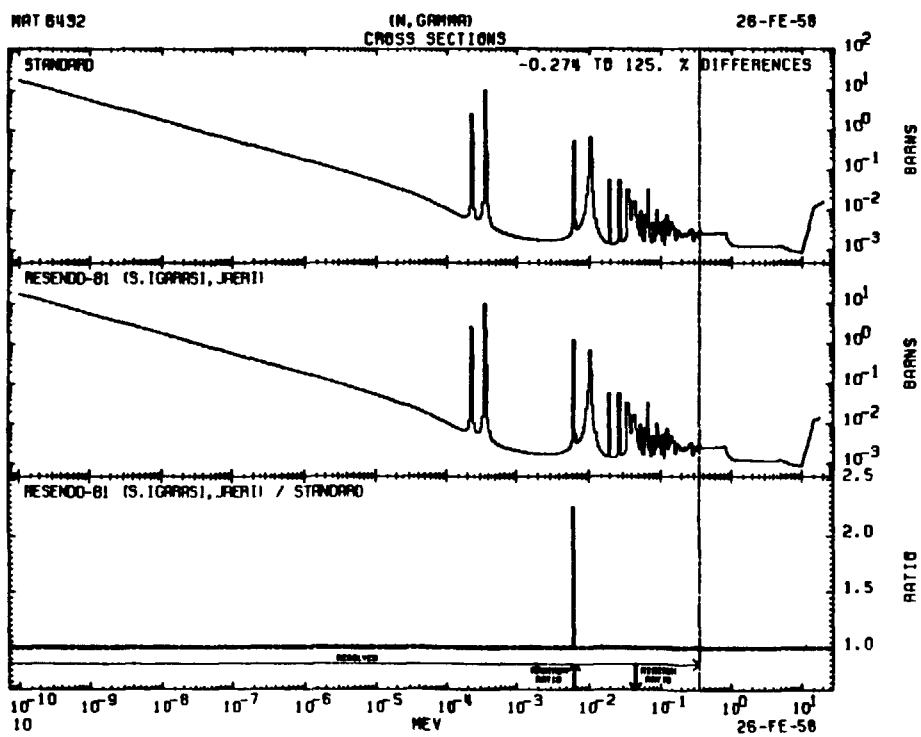

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-0.468 TO 5287 % DIFFERENCES
RESENDD-81 (S.IGARASI,JAERI)
RESENDD-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
92-U -238

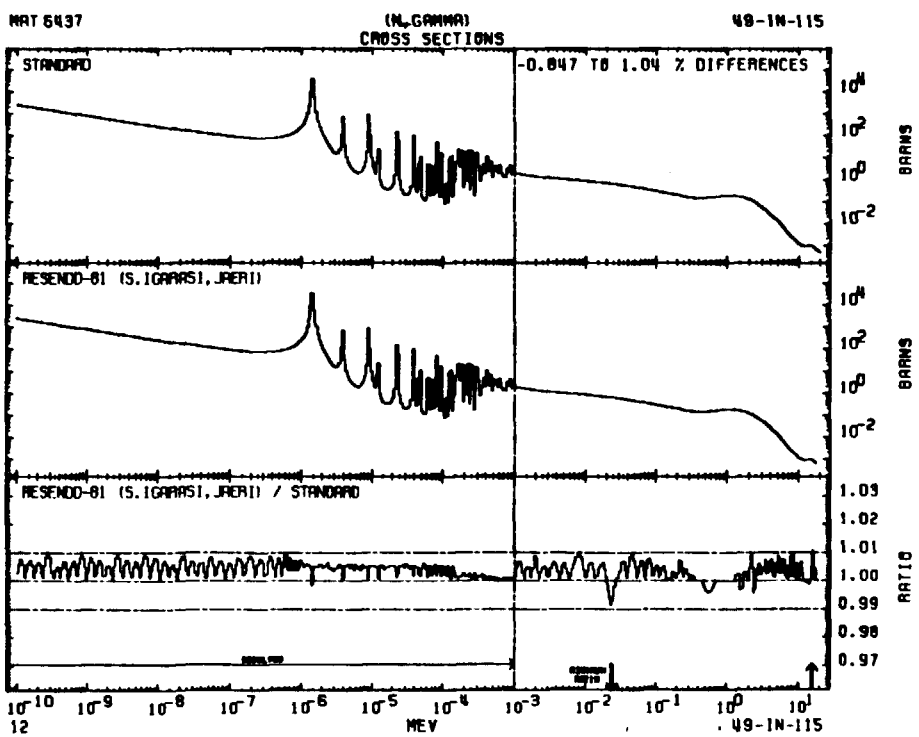

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-1.58 TO 1.79 % DIFFERENCES
RESENDD-81 (S.IGARASI,JAERI)
RESENDD-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
92-U -235


MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-0.761 TO 5468 % DIFFERENCES
RESENDD-81 (S.IGARASI,JAERI)
RESENDD-81 (S.IGARASI,JAERI) / STANDARD
BARNS
RATIO
MEV
92-U -238


MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-0.882 TO 1.94 % DIFFERENCES
RESENDD-81 (S.IGARASI, JAERI)
RESENDD-81 (S.IGARASI, JAERI) / STANDARD
BARNS
RATIO
MEV
9
94-PU-239


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-0.039 TO 94.0 % DIFFERENCES
RESENDD-81 (S.IGARASI, JAERI)
RESENDD-81 (S.IGARASI, JAERI) / STANDARD
BARNS
RATIO
MEV
11
29-CU-63


MAT 6492
(N,GAMMA)
CROSS SECTIONS
26-FE-56
STANDARD
-0.274 TO 125. % DIFFERENCES
RESENDD-81 (S.IGARASI, JAERI)
RESENDD-81 (S.IGARASI, JAERI) / STANDARD
BARNS
RATIO
MEV
10
26-FE-56


MAT 6437
(N,GAMMA)
CROSS SECTIONS
49-IN-115
STANDARD
-0.847 TO 1.04 % DIFFERENCES
RESENDD-81 (S.IGARASI, JAERI)
RESENDD-81 (S.IGARASI, JAERI) / STANDARD
BARNS
RATIO
MEV
12
49-IN-115

FEDGROUP-3
==========

The FEDGROUP-3 code is designed to generate complete multigroup data sets for use in applications.

FEDGROUP-3 results have been submitted for only a portion of the ENDF/B-V dosimetry library. Comparison of the initial FEDGROUP-3 results performed in 1982 indicate large differences in the resolved resonance region (e.g., ^{23}Na-capture, ^{59}Co-capture, ^{232}Th-capture and fission) as well as in the unresolved region (e.g., ^{235}U-fission). In addition surprisingly large differences were found even at higher energies where the original evaluated data are tabulated (e.g., ^{59}Co-capture and ^{232}Th-fission) which appear to be due to interpolation.

The latest FEDGROUP-3 comparison performed in 1983 were also only for a portion of the ENDF/B-V dosimetry library. The latest results show improvement in the resolved resonance region treatment as well as at higher energies where the cross section is tabulated. The ^{235}U-fission results also indicate an improvement in the unresolved resonance treatment. The ^{237}Np-fission results indicate that FEDGROUP-3 is still using the ENDF/B-IV convention of interpolating unresolved parameters.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=FEDGROUP-3-82 (P.VERTES,KFKI)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2=FEDGROUP-3 ENDF/B-V DOSIMETRY LIBRARY (VERTES,BUDAPEST,1982) 9000

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-21.179 *	13.001 *	2.86942- 4	2.26170- 4	3.54688- 4	4.00800- 4
13-AL- 27	103	6313	6313	365	325	1.8000+ 6	2.0000+ 7	-0.086	0.098				
13-AL- 27	107	6313	6313	337	297	3.2000+ 6	2.0000+ 7	-0.034	0.160				
25-MN- 55	16	6325	6325	193	153	1.0400+ 7	2.0000+ 7	-0.073	0.169				
27-CO- 59	16	6327	*** NO COMPARISON ***										
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-58.796 *	187.518 *	8.20313- 3	3.38000- 3	5.46852- 2	1.57230- 1
27-CO- 59	107	6327	*** NO COMPARISON ***										
93-NP-237	18	6337	*** NO COMPARISON ***										
79-AU-197	102	6379	*** NO COMPARISON ***										
90-TH-232	18	6390	6390	861	821	5.0000+ 0	2.0000+ 7	-30.733 *	63.065 *	3.61400- 1	2.50330- 1	3.25753- 3	5.31190- 3

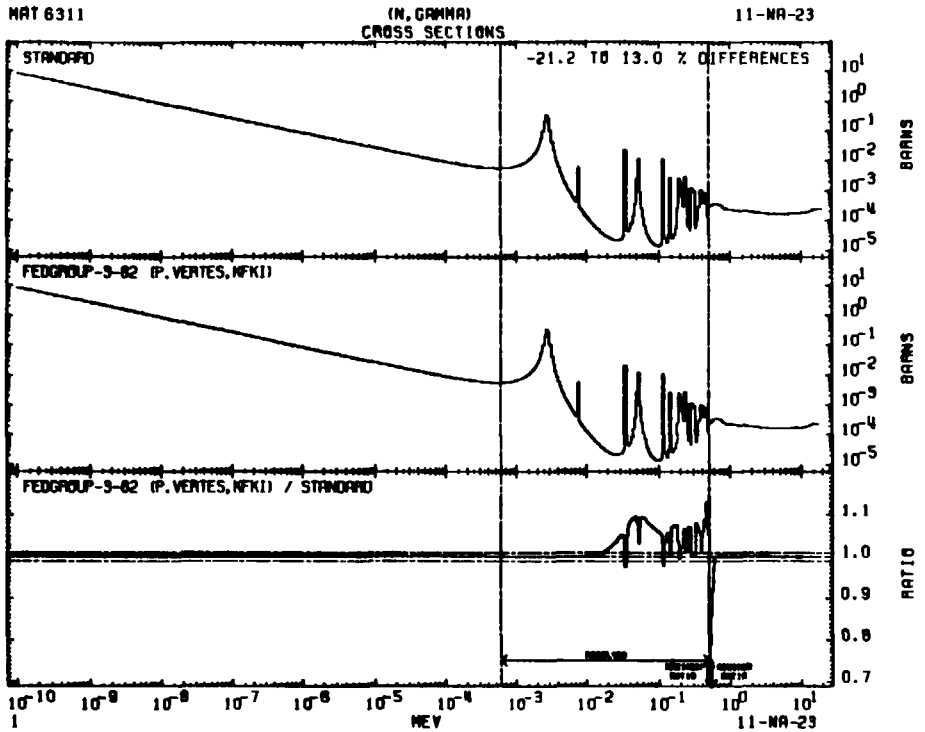
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 4.75000+ 5 EV.

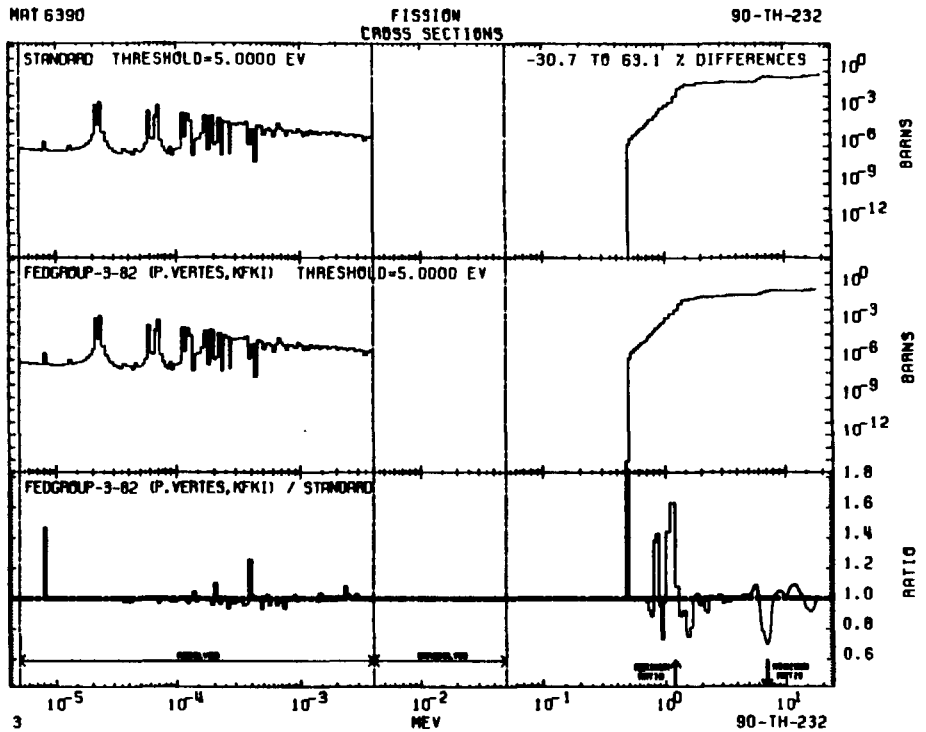
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-23.407 *	31.454 *	3.82500- 1	2.92970- 1	4.91008- 1	6.45450- 1
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-13.103 *	20.012 *	3.24452+ 1	2.81940+ 1	1.01748+ 1	1.22110+ 1
92-U -238	18	6398	*** NO COMPARISON ***										
92-U -238	102	6398	*** NO COMPARISON ***										
94-PU-239	18	6399	*** NO COMPARISON ***										
3-LI- 6	207	6424	6424	1280	1240	1.0000- 4	2.0000+ 7	-0.072	0.181				
5-B - 10	207	6425	6425	1280	1240	1.0000- 4	2.0000+ 7	-0.090	0.175				
21-SC- 45	102	6426	*** NO COMPARISON ***										
22-TI- 46	103	6427	*** NO COMPARISON ***										
22-TI- 47	28	6428	*** NO COMPARISON ***										
22-TI- 47	103	6428	*** NO COMPARISON ***										
22-TI- 48	28	6429	*** NO COMPARISON ***										
22-TI- 48	103	6429	*** NO COMPARISON ***										
26-FE- 54	103	6430	*** NO COMPARISON ***										
26-FE- 56	103	6431	*** NO COMPARISON ***										
26-FE- 58	102	6432	*** NO COMPARISON ***										
28-NI- 58	16	6433	*** NO COMPARISON ***										
28-NI- 58	103	6433	*** NO COMPARISON ***										
28-NI- 60	103	6434	*** NO COMPARISON ***										
29-CU- 63	102	6435	*** NO COMPARISON ***										
29-CU- 63	107	6435	*** NO COMPARISON ***										
29-CU- 65	16	6436	*** NO COMPARISON ***										
49-IN-115	51	6437	*** NO COMPARISON ***										
49-IN-115	102	6437	*** NO COMPARISON ***										
53-I -127	16	6438	*** NO COMPARISON ***										
16-S - 32	103	6439	*** NO COMPARISON ***										

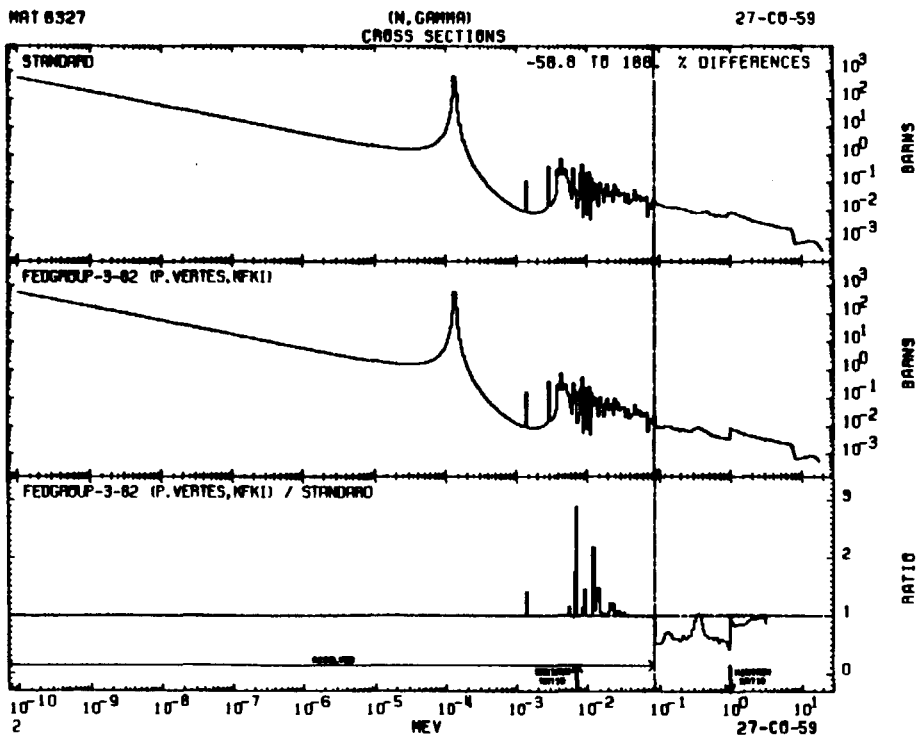
5 PLOTS GENERATED

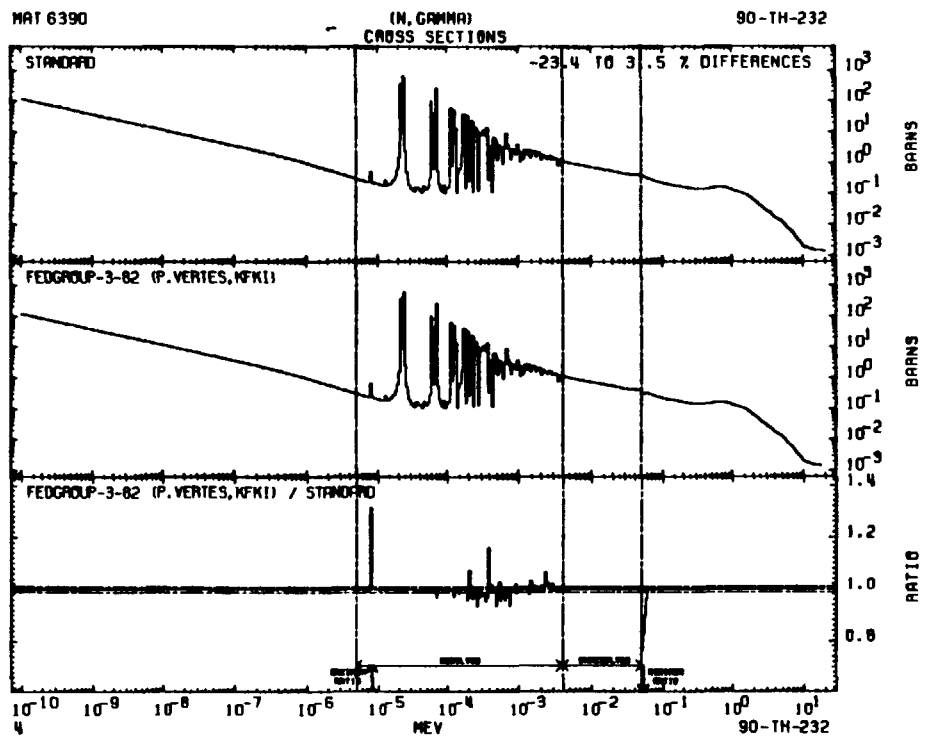
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

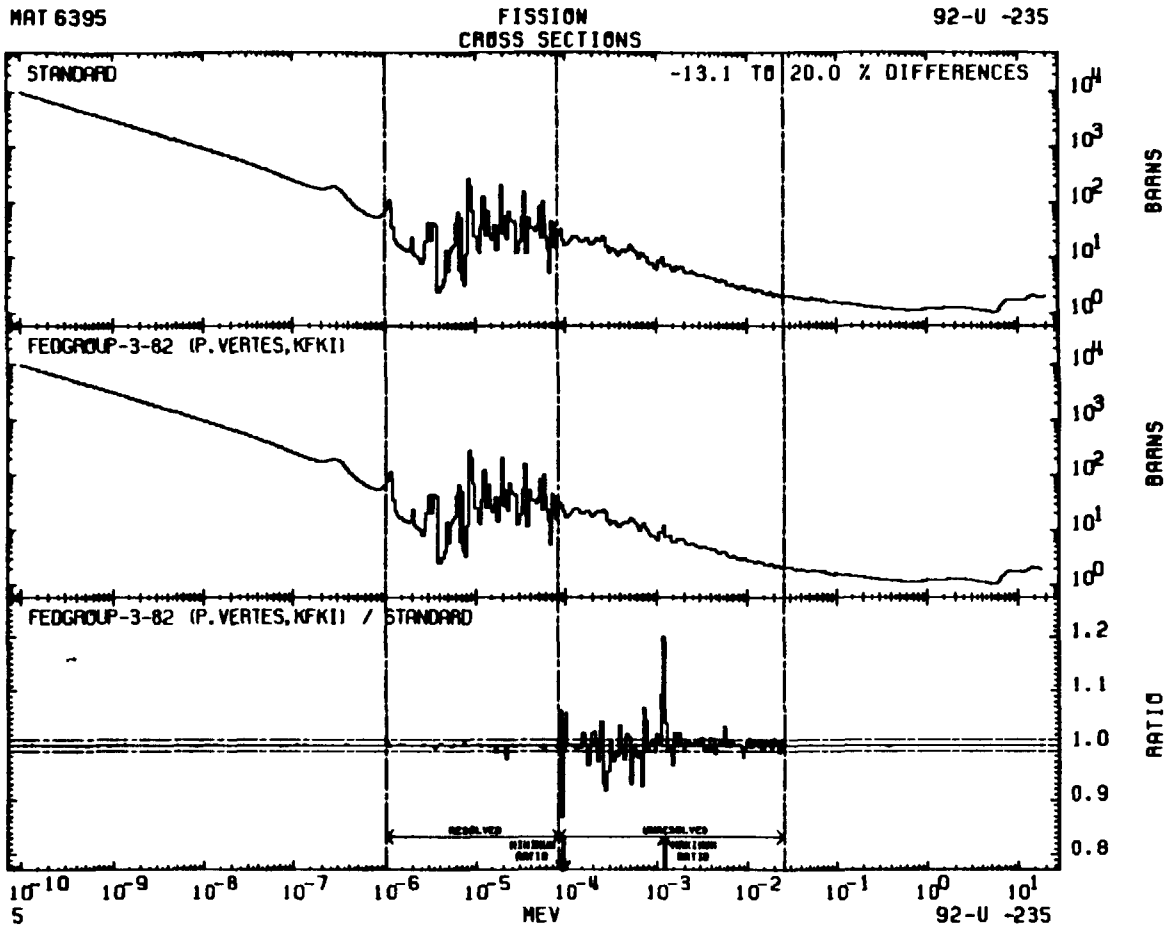
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS


MAT 6311
(N,GAMMA)
CROSS SECTIONS
11-NA-23
STANDARD
-21.2 TO 13.0 % DIFFERENCES
FEDGROUP-3-82 (P.VERTES,MFKI)
FEDGROUP-3-82 (P.VERTES,MFKI) / STANDARD
BARNS
RATIO
MEV
1
11-NA-23


MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-30.7 TO 63.1 % DIFFERENCES
FEDGROUP-3-82 (P.VERTES,MFKI) THRESHOLD=5.0000 EV
FEDGROUP-3-82 (P.VERTES,MFKI) / STANDARD
BARNS
RATIO
MEV
3
90-TH-232


MAT 6327
(N,GAMMA)
CROSS SECTIONS
27-CO-59
STANDARD
-58.8 TO 188. % DIFFERENCES
FEDGROUP-3-82 (P.VERTES,MFKI)
FEDGROUP-3-82 (P.VERTES,MFKI) / STANDARD
BARNS
RATIO
MEV
2
27-CO-59


MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-23.4 TO 3.5 % DIFFERENCES
FEDGROUP-3-82 (P.VERTES,MFKI)
FEDGROUP-3-82 (P.VERTES,MFKI) / STANDARD
BARNS
RATIO
MEV
4
90-TH-232


MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-13.1 TO 20.0 % DIFFERENCES
FEDGROUP-3-82 (P.VERTES,KFKI)
FEDGROUP-3-82 (P.VERTES,KFKI) / STANDARD
BARNS
BARNS
RATIO
MEV
92-U -235

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=FEDGROUP-3-83 (P.VERTES,KFKI)

ENDF/B TAPE LABELS

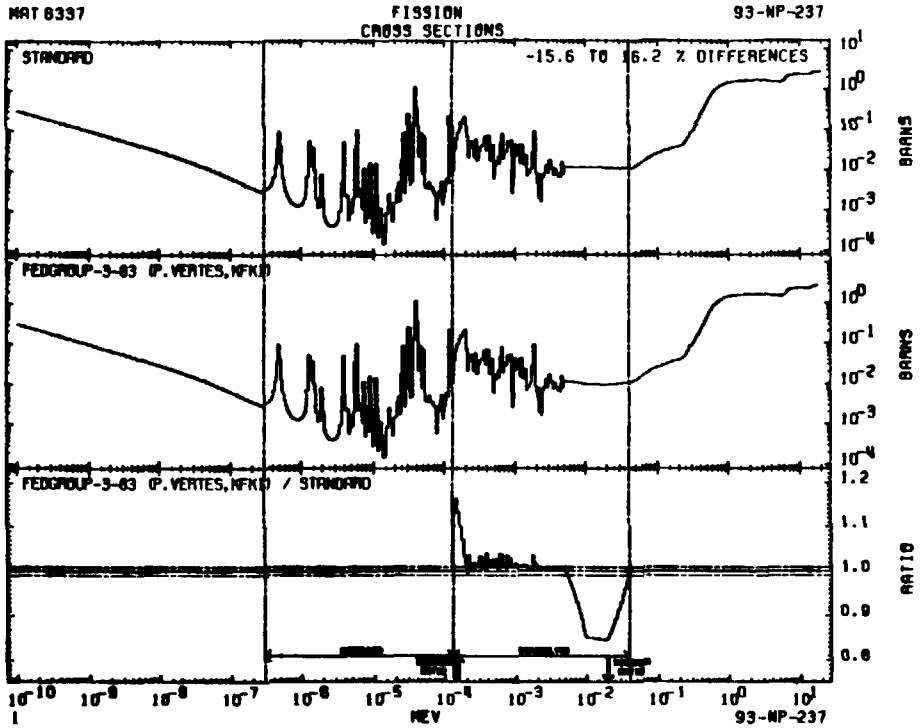
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2=FEDGROUP-3 ENDF/B-V DOSIMETRY LIBRARY (VERTES,BUDAPEST,1983) 9000

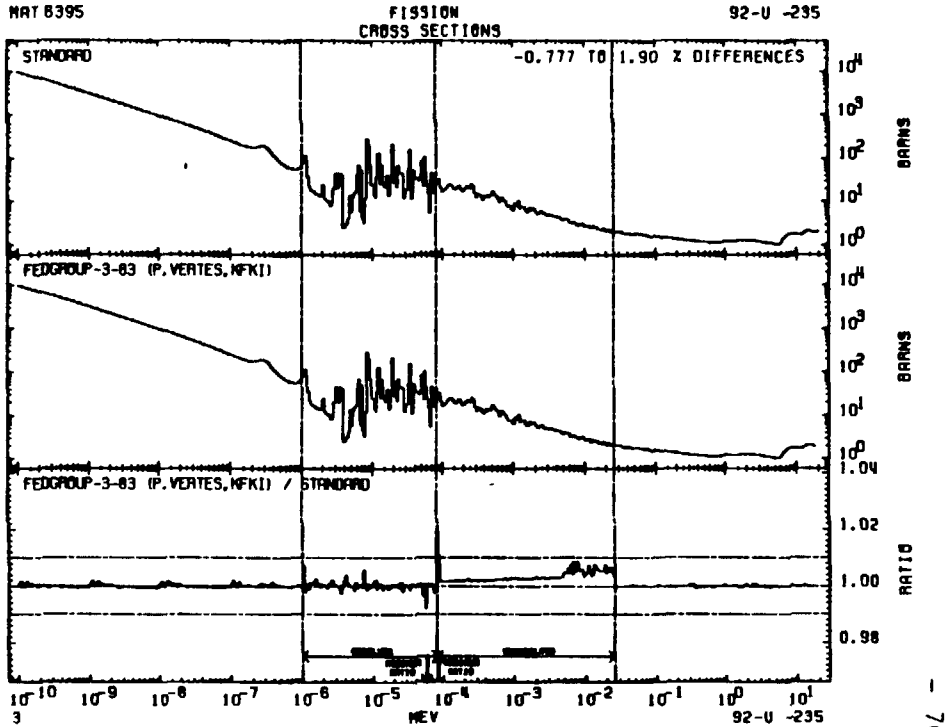
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-0.171	0.910				
13-AL- 27	103	6313	*** NO COMPARISON ***										
13-AL- 27	107	6313	*** NO COMPARISON ***										
25-MN- 55	16	6325	*** NO COMPARISON ***										
27-CO- 59	16	6327	*** NO COMPARISON ***										
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-0.761	0.341				
27-CO- 59	107	6327	*** NO COMPARISON ***										
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-15.582 *	16.223 *	1.14631- 2	9.67690- 3	5.68665- 2	6.60920- 2
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-0.494	0.157				
90-TH-232	18	6390	6390	861	821	5.0000+ 0	2.0000+ 7	-0.981	0.437				
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-1.025 *	0.248	1.71942- 1	1.70180- 1		
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-0.777	1.900 *			2.50598+ 1	2.55360+ 1
92-U -238	18	6398	*** NO COMPARISON ***										
92-U -238	102	6398	*** NO COMPARISON ***										
94-PU-239	18	6399	*** NO COMPARISON ***										
3-LI- 6	207	6424	*** NO COMPARISON ***										
5-B - 10	207	6425	*** NO COMPARISON ***										
21-SC- 45	102	6426	*** NO COMPARISON ***										
22-TI- 46	103	6427	*** NO COMPARISON ***										
22-TI- 47	28	6428	*** NO COMPARISON ***										
22-TI- 47	103	6428	*** NO COMPARISON ***										
22-TI- 48	28	6429	*** NO COMPARISON ***										
22-TI- 48	103	6429	*** NO COMPARISON ***										
26-FE- 54	103	6430	*** NO COMPARISON ***										
26-FE- 56	103	6431	*** NO COMPARISON ***										
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.130	0.148				
28-NI- 58	16	6433	*** NO COMPARISON ***										
28-NI- 58	103	6433	*** NO COMPARISON ***										
28-NI- 60	103	6434	*** NO COMPARISON ***										
29-CU- 63	102	6435	*** NO COMPARISON ***										
29-CU- 63	107	6435	*** NO COMPARISON ***										
29-CU- 65	16	6436	*** NO COMPARISON ***										
49-IN-115	51	6437	*** NO COMPARISON ***										
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-0.716	0.111				
53-I -127	16	6438	*** NO COMPARISON ***										
16-S - 32	103	6439	*** NO COMPARISON ***										

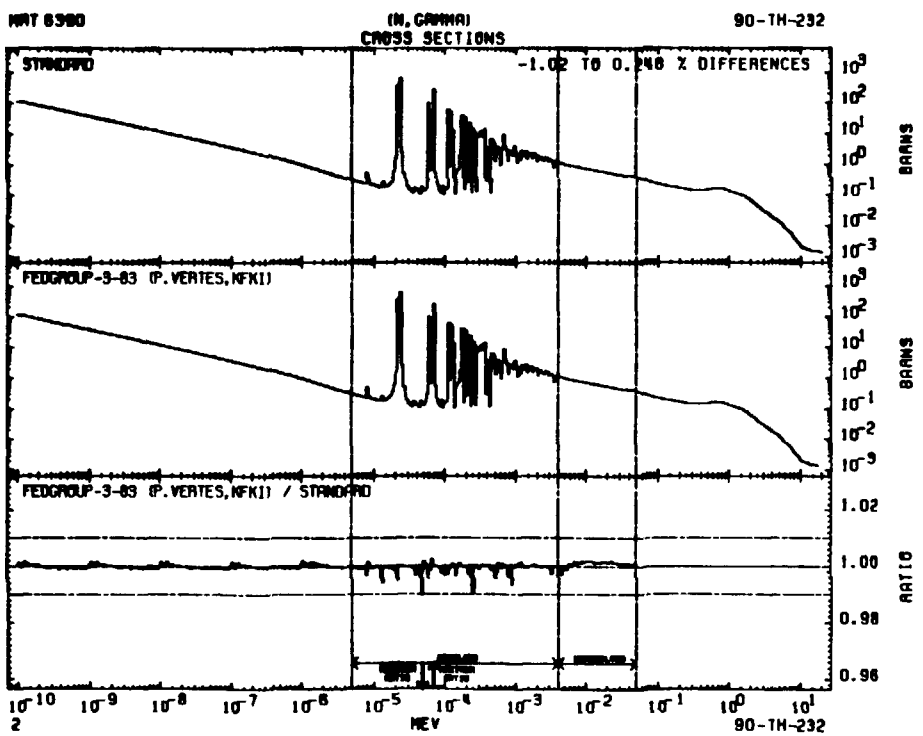
3 PLOTS GENERATED

* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS


MAT 8337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-15.6 TO 16.2 % DIFFERENCES
FEDGROUP-3-83 (P.VERTES,NFKI)
FEDGROUP-3-83 (P.VERTES,NFKI) / STANDARD
BARNS
RATIO
MEV
1
93-NP-237


MAT 8395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-0.777 TO 1.90 % DIFFERENCES
FEDGROUP-3-83 (P.VERTES,NFKI)
FEDGROUP-3-83 (P.VERTES,NFKI) / STANDARD
BARNS
RATIO
MEV
3
92-U -235


MAT 8390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
FEDGROUP-3-83 (P.VERTES,NFKI)
FEDGROUP-3-83 (P.VERTES,NFKI) / STANDARD
BARNS
RATIO
MEV
2
90-TH-232

FEDGROUP-C
==========

FEDGROUP-C is designed to generate complete multigroup data sets for use in applications.

The initial FEDGROUP-C comparisons performed in 1982 were for only a few reactions. The initial comparisons indicated that FEDGROUP-C was still using the ENDF/B-IV convention of interpolating unresolved parameters (e.g., ^{237}Np-fission) and that it had a problem in calculating fluctuation integrals (e.g., ^{232}Th-capture). The ^{232}Th-fission results indicated some problem in representing narrow resonances in the resolved region. The ^{63}Cu-capture results indicate a problem in selection of the energy grid in the resolved region, particularly in extending the grid a long distance from isolated resonances.

The latest FEGROUP-C results are for the entire ENDF/B-V dosimetry library. All of the problems described above have been eliminated and the latest FEDGROUP-C results agree with the benchmark results.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=FEDGROUP-C-82 (A.TRKOV,LJUBLJANA)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2= FEDGROUP-C...ENDF/B-V DOSIMETRY LIBRARY (A.TRKOV,LJUBLJANA,1982) 9000

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	*** NO COMPARISON ***										
13-AL- 27	103	6313	*** NO COMPARISON ***										
13-AL- 27	107	6313	*** NO COMPARISON ***										
25-MN- 55	16	6325	*** NO COMPARISON ***										
27-CO- 59	16	6327	*** NO COMPARISON ***										
27-CO- 59	102	6327	*** NO COMPARISON ***										
27-CO- 59	107	6327	*** NO COMPARISON ***										
93-NP-237	18	6337	6337	1280	1280	1.0000- 4	2.0000+ 7	-23.832 *	18.918 *	1.15840- 2	8.82330- 3	3.29277- 2	3.91570- 2
79-AU-197	102	6379	*** NO COMPARISON ***										
90-TH-232	18	6390	6390	861	861	5.0000+ 0	2.0000+ 7	-4.756 *	1.881 *	5.58840- 5	5.32260- 5	4.44665- 8	4.53030- 8

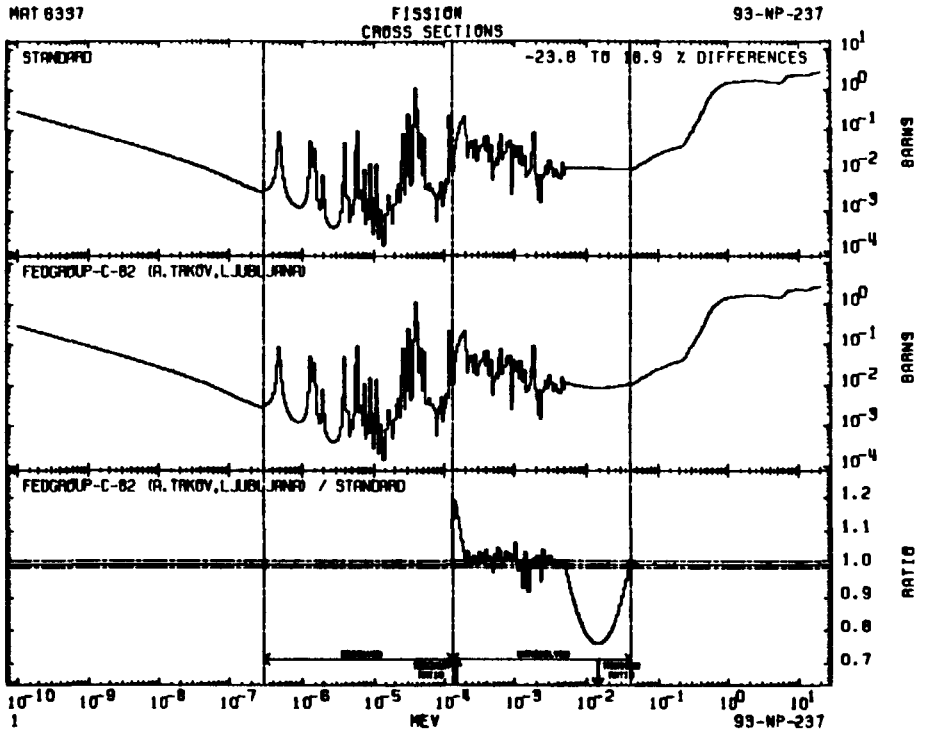
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 4.00000+ 3 EV.

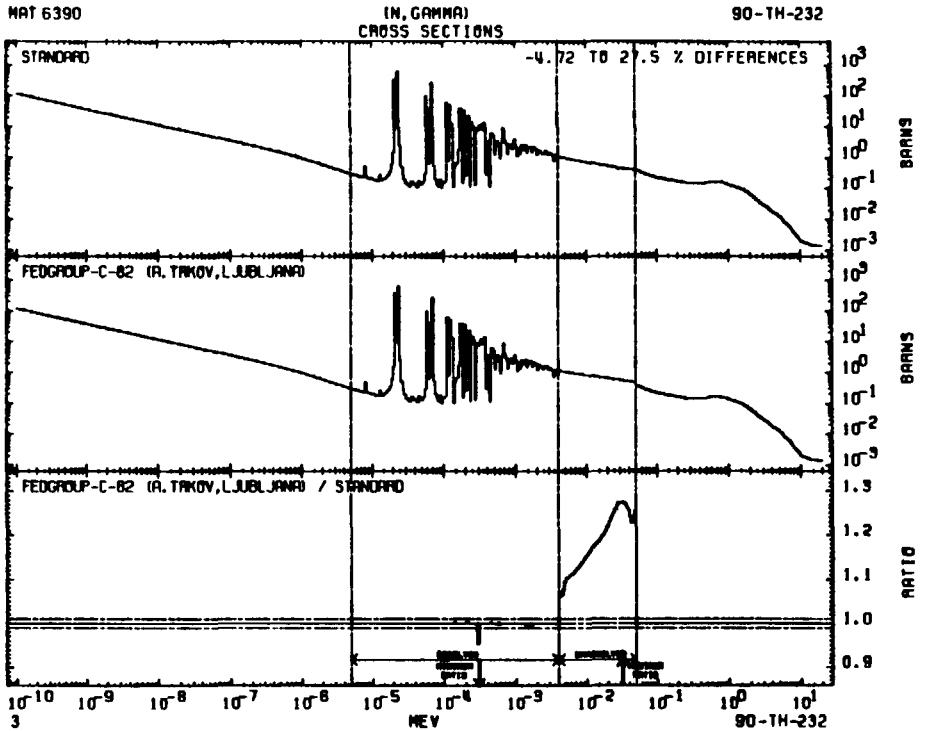
90-TH-232	102	6390	6390	1280	1280	1.0000- 4	2.0000+ 7	-4.718 *	27.491 *	9.03857+ 0	8.61210+ 0	4.48675- 1	5.72020- 1
92-U -235	18	6395	*** NO COMPARISON ***										
92-U -238	18	6398	*** NO COMPARISON ***										
92-U -238	102	6398	*** NO COMPARISON ***										
94-PU-239	18	6399	*** NO COMPARISON ***										
3-LI- 6	207	6424	*** NO COMPARISON ***										
5-B - 10	207	6425	*** NO COMPARISON ***										
21-SC- 45	102	6426	*** NO COMPARISON ***										
22-TI- 46	103	6427	*** NO COMPARISON ***										
22-TI- 47	28	6428	*** NO COMPARISON ***										
22-TI- 47	103	6428	*** NO COMPARISON ***										
22-TI- 48	28	6429	*** NO COMPARISON ***										
22-TI- 48	103	6429	*** NO COMPARISON ***										
26-FE- 54	103	6430	*** NO COMPARISON ***										
26-FE- 56	103	6431	*** NO COMPARISON ***										
26-FE- 58	102	6432	6432	1280	1280	1.0000- 4	2.0000+ 7	-0.130	0.555				
28-NI- 58	16	6433	*** NO COMPARISON ***										
28-NI- 58	103	6433	*** NO COMPARISON ***										
28-NI- 60	103	6434	*** NO COMPARISON ***										
29-CU- 63	102	6435	6435	1280	1280	1.0000- 4	2.0000+ 7	-3.097	*2482.176 *	8.01181- 2	7.76370- 2	1.10980- 2	2.86570- 1
29-CU- 63	107	6435	*** NO COMPARISON ***										
29-CU- 65	16	6436	*** NO COMPARISON ***										
49-IN-115	51	6437	*** NO COMPARISON ***										
49-IN-115	102	6437	*** NO COMPARISON ***										
53-I -127	16	6438	*** NO COMPARISON ***										
16-S - 32	103	6439	*** NO COMPARISON ***										

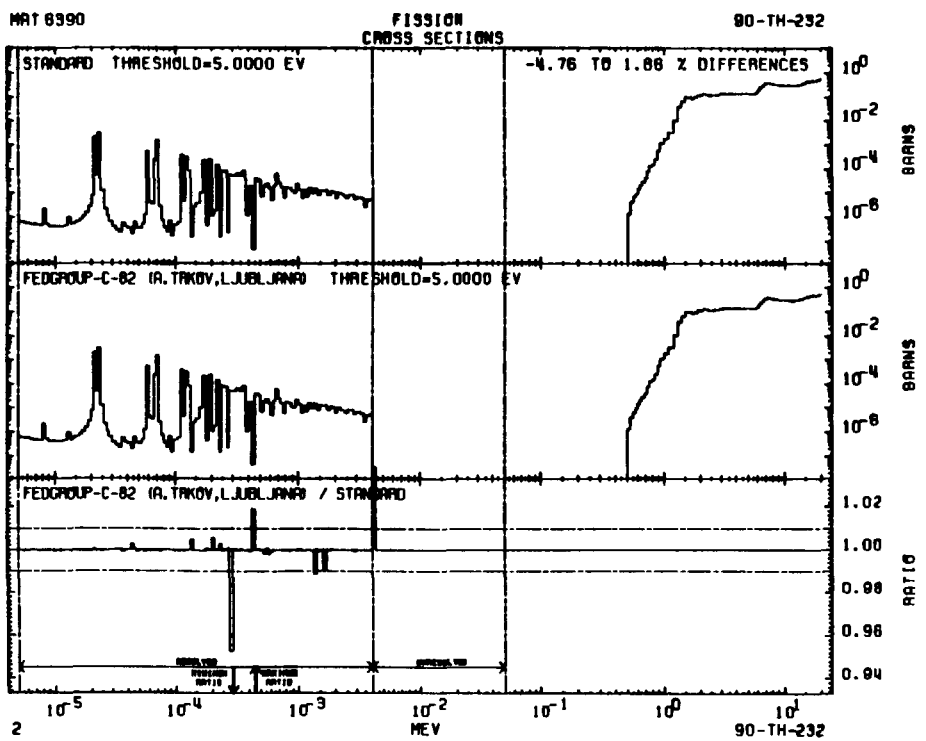
4 PLOTS GENERATED

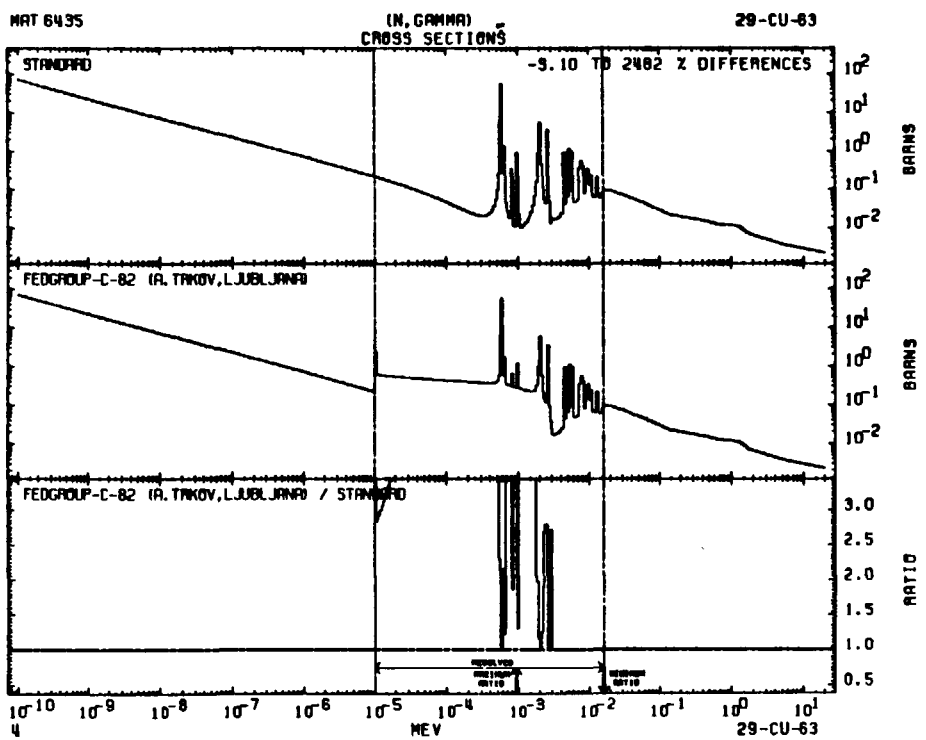
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS


MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-23.8 TO 16.9 % DIFFERENCES
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA)
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA / STANDARD
BARNS
RATIO
MEV
1
93-NP-237


MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-4.72 TO 27.5 % DIFFERENCES
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA)
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA / STANDARD
BARNS
RATIO
MEV
3
90-TH-232


MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-4.76 TO 1.88 % DIFFERENCES
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA THRESHOLD=5.0000 EV
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA / STANDARD
BARNS
RATIO
MEV
2
90-TH-232


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-9.10 TO 2482 % DIFFERENCES
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA)
FEDGROUP-C-82 (A.TAKOV,LJUBLJANA / STANDARD
BARNS
RATIO
MEV
4
29-CU-63

NJOY
====

The NJOY system is designed to calculate complete multigroup data sets for use in applications.

The initial NJOY comparisons performed in 1981 showed excellent agreement in the resolved resonance region (the best initial results submitted by any participating code). The unresolved results for ^{237}Np-fission indicated that NJOY was still using the ENDF/B-IV convention of interpolating unresolved parameters and the ^{235}U-fission and ^{239}Pu-fission results indicated some problem in calculating fluctuation integrals. The only other observed differences were due to the NJOY convention of assuming that small cross sections (10^{-9} to 10^{-6} barns) are linearly interpolable (e.g. ^{54}Fe (n,p), ^{56}Fe(n,p), ^{60}Ni(n,p), ^{63}Cu(n,alpha)) and treating very small cross sections (less than 10^{-9} barns) as zero (e.g. ^{27}Al(n,alpha), ^{47}Ti(n,p), ^{54}Fe(n,p), ^{58}Ni(n,p)).

The latest NJOY results performed in 1984 indicate that in the unresolved resonance region NJOY is now using an improved method calculating fluctuation integrals (e.g. ^{235}U and ^{239}Pu fission) and a modified interpolation scheme. Where the parameters are given at closely spaced energies NJOY is interpolating cross sections (e.g. ^{237}Np-fission below 5 KeV) and where parameters are given at widely spaced energies NJOY is first interpolating parameters to a fine energy grid and then interpolate cross sections to a finer energy grid (e.g. ^{237}Np-fission 5 to 40 KeV). As pointed out earlier in this work the differences obtained in the unresolved resonance region by various codes are due to the uncertainty introduced by the change in ENDF/B conventions between ENDF/B-IV and V, rather than due to errors in the cross section processing codes. As such, as yet it is not possible to say which codes are generating the most consistent and physically reliable results. However, it should be mentioned that the unresolved resonance treatment as seen in the latest NJOY results corresponds to the method recently recommended by the Cross Section Evaluation Working Group (CSEWG).

Small cross sections (10^{-6} to 10^{-9} barns) are now interpolated using the ENDF/B interpolation law (e.g., ^{54}Fe(n,p), ^{56}Fe(n,p), ^{60}Ni(n,p), ^{63}Cu(n,alpha)) yielding results which agree with the benchmark results. For practical reasons, as explained earlier, NJOY will continue to treat very small cross sections as equal to zero.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=NJOY-81 (R.MACFARLANE,LANL)

ENDF/B TAPE LABELS

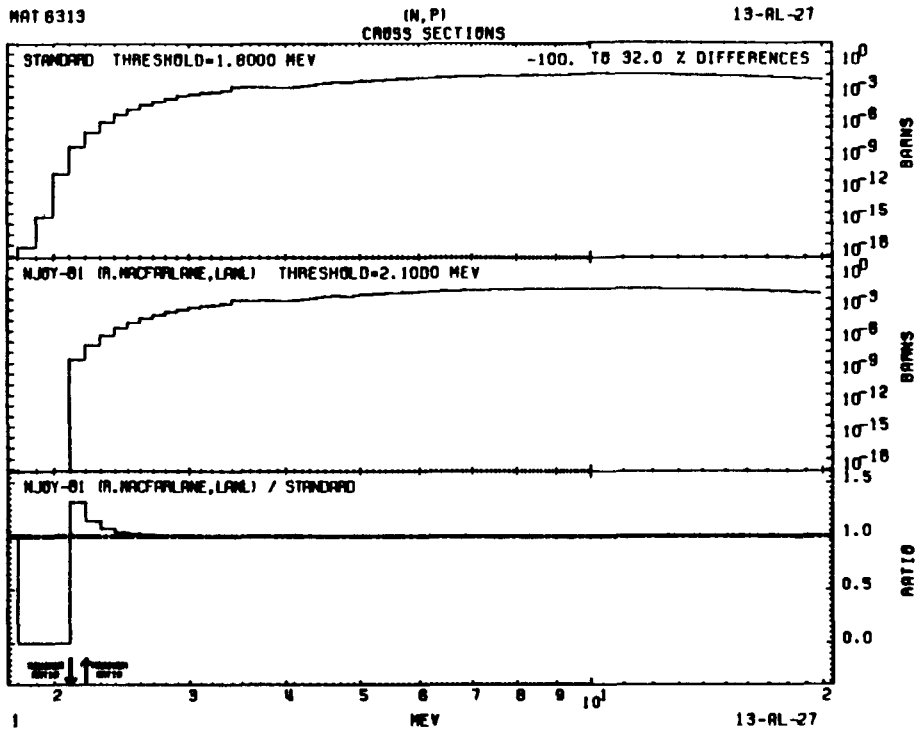
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2= ENDF/B-V DOSIMETRY LIBRARY FROM NJOY/CDC (MACFARLANE,LANL) 1

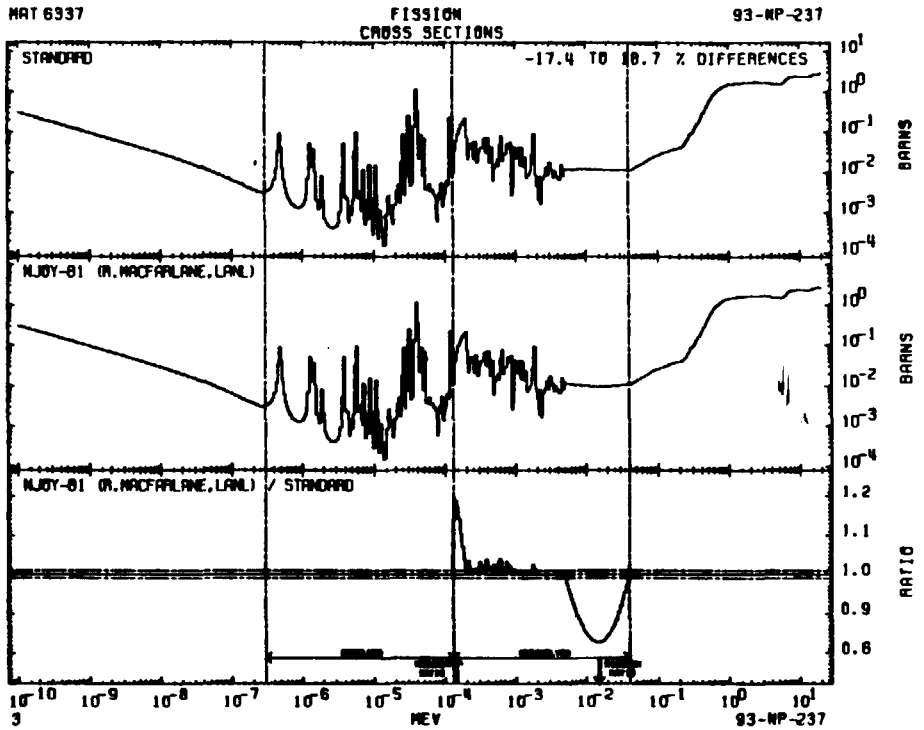
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE		MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2		DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1278	1.0000- 4	2.0000+ 7	-0.078		0.785							
13-AL- 27	103	6313	6313	365	357	1.8000+ 6	2.0000+ 7	-100.000	*	31.981	*	4.81401-11	0.0	+ 0		1.62941- 8	2.15051- 8
13-AL- 27	107	6313	6313	337	313	3.2000+ 6	2.0000+ 7	-100.000	*	5.786	*	4.72629-10	0.0	+ 0		2.90406- 9	3.07210- 9
25-MN- 55	16	6325	6325	193	191	1.0400+ 7	2.0000+ 7	-0.080		0.082							
27-CO- 59	16	6327	6327	189	187	1.0600+ 7	2.0000+ 7	-0.142		0.000							
27-CO- 59	102	6327	6327	1280	1278	1.0000- 4	2.0000+ 7	-0.149		0.204							
27-CO- 59	107	6327	6327	291	289	5.5000+ 6	2.0000+ 7	-0.000		0.042							
93-NP-237	18	6337	6337	1280	1278	1.0000- 4	2.0000+ 7	-17.376	*	18.738	*	1.15679- 2	9.55786- 3			3.29277- 2	3.90978- 2
79-AU-197	102	6379	6379	1280	1278	1.0000- 4	2.0000+ 7	-0.060		0.082							
90-TH-232	18	6390	6390	861	675	5.0000+ 0	2.0000+ 7	-0.166		0.070							
90-TH-232	102	6390	6390	1280	1278	1.0000- 4	2.0000+ 7	-0.436		0.070							
92-U -235	18	6395	6395	1280	1278	1.0000- 4	2.0000+ 7	-1.909	*	2.271	*	1.56412+ 1	1.53426+ 1			2.48513+ 1	2.54156+ 1
92-U -238	18	6398	6398	1280	1268	1.0000- 4	2.0000+ 7	-100.000	*	0.055		9.39702-10	0.0	+ 0			
92-U -238	102	6398	6398	1280	1278	1.0000- 4	2.0000+ 7	-0.105		1.294	*					3.68240- 1	3.73005- 1
94-PU-239	18	6399	6399	1280	1278	1.0000- 4	2.0000+ 7	-0.846		2.309	*					3.03207+ 0	3.10209+ 0
3-LI- 6	207	6424	6424	1280	1278	1.0000- 4	2.0000+ 7	-0.074		0.090							
5-B - 10	207	6425	6425	1280	1278	1.0000- 4	2.0000+ 7	-0.090		0.053							
21-SC- 45	102	6426	6426	1280	1278	1.0000- 4	2.0000+ 7	-0.094		0.245							
22-TI- 46	103	6427	6427	369	367	1.6000+ 6	2.0000+ 7	-0.677		0.001							
22-TI- 47	28	6428	6428	189	187	1.0600+ 7	2.0000+ 7	-40.750	*	0.223		9.37500- 6	5.55466- 6				
22-TI- 47	103	6428	6428	1280	387	1.0000- 4	2.0000+ 7	-100.000	*	0.001		8.87585-10	0.0	+ 0			
22-TI- 48	28	6429	6429	169	167	1.1600+ 7	2.0000+ 7	-10.903	*	0.221		2.23744- 6	1.99349- 6				
22-TI- 48	103	6429	6429	337	333	3.2000+ 6	2.0000+ 7	-100.000	*	0.001		3.44827-10	0.0	+ 0			
26-FE- 54	103	6430	6430	1280	521	1.0000- 4	2.0000+ 7	-100.000	*	100.748	*	9.97488-10	0.0	+ 0		2.90221- 7	5.82615- 7
26-FE- 56	103	6431	6431	343	341	2.9000+ 6	2.0000+ 7	-0.087		872.528	*					1.96579- 8	1.91179- 7
26-FE- 58	102	6432	6432	1280	1278	1.0000- 4	2.0000+ 7	-0.110		0.425							
28-NI- 58	16	6433	6433	153	151	1.2400+ 7	2.0000+ 7	-1.341	*	0.000		4.28500- 5	4.22752- 5				
28-NI- 58	103	6433	6433	1280	691	1.0000- 4	2.0000+ 7	-100.000	*	22.300	*	9.79989-10	0.0	+ 0		2.92430- 6	3.57642- 6
28-NI- 60	103	6434	6434	351	349	2.5000+ 6	2.0000+ 7	-0.081		472.913	*					4.04948- 7	2.32000- 6
29-CU- 63	102	6435	6435	1280	1278	1.0000- 4	2.0000+ 7	-0.105		0.053							
29-CU- 63	107	6435	6435	367	365	1.7000+ 6	2.0000+ 7	-0.077		8.939	*					4.63949- 7	5.05422- 7
29-CU- 65	16	6436	6436	201	199	1.0000+ 7	2.0000+ 7	-0.000		0.010							
49-IN-115	51	6437	6437	427	425	3.2000+ 5	2.0000+ 7	-0.062		2.512	*					1.33523- 4	1.36877- 4
49-IN-115	102	6437	6437	1280	1278	1.0000- 4	2.0000+ 7	-0.108		0.579							
53-I -127	16	6438	6438	217	215	9.2000+ 6	2.0000+ 7	-0.056		0.096							
16-S - 32	103	6439	*** NO COMPARISON ***														

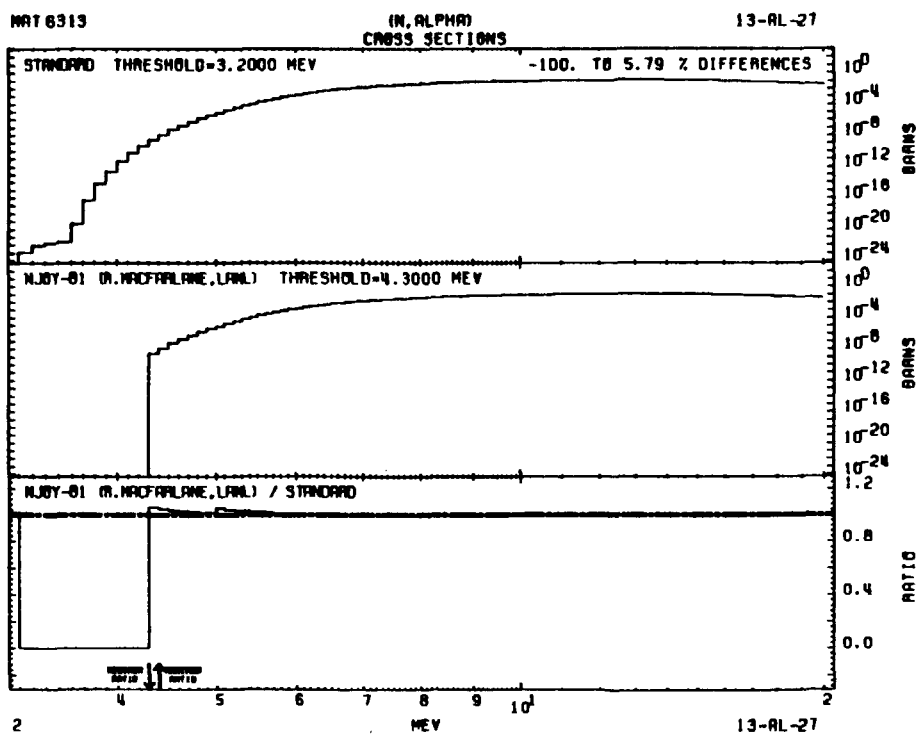
18 PLOTS GENERATED

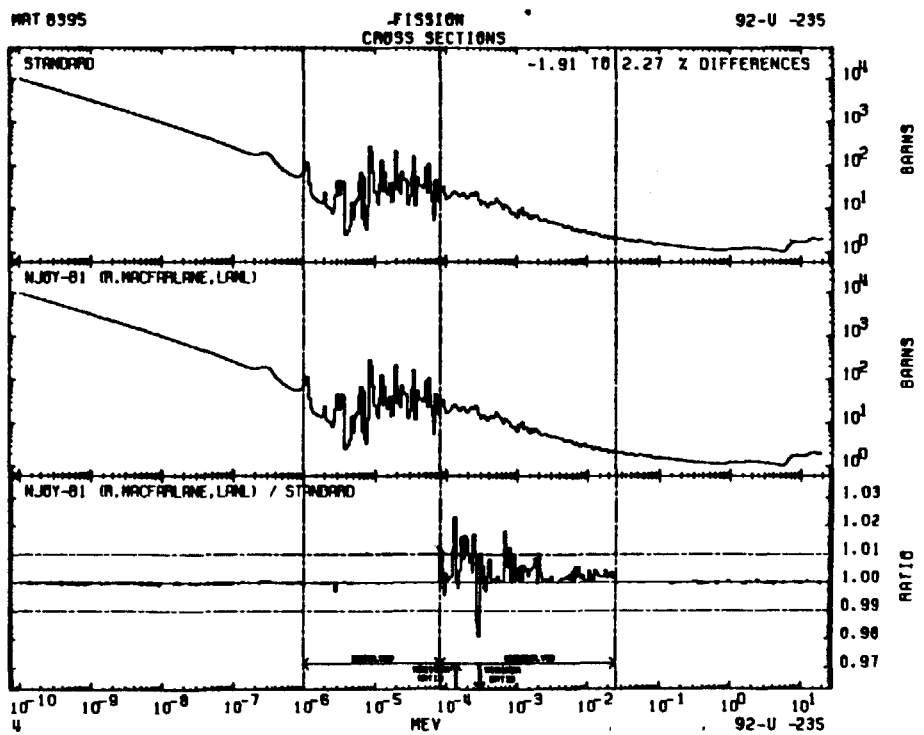
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

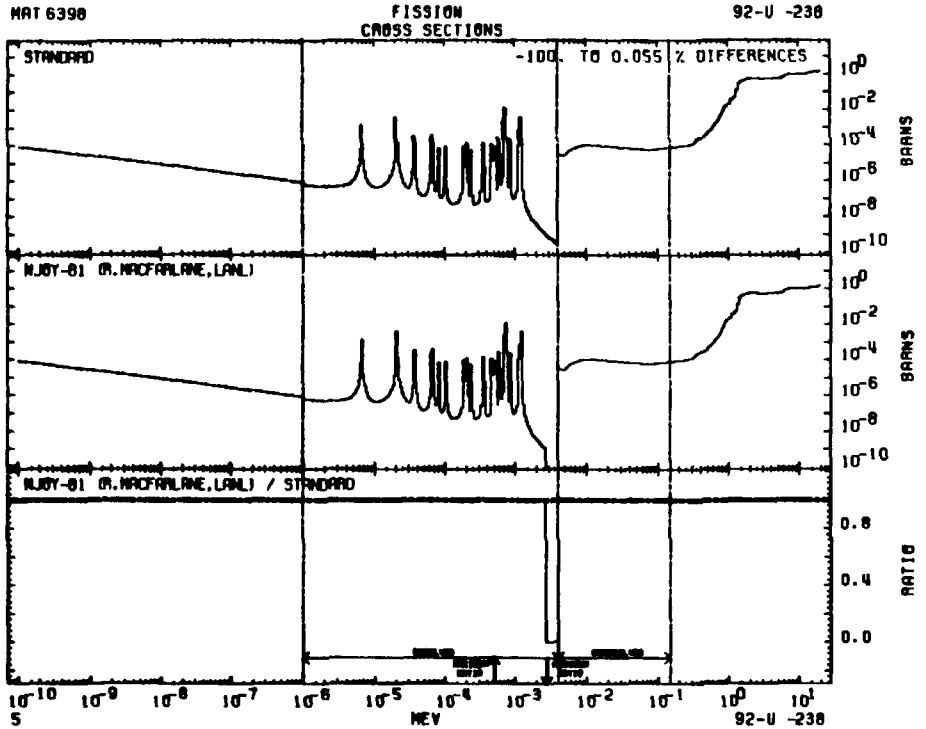
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

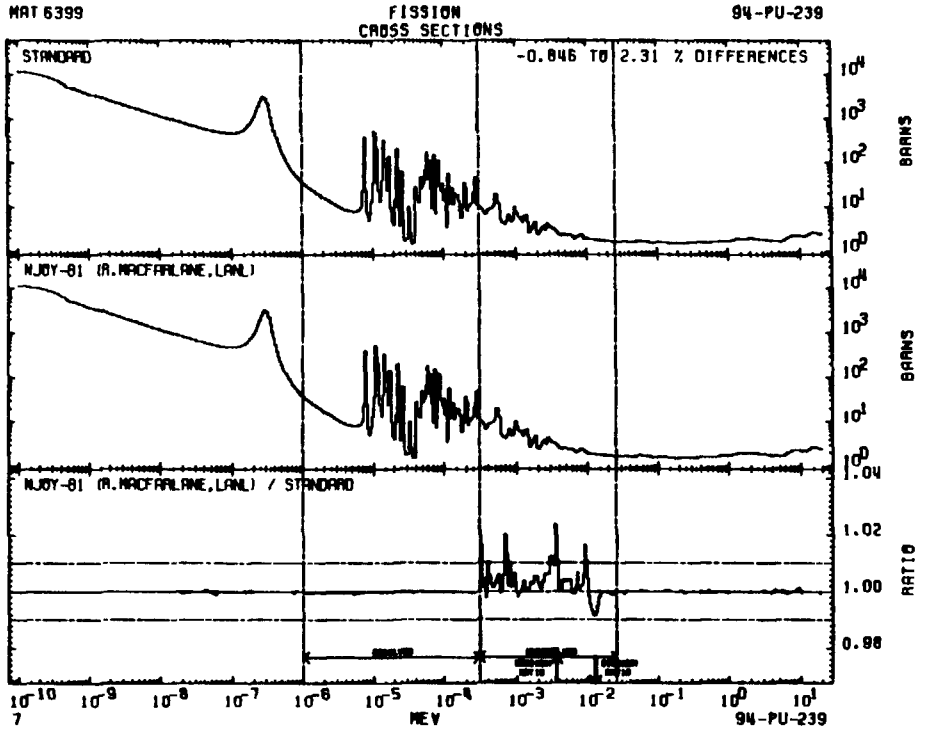

MAT 6313
(N,P)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=1.8000 MEV
-100. TO 32.0 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=2.1000 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
1
13-AL-27

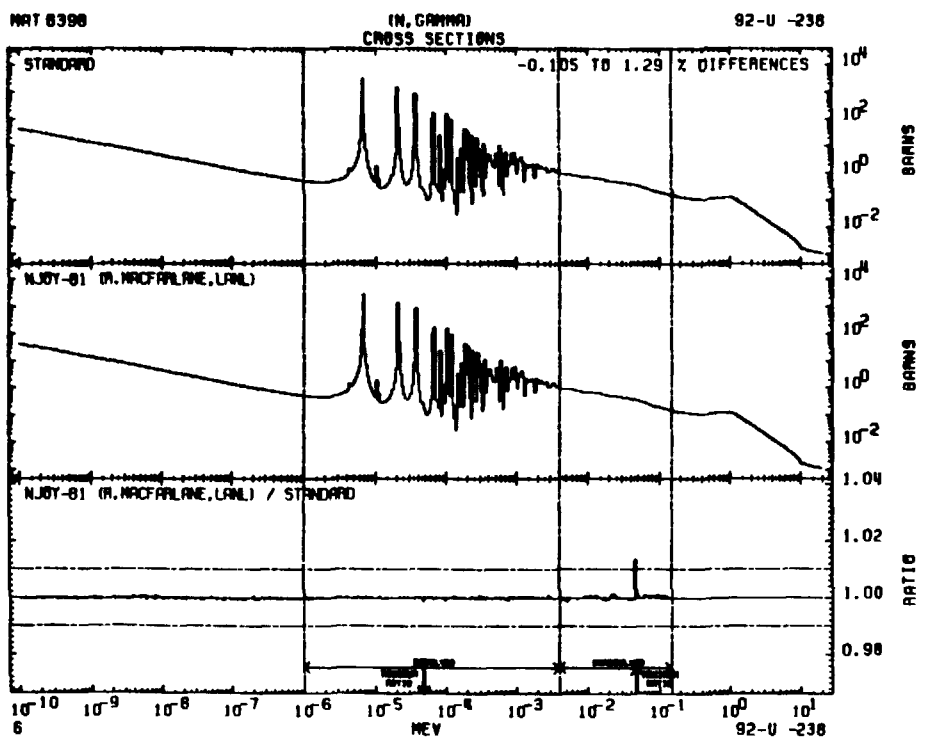

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-17.4 TO 18.7 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL)
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
3
93-NP-237

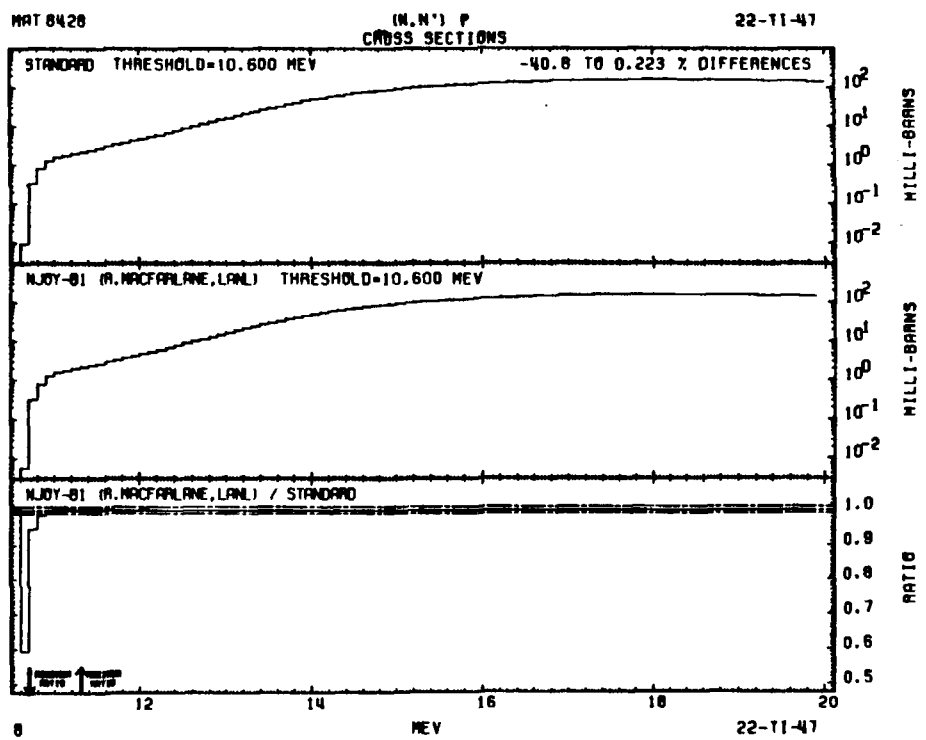

MAT 6313
(N,ALPHA)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=3.2000 MEV
-100. TO 5.79 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=4.3000 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
2
13-AL-27

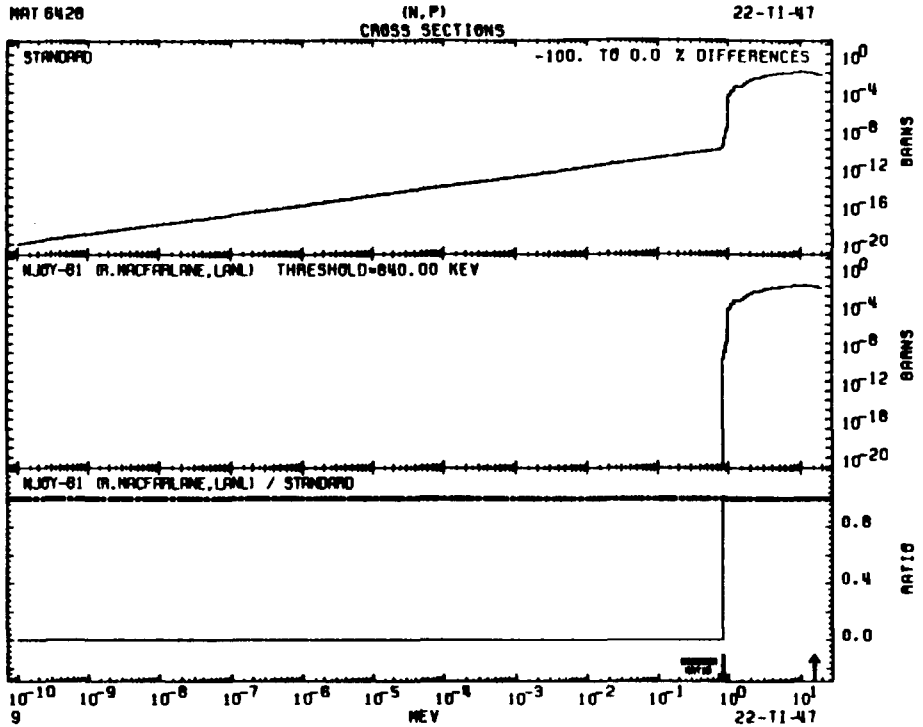

MAT 8395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-1.91 TO 2.27 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL)
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
4
92-U -235

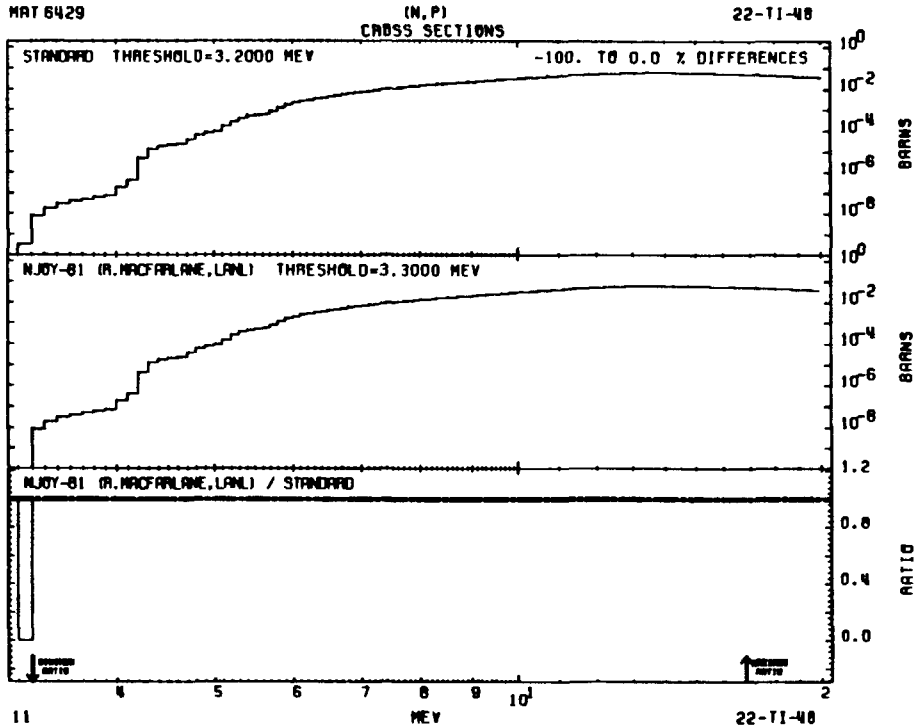

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-100. TO 0.055 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL)
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
5
92-U -238

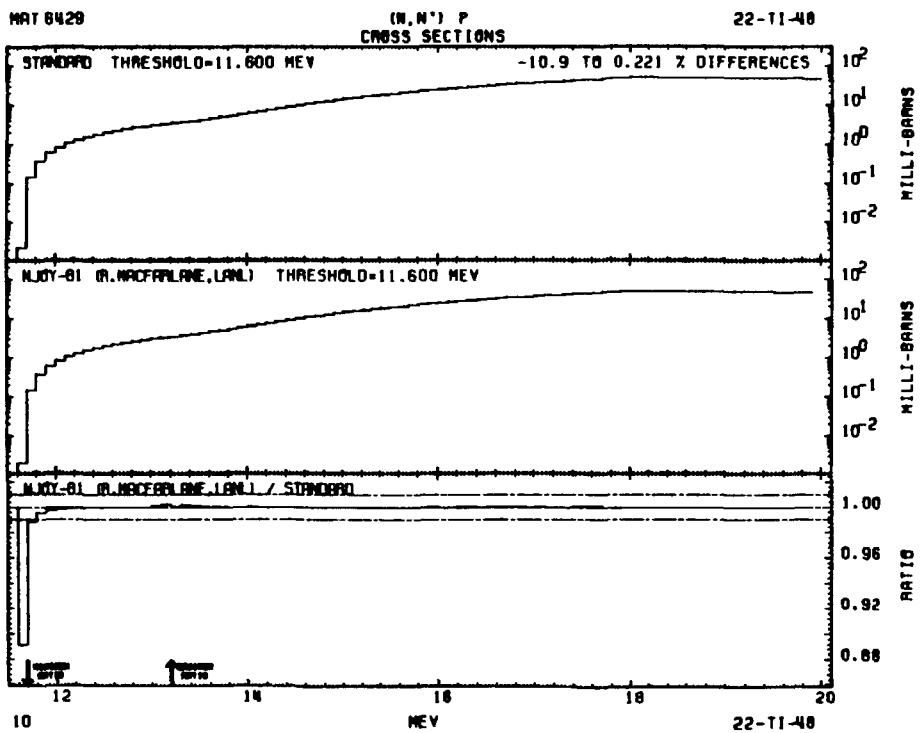

MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-0.846 TO 2.31 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL)
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
7
94-PU-239

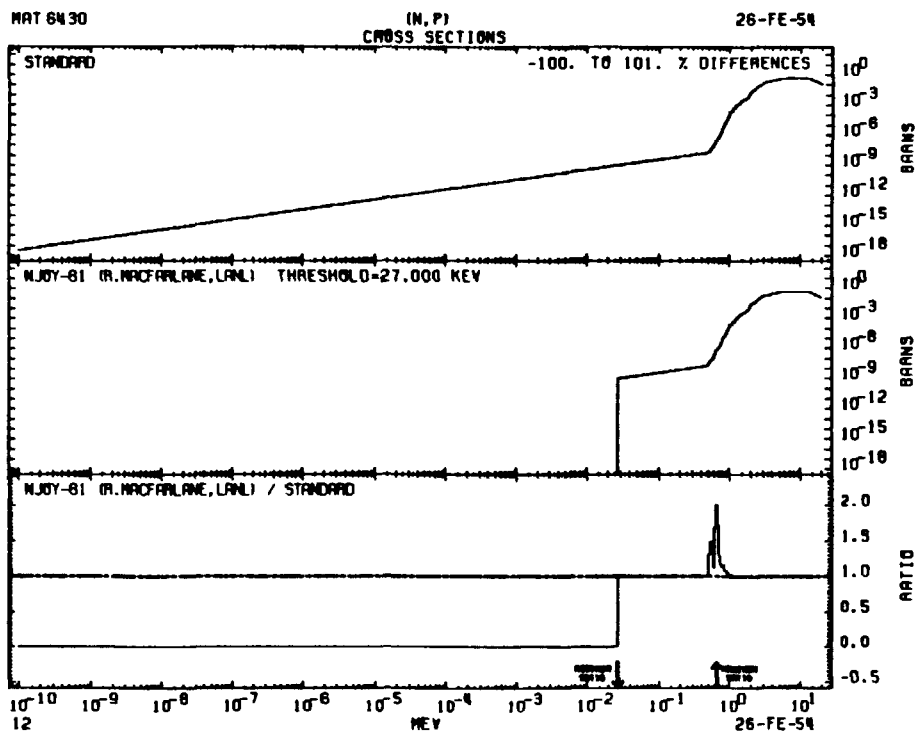

MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-0.105 TO 1.29 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL)
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
6
92-U -238


MAT 8428
(N,N') P
CROSS SECTIONS
22-TI-47
STANDARD THRESHOLD=10.600 MEV
-40.8 TO 0.223 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=10.600 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
MILLI-BARNS
RATIO
MEV
8
22-TI-47

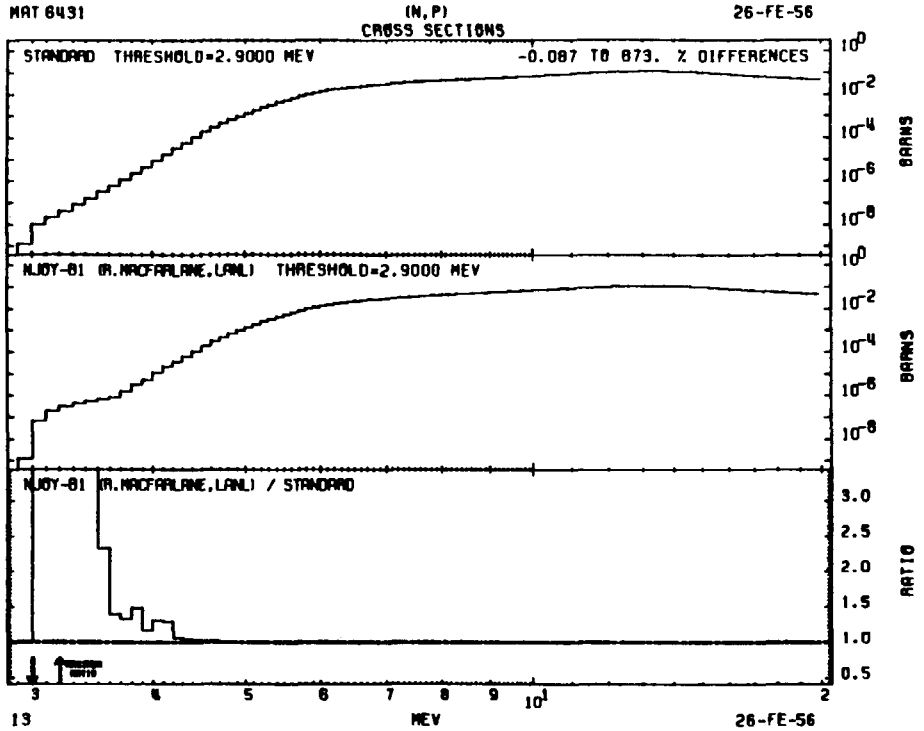

MAT 6426
(N,P)
CROSS SECTIONS
22-TI-47
STANDARD
-100. TO 0.0 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=840.00 KEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
9
22-TI-47

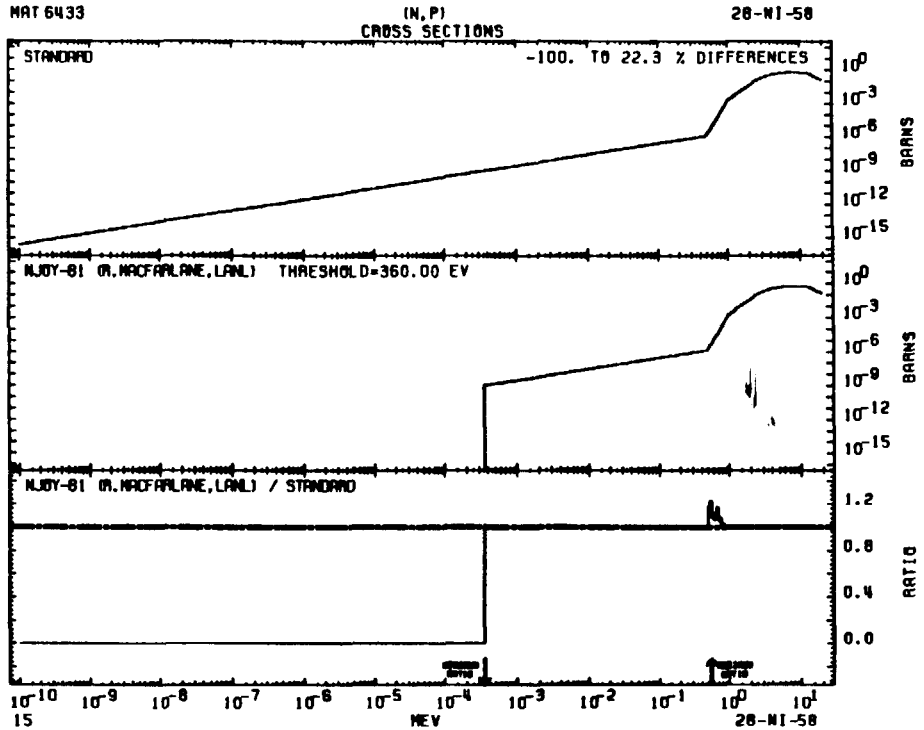

MAT 6429
(N,P)
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=3.2000 MEV
-100. TO 0.0 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=3.3000 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
11
22-TI-48

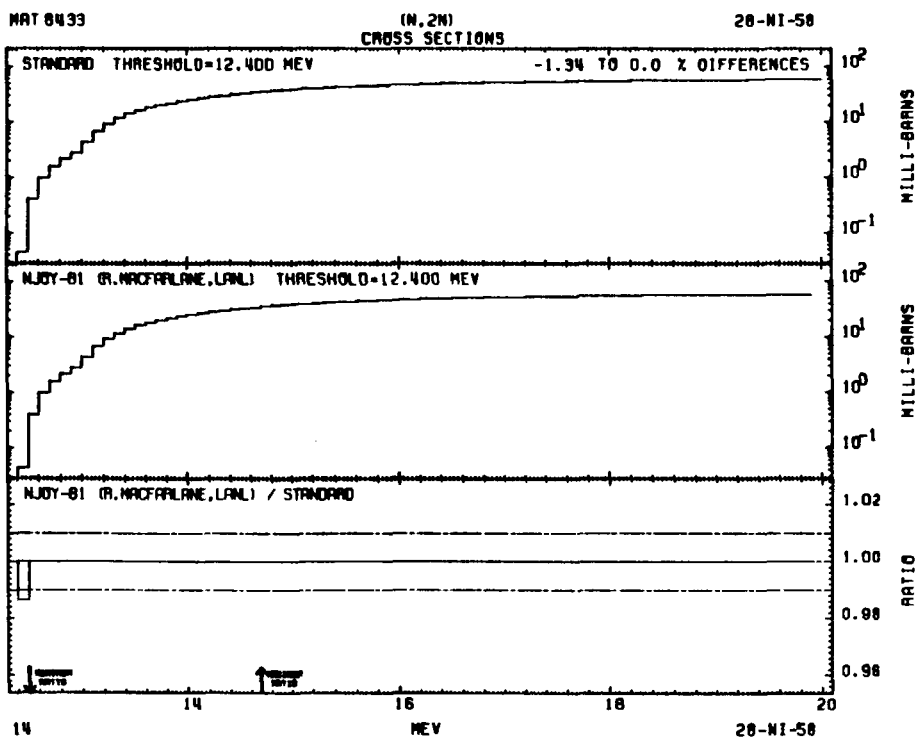

MAT 6429
(N,N') P
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=11.600 MEV
-10.9 TO 0.221 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=11.600 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
MILLI-BARNS
RATIO
MEV
10
22-TI-48

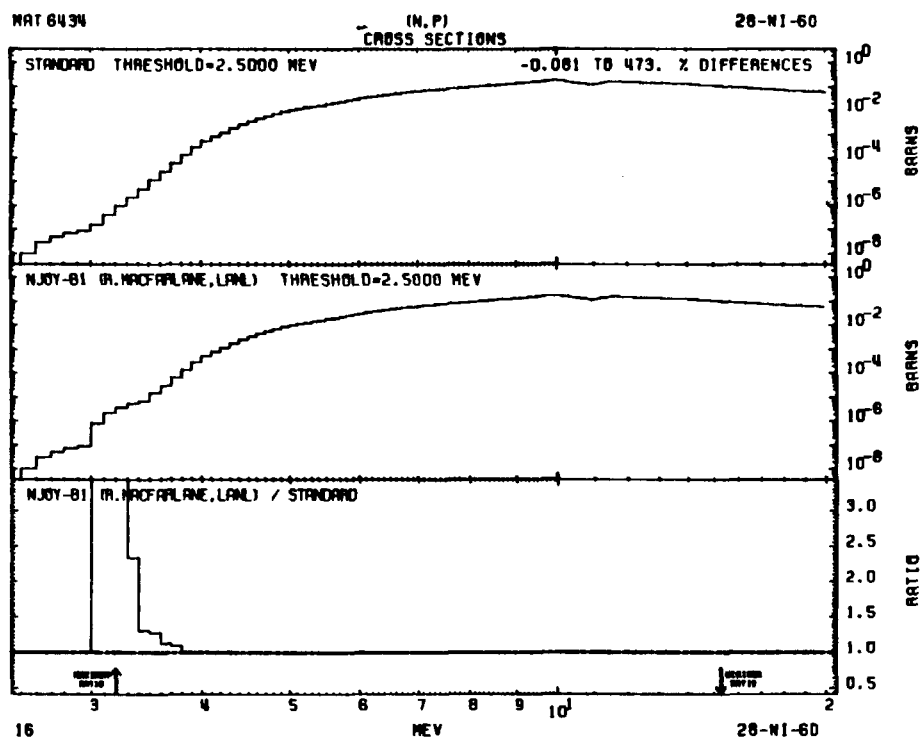

MAT 6430
(N,P)
CROSS SECTIONS
26-FE-54
STANDARD
-100. TO 101. % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=27.000 KEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
12
26-FE-54

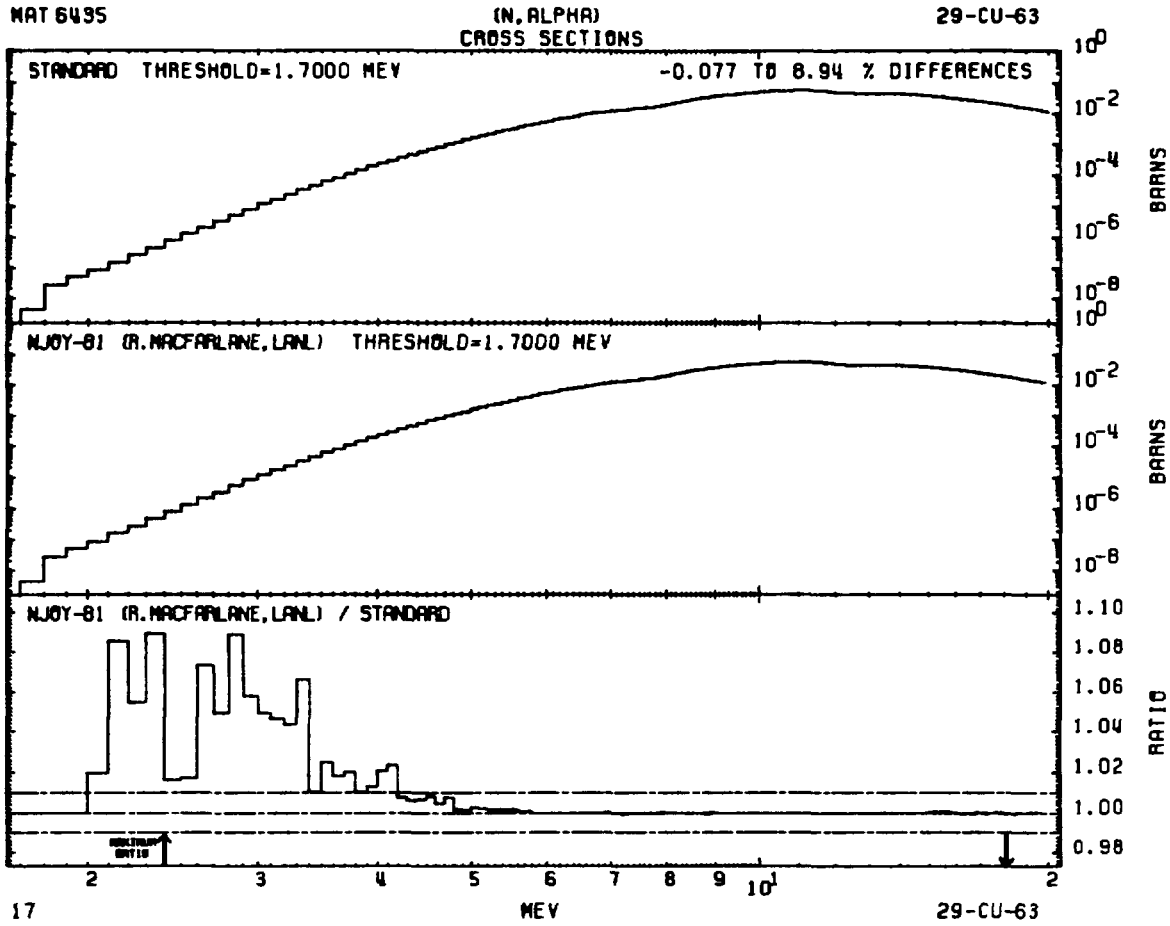
- 78 -

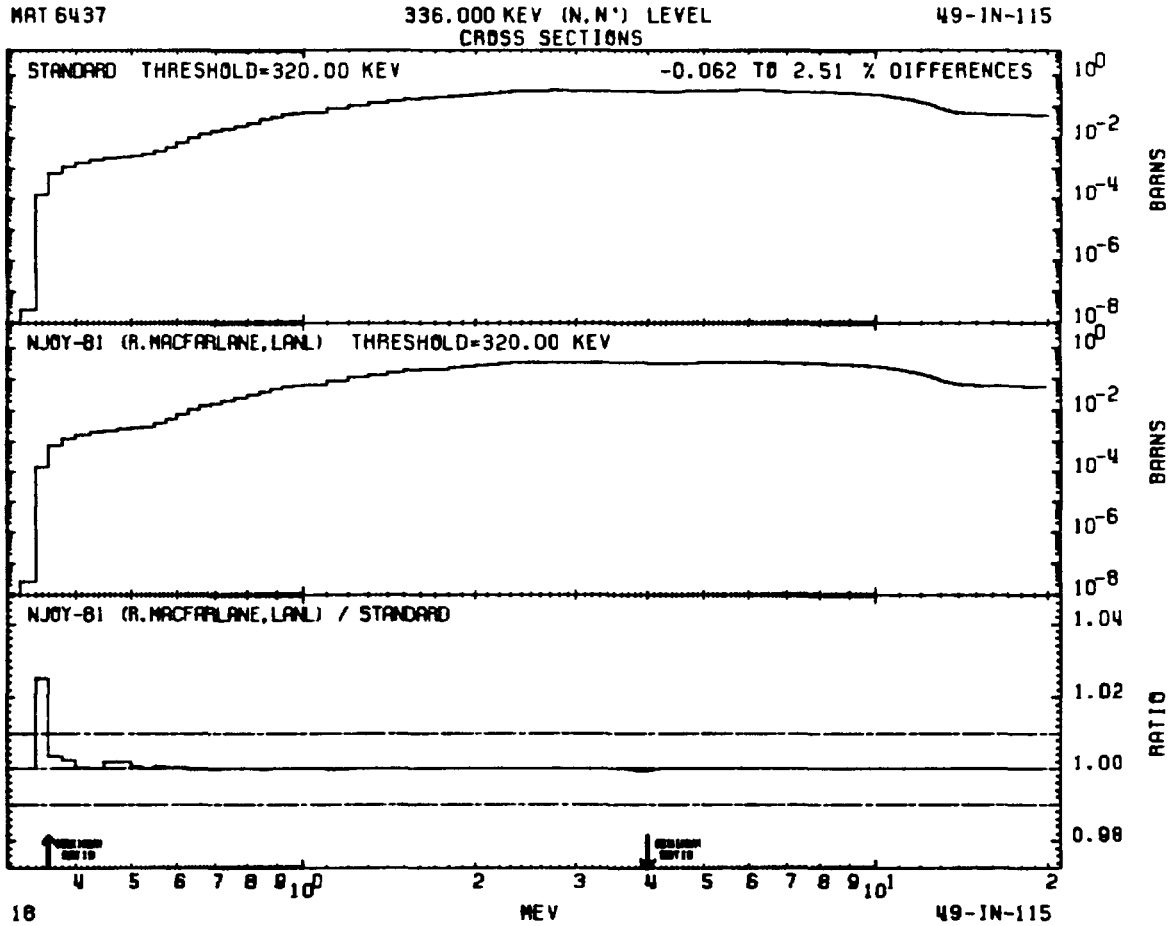

MAT 6431
(N,P)
CROSS SECTIONS
26-FE-56
STANDARD THRESHOLD=2.9000 MEV
-0.087 TO 873. % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=2.9000 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
13
26-FE-56


MAT 6433
(N,P)
CROSS SECTIONS
28-NI-58
STANDARD
-100. TO 22.3 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=360.00 EV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
15
28-NI-58


MAT 6433
(N,2N)
CROSS SECTIONS
28-NI-58
STANDARD THRESHOLD=12.400 MEV
-1.34 TO 0.0 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=12.400 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
MILLI-BARNS
RATIO
MEV
14
28-NI-58


MAT 6434
(N,P)
CROSS SECTIONS
28-NI-60
STANDARD THRESHOLD=2.5000 MEV
-0.081 TO 473. % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=2.5000 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
16
28-NI-60


MAT 6435
(N,ALPHA)
CROSS SECTIONS
29-CU-63
STANDARD THRESHOLD=1.7000 MEV
-0.077 TO 8.94 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=1.7000 MEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
17
29-CU-63


MAT 6437
336.000 KEV (N,N') LEVEL
CROSS SECTIONS
49-IN-115
STANDARD THRESHOLD=320.00 KEV
-0.062 TO 2.51 % DIFFERENCES
NJOY-81 (R.MACFARLANE,LANL) THRESHOLD=320.00 KEV
NJOY-81 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
18
49-IN-115

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=NJOY-84 (R.MACFARLANE,LANL)

ENDF/B TAPE LABELS

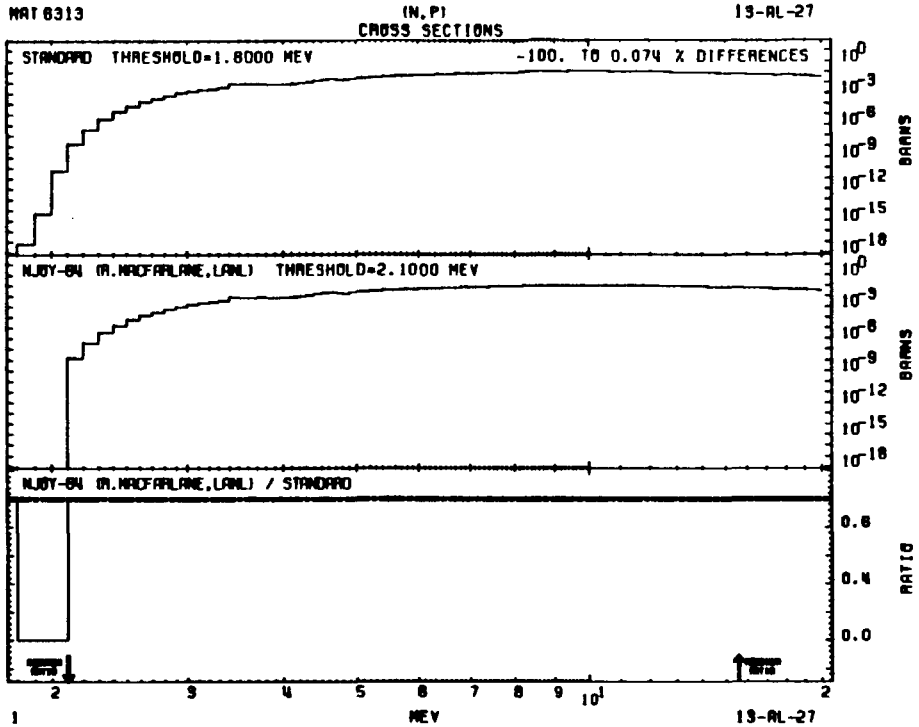
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2= ENDF/B-V, MOD. 1 DOSIMETRY - NJOY 640 GROUPS (MACFARLANE,LANL) 1

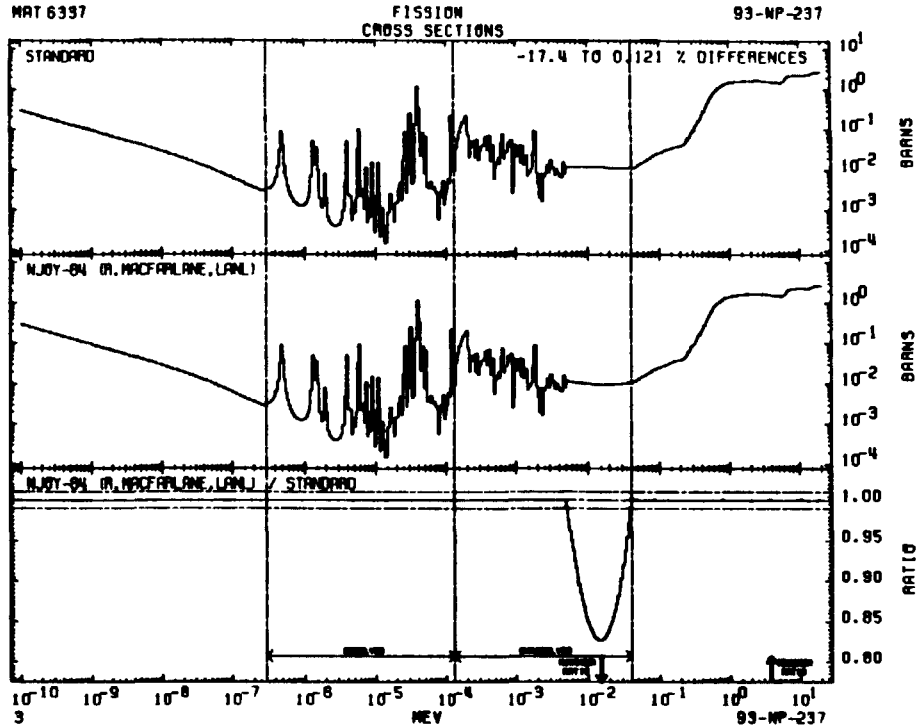
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE		MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1280	1.0000- 4	2.0000+ 7	-0.146		0.094				
13-AL- 27	103	6313	6313	365	359	1.8000+ 6	2.0000+ 7	-100.000	*	0.074	4.81401-11	0.0	+ 0	
13-AL- 27	107	6313	6313	337	315	3.2000+ 6	2.0000+ 7	-100.000	*	0.006	4.72629-10	0.0	+ 0	
25-MN- 55	16	6325	6325	193	193	1.0400+ 7	2.0000+ 7	-0.080		0.082				
27-CO- 59	16	6327	6327	189	189	1.0600+ 7	2.0000+ 7	-0.153		0.000				
27-CO- 59	102	6327	6327	1280	1280	1.0000- 4	2.0000+ 7	-0.240		0.076				
27-CO- 59	107	6327	6327	291	291	5.5000+ 6	2.0000+ 7	-0.000		0.042				
93-NP-237	18	6337	6337	1280	1280	1.0000- 4	2.0000+ 7	-17.376	*	0.121	1.15679- 2	9.55786- 3		
79-AU-197	102	6379	6379	1280	1280	1.0000- 4	2.0000+ 7	-0.064		0.080				
90-TH-232	18	6390	6390	861	677	5.0000+ 0	2.0000+ 7	-0.176		0.060				
90-TH-232	102	6390	6390	1280	1280	1.0000- 4	2.0000+ 7	-0.153		0.059				
92-U -235	18	6395	6395	1280	1280	1.0000- 4	2.0000+ 7	-0.322		0.082				
92-U -238	18	6398	6398	1280	1270	1.0000- 4	2.0000+ 7	-100.000	*	0.049	9.39702-10	0.0	+ 0	
92-U -238	102	6398	6398	1280	1280	1.0000- 4	2.0000+ 7	-0.124		0.073				
94-PU-239	18	6399	6399	1280	1280	1.0000- 4	2.0000+ 7	-0.098		0.124				
3-LI- 6	207	6424	6424	1280	1280	1.0000- 4	2.0000+ 7	-0.074		0.090				
5-B - 10	207	6425	6425	1280	1280	1.0000- 4	2.0000+ 7	-0.090		0.053				
21-SC- 45	102	6426	6426	1280	1280	1.0000- 4	2.0000+ 7	-0.094		0.084				
22-TI- 46	103	6427	6427	369	369	1.6000+ 6	2.0000+ 7	-0.679		0.001				
22-TI- 47	28	6428	6428	189	189	1.0600+ 7	2.0000+ 7	-40.757	*	0.026	9.37500- 6	5.55408- 6		
22-TI- 47	103	6428	6428	1280	389	1.0000- 4	2.0000+ 7	-100.000	*	0.001	8.87585-10	0.0	+ 0	
22-TI- 48	28	6429	6429	169	169	1.1600+ 7	2.0000+ 7	-10.914	*	0.084	2.23744- 6	1.99325- 6		
22-TI- 48	103	6429	6429	337	335	3.2000+ 6	2.0000+ 7	-100.000	*	0.001	3.44827-10	0.0	+ 0	
26-FE- 54	103	6430	6430	1280	523	1.0000- 4	2.0000+ 7	-100.000	*	0.085	9.97488-10	0.0	+ 0	
26-FE- 56	103	6431	6431	343	343	2.9000+ 6	2.0000+ 7	-0.090		0.007				
26-FE- 58	102	6432	6432	1280	1280	1.0000- 4	2.0000+ 7	-0.110		0.092				
28-NI- 58	16	6433	6433	153	153	1.2400+ 7	2.0000+ 7	-1.354	*	0.000	4.28500- 5	4.22700- 5		
28-NI- 58	103	6433	6433	1280	693	1.0000- 4	2.0000+ 7	-100.000	*	0.078	9.79989-10	0.0	+ 0	
28-NI- 60	103	6434	6434	351	351	2.5000+ 6	2.0000+ 7	-0.081		0.048				
29-CU- 63	102	6435	6435	1280	1280	1.0000- 4	2.0000+ 7	-0.105		0.051				
29-CU- 63	107	6435	6435	367	367	1.7000+ 6	2.0000+ 7	-0.077		0.086				
29-CU- 65	16	6436	6436	201	201	1.0000+ 7	2.0000+ 7	-0.000		0.000				
49-IN-115	51	6437	6437	427	427	3.2000+ 5	2.0000+ 7	-0.062		0.025				
49-IN-115	102	6437	6437	1280	1280	1.0000- 4	2.0000+ 7	-0.112		0.113				
53-I -127	16	6438	6438	217	217	9.2000+ 6	2.0000+ 7	-0.056		0.096				
16-S - 32	103	6439	6439	385	385	9.2000+ 5	2.0000+ 7	0.0		0.001				

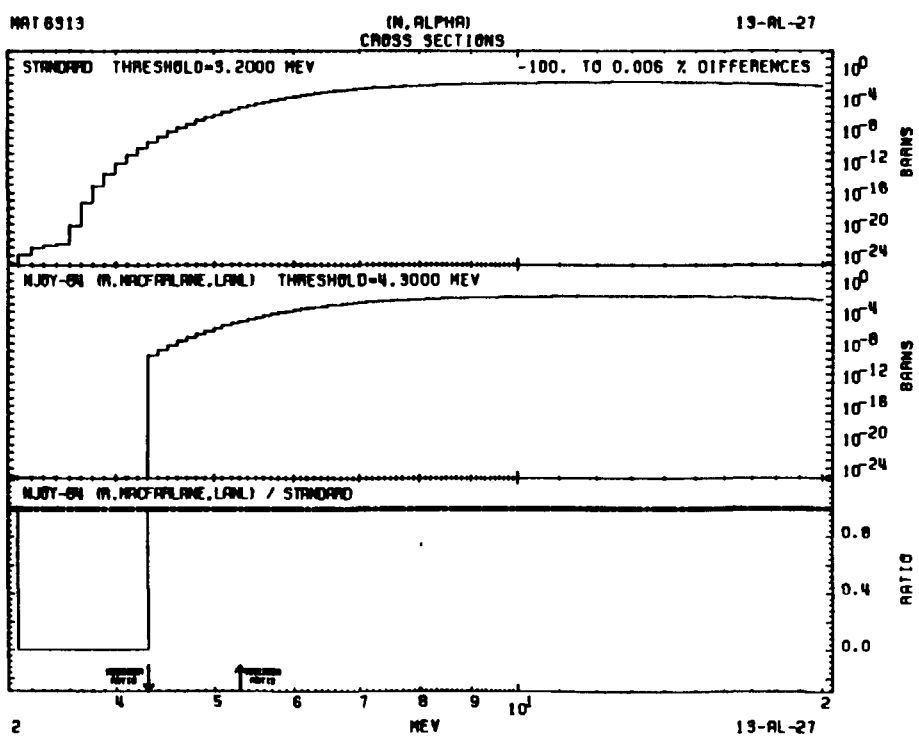
11 PLOTS GENERATED

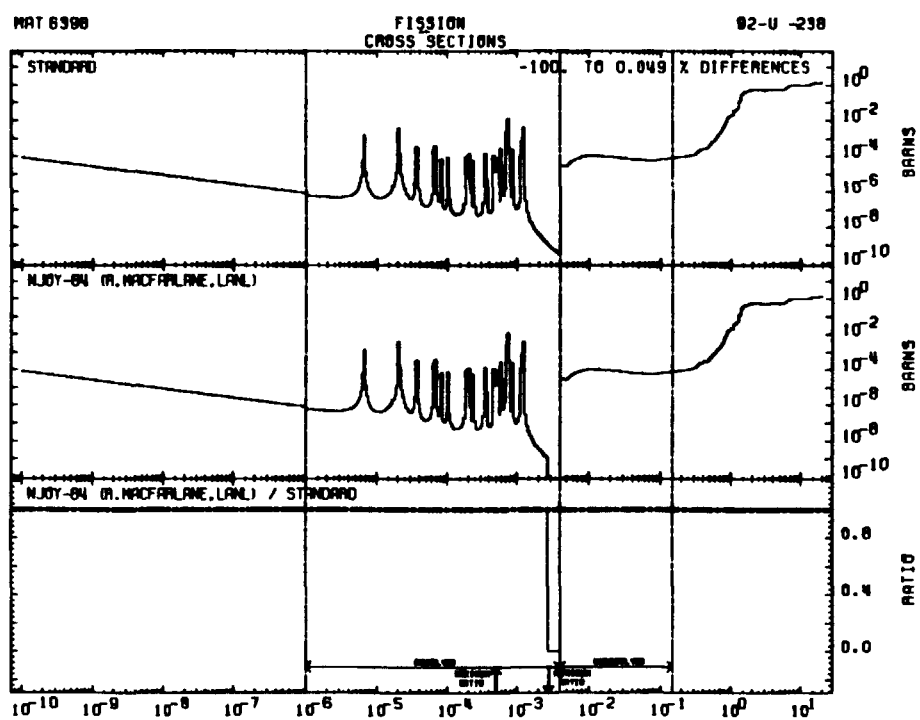
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

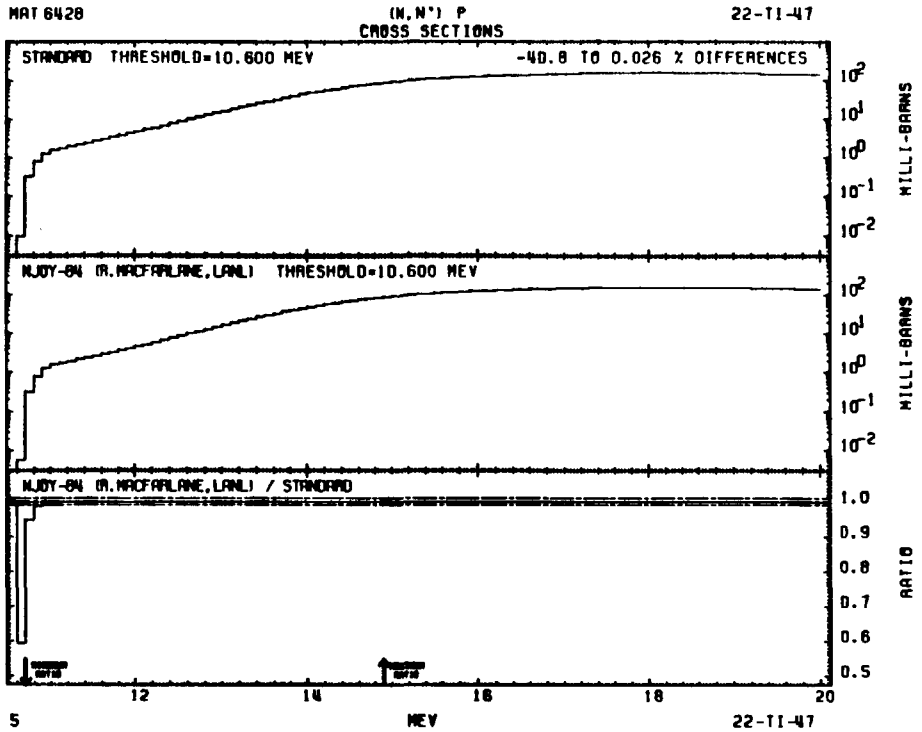
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

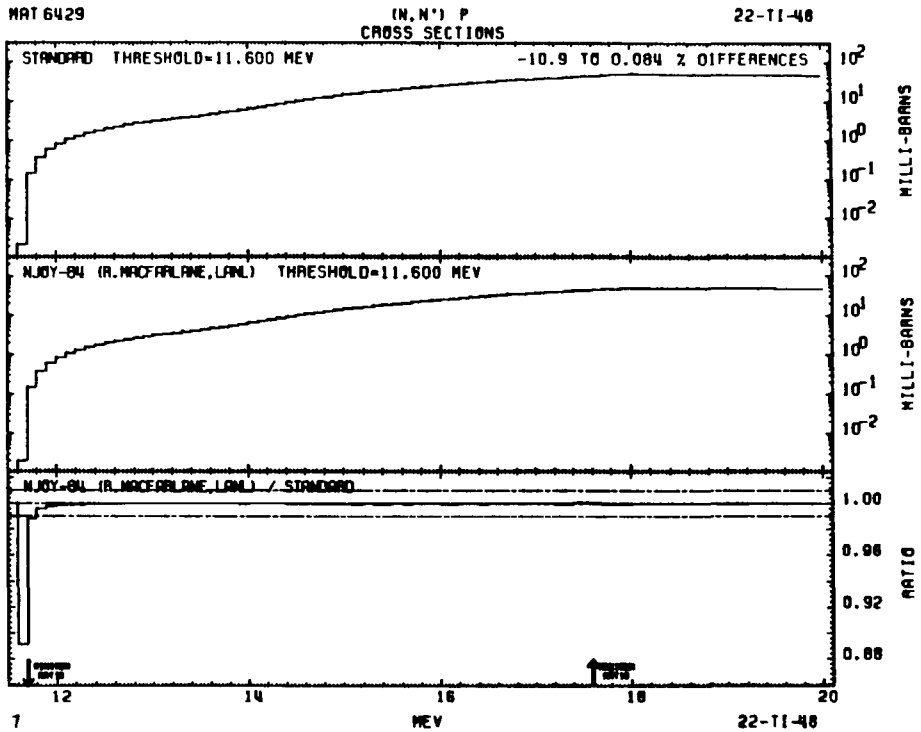

MAT 6313
(N,P)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=1.8000 MEV
-100. TO 0.074 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=2.1000 MEV
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
1
13-AL-27

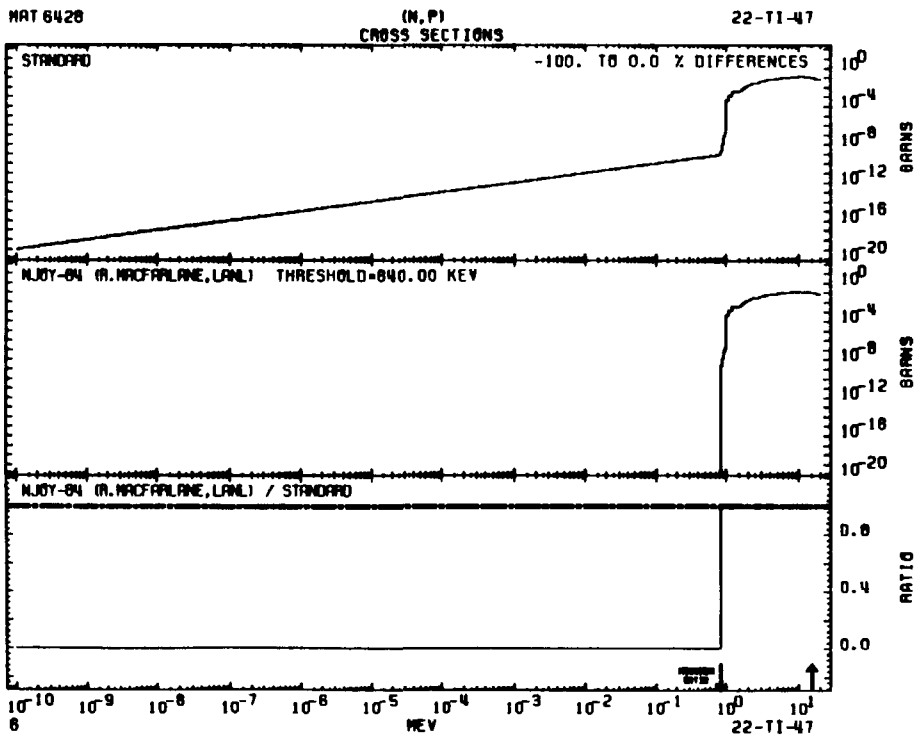

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-17.4 TO 0.121 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL)
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
3
93-NP-237

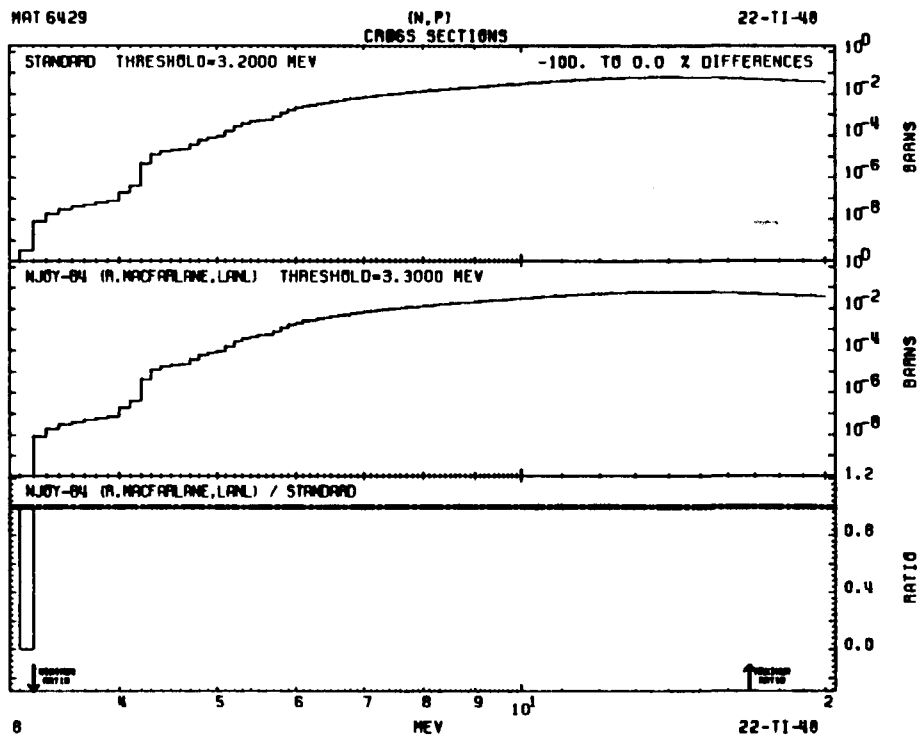

MAT 6313
(N,ALPHA)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=3.2000 MEV
-100. TO 0.006 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=4.3000 MEV
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
2
13-AL-27

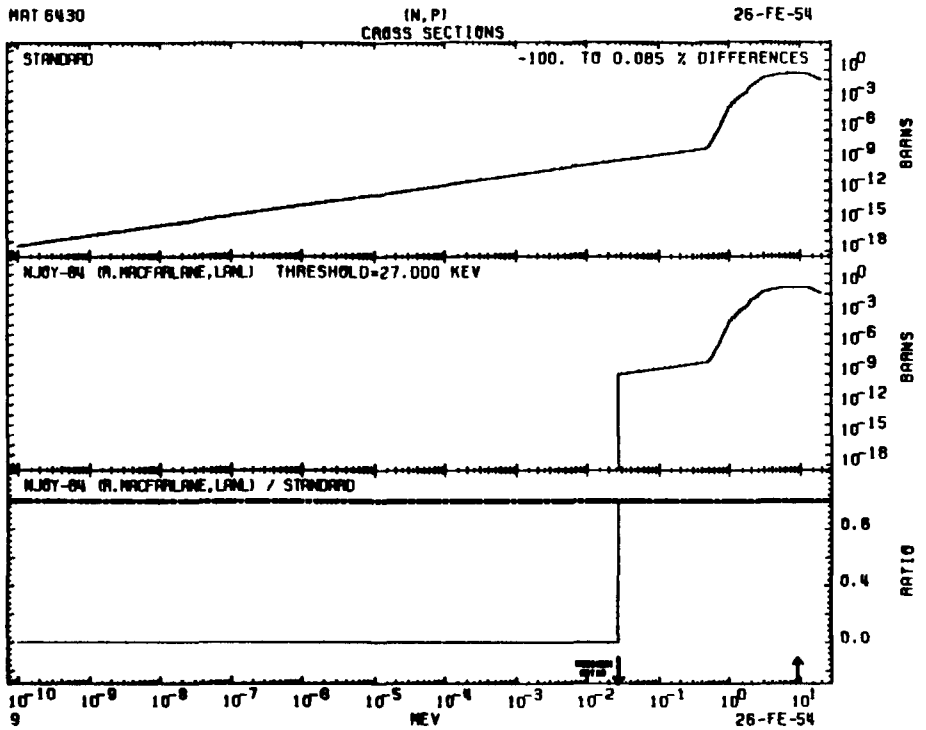

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-100. TO 0.049 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL)
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
4
92-U -238

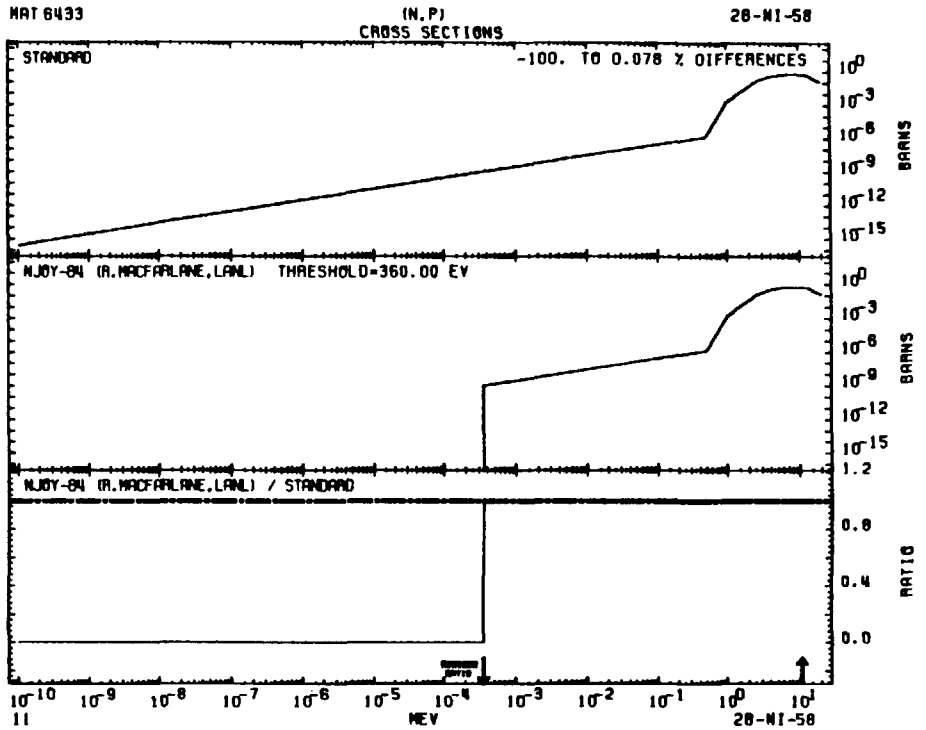

MAT 6428
(N,N') P
CROSS SECTIONS
22-TI-47
STANDARD THRESHOLD=10.600 MEV
-40.8 TO 0.026 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=10.600 MEV
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
MILLI-BARNS
RATIO
MEV
5
22-TI-47

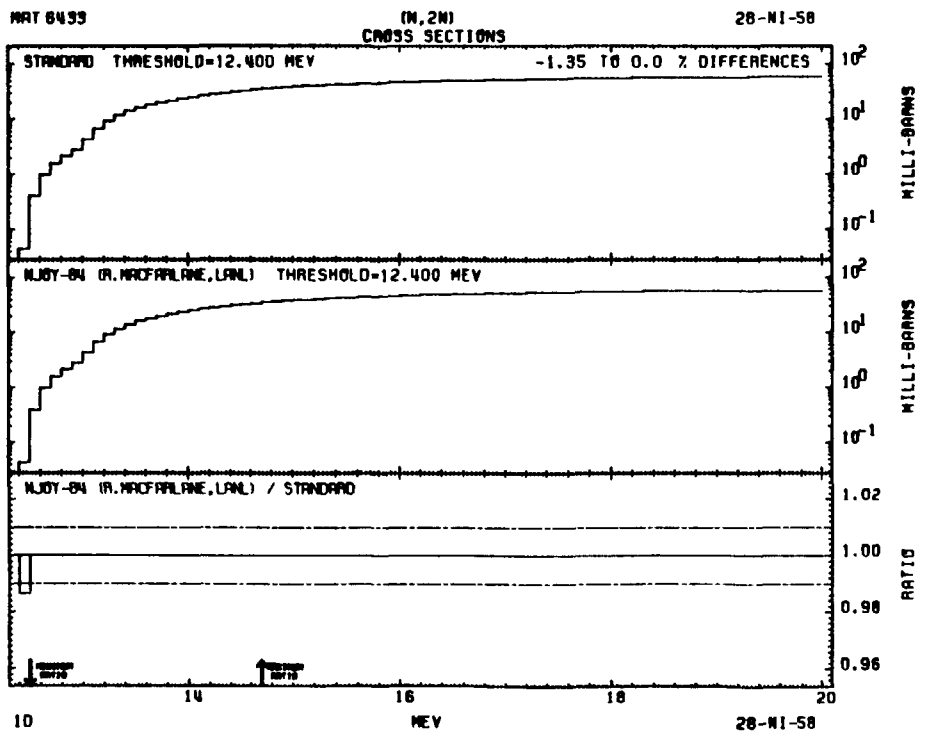

MAT 6429
(N,N') P
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=11.600 MEV
-10.9 TO 0.084 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=11.600 MEV
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
MILLI-BARNS
RATIO
MEV
7
22-TI-48


MAT 6428
(N,P)
CROSS SECTIONS
22-TI-47
STANDARD
-100. TO 0.0 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=840.00 KEV
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
6
22-TI-47


MAT 6429
(N,P)
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=3.2000 MEV
-100. TO 0.0 % DIFFERENCES
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=3.3000 MEV
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
BARNS
RATIO
MEV
8
22-TI-48


MAT 6430
(N,P)
CROSS SECTIONS
26-FE-54
STANDARD
-100. TO 0.085 % DIFFERENCES
BARNS
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=27.000 KEV
BARNS
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
RATIO
MEV
9
26-FE-54


MAT 6433
(N,P)
CROSS SECTIONS
28-NI-58
STANDARD
-100. TO 0.078 % DIFFERENCES
BARNS
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=360.00 EV
BARNS
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
RATIO
MEV
11
28-NI-58


MAT 6433
(N,2N)
CROSS SECTIONS
28-NI-58
STANDARD THRESHOLD=12.400 MEV
-1.35 TO 0.0 % DIFFERENCES
MILLI-BARNS
NJOY-84 (R.MACFARLANE,LANL) THRESHOLD=12.400 MEV
MILLI-BARNS
NJOY-84 (R.MACFARLANE,LANL) / STANDARD
RATIO
MEV
10
28-NI-58

NJOY/IBM

In this report results have been presented for only one version of each code, because it was felt that only by working with the code author would it be possible to not only identify problem areas in codes, but to actually improve each code. Because NJOY, which was written for use on a CDC-7600 computer (a long word length computer), is widely used on a number of different computers it was decided to include results obtained from NJOY as implemented on an IBM computer (a short word length computer). For this purpose the version of NJOY implemented at the NEA/Data Bank on an IBM computer was used.

The objective of the NJOY/IBM comparisons was somewhat different than our other comparisons. In the other comparisons we attempted to identify problems in each code and to have the code designer correct the code in order to obtain agreement with our benchmark results. Since NJOY was already participating in this study it was decided to use the NJOY/IBM results to identify computer dependent problems in NJOY, particularly those due to numerical instability and round-off on the shorter word length IBM computer. E. Sartori, NEA Data Bank, would then use the NJOY/IBM results to identify and eliminate computer dependent problems in an attempt to reproduce the initial NJOY results (rather than our benchmark results). Using this approach it was hoped that the improvements being implemented by NJOY's author could be combined with the improvements implemented by E. Sartori to obtain an improved version of NJOY which could be used on a variety of computers.

When compared to the initial NJOY results the NJOY/IBM results showed a numerical instability close to resonance region boundaries (e.g. ^{237}Np-fission, ^{232}Th-fission and capture, ^{238}U-fission and capture, ^{239}Pu-fission and ^{63}Cu-capture). Unlike the numerical instability found in other codes, where the effect was isolated to a single group, this instability extended over a number of groups.

E. Sartori, NEA/Data Bank, was available to sucessfully modify NJOY/IBM to eliminate the numerical instability problem and to reproduce the initial NJOY (CDC) results. In addition E. Sartori lowered the minimum cut-off cross sectons used by NJOY, which eliminated or reduced the differences found for low cross sections near thresholds.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=NJOY/IBM-82 (E.SARTORI,NEA/DB)

ENDF/B TAPE LABELS

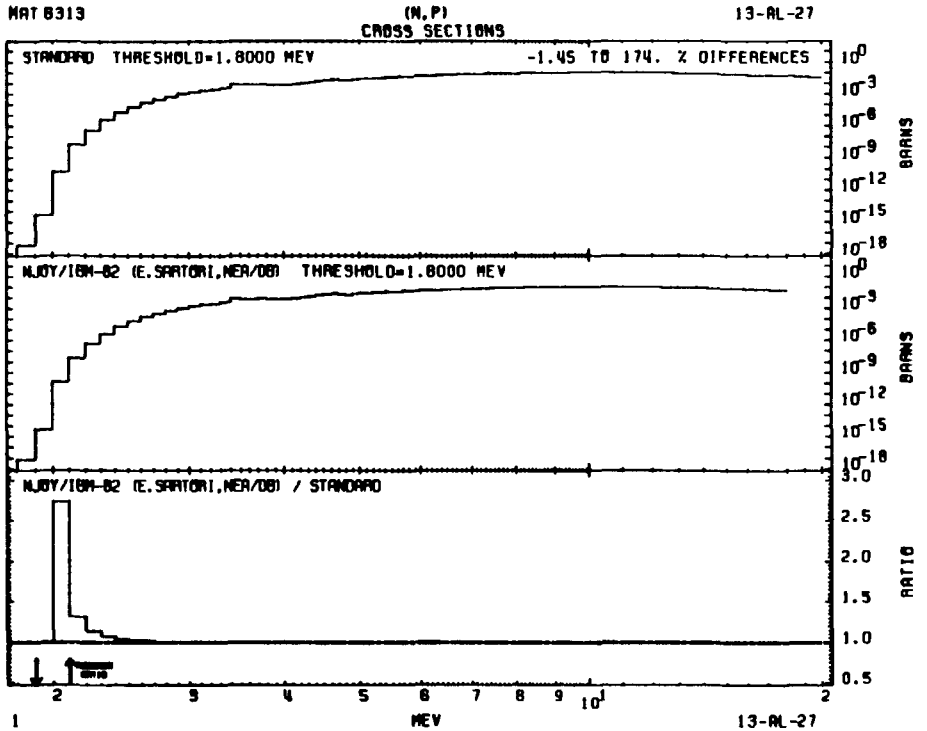
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2=NJOY/IBM...ENDF/B-V DOSIMETRY LIBRARY (E.SARTORI,NEA/DB,1982) 9000

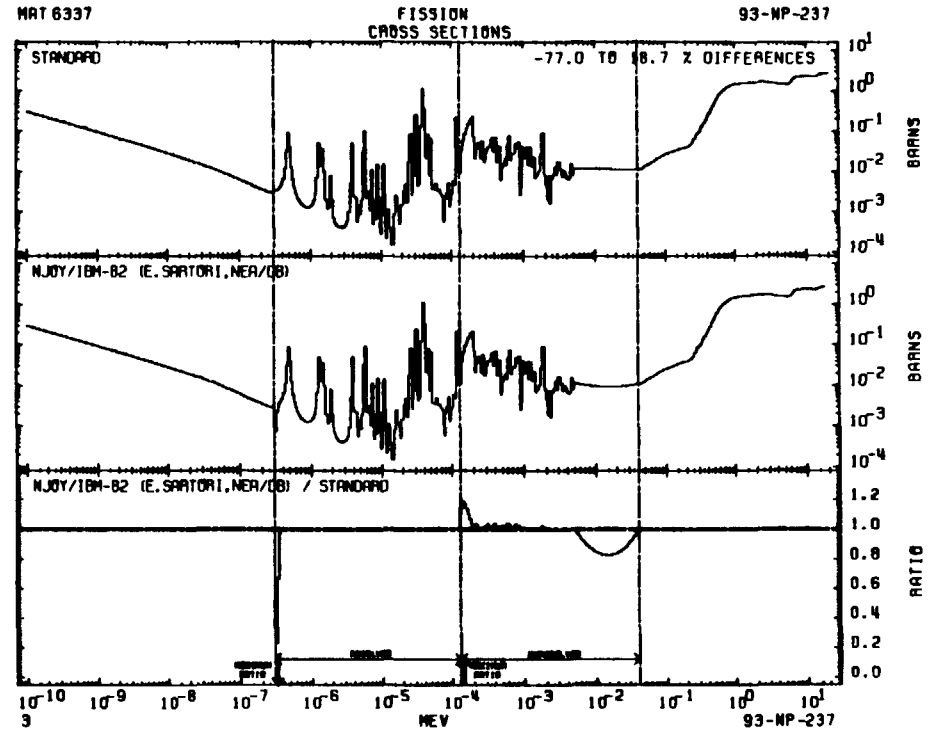
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-0.079	0.992					
13-AL- 27	103	6313	6313	365	325	1.8000+ 6	2.0000+ 7	-1.454	* 173.884	*	6.65345-18	6.55669-18	4.81401-11	1.31848-10
13-AL- 27	107	6313	6313	337	297	3.2000+ 6	2.0000+ 7	-0.034	247.102	*			4.83039-17	1.67664-16
25-MN- 55	16	6325	6325	193	153	1.0400+ 7	2.0000+ 7	-0.073	0.082					
27-CO- 59	16	6327	6327	189	149	1.0600+ 7	2.0000+ 7	-0.150	0.007					
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-0.135	0.181					
27-CO- 59	107	6327	6327	291	251	5.5000+ 6	2.0000+ 7	-0.001	0.042					
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-77.036	* 18.737	*	3.31167- 3	7.60508- 4	3.29277- 2	3.90974- 2
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-0.057	0.079					
90-TH-232	18	6390	6390	861	821	5.0000+ 0	2.0000+ 7	-81.010	* 0.571		6.56278- 7	1.24626- 7		
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-27.977	* 0.465		3.02312- 1	2.17733- 1		
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-39.375	* 2.269	*	7.41516+ 1	4.49544+ 1	2.48513+ 1	2.54153+ 1
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-100.000	* 77.752	*	6.11938- 7	0.0 + 0	2.82507-10	5.02161-10
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-91.248	* 1.294	*	4.91881- 1	4.30510- 2	3.68240- 1	3.73005- 1
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-42.543	* 2.309	*	3.53280+ 1	2.02983+ 1	3.03207+ 0	3.10207+ 0
3-LI- 6	207	6424	6424	1280	1240	1.0000- 4	2.0000+ 7	-0.074	0.090					
5-B - 10	207	6425	6425	1280	1240	1.0000- 4	2.0000+ 7	-0.090	0.053					
21-SC- 45	102	6426	6426	1280	1240	1.0000- 4	2.0000+ 7	-0.094	0.245					
22-TI- 46	103	6427	6427	369	329	1.6000+ 6	2.0000+ 7	-0.679	0.000					
22-TI- 47	28	6428	6428	189	149	1.0600+ 7	2.0000+ 7	-40.755	* 0.223		9.37500- 6	5.55425- 6		
22-TI- 47	103	6428	6428	1280	1240	1.0000- 4	2.0000+ 7	-0.001	0.002					
22-TI- 48	28	6429	6429	169	129	1.1600+ 7	2.0000+ 7	-10.782	* 0.221		2.23744- 6	1.99621- 6		
22-TI- 48	103	6429	6429	337	297	3.2000+ 6	2.0000+ 7	-3.786	* 0.001		3.44827-10	3.31773-10		
26-FE- 54	103	6430	6430	1280	1240	1.0000- 4	2.0000+ 7	-0.080	100.748	*			2.90221- 7	5.82614- 7
26-FE- 56	103	6431	6431	343	303	2.9000+ 6	2.0000+ 7	-0.084	872.520	*			1.96579- 8	1.91177- 7
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.110	0.425					
28-NI- 58	16	6433	6433	153	113	1.2400+ 7	2.0000+ 7	-1.354	* 0.006		4.28500- 5	4.22700- 5		
28-NI- 58	103	6433	6433	1280	1240	1.0000- 4	2.0000+ 7	-0.073	22.299	*			2.92430- 6	3.57640- 6
28-NI- 60	103	6434	6434	351	311	2.5000+ 6	2.0000+ 7	-0.081	472.913	*			4.04948- 7	2.32000- 6
29-CU- 63	102	6435	6435	1280	1240	1.0000- 4	2.0000+ 7	-89.770	* 0.051		2.17329- 1	2.22327- 2		
29-CU- 63	107	6435	6435	367	327	1.7000+ 6	2.0000+ 7	-0.070	8.939	*			4.63949- 7	5.05420- 7
29-CU- 65	16	6436	6436	201	161	1.0000+ 7	2.0000+ 7	0.0	0.005					
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.062	0.193					
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-0.108	0.113					
53-I -127	16	6438	6438	217	177	9.2000+ 6	2.0000+ 7	-0.056	0.096					
16-S - 32	103	6439	6439	385	345	9.2000+ 5	2.0000+ 7	-0.001	0.001					

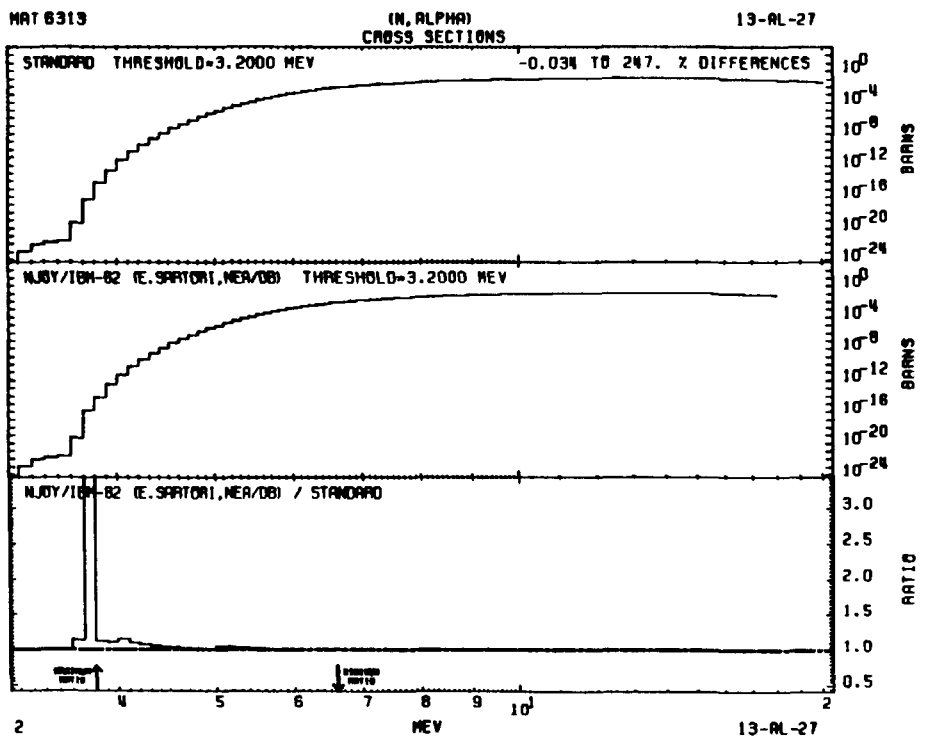
19 PLOTS GENERATED

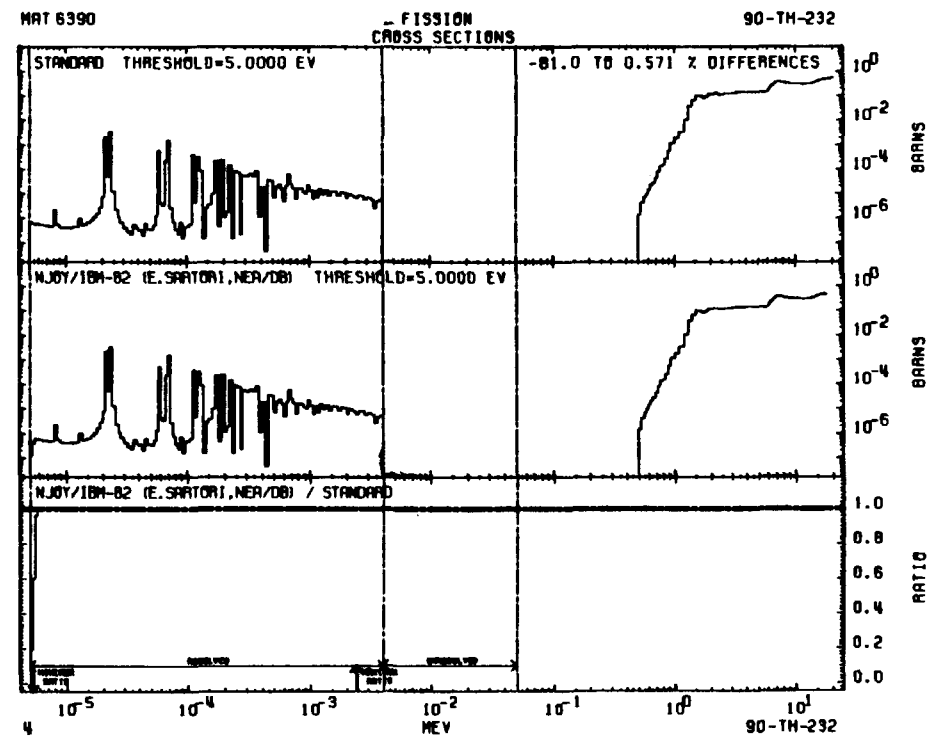
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

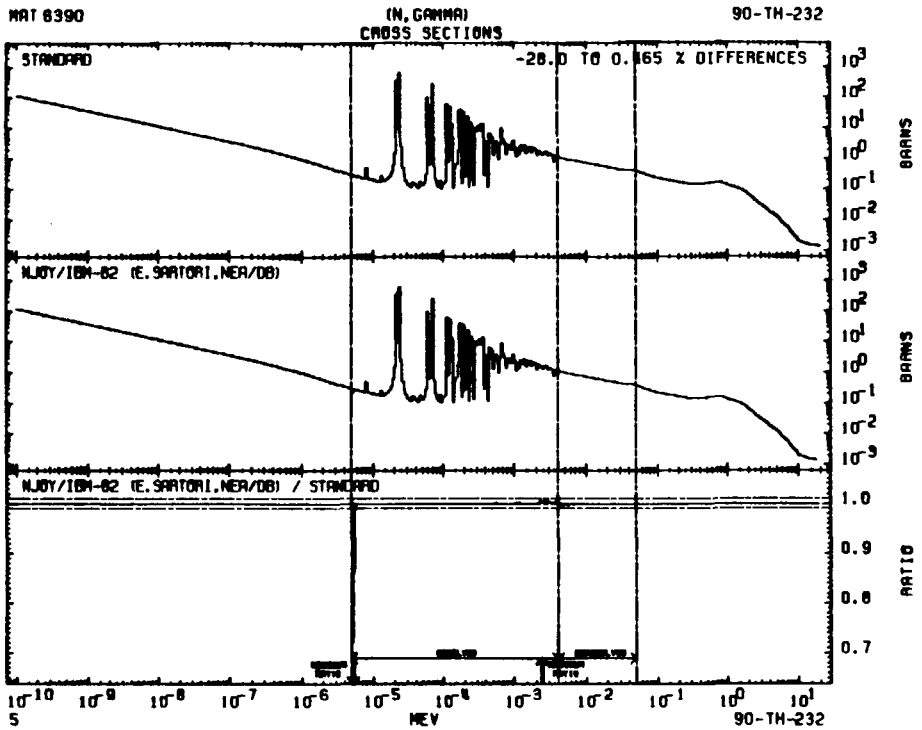
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

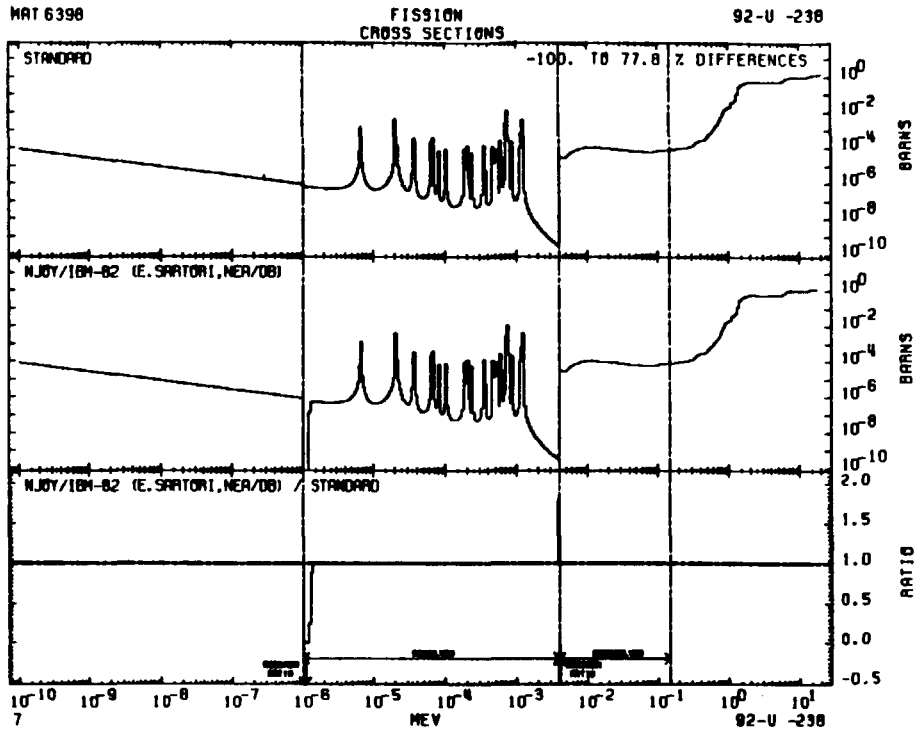

MAT 6313
(N,P)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=1.8000 MEV
-1.45 TO 174. % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=1.8000 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
13-AL-27

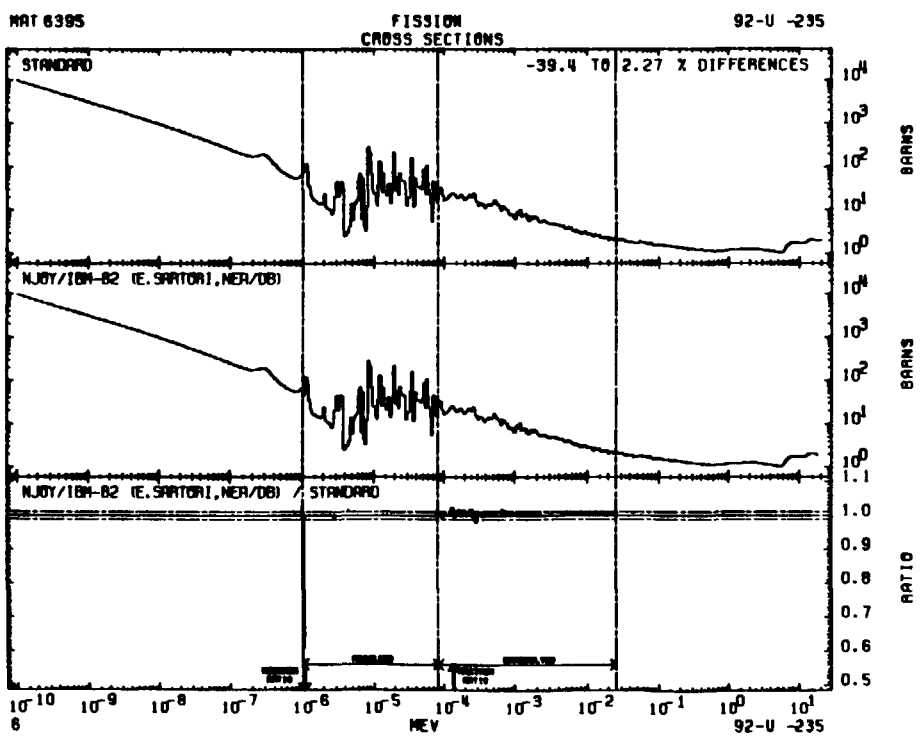

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-77.0 TO 18.7 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
93-NP-237

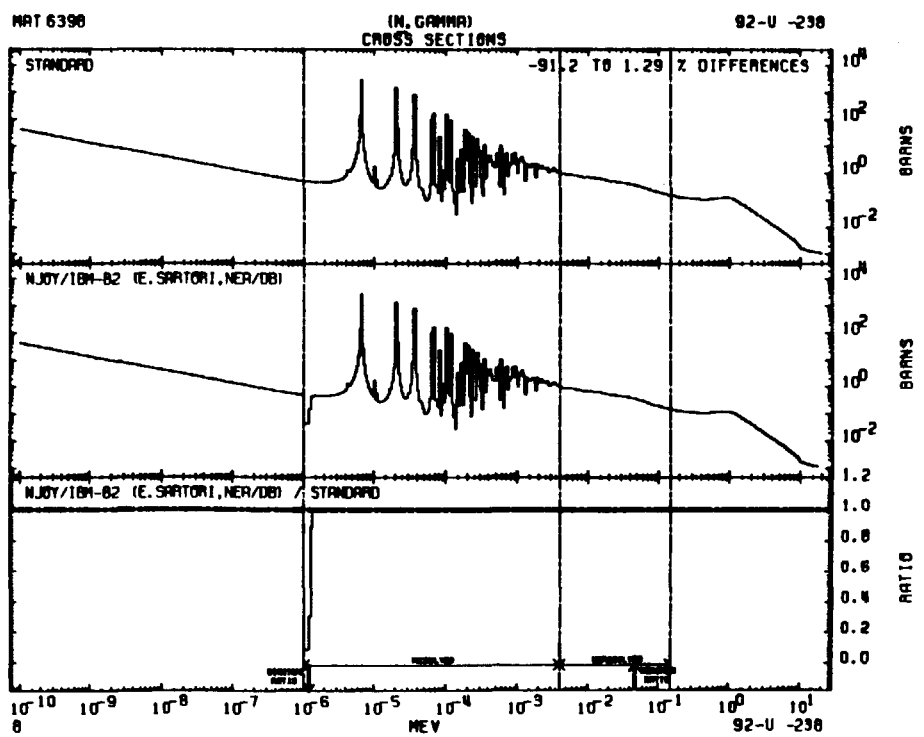

MAT 6313
(N,ALPHA)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=3.2000 MEV
-0.03% TO 247. % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=3.2000 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
13-AL-27

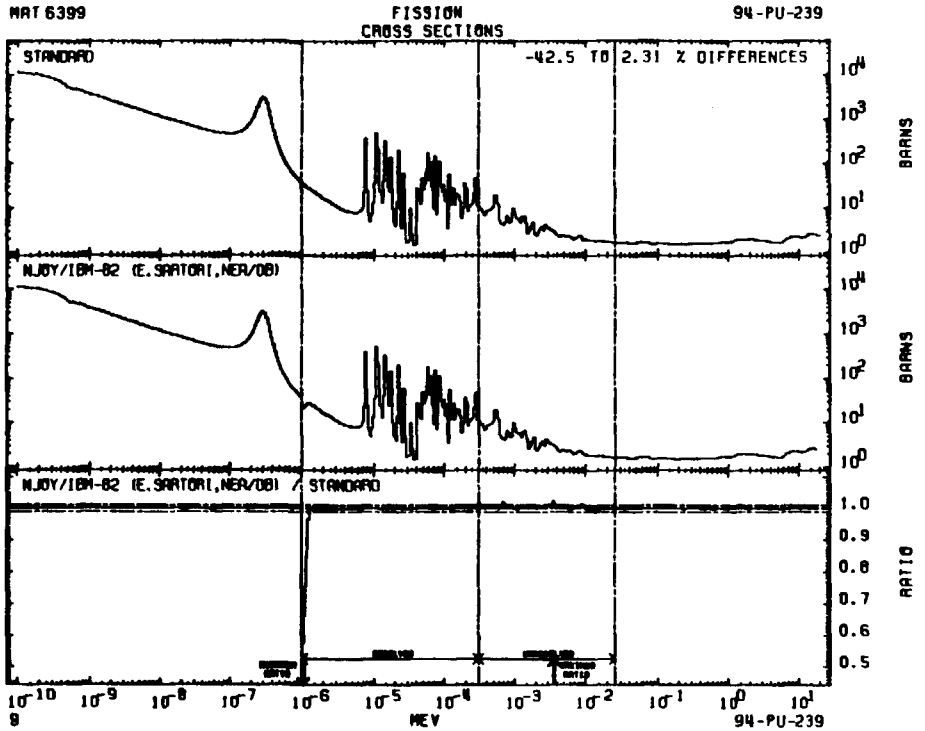

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-81.0 TO 0.571 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=5.0000 EV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
90-TH-232

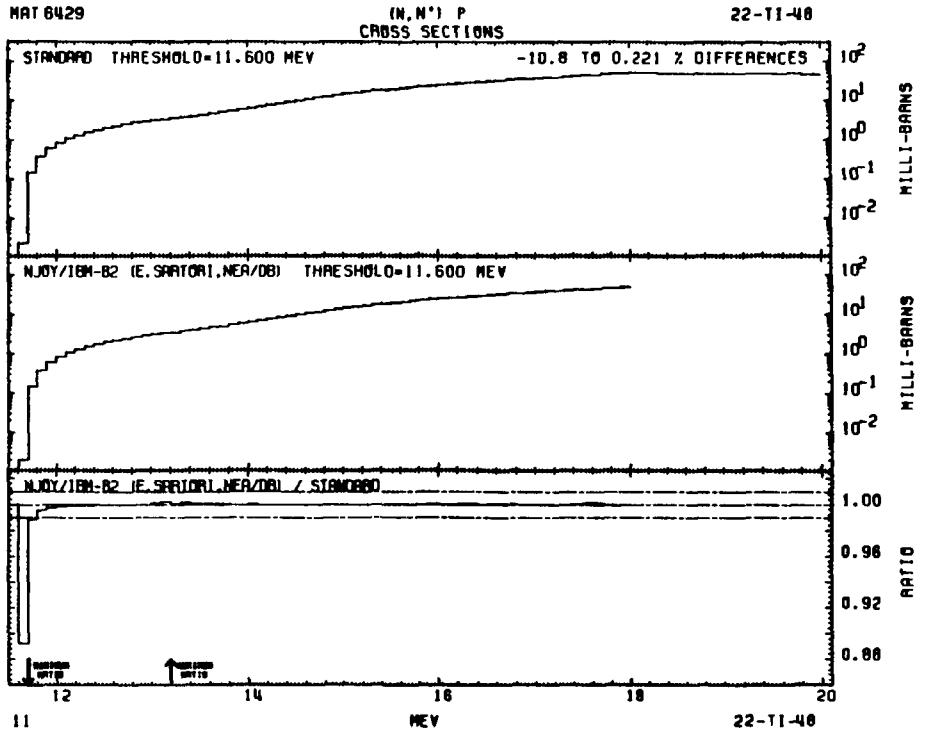

MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-28.0 TO 0.165 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
90-TH-232

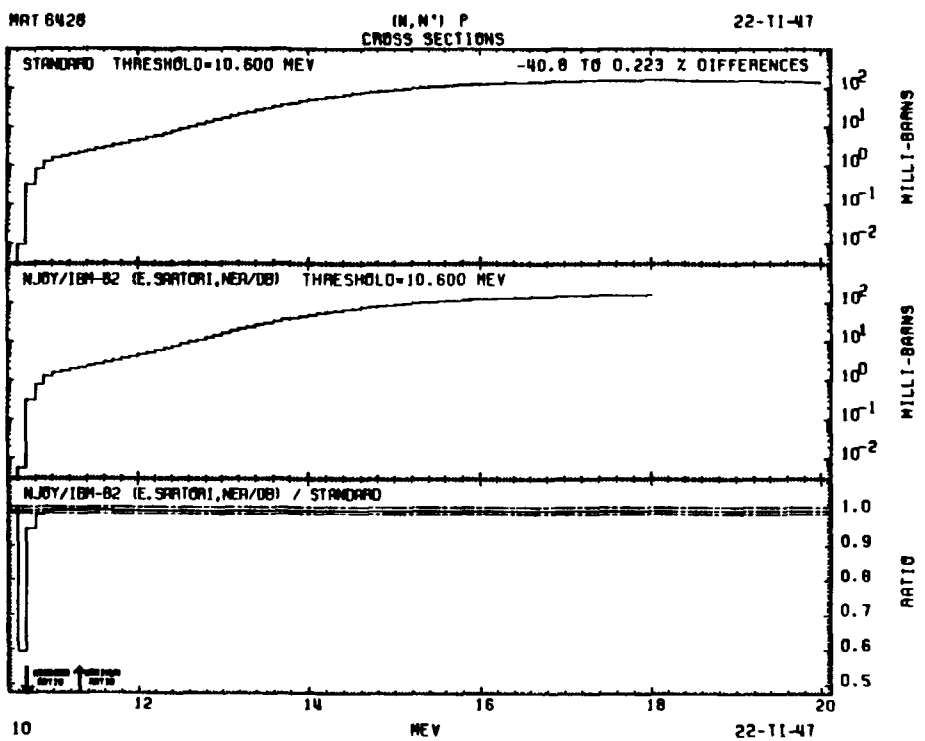

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-100. TO 77.8 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
92-U -238

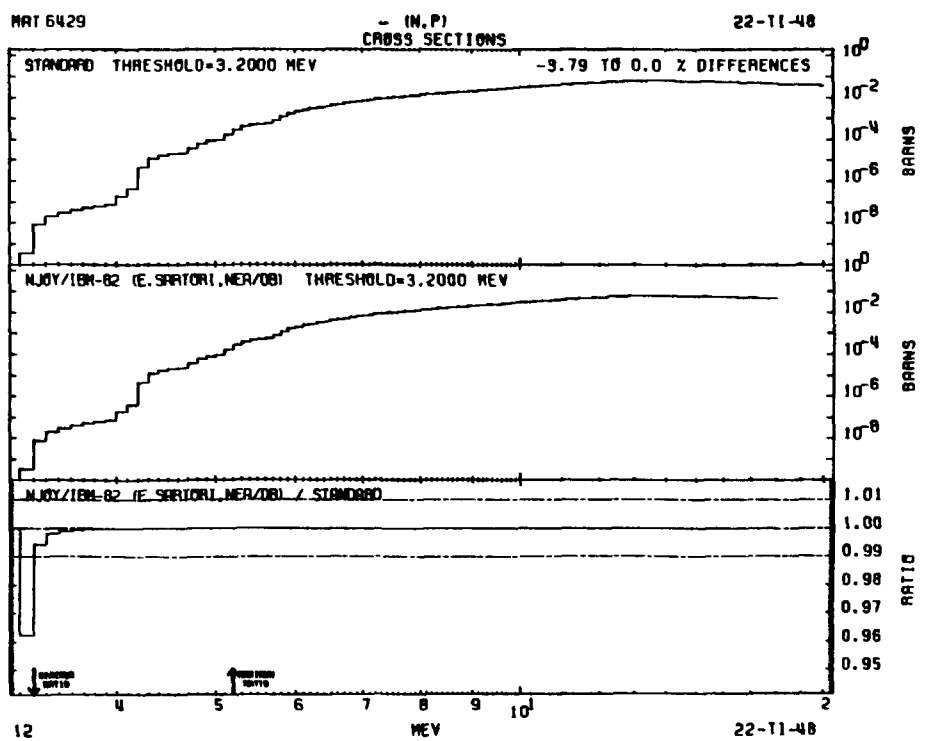

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-39.4 TO 2.27 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
92-U -235

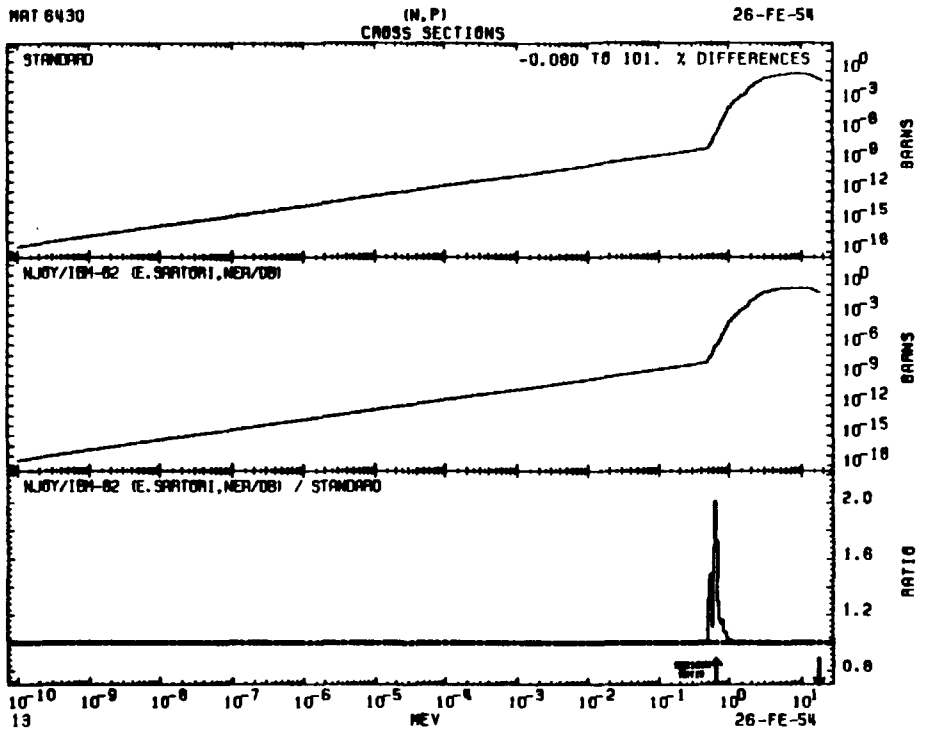

MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-91.2 TO 1.29 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
92-U -238

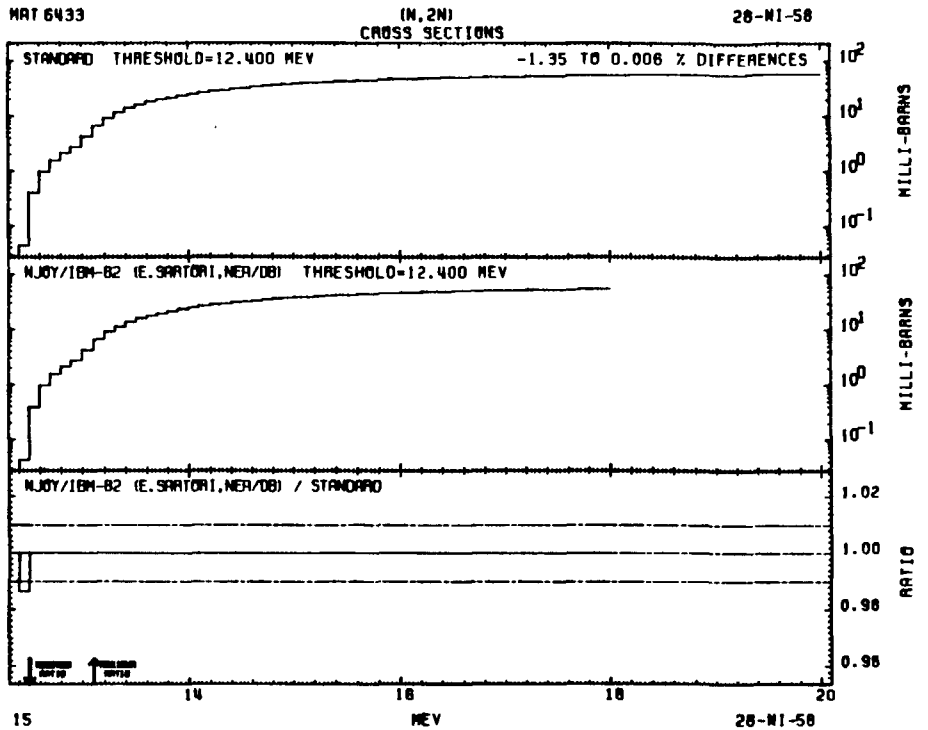

MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-42.5 TO 2.31 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
9
94-PU-239

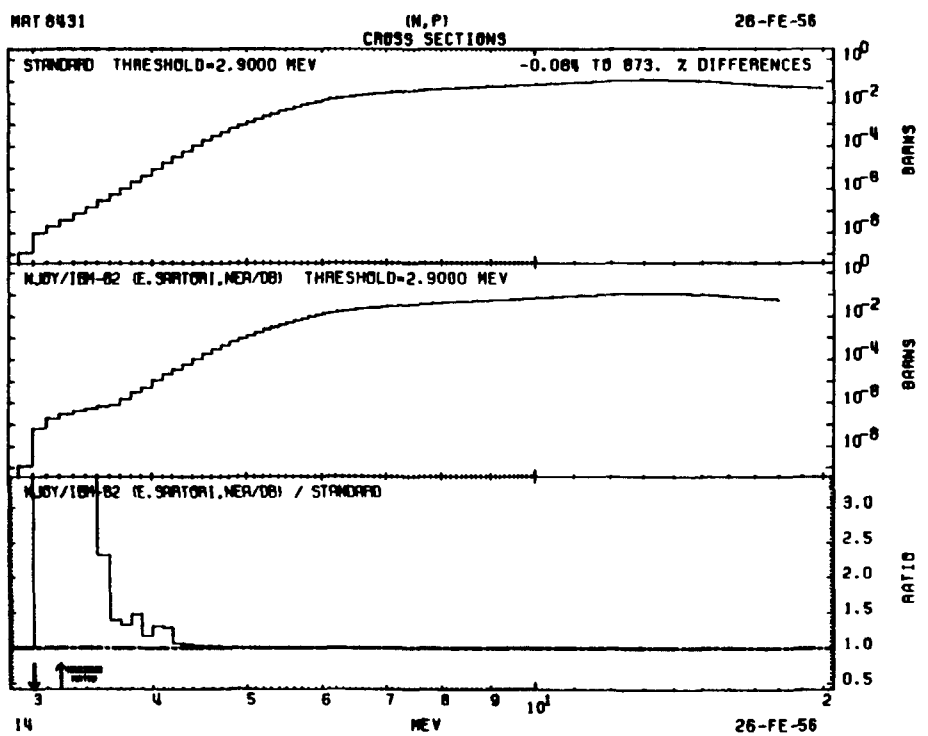

MAT 6429
(N,N') P
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=11.600 MEV
-10.8 TO 0.221 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=11.600 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
MILLI-BARNS
RATIO
MEV
11
22-TI-48

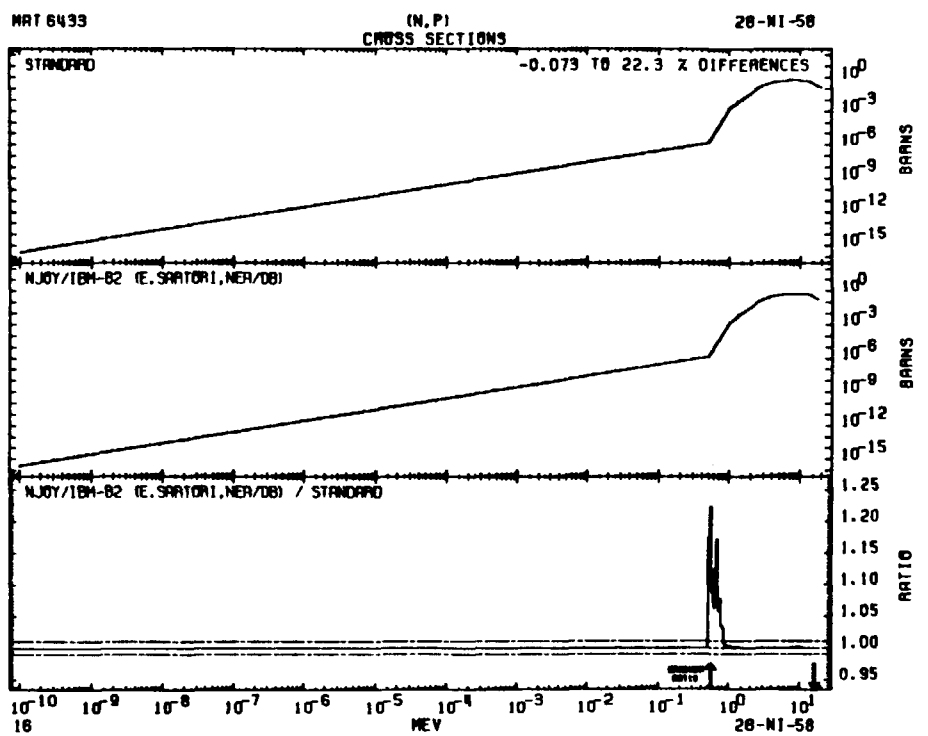

MAT 6428
(N,N') P
CROSS SECTIONS
22-TI-47
STANDARD THRESHOLD=10.600 MEV
-40.8 TO 0.223 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=10.600 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
MILLI-BARNS
RATIO
MEV
10
22-TI-47

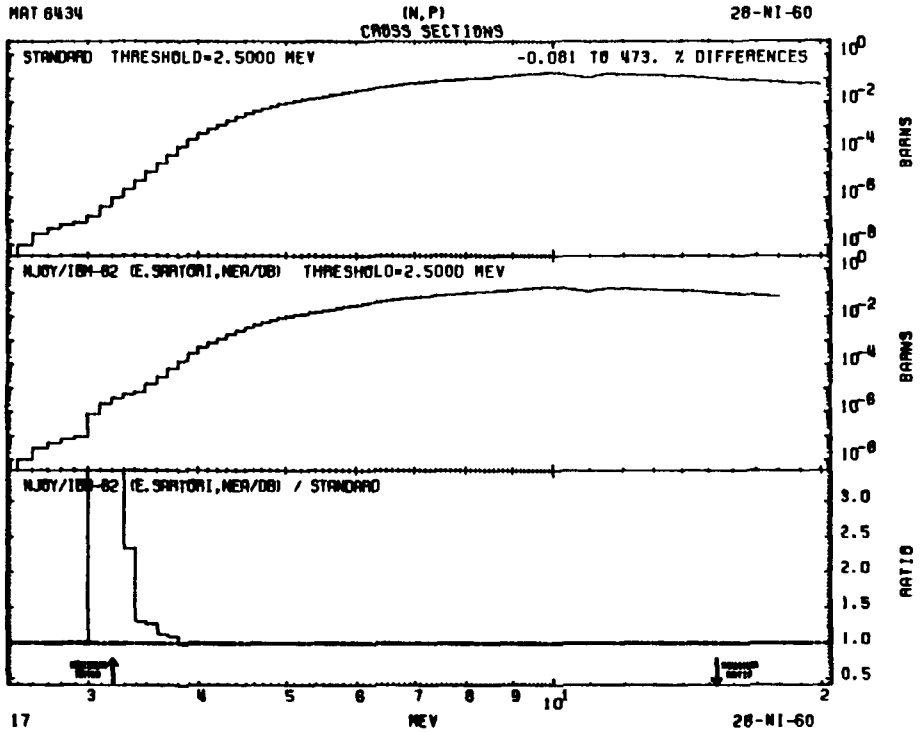

MAT 6429
- (N,P)
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=3.2000 MEV
-9.79 TO 0.0 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=3.2000 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
12
22-TI-48

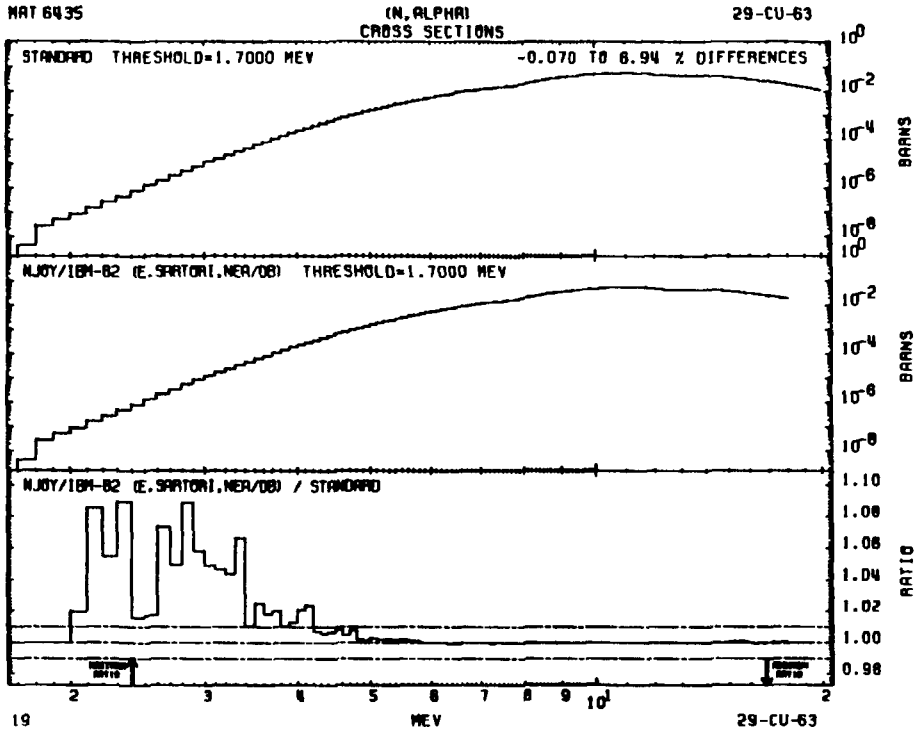

MAT 6430
(N,P)
CROSS SECTIONS
26-FE-54
STANDARD
-0.080 TO 101. % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
13
26-FE-54

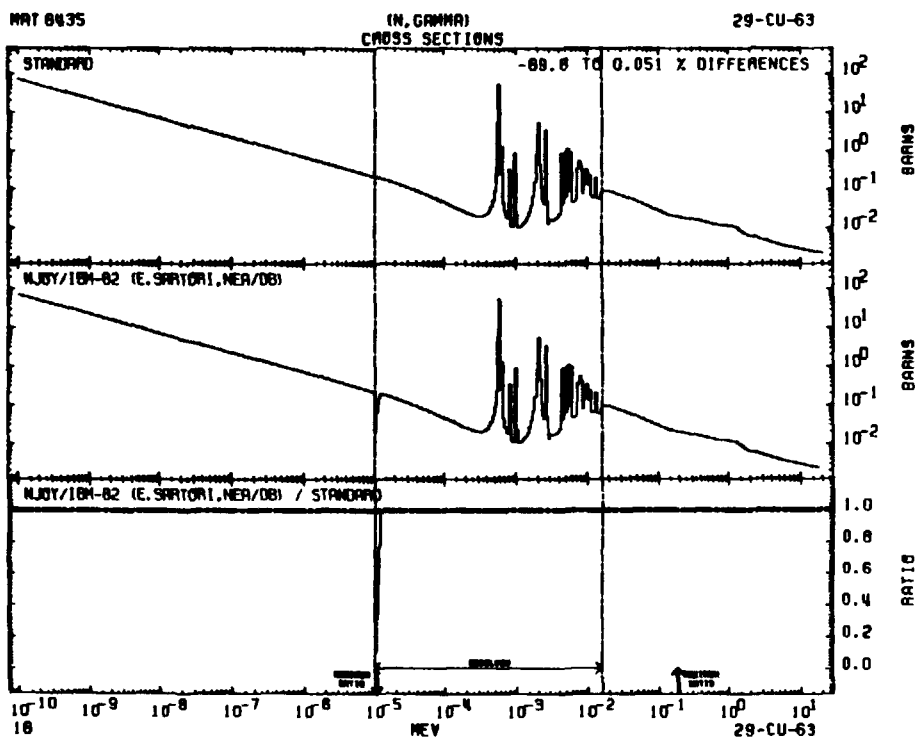

MAT 6433
(N,2N)
CROSS SECTIONS
28-NI-58
STANDARD THRESHOLD=12.400 MEV
-1.35 TO 0.006 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=12.400 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
MILLI-BARNS
RATIO
MEV
15
28-NI-58


MAT 8431
(N,P)
CROSS SECTIONS
26-FE-56
STANDARD THRESHOLD=2.9000 MEV
-0.084 TO 873. % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=2.9000 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
14
26-FE-56


MAT 6433
(N,P)
CROSS SECTIONS
28-NI-58
STANDARD
-0.079 TO 22.3 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
16
28-NI-58


MAT 6434
(N,P)
CROSS SECTIONS
28-NI-60
STANDARD THRESHOLD=2.5000 MEV
-0.081 TO 473. % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=2.5000 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
17
28-NI-60


MAT 6435
(N,ALPHA)
CROSS SECTIONS
29-CU-63
STANDARD THRESHOLD=1.7000 MEV
-0.070 TO 6.94 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB) THRESHOLD=1.7000 MEV
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
19
29-CU-63


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-69.6 TO 0.051 % DIFFERENCES
NJOY/IBM-82 (E.SARTORI,NEA/DB)
NJOY/IBM-82 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
18
29-CU-63

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=NJOY/IBM-83 (E.SARTORI,NEA/DB)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2=NJOY/IBM...ENDF/B-V DOSIMETRY LIBRARY (E.SARTORI,NEA/DB,1983) 9000

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE		MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-0.078		0.786					
13-AL- 27	103	6313	6313	365	325	1.8000+ 6	2.0000+ 7	-1.454	*	0.091		6.65345-18	6.55669-18		
13-AL- 27	107	6313	6313	337	297	3.2000+ 6	2.0000+ 7	-0.034		0.194					
25-MN- 55	16	6325	6325	193	153	1.0400+ 7	2.0000+ 7	-0.080		0.082					
27-CO- 59	16	6327	6327	189	149	1.0600+ 7	2.0000+ 7	-0.153		0.000					
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-0.135		0.384					
27-CO- 59	107	6327	6327	291	251	5.5000+ 6	2.0000+ 7	-0.001		0.042					
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-17.377	*	18.736	*	1.15679- 2	9.55779- 3	3.29277- 2	3.90971- 2
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-0.055		0.079					
90-TH-232	18	6390	6390	861	823	4.7500+ 0	2.0000+ 7	-0.153		0.498					

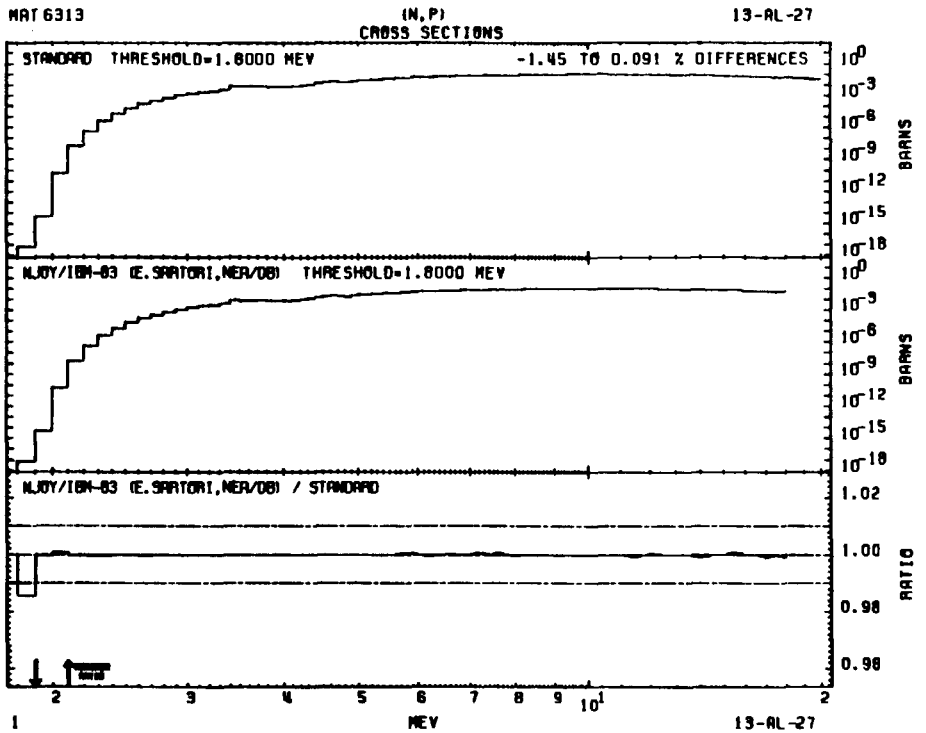
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 4.75000+ 0 EV.

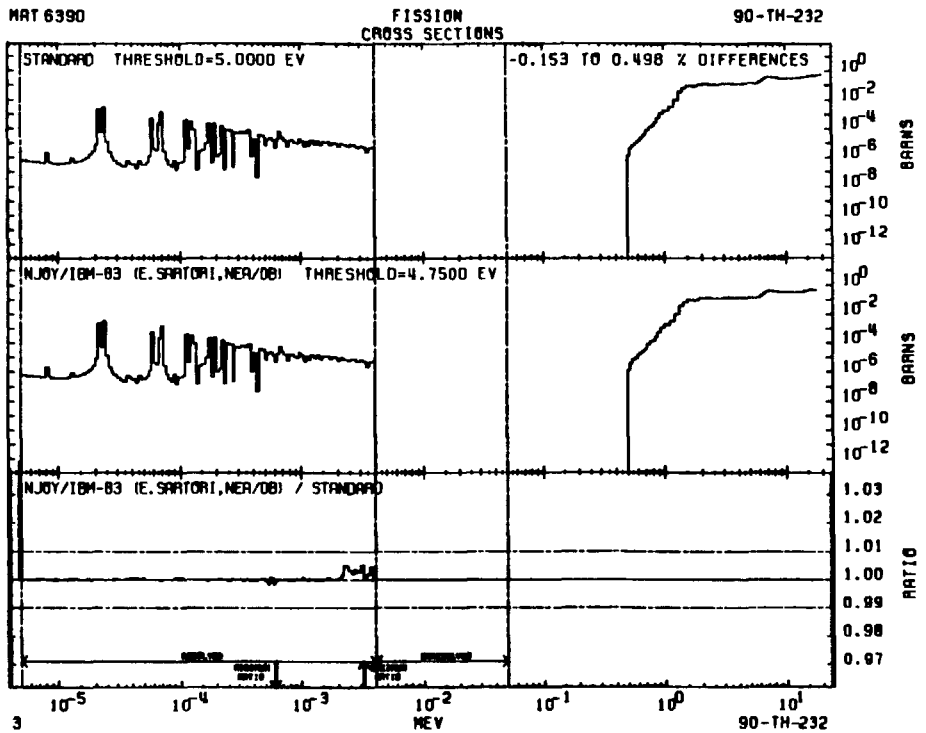
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-0.437		0.386					
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-1.910	*	2.269	*	1.56412+ 1	1.53425+ 1	2.48513+ 1	2.54153+ 1
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-0.082		51.818	*			2.82507-10	4.28896-10
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-0.107		1.294	*			3.68240- 1	3.73005- 1
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-0.847		2.309	*			3.03207+ 0	3.10207+ 0
3-LI- 6	207	6424	6424	1280	1240	1.0000- 4	2.0000+ 7	-0.074		0.090					
5-B - 10	207	6425	6425	1280	1240	1.0000- 4	2.0000+ 7	-0.090		0.053					
21-SC- 45	102	6426	6426	1280	1240	1.0000- 4	2.0000+ 7	-0.094		0.083					
22-TI- 46	103	6427	6427	369	329	1.6000+ 6	2.0000+ 7	-0.679		0.000					
22-TI- 47	28	6428	6428	189	149	1.0600+ 7	2.0000+ 7	-40.757	*	0.025		9.37500- 6	5.55407- 6		
22-TI- 47	103	6428	6428	1280	1240	1.0000- 4	2.0000+ 7	-0.000		0.002					
22-TI- 48	28	6429	6429	169	129	1.1600+ 7	2.0000+ 7	-10.914	*	0.084		2.23744- 6	1.99325- 6		
22-TI- 48	103	6429	6429	337	297	3.2000+ 6	2.0000+ 7	-3.786	*	0.001		3.44827-10	3.31773-10		
26-FE- 54	103	6430	6430	1280	1240	1.0000- 4	2.0000+ 7	-0.080		0.085					
26-FE- 56	103	6431	6431	343	303	2.9000+ 6	2.0000+ 7	-0.087		0.007					
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.110		0.135					
28-NI- 58	16	6433	6433	153	113	1.2400+ 7	2.0000+ 7	-1.365	*	0.000		4.28500- 5	4.22650- 5		
28-NI- 58	103	6433	6433	1280	1240	1.0000- 4	2.0000+ 7	-0.072		0.078					
28-NI- 60	103	6434	6434	351	311	2.5000+ 6	2.0000+ 7	-0.081		0.048					
29-CU- 63	102	6435	6435	1280	1240	1.0000- 4	2.0000+ 7	-0.105		0.052					
29-CU- 63	107	6435	6435	367	327	1.7000+ 6	2.0000+ 7	-0.070		0.086					
29-CU- 65	16	6436	6436	201	161	1.0000+ 7	2.0000+ 7	-0.000		0.000					
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.062		0.025					
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-0.108		0.113					
53-I -127	16	6438	6438	217	177	9.2000+ 6	2.0000+ 7	-0.056		0.096					
16-S - 32	103	6439	6439	385	345	9.2000+ 5	2.0000+ 7	-0.001		0.001					

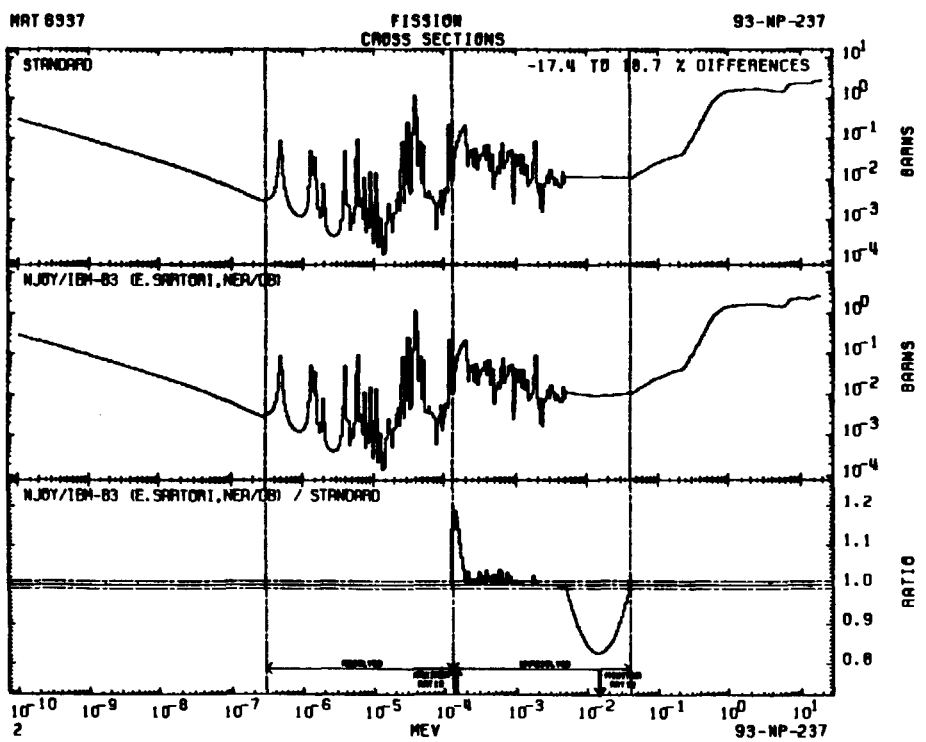
11 PLOTS GENERATED

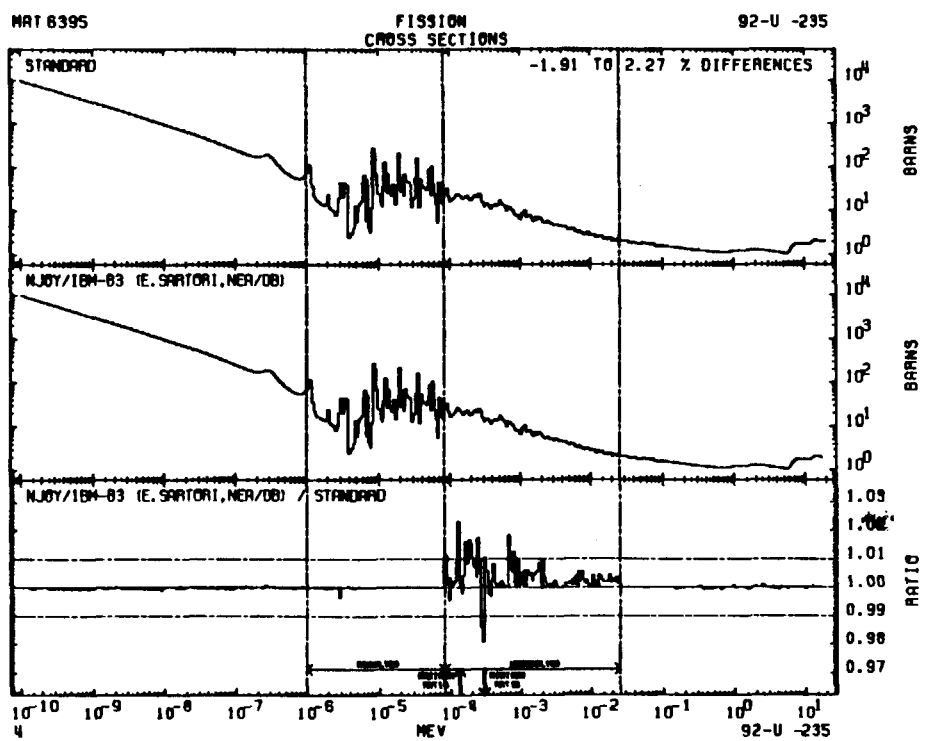
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

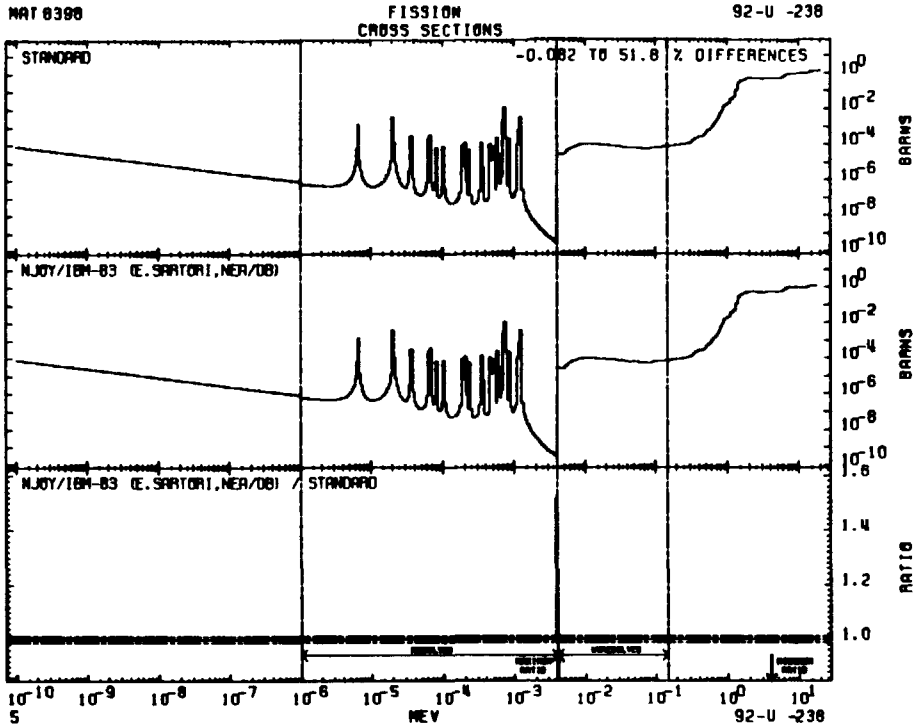
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

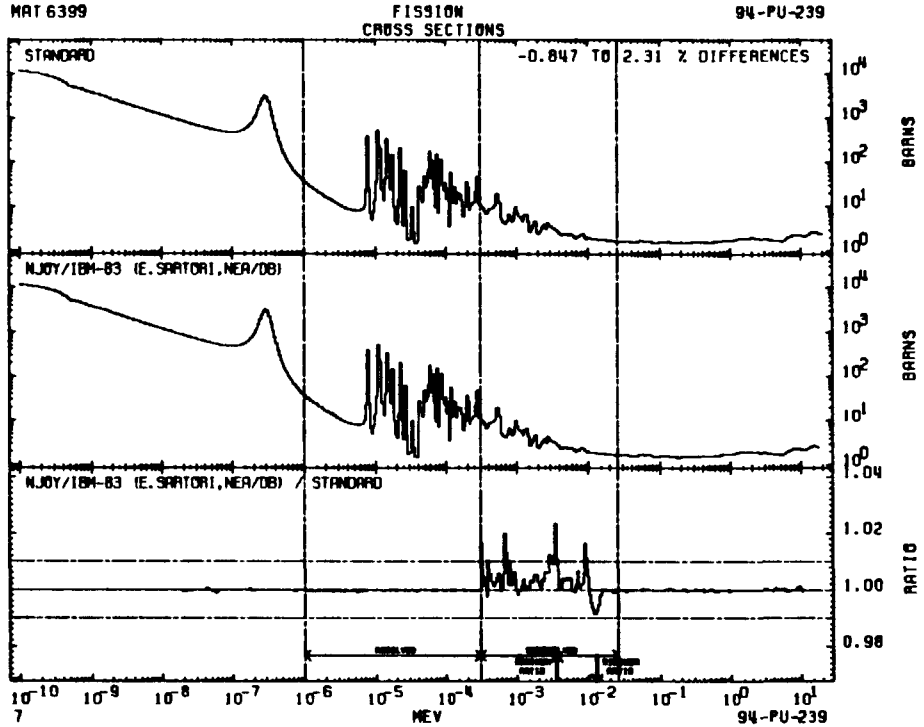

MAT 6313
(N,P)
CROSS SECTIONS
13-AL-27
STANDARD THRESHOLD=1.8000 MEV
-1.45 TO 0.091 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB) THRESHOLD=1.8000 MEV
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
1
13-AL-27

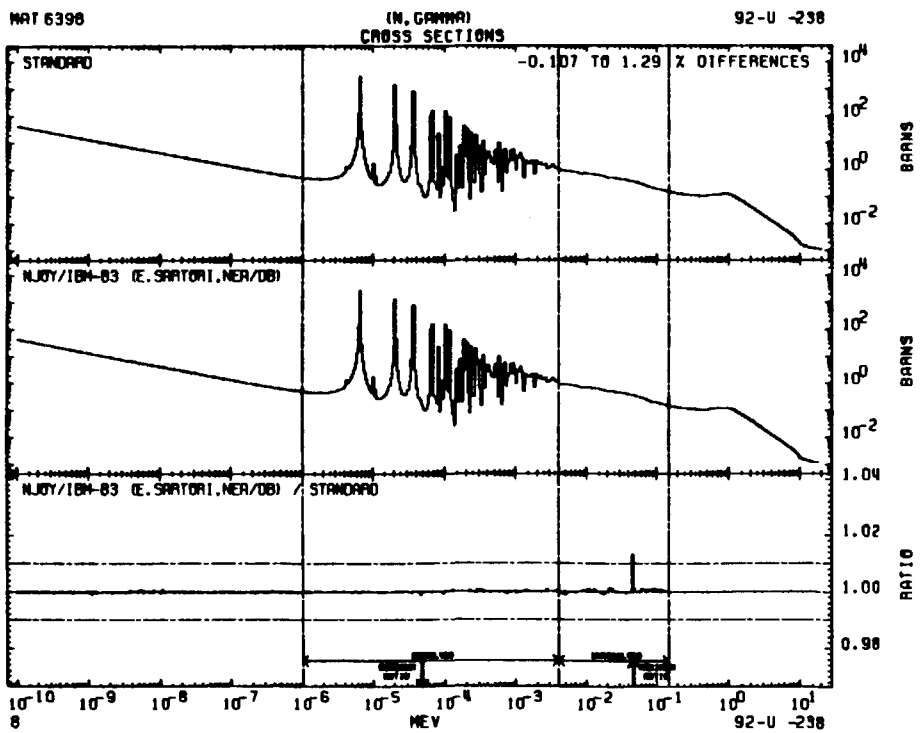

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-0.153 TO 0.498 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB) THRESHOLD=4.7500 EV
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
3
90-TH-232

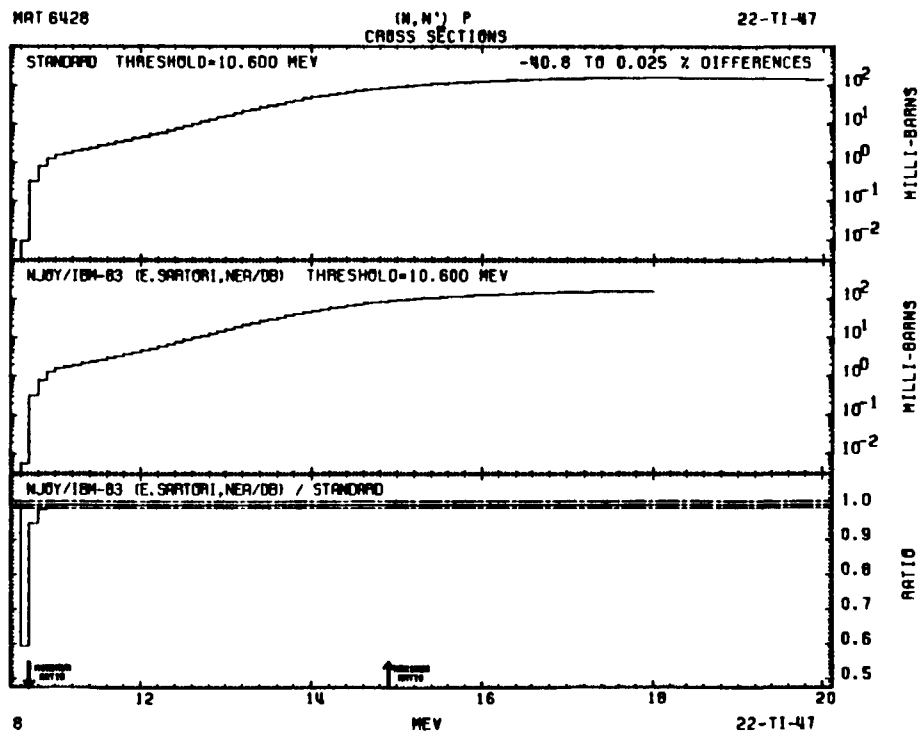

MAT 6937
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-17.4 TO 18.7 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB)
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
2
93-NP-237

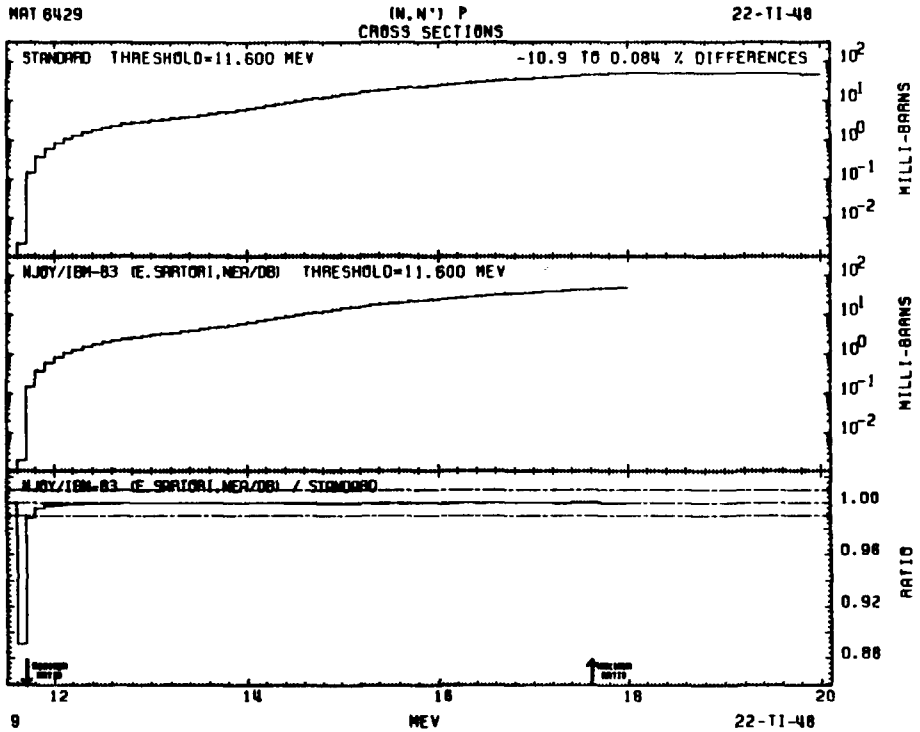

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-1.91 TO 2.27 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB)
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
4
92-U -235

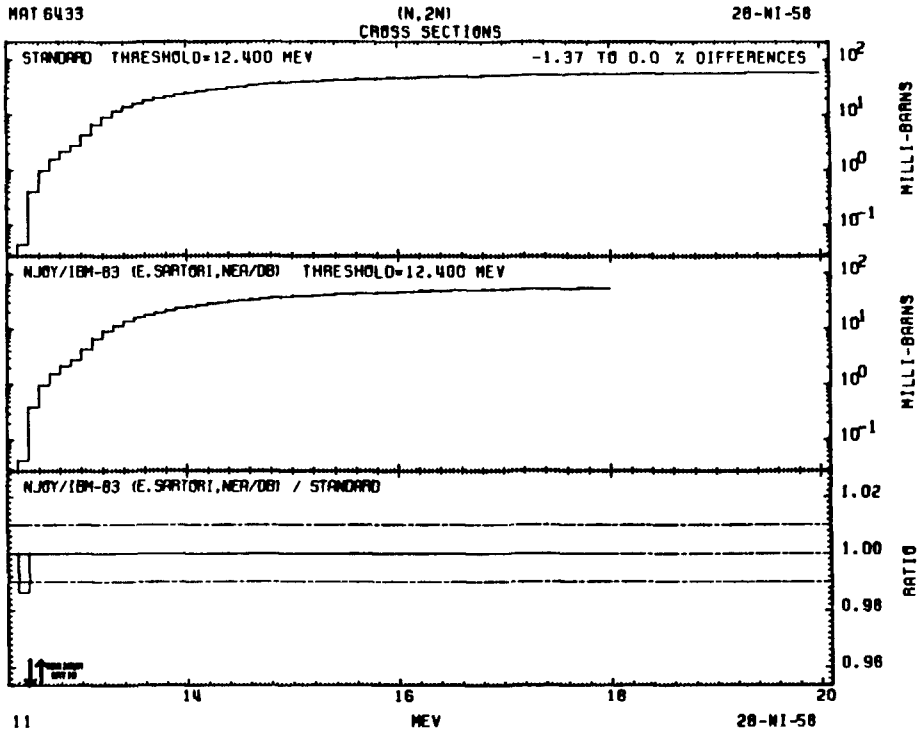

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-0.082 TO 51.8 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB)
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
5
92-U -238

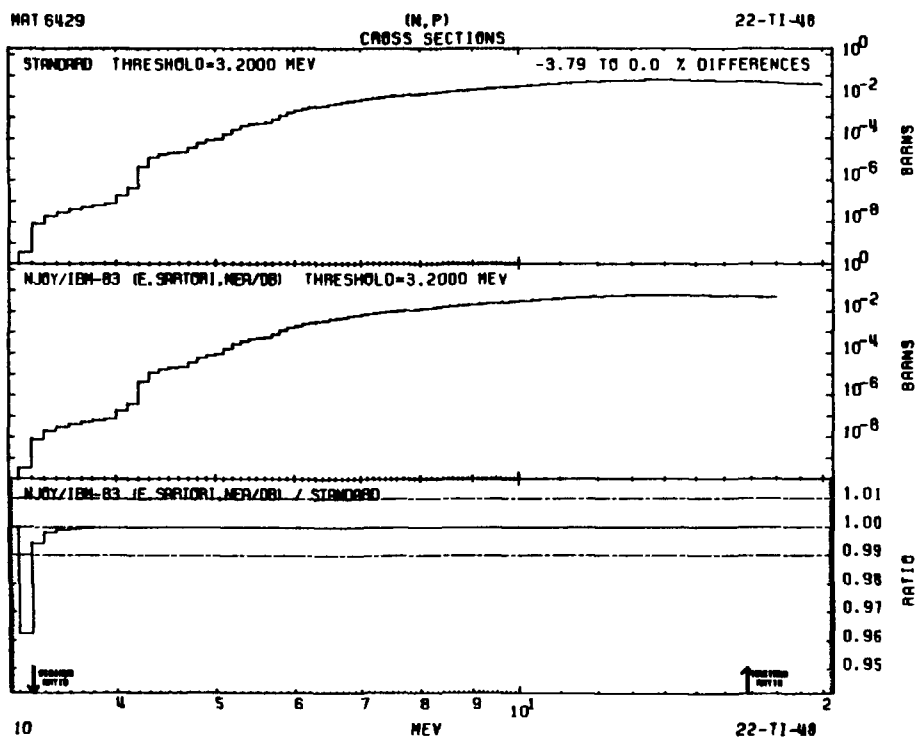

MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-0.847 TO 2.31 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB)
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
7
94-PU-239


MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-0.107 TO 1.29 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB)
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
8
92-U -238


MAT 6428
(N,N') P
CROSS SECTIONS
22-TI-47
STANDARD THRESHOLD=10.600 MEV
-40.8 TO 0.025 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB) THRESHOLD=10.600 MEV
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
MILLI-BARNS
RATIO
MEV
8
22-TI-47


MAT 6429
(N,N') P
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=11.600 MEV
-10.9 TO 0.084 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB) THRESHOLD=11.600 MEV
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
MILLI-BARNS
RATIO
MEV
9
22-TI-48


MAT 6433
(N,2N)
CROSS SECTIONS
28-NI-58
STANDARD THRESHOLD=12.400 MEV
-1.37 TO 0.0 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB) THRESHOLD=12.400 MEV
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
MILLI-BARNS
RATIO
MEV
11
28-NI-58


MAT 6429
(N,P)
CROSS SECTIONS
22-TI-48
STANDARD THRESHOLD=3.2000 MEV
-3.79 TO 0.0 % DIFFERENCES
NJOY/IBM-83 (E.SARTORI,NEA/DB) THRESHOLD=3.2000 MEV
NJOY/IBM-83 (E.SARTORI,NEA/DB) / STANDARD
BARNS
RATIO
MEV
10
22-TI-48

AMPX
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The AMPX system is designed to calculate complete multigroup data sets for use in applications.

The initial AMPX comparisons performed in 1982 showed generally good agreement in the resolved region; the only exception being ^{58}Fe capture where 24% differences were found in the minima between resonances. The unresolved resonance results illustrated that AMPX was still using the ENDF/B-IV convention of interpolating unresolved parameters (e.g. ^{237}Np fission), but there were additional problems with ^{235}U fission, ^{238}U capture and ^{239}Pu fission which resulted in differences of up to 17.5%. The agreement for all other reactions was excellent.

The latest AMPX results show improvements in the resolved resonance region (note, the agreement for ^{58}Fe capture). In the unresolved resonance region AMPX is now using the ENDF/B-V convention of interpolating cross sections and has an improved algorithm for calculating fluctuation integrals, which has resulted in greatly improved results. In general the latest AMPX results agree closely with our benchmark results.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=AMPX-82 (M.GREENE,ORNL)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2= AMPX OUTPUT...ENDF/B-V DOSIMETRY LIBRARY (M.GREENE, ORNL, 1982) 9000

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE		MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-1.877	*	0.306		1.31295- 4	1.28830- 4		
13-AL- 27	103	6313	6313	365	325	1.8000+ 6	2.0000+ 7	-0.152		0.074					
13-AL- 27	107	6313	6313	337	297	3.2000+ 6	2.0000+ 7	-0.120		0.004					
25-MN- 55	16	6325	6325	193	153	1.0400+ 7	2.0000+ 7	-0.088		0.080					
27-CO- 59	16	6327	6327	189	149	1.0600+ 7	2.0000+ 7	-0.003		0.003					
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-8.855	*	0.672		5.85290+ 2	5.33460+ 2		
27-CO- 59	107	6327	6327	291	251	5.5000+ 6	2.0000+ 7	-0.003		0.042					
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-16.529	*	19.705	*	1.15679- 2	9.65580- 3	3.29277- 2	3.94160- 2
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-10.955	*	0.463		1.53686+ 3	1.36850+ 3		
90-TH-232	18	6390	6390	861	821	5.0000+ 0	2.0000+ 7	-8.674	*	0.741		6.56278- 7	5.99350- 7		

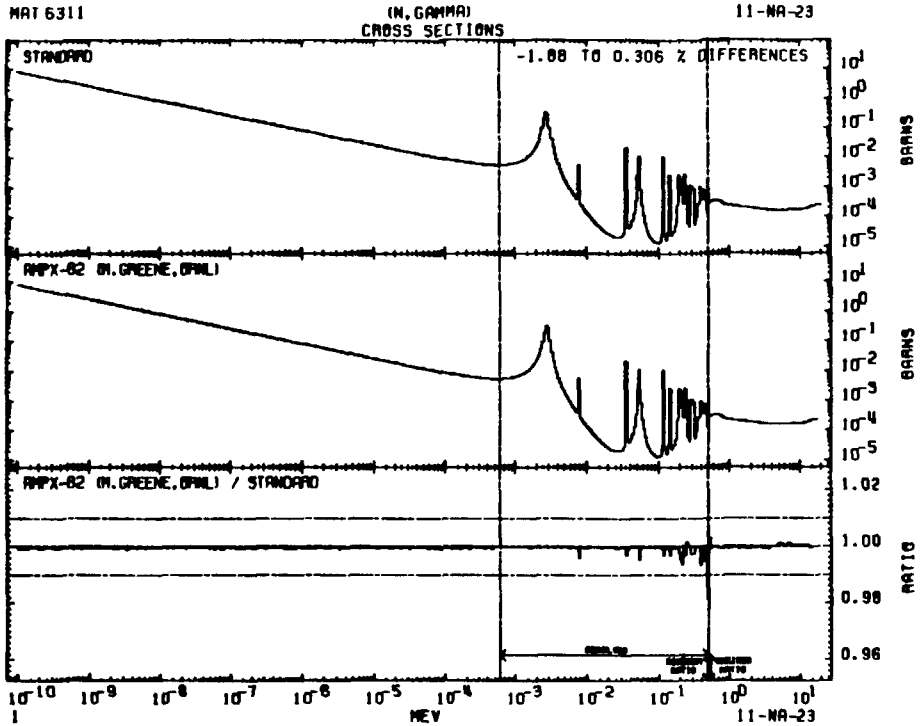
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 4.00000+ 3 EV.

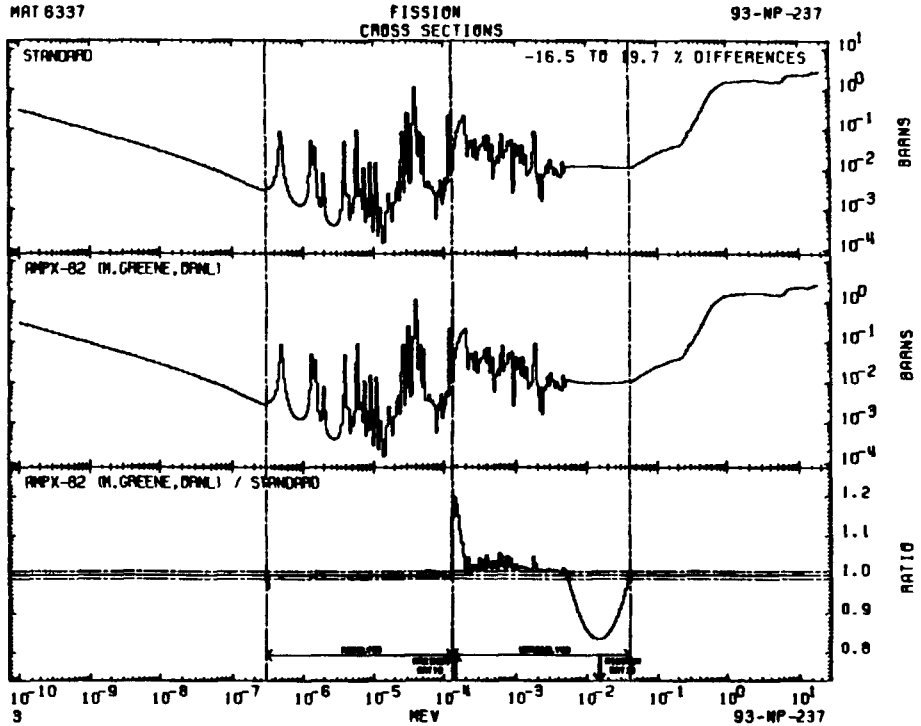
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-2.872	*	0.639		3.02312- 1	2.93630- 1		
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-1.344	*	2.888	*	1.56412+ 1	1.54310+ 1	2.48513+ 1	2.55690+ 1
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-6.458	*	1.432	*	6.11938- 7	5.72421- 7	2.85364- 7	2.89450- 7
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-17.489	*	0.647		1.56985- 1	1.29530- 1		
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-1.368	*	3.860	*	1.15896+ 1	1.14310+ 1	3.03207+ 0	3.14910+ 0
3-LI- 6	207	6424	6424	1280	1240	1.0000- 4	2.0000+ 7	-0.100		0.090					
5-B - 10	207	6425	6425	1280	1240	1.0000- 4	2.0000+ 7	-0.101		0.053					
21-SC- 45	102	6426	6426	1280	1240	1.0000- 4	2.0000+ 7	-0.750		0.267					
22-TI- 46	103	6427	6427	369	329	1.6000+ 6	2.0000+ 7	-0.003		0.004					
22-TI- 47	28	6428	6428	189	149	1.0600+ 7	2.0000+ 7	-0.091		0.001					
22-TI- 47	103	6428	6428	1280	1240	1.0000- 4	2.0000+ 7	-0.003		0.005					
22-TI- 48	28	6429	6429	169	129	1.1600+ 7	2.0000+ 7	-0.099		0.041					
22-TI- 48	103	6429	6429	337	297	3.2000+ 6	2.0000+ 7	-0.002		0.004					
26-FE- 54	103	6430	6430	1280	1240	1.0000- 4	2.0000+ 7	-0.102		0.085					
26-FE- 56	103	6431	6431	343	303	2.9000+ 6	2.0000+ 7	-0.072		0.003					
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-23.971	*	0.106		1.75315- 3	1.33290- 3		
28-NI- 58	16	6433	6433	153	113	1.2400+ 7	2.0000+ 7	-0.014		0.005					
28-NI- 58	103	6433	6433	1280	1240	1.0000- 4	2.0000+ 7	-0.110		0.072					
28-NI- 60	103	6434	6434	351	311	2.5000+ 6	2.0000+ 7	-0.108		0.023					
29-CU- 63	102	6435	6435	1280	1240	1.0000- 4	2.0000+ 7	-10.118	*	0.143		2.17329- 1	1.95340- 1		
29-CU- 63	107	6435	6435	367	327	1.7000+ 6	2.0000+ 7	-0.096		0.070					
29-CU- 65	16	6436	6436	201	161	1.0000+ 7	2.0000+ 7	-0.022		0.001					
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.067		0.004					
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-11.347	*	0.111		2.52974+ 3	2.24270+ 3		
53-I -127	16	6438	6438	217	177	9.2000+ 6	2.0000+ 7	-0.055		0.093					
16-S - 32	103	6439	6439	385	345	9.2000+ 5	2.0000+ 7	0.0		0.014					

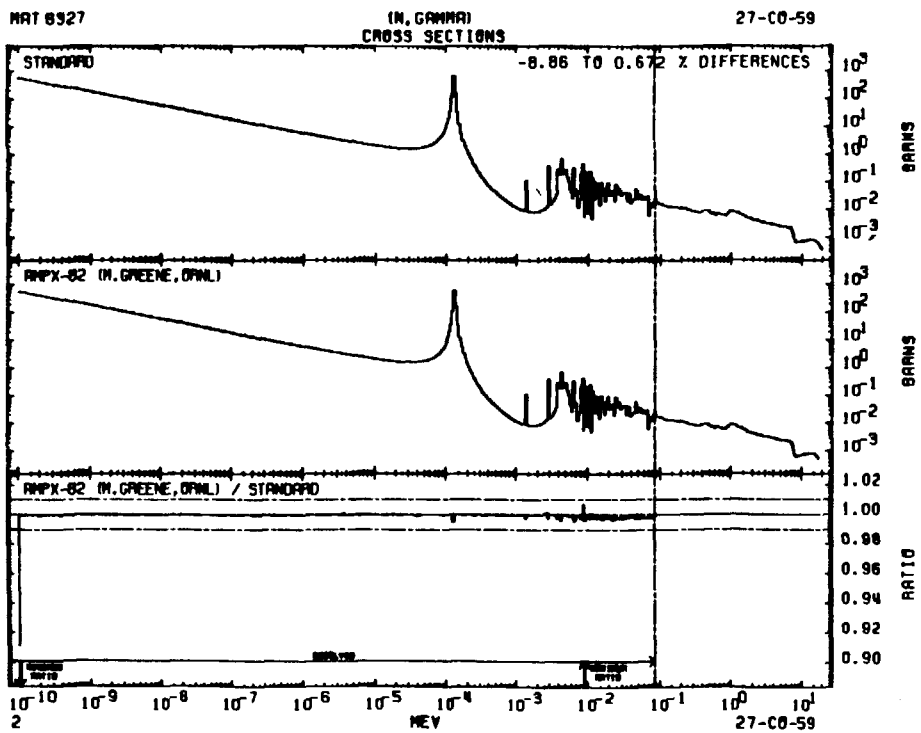
13 PLOTS GENERATED

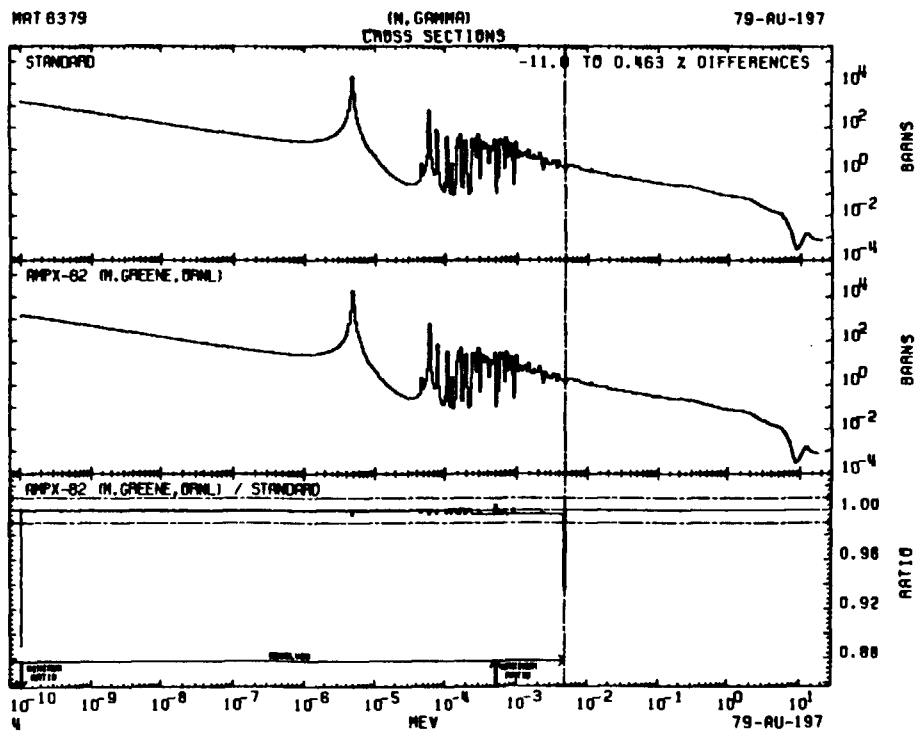
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

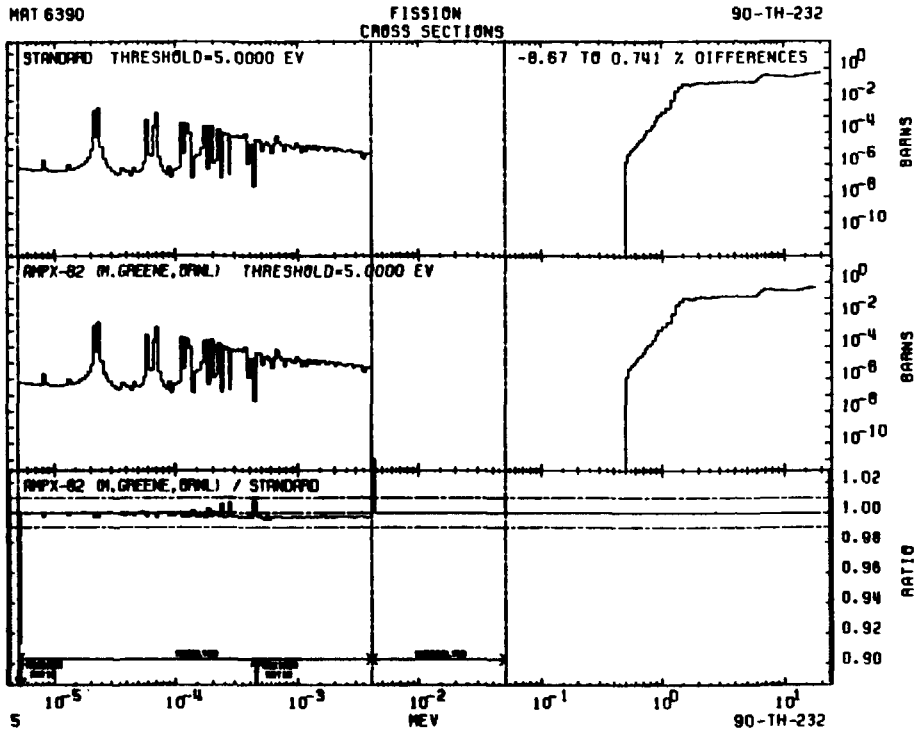
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

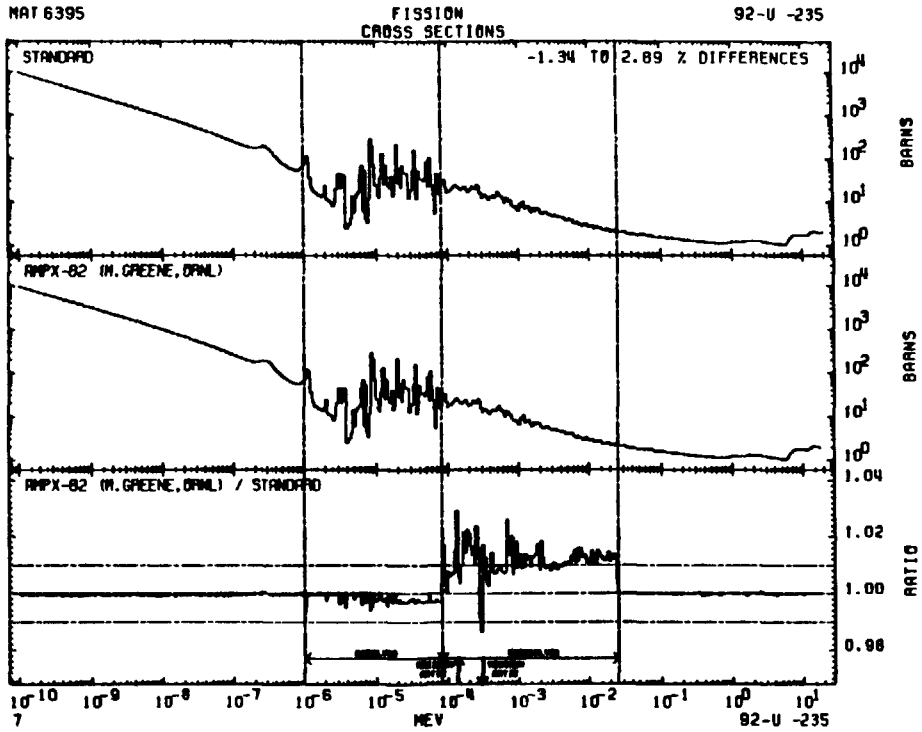

MAT 6311
(N,GAMMA)
CROSS SECTIONS
11-NA-23
STANDARD
-1.08 TO 0.306 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
1
11-NA-23

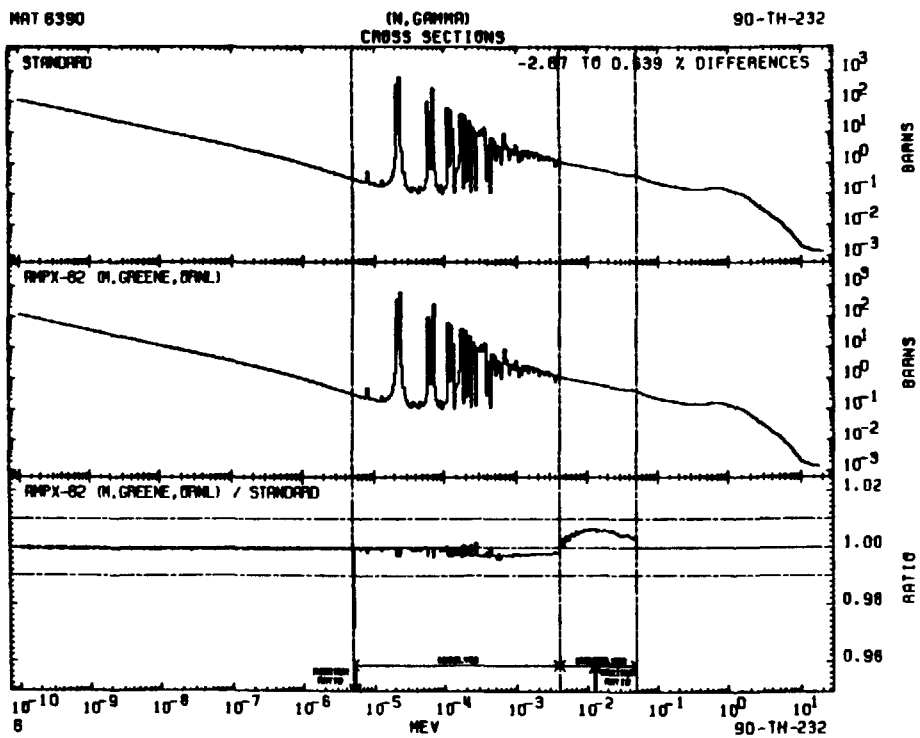

MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-16.5 TO 19.7 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
3
93-NP-237

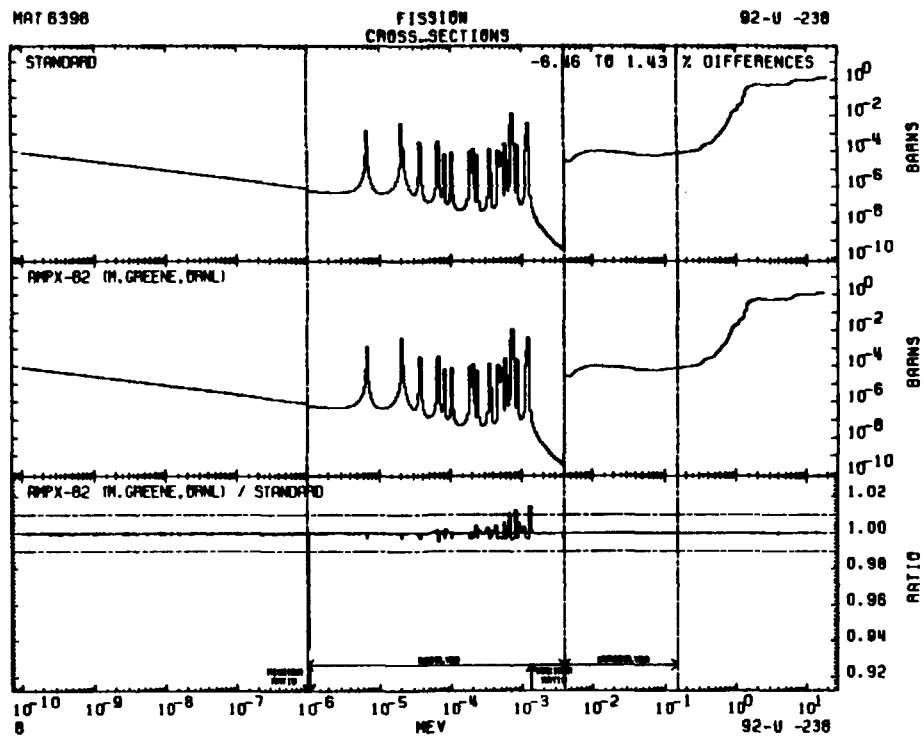

MAT 6927
(N,GAMMA)
CROSS SECTIONS
27-CO-59
STANDARD
-8.86 TO 0.672 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
2
27-CO-59

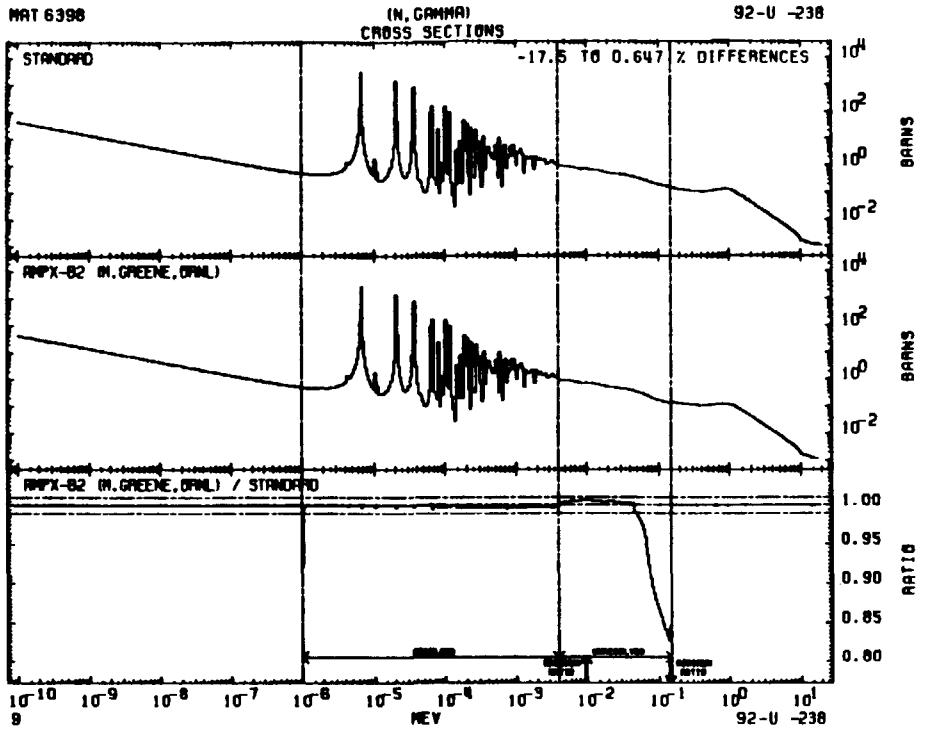

MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-11.0 TO 0.463 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
4
79-AU-197

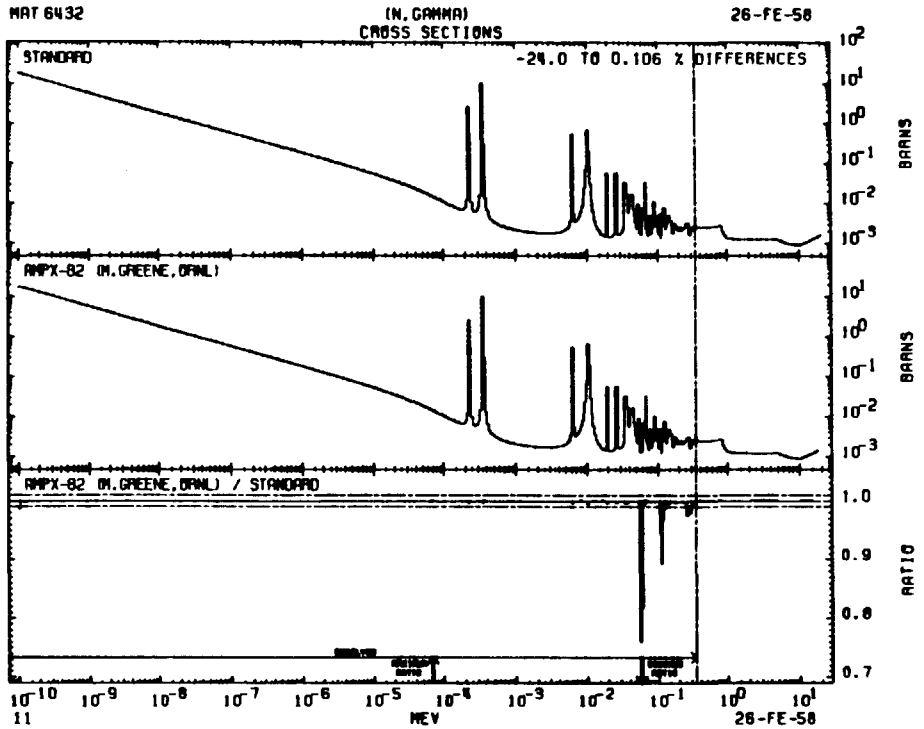

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-8.67 TO 0.741 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL) THRESHOLD=5.0000 EV
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
5
90-TH-232

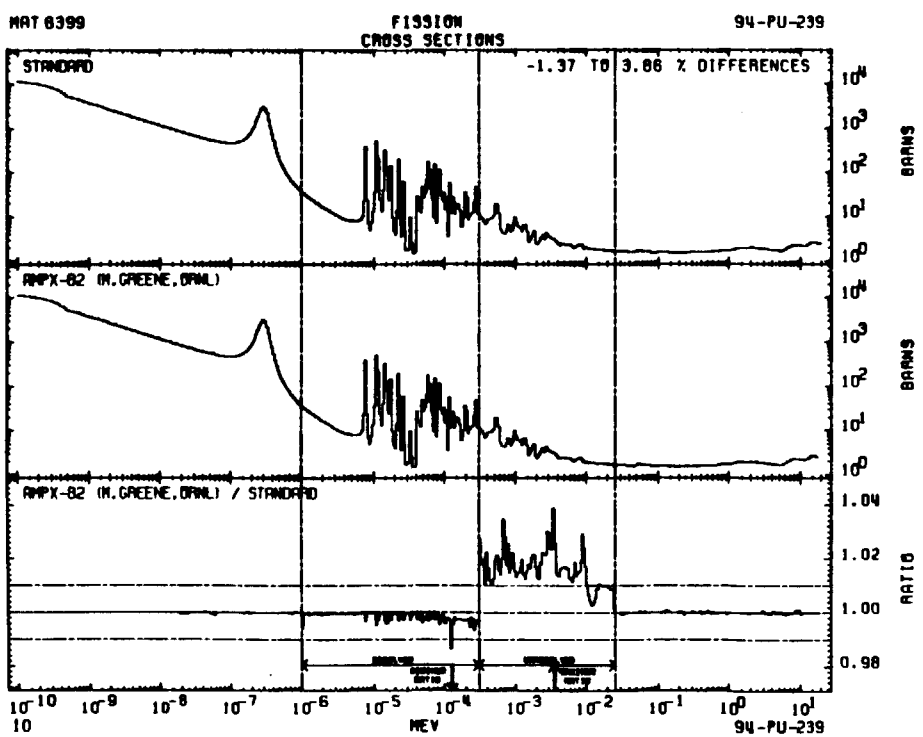

MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-1.34 TO 2.89 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
7
92-U -235

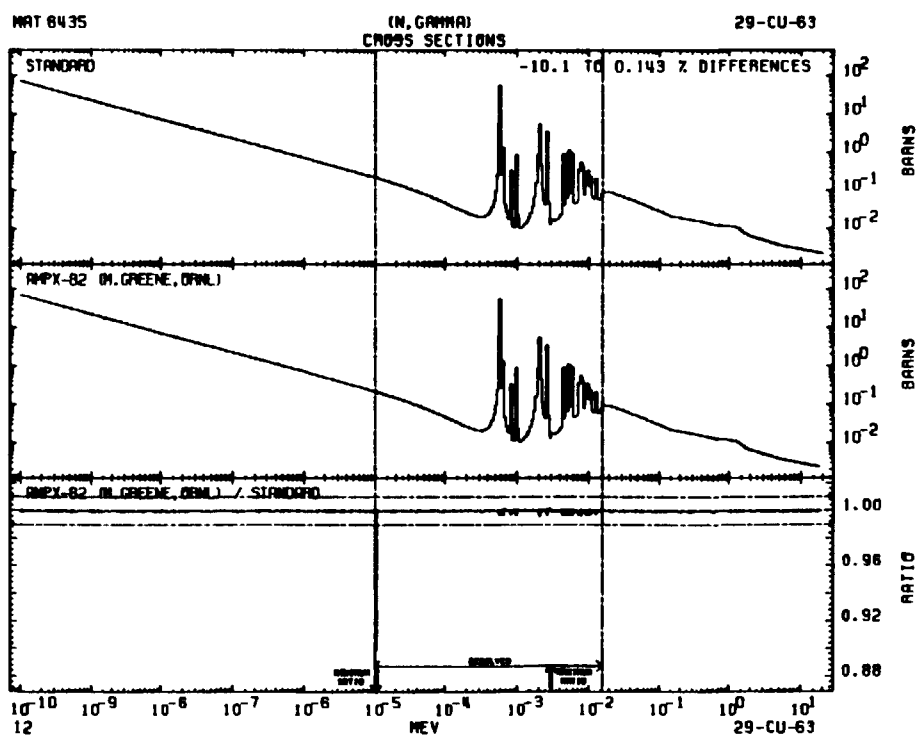

MAT 6390
(N,GAMMA)
CROSS SECTIONS
90-TH-232
STANDARD
-2.67 TO 0.639 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
8
90-TH-232

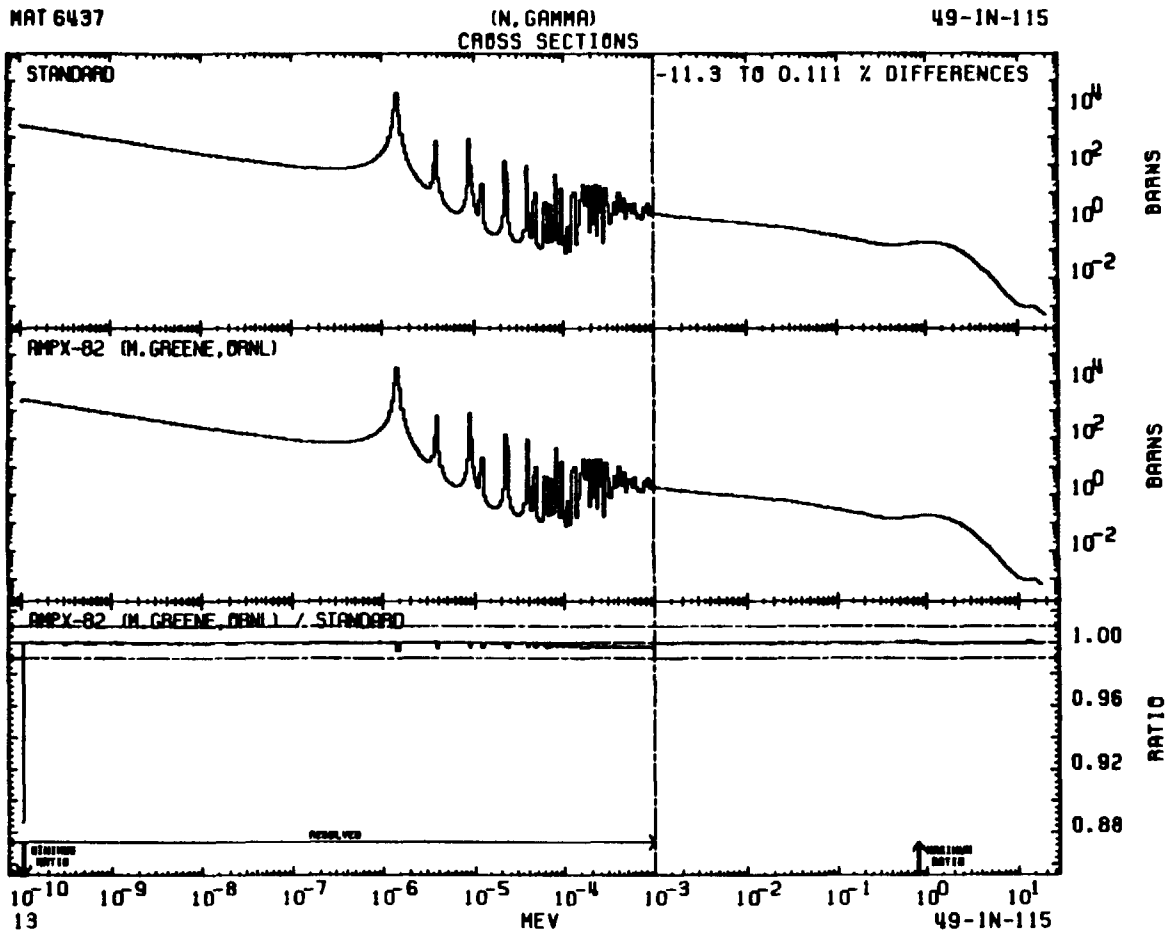

MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-6.46 TO 1.43 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
8
92-U -238


MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-17.5 TO 0.647 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
9
92-U -238


MAT 6432
(N,GAMMA)
CROSS SECTIONS
26-FE-58
STANDARD
-24.0 TO 0.106 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
11
26-FE-58


MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-1.37 TO 3.86 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
10
94-PU-239


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-10.1 TO 0.143 % DIFFERENCES
AMPX-82 (M.GREENE,ORNL)
AMPX-82 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
12
29-CU-63


MAT 6437
(N, GAMMA)
CROSS SECTIONS
49-IN-115
STANDARD
-11.3 TO 0.111 % DIFFERENCES
BARNS
AMPX-82 (M.GREENE,ORNL)
BARNS
AMPX-82 (M.GREENE,ORNL) / STANDARD
RATIO
1.00
0.96
0.92
0.88
MEV
13
49-IN-115

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=AMPX-83 (M.GREENE,ORNL)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2=AMPX OUTPUT...ENDF/B-V DOSIMETRY LIBRARY (M.GREENE, ORNL, 1983) 9000

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2
11-NA- 23	102	6311	*** NO COMPARISON ***									
13-AL- 27	103	6313	*** NO COMPARISON ***									
13-AL- 27	107	6313	*** NO COMPARISON ***									
25-MN- 55	16	6325	*** NO COMPARISON ***									
27-CO- 59	16	6327	6327	189	149	1.0600+ 7	2.0000+ 7	-0.003	0.003			
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-0.386	0.671			
27-CO- 59	107	6327	6327	291	251	5.5000+ 6	2.0000+ 7	-0.003	0.042			
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-0.445	1.574	*	8.69192- 2	8.82870- 2
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-0.289	0.445			
90-TH-232	18	6390	6390	861	821	5.0000+ 0	2.0000+ 7	-0.430	0.743			

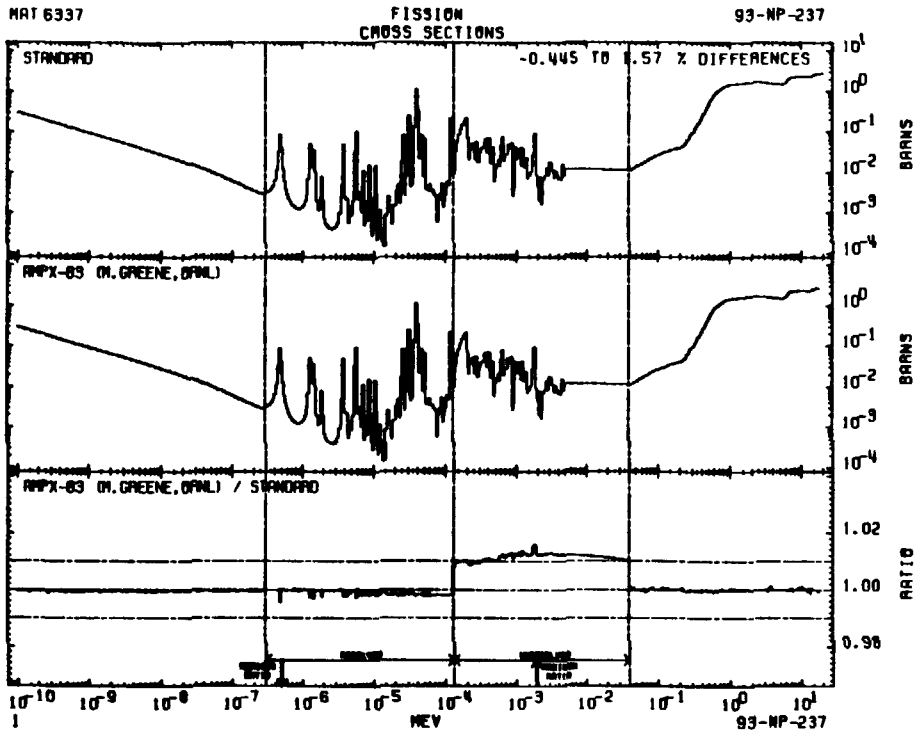
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 2 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 4.00000+ 3 EV.

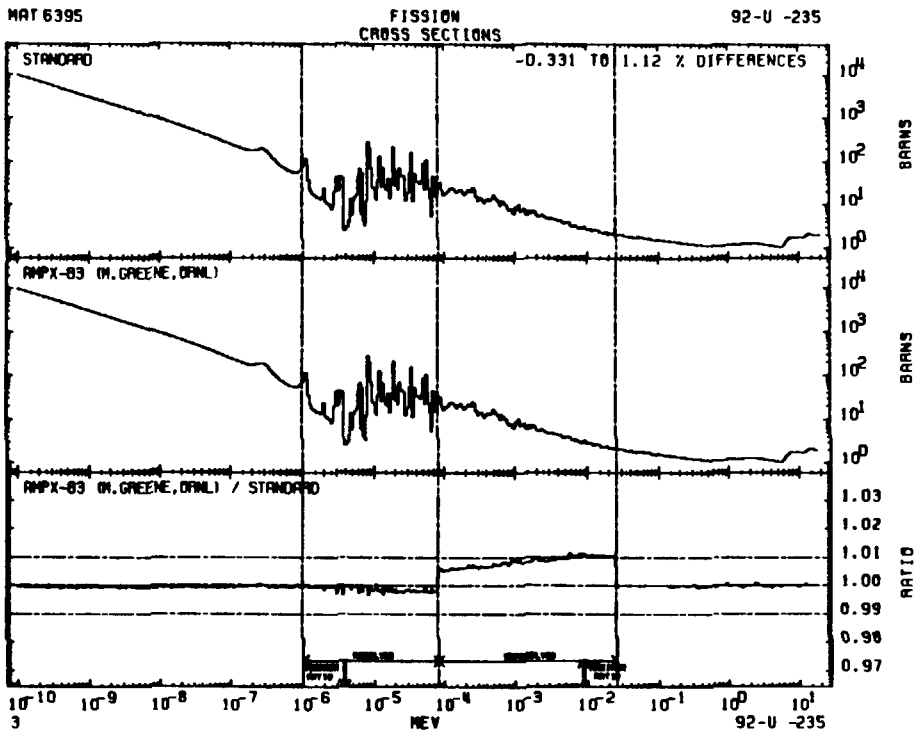
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-0.387	0.656			
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-0.331	1.120	*	3.10750+ 0	3.14230+ 0
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-0.388	1.418	*	2.85364- 7	2.89410- 7
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-0.389	0.661			
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-0.348	1.667	*	3.68446+ 0	3.74590+ 0
3-LI- 6	207	6424	*** NO COMPARISON ***									
5-B - 10	207	6425	*** NO COMPARISON ***									
21-SC- 45	102	6426	*** NO COMPARISON ***									
22-TI- 46	103	6427	*** NO COMPARISON ***									
22-TI- 47	28	6428	*** NO COMPARISON ***									
22-TI- 47	103	6428	*** NO COMPARISON ***									
22-TI- 48	28	6429	*** NO COMPARISON ***									
22-TI- 48	103	6429	*** NO COMPARISON ***									
26-FE- 54	103	6430	*** NO COMPARISON ***									
26-FE- 56	103	6431	*** NO COMPARISON ***									
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.343	0.106			
28-NI- 58	16	6433	*** NO COMPARISON ***									
28-NI- 58	103	6433	*** NO COMPARISON ***									
28-NI- 60	103	6434	*** NO COMPARISON ***									
29-CU- 63	102	6435	*** NO COMPARISON ***									
29-CU- 63	107	6435	*** NO COMPARISON ***									
29-CU- 65	16	6436	*** NO COMPARISON ***									
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.067	0.004			
49-IN-115	102	6437	*** NO COMPARISON ***									
53-I -127	16	6438	*** NO COMPARISON ***									
16-S - 32	103	6439	*** NO COMPARISON ***									

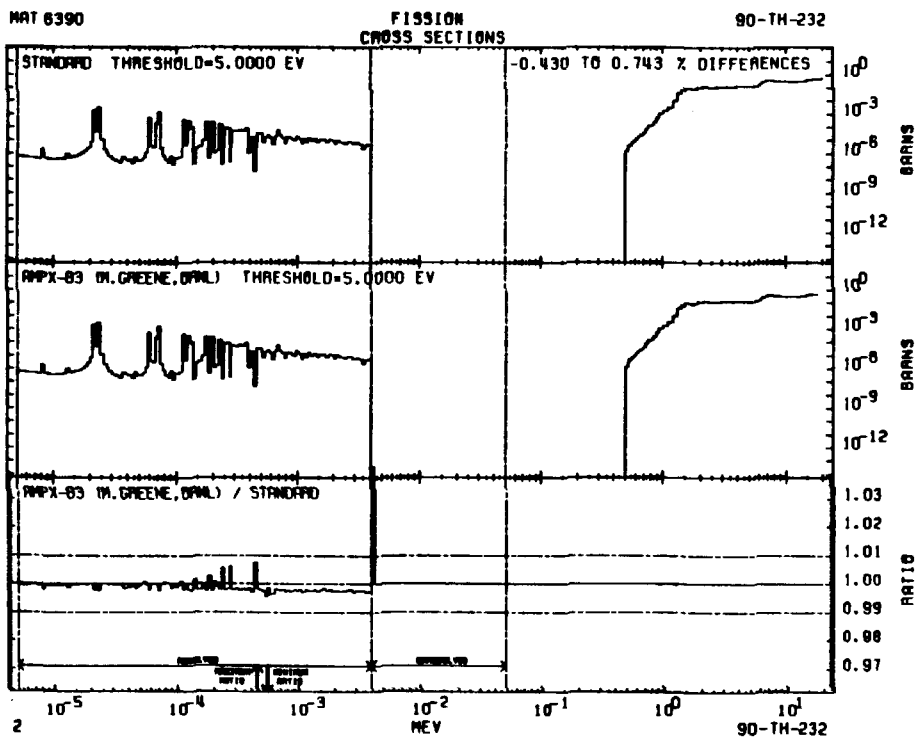
5 PLOTS GENERATED

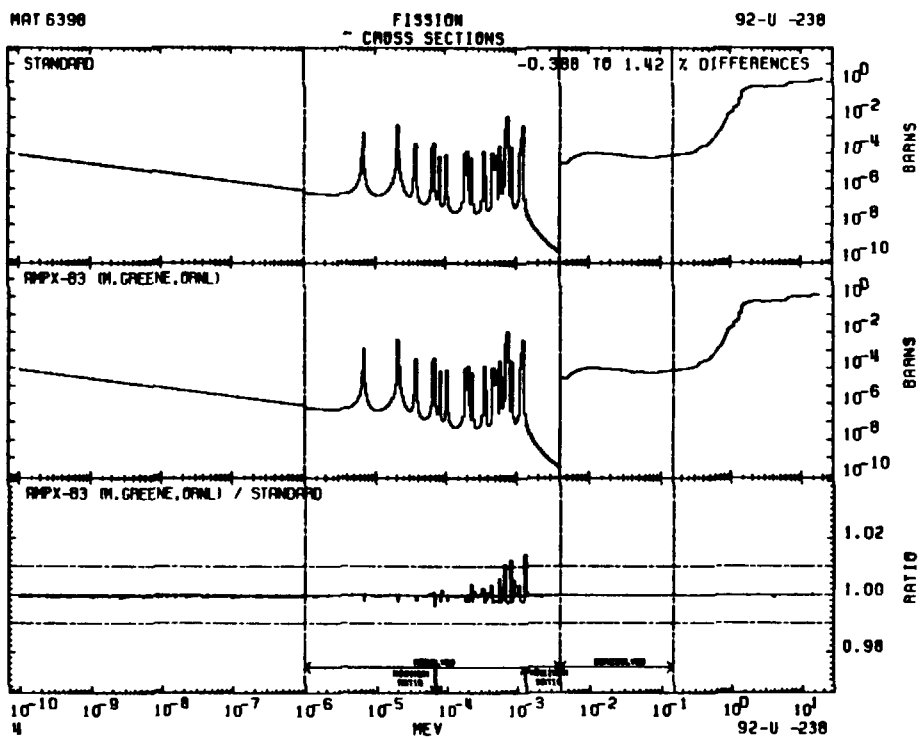
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

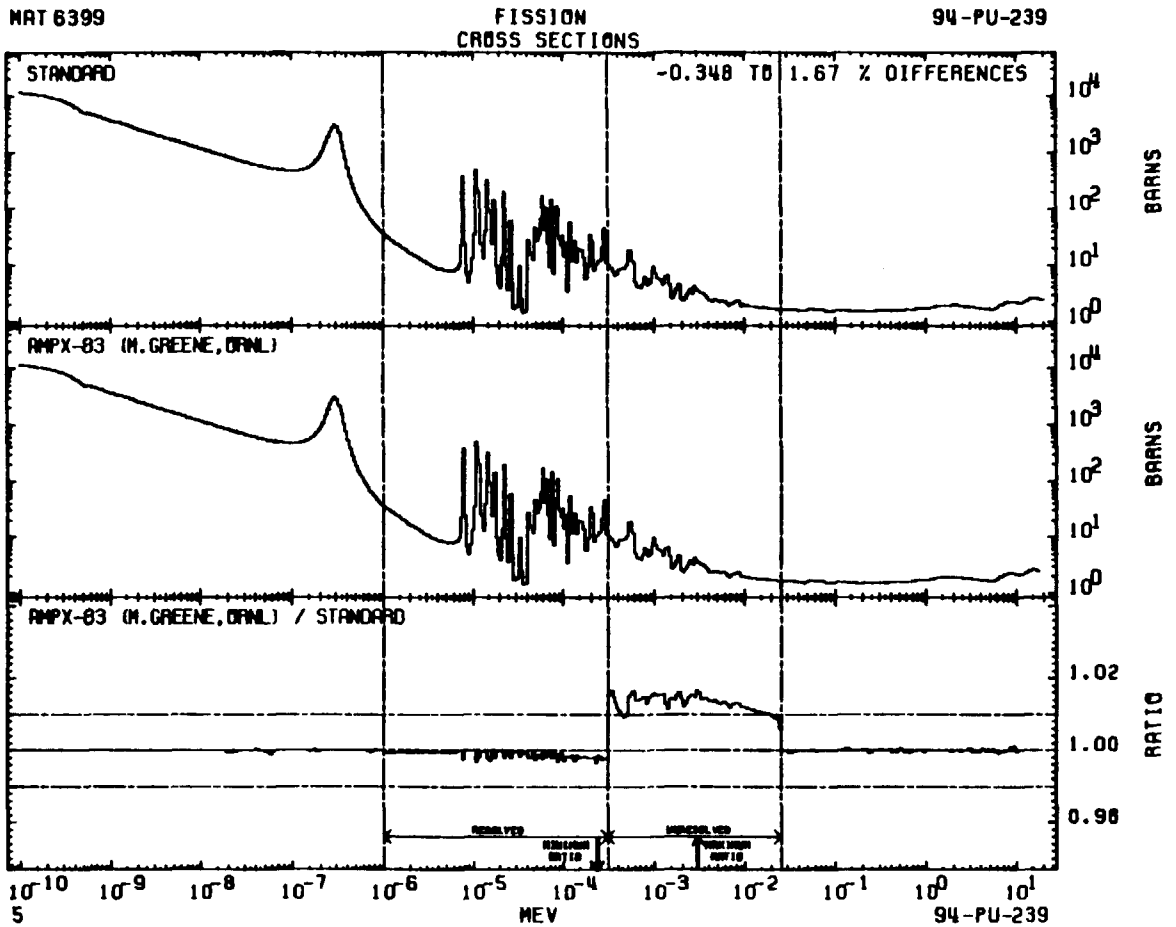
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS


MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-0.445 TO 1.57 % DIFFERENCES
AMPX-83 (M.GREENE,ORNL)
AMPX-83 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
1
93-NP-237


MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-0.331 TO 1.12 % DIFFERENCES
AMPX-83 (M.GREENE,ORNL)
AMPX-83 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
3
92-U -235


MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-0.430 TO 0.743 % DIFFERENCES
AMPX-83 (M.GREENE,ORNL) THRESHOLD=5.0000 EV
AMPX-83 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
2
90-TH-232


MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
% DIFFERENCES
AMPX-83 (M.GREENE,ORNL)
AMPX-83 (M.GREENE,ORNL) / STANDARD
BARNS
RATIO
MEV
4
92-U -238


MAT 6399
FISSION
CROSS SECTIONS
94-PU-239
STANDARD
-0.348 TO 1.67 % DIFFERENCES
AMPX-83 (M.GREENE,ORNL)
AMPX-83 (M.GREENE,ORNL) / STANDARD
BARNS
BARNS
RATIO
1.02
1.00
0.98
MEV
5
94-PU-239

MINX

MINX is a complete multigroup processing system which is designed to generate complete multigroup data sets for use in applications.

The MINX comparisons performed in 1983 indicate excellent agreement in the unresolved region and good agreement in the resolved region. The only major differences seen were for ^{238}U-capture and fission and ^{63}Cu-capture which appear to be due to an error in interpolating cross sections à la RESEND. The ^{197}Au-capture results at the resolved region boundary indicate a numerical instability in the multigroup averaging scheme used.

The error which led to the ^{238}U-capture and fission and ^{63}Cu-capture differences as well as the instability that led to the ^{197}Au-capture results have been reported to have been remedied in MINX. However, no later results were submitted for comparison.

COMPARISON OF EVALUATED DATA (COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=MINX-83 (J.WHITE,ORNL)

ENDF/B TAPE LABELS

DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD. 1) 9000
DATA2= MINX...ENDF/B-V DOSIMETRY LIBRARY (J.WHITE, ORNL) 9000

MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE		MAXIMUM PER-CENT DIFFERENCES POSITIVE		CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2		
11-NA- 23	102	6311	6311	1280	1240	1.0000- 4	2.0000+ 7	-1.302	*	0.375		1.54897- 3	1.52880- 3		
13-AL- 27	103	6313	6313	365	325	1.8000+ 6	2.0000+ 7	-0.170		0.163					
13-AL- 27	107	6313	6313	337	297	3.2000+ 6	2.0000+ 7	-0.180		0.158					
25-MN- 55	16	6325	6325	193	153	1.0400+ 7	2.0000+ 7	-0.055		0.099					
27-CO- 59	16	6327	6327	189	149	1.0600+ 7	2.0000+ 7	-0.000		0.000					
27-CO- 59	102	6327	6327	1280	1240	1.0000- 4	2.0000+ 7	-0.847		0.562					
27-CO- 59	107	6327	6327	291	251	5.5000+ 6	2.0000+ 7	-0.173		0.001					
93-NP-237	18	6337	6337	1280	1240	1.0000- 4	2.0000+ 7	-0.262		0.269					
79-AU-197	102	6379	6379	1280	1240	1.0000- 4	2.0000+ 7	-0.349		2017.561	*			1.22906+ 0	2.60261+ 1
90-TH-232	18	6390	6390	861	1240	1.0000- 4	2.0000+ 7	-0.882		0.434					

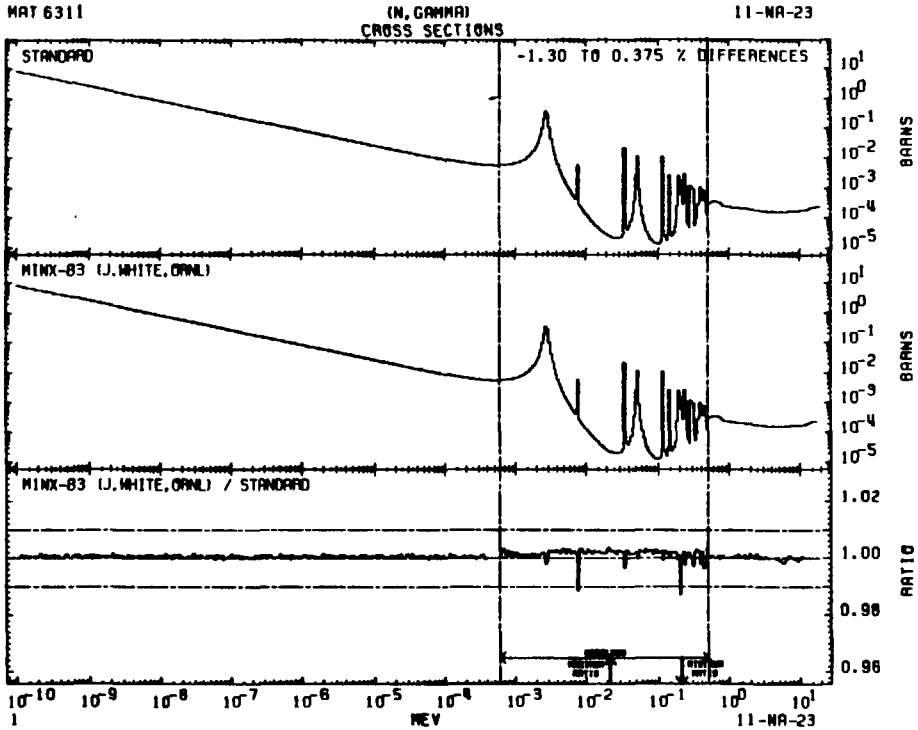
WARNING...FOR ABOVE COMPARISON COULD NOT DEFINE RATIO AT ALL ENERGIES.
DATA1 IS ZERO AT 422 ENERGIES WHERE DATA2 IS NON-ZERO.
FIRST OCCURRENCE AT 1.00000- 4 EV.

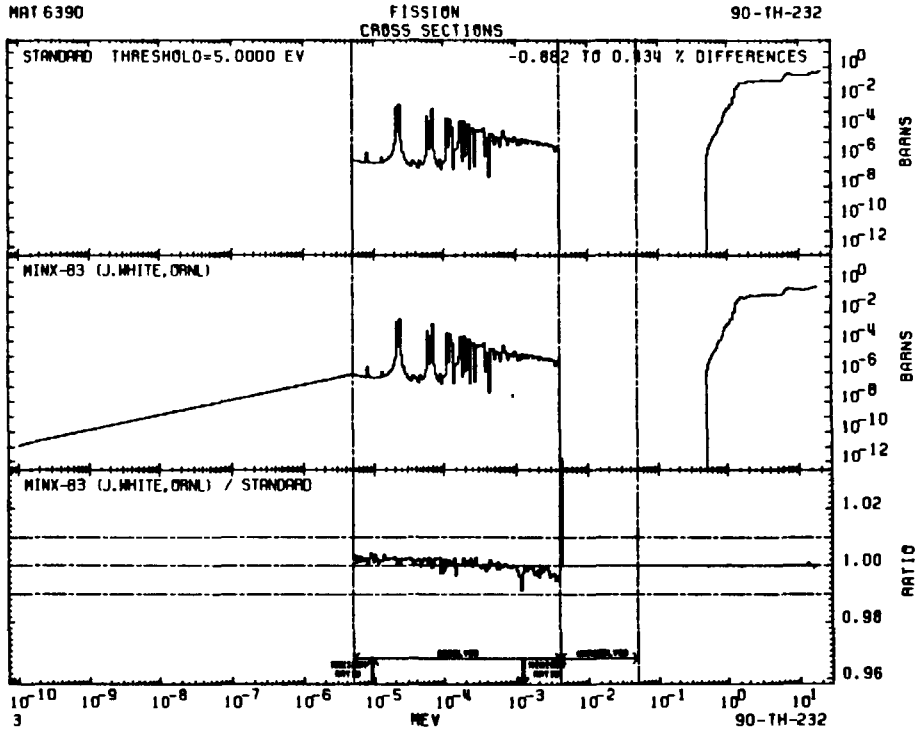
90-TH-232	102	6390	6390	1280	1240	1.0000- 4	2.0000+ 7	-0.767		0.250					
92-U -235	18	6395	6395	1280	1240	1.0000- 4	2.0000+ 7	-1.022	*	0.708		1.40193+ 1	1.38760+ 1		
92-U -238	18	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-5.123	*	14.912	*	5.12500- 5	4.86245- 5	4.32594- 7	4.97101- 7
92-U -238	102	6398	6398	1280	1240	1.0000- 4	2.0000+ 7	-2.092	*	12.869	*	9.75215- 1	9.54811- 1	1.84121- 1	2.07816- 1
94-PU-239	18	6399	6399	1280	1240	1.0000- 4	2.0000+ 7	-0.982		0.747					
3-LI- 6	207	6424	6424	1280	1240	1.0000- 4	2.0000+ 7	-0.142		0.180					
5-B - 10	207	6425	6425	1280	1240	1.0000- 4	2.0000+ 7	-0.129		0.184					
21-SC- 45	102	6426	6426	1280	1240	1.0000- 4	2.0000+ 7	-0.565		0.556					
22-TI- 46	103	6427	6427	369	329	1.6000+ 6	2.0000+ 7	-0.000		0.000					
22-TI- 47	28	6428	6428	189	149	1.0600+ 7	2.0000+ 7	-0.022		0.123					
22-TI- 47	103	6428	6428	1280	1240	1.0000- 4	2.0000+ 7	-0.024		0.002					
22-TI- 48	28	6429	6429	169	129	1.1600+ 7	2.0000+ 7	-0.064		0.138					
22-TI- 48	103	6429	6429	337	297	3.2000+ 6	2.0000+ 7	-0.000		0.001					
26-FE- 54	103	6430	6430	1280	1240	1.0000- 4	2.0000+ 7	-0.165		0.162					
26-FE- 56	103	6431	6431	343	303	2.9000+ 6	2.0000+ 7	-0.100		0.083					
26-FE- 58	102	6432	6432	1280	1240	1.0000- 4	2.0000+ 7	-0.879		0.560					
28-NI- 58	16	6433	6433	153	113	1.2400+ 7	2.0000+ 7	-0.000		0.000					
28-NI- 58	103	6433	6433	1280	1240	1.0000- 4	2.0000+ 7	-0.168		0.134					
28-NI- 60	103	6434	6434	351	311	2.5000+ 6	2.0000+ 7	-0.122		0.163					
29-CU- 63	102	6435	6435	1280	1240	1.0000- 4	2.0000+ 7	-0.090		93.065	*			1.07784- 2	2.08093- 2
29-CU- 63	107	6435	6435	367	327	1.7000+ 6	2.0000+ 7	-0.150		0.138					
29-CU- 65	16	6436	6436	201	161	1.0000+ 7	2.0000+ 7	-0.176		0.000					
49-IN-115	51	6437	6437	427	387	3.2000+ 5	2.0000+ 7	-0.200		0.158					
49-IN-115	102	6437	6437	1280	1240	1.0000- 4	2.0000+ 7	-0.447		0.565					
53-I -127	16	6438	6438	217	177	9.2000+ 6	2.0000+ 7	-0.149		0.081					
16-S - 32	103	6439	6439	385	345	9.2000+ 5	2.0000+ 7	-0.209		0.106					

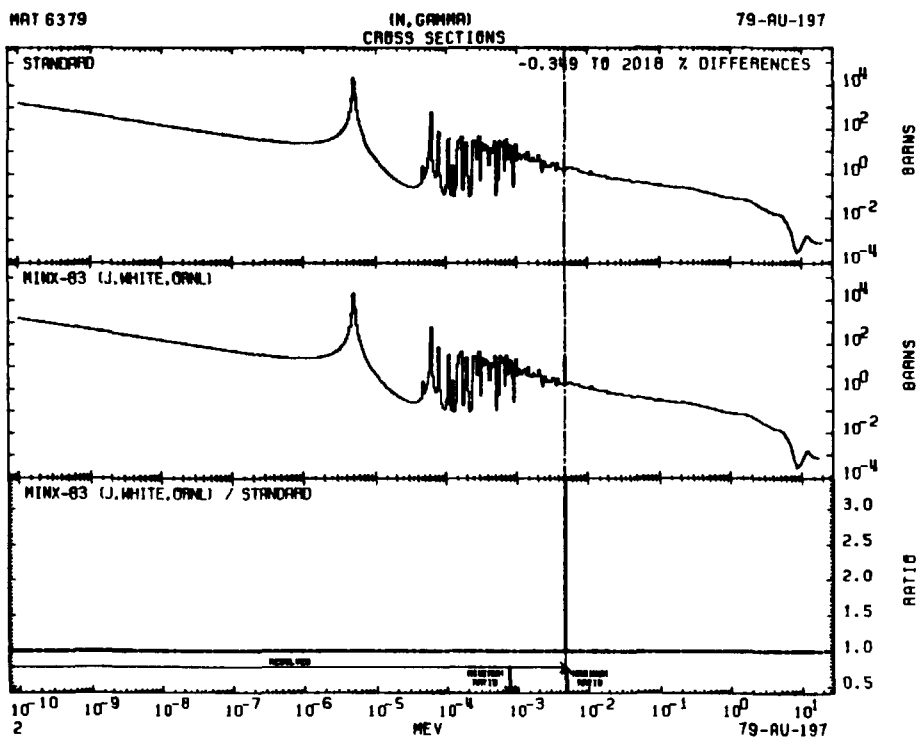
7 PLOTS GENERATED

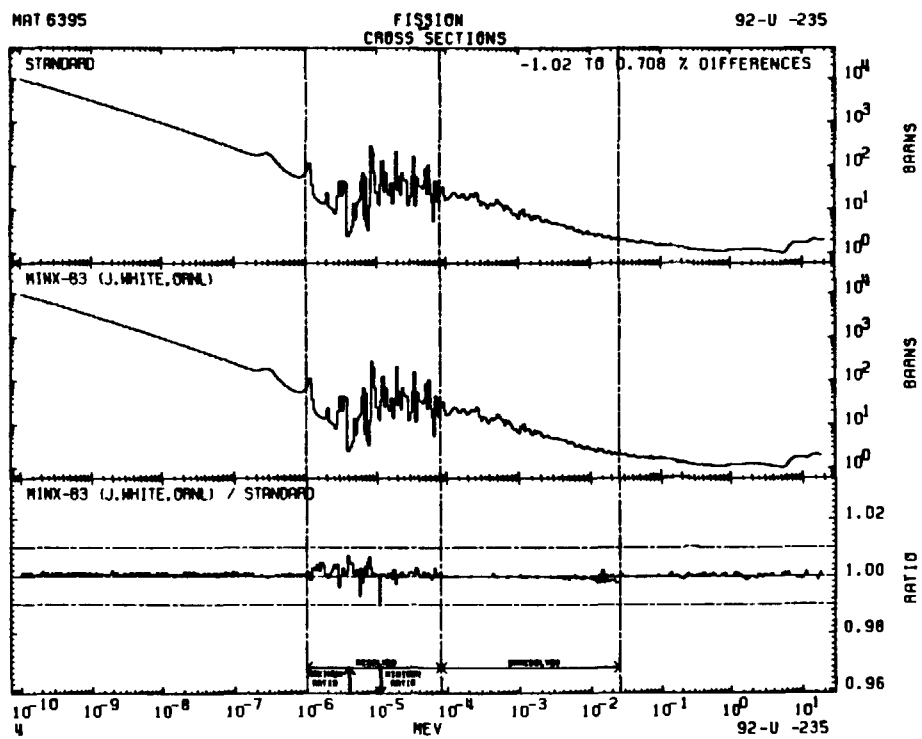
* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

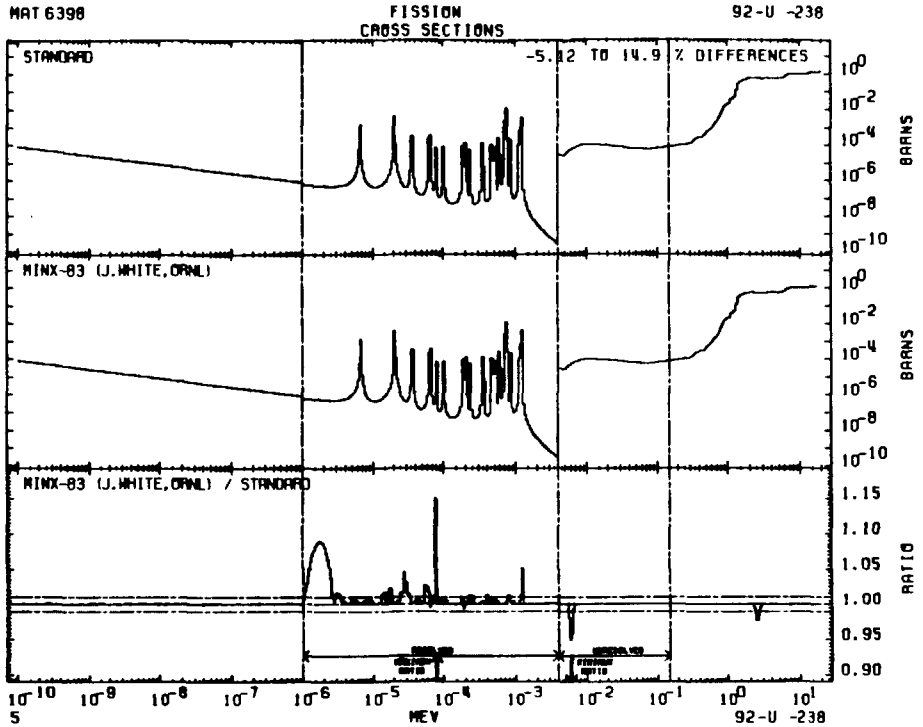
PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS

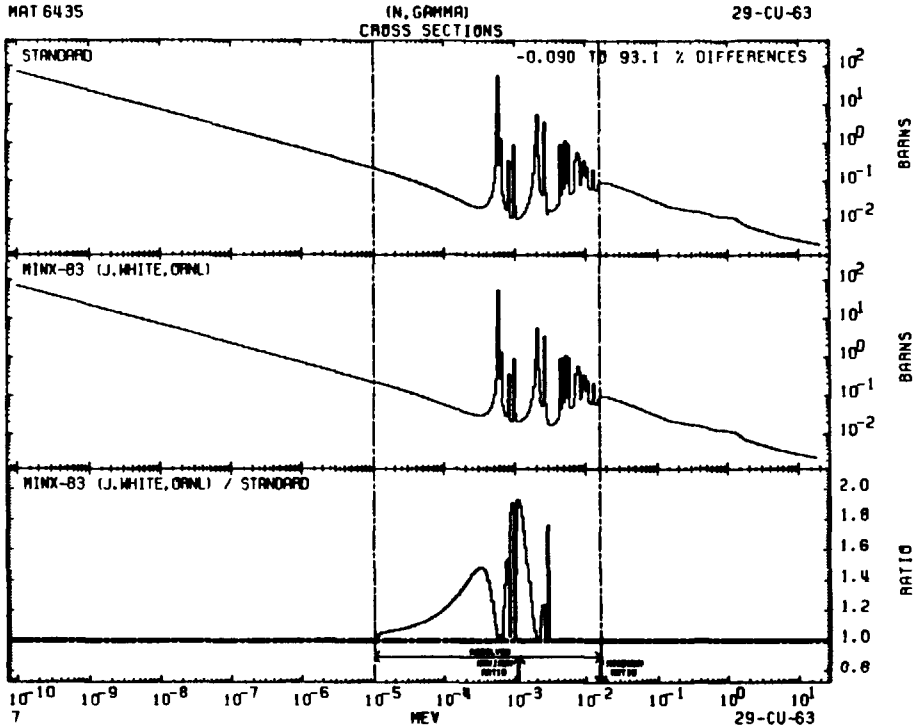

MAT 6311
(N,GAMMA)
CROSS SECTIONS
11-NA-23
STANDARD
-1.30 TO 0.375 % DIFFERENCES
MINX-83 (J.WHITE,ORNL)
MINX-83 (J.WHITE,ORNL) / STANDARD
BARNS
RATIO
MEV
1
11-NA-23

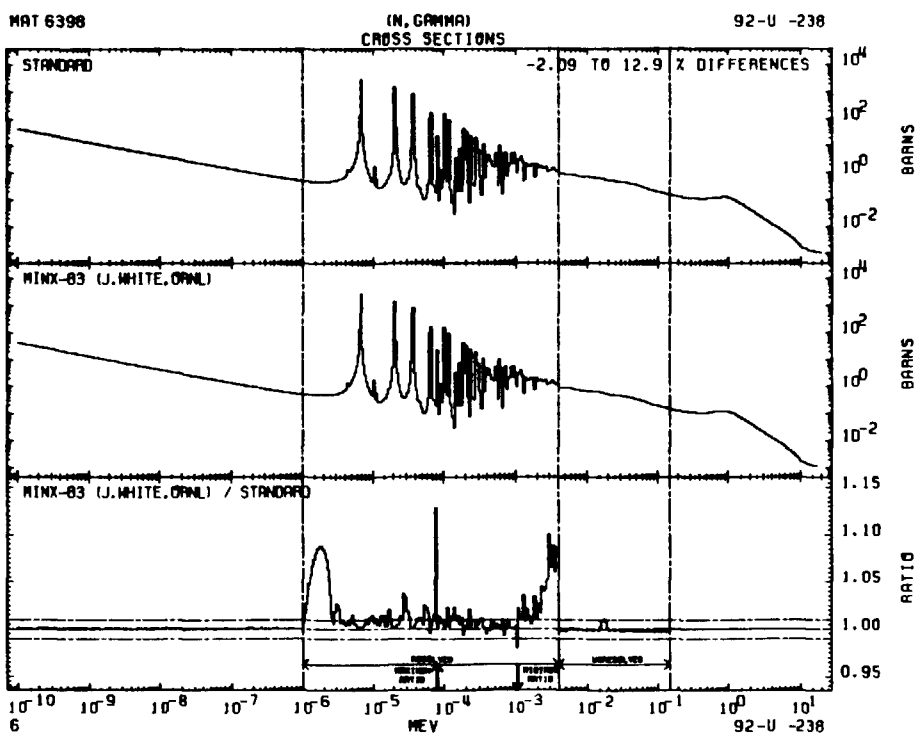

MAT 6390
FISSION
CROSS SECTIONS
90-TH-232
STANDARD THRESHOLD=5.0000 EV
-0.882 TO 0.434 % DIFFERENCES
MINX-83 (J.WHITE,ORNL)
MINX-83 (J.WHITE,ORNL) / STANDARD
BARNS
RATIO
MEV
3
90-TH-232


MAT 6379
(N,GAMMA)
CROSS SECTIONS
79-AU-197
STANDARD
-0.349 TO 2018 % DIFFERENCES
MINX-83 (J.WHITE,ORNL)
MINX-83 (J.WHITE,ORNL) / STANDARD
BARNS
RATIO
MEV
2
79-AU-197


MAT 6395
FISSION
CROSS SECTIONS
92-U -235
STANDARD
-1.02 TO 0.708 % DIFFERENCES
MINX-83 (J.WHITE,ORNL)
MINX-83 (J.WHITE,ORNL) / STANDARD
BARNS
RATIO
MEV
4
92-U -235


MAT 6398
FISSION
CROSS SECTIONS
92-U -238
STANDARD
-5.12 TO 14.9 % DIFFERENCES
MINX-83 (J.WHITE,ORNL)
MINX-83 (J.WHITE,ORNL) / STANDARD
BARNS
RATIO
MEV
5
92-U -238


MAT 6435
(N,GAMMA)
CROSS SECTIONS
29-CU-63
STANDARD
-0.090 TO 93.1 % DIFFERENCES
MINX-83 (J.WHITE,ORNL)
MINX-83 (J.WHITE,ORNL) / STANDARD
BARNS
RATIO
MEV
7
29-CU-63


MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-2.09 TO 12.9 % DIFFERENCES
MINX-83 (J.WHITE,ORNL)
MINX-83 (J.WHITE,ORNL) / STANDARD
BARNS
RATIO
MEV
6
92-U -238

GRUCON
======

GRUCON is designed to calculate complete sets of multigroup data for use in applications.

GRUCON results were submitted for only four reactions, and comparisons performed in 1983 to our benchmark results showed generally good agreement. In particular the ^{237}Np fission results indicate that GRUCON is using the ENDF/B-V convention to interpolate cross sections.

Unfortunately, since only four reactions were submitted for GRUCON even though the agreement for these four reactions is quite good it is not possible at this time to draw any conclusions regarding GRUCON's ability to reproduce the benchmark results for the entire ENDF/B-V Dosimetry library.

COMPARISON OF EVALUATED DATA (PROGRAM COMPLOT 84-2)

DATA IDENTIFICATIONS

DATA1=STANDARD
DATA2=GRUCON-83 (V.MANOKHIN,OBNINSK)

ENDF/B TAPE LABELS

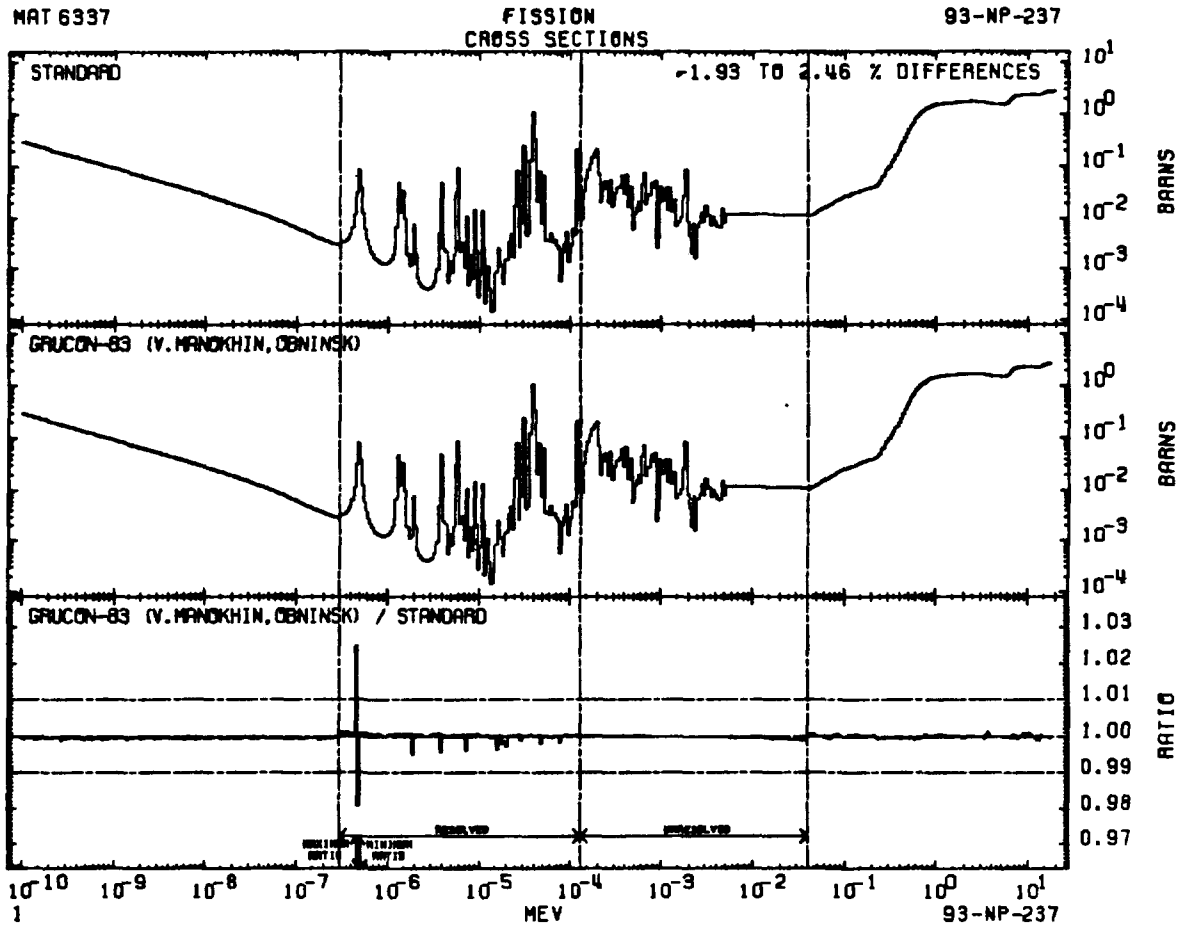
DATA1=IAEA PROCESSING CODE VERIFICATION PROJECT STANDARD (MOD.0) 9000
DATA2= GRUCON...ENDF/B-V DOSIMETRY LIBRARY (V.MANOKHIN,OBNINSK,1983) 9000

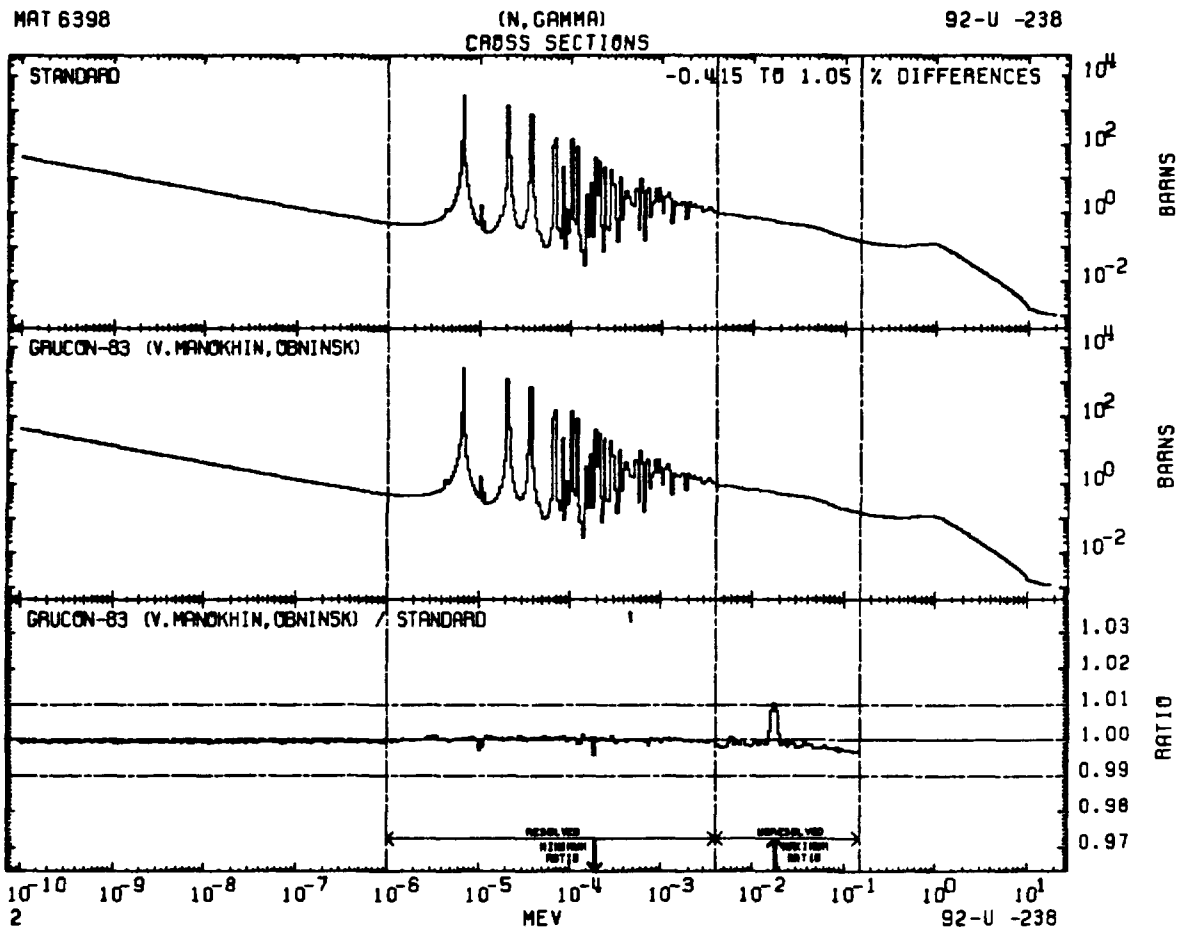
MATERIAL	MT	MAT1	MAT2	POINT1	POINT2	ENERGY RANGE (EV) MINIMUM	ENERGY RANGE (EV) MAXIMUM	MAXIMUM PER-CENT DIFFERENCES NEGATIVE	MAXIMUM PER-CENT DIFFERENCES POSITIVE	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA1	CROSS SECTION (BARNS) AT POINTS OF MAXIMUM PER-CENT DIFFERENCE DATA2	DATA1	DATA2
11-NA- 23	102	6311	*** NO COMPARISON ***										
13-AL- 27	103	6313	*** NO COMPARISON ***										
13-AL- 27	107	6313	*** NO COMPARISON ***										
25-MN- 55	16	6325	*** NO COMPARISON ***										
27-CO- 59	16	6327	*** NO COMPARISON ***										
27-CO- 59	102	6327	*** NO COMPARISON ***										
27-CO- 59	107	6327	*** NO COMPARISON ***										
93-NP-237	18	6337	6337	1280	1238	1.0000- 4	2.0000+ 7	-1.926 *	2.460 *	8.56108- 2	8.39617- 2	3.13213- 2	3.20919- 2
79-AU-197	102	6379	*** NO COMPARISON ***										
90-TH-232	18	6390	*** NO COMPARISON ***										
90-TH-232	102	6390	6390	1280	1238	1.0000- 4	2.0000+ 7	-0.383	0.109				
92-U -235	18	6395	*** NO COMPARISON ***										
92-U -238	18	6398	6398	1280	1238	1.0000- 4	2.0000+ 7	-0.413	0.739				
92-U -238	102	6398	6398	1280	1238	1.0000- 4	2.0000+ 7	-0.415	1.047 *			5.63688- 1	5.69588- 1
94-PU-239	18	6399	*** NO COMPARISON ***										
3-LI- 6	207	6424	*** NO COMPARISON ***										
5-B - 10	207	6425	*** NO COMPARISON ***										
21-SC- 45	102	6426	*** NO COMPARISON ***										
22-TI- 46	103	6427	*** NO COMPARISON ***										
22-TI- 47	28	6428	*** NO COMPARISON ***										
22-TI- 47	103	6428	*** NO COMPARISON ***										
22-TI- 48	28	6429	*** NO COMPARISON ***										
22-TI- 48	103	6429	*** NO COMPARISON ***										
26-FE- 54	103	6430	*** NO COMPARISON ***										
26-FE- 56	103	6431	*** NO COMPARISON ***										
26-FE- 58	102	6432	*** NO COMPARISON ***										
28-NI- 58	16	6433	*** NO COMPARISON ***										
28-NI- 58	103	6433	*** NO COMPARISON ***										
28-NI- 60	103	6434	*** NO COMPARISON ***										
29-CU- 63	102	6435	*** NO COMPARISON ***										
29-CU- 63	107	6435	*** NO COMPARISON ***										
29-CU- 65	16	6436	*** NO COMPARISON ***										
49-IN-115	51	6437	*** NO COMPARISON ***										
49-IN-115	102	6437	*** NO COMPARISON ***										
53-I -127	16	6438	*** NO COMPARISON ***										
16-S - 32	103	6439	*** NO COMPARISON ***										

2 PLOTS GENERATED

* - INDICATES DIFFERENCE EXCEEDS 1.00 PER-CENT

PER-CENT DIFFERENCE = 100 * ((DATA1-DATA2)/DATA1) AT EACH ENERGY POINT
MAXIMUM PER-CENT DIFFERENCE = LARGEST PER-CENT DIFFERENCE AT ANY ONE OR MORE ENERGY POINTS


MAT 6337
FISSION
CROSS SECTIONS
93-NP-237
STANDARD
-1.93 TO 2.46 % DIFFERENCES
GRUCON-83 (V.MANOKHIN,OBNINSK)
GRUCON-83 (V.MANOKHIN,OBNINSK) / STANDARD
BARNS
RATIO
MEV
1
93-NP-237


MAT 6398
(N,GAMMA)
CROSS SECTIONS
92-U -238
STANDARD
-0.415 TO 1.05 % DIFFERENCES
GRUCON-83 (V.MANOKHIN,OBNINSK)
GRUCON-83 (V.MANOKHIN,OBNINSK) / STANDARD
BARNS
RATIO
MEV
2
92-U -238

CONCLUSIONS

This report presents the results of the first step, or round, of verification comparisons. The first round of comparisons is intended to test the ability of processing codes to accurately produce, cold (0 Kelvin), unshielded, flat weighted multigroup cross sections; in principle this should be the simplest quantity that can be derived from evaluations. At present contributions to this project have been received from forty-two participants using thirteen different processing codes. In the initial comparisons not one participant has been able to obtain agreement with benchmark results; differences varied from 2% to a factor of over 50. However, this project has already in its initial phase been successful in detecting and correcting problems with a number of cross section processing codes and, in particular, has led to the practical result of identifying accurate codes and of improving the ENDF/B-V dosimetry library as distributed in 620 groups.

Of the thirteen cross section processing codes which participated in this project seven have been improved to the point where they can currently reproduce the benchmark results for the entire ENDF/B library (ENTOSAN, RECENT, FOURACES, RESENDD, FEDGROUP-C, NJOY AND AMPX). Based upon our experience in this project code comparisons can be used to easily identify and allow problems to be eliminated from codes. The fact that problems were found in every code which participated in this project indicates that all processing codes should participate in this project. Code users and designers are still encouraged to submit results for the first round of comparisons.

ACKNOWLEDGEMENTS

The author thanks Miss Sabine Schmied for preparing the text and figures which appear in this publication. The author thanks each of the forty-two participants who contributed results for this project. It is worth noting that even though the combined effort of the forty-two participants to perform calculations and correct processing codes involved several man-years of effort all participation in this project was on a voluntary basic and the entire project was conducted at no cost to the International Atomic Energy Agency.

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