INTERNATIONAL ATOMIC ENERGY AGENCY

INDC(SEC)-0107
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I N D C INTERNATIONAL NUCLEAR DATA COMMITTEE

GUIDELINES FOR NUCLEAR DATA VERIFICATION AND VALIDATION

Prepared by

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August 2005

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Produced by the IAEA in Austria
August 2005

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Abstract

The report describes the procedures for the verification of nuclear data files adopted at the IAEA-NDS. Part A addresses the basic evaluated nuclear data files. Part B refers to application libraries in ACE format for Monte Carlo calculations.

August 2005

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1. Evaluated nuclear data files

1.1 Objectives

1.1.1 General objectives

The main objective is to verify that the evaluated nuclear data files conform to ENDF format rules, that they are readable, complete, self-consistent and that they truly reflect the basic data from which they were generated.

1.1.2 Specific objectives

The main objective is achieved through the following:

- Verification of the formal correctness, and internal consistency of the file.
- Verification the cross sections by comparison to other libraries and experimental data in the EXFOR database.

1.2 Procedures

1.2.1 Verification of formal correctness and internal consistency

Verification of the formal correctness, and internal consistency of the file is achieved by running the ENDF Utility Codes available from the IAEA web server "http://www-nds.iaea.org". The following codes must be executed:

1. CHECKR to check for format errors.
2. FIZCON to check internal consistency of the data.
3. PSYCHE to perform additional checks of internal consistency of the data.

The user should be aware that the above verification procedure cannot trap all errors, but successful completion of the tests ensures with a high probability that the files are processable.

1.2.2 Verification by comparison with experimental data

Comparison of the data in an evaluated nuclear data file with other libraries and experimental data in the EXFOR database can be performed with the ENDVER package available from the IAEA on CD-ROM and can ordered on-line from the web server "http://www-nds.iaea.org". The procedures in ENDVER make extensive use of the ENDF Pre-Processing Codes, which are also available from the same address. The verification procedure for a single-material evaluation consists of the following steps:

1. Retrieve the experimental data and convert them to computational format.
2. Select evaluated data files for comparison and process them into pointwise representation.
3. Extract information from the ENDF files that can be compared to the experimental data and prepare graphic files.
4. View the graphic files and check for consistency.
5. Optionally, run COMPLOT of the ENDF Pre-Processing codes to compare pointwise ENDF file with some other file to which the tested file might closely relate. Note that such comparison only includes the cross section data.

The EXFOR database is an integral part of the ENDVER package. Tasks 1-4 can be done through a user-friendly graphics interface. See ENDVER documentation for additional details.

1.3 Output

For archival purposes the following information is required:

1. Comments or the scope of testing and justification for any deviation from the standard.
2. List file from CHECKR, FIZCON and PSYCHE.
3. List files from LINEAR, RECENT, LEGEND and SIXPAK.
4. List file from EXFOR retrieval.
5. Comparison plots for all reactions in the list file from the EXFOR retrieval.
6. Plots comparing two libraries with COMPLOT (if applicable).
7. Comments on any messages or discrepancies identified by the checking procedure.

For the interpretation of the messages from the checking codes and the Pre-Processing codes the original documentation should be consulted. In Appendix A, samples of list files corresponding to items 2, 4 and 5 are presented. Sample listings from item 3 are also part of the ACE library validation and can be seen in Appendix B.

Comparison plots under item 5 show ENDF/B-VI Release 8 (labelled “e68”) and JEFF-3.1 (labelled “f31”) nuclear data libraries.

2. Ace library for monte-carlo codes

2.1 Objectives

2.1.1 General objectives

The main objective is to verify that the files are complete, readable and that they truly reflect the basic data from which they were generated.

2.1.2 Specific objectives

The main objective is achieved by producing and archiving the following additional information:

- Listing of the summary of contents of the ACE file.
- Verification of the cross sections in the file by comparison with independently calculated set to check:
  - Cross section reconstruction from resonance parameters.
  - Interpolation linearisation tolerance.
- Verification of the cross sections by comparison to other libraries and experimental data in the EXFOR database (if not available for the source evaluated data file).

2.2 Procedures

2.2.1 Summary of contents of an ACE file

A summary of contents provides information on which reactions are present in the file and whether they include gamma-production data, gas production, radiation damage and dpa cross sections, etc. To produce the summary listing the ACELST code can be used, which is part of the SIGACE package of *Ace Library Support Utilities*, available from the IAEA web server "http://www-nds.iaea.org".

2.2.2 Cross section processing verification

The ACE libraries are generally produced by the NJOY nuclear data processing system. Although "ACE" stands for "*A Compact ENDF"*, there is nevertheless some data processing involved, which is susceptible to code errors. Verification of the cross section data by comparison to an independently processed data set may highlight possible errors due to:

- ACE file assembly.
- Data linearisation.
- Resonance reconstruction.
- Conversion of data representation for angular and energy distributions (where applicable).

For all intents and purposes we may consider the ENDF Pre-Processing codes to be independent of NJOY and suitable for the data verification tasks.

The above-listed checking tasks can be accomplished by executing the following sequence of codes:

1. Run the ACER module of NJOY in edit mode on the tested ACE file.
2. Run ACELST to generate the ACE file summary of contents and to convert the data as much as possible into pointwise ENDF format.
3. Retrieve the basic evaluated nuclear data file from which the ACE library was generated.
4. Run LINEAR on the tested file to linearise any non-linear interpolation laws.
5. Run RECENT on the output of LINEAR to reconstruct cross sections from the resonance parameters.
6. Run SIGMA1 on the output of RECENT to Doppler-broaden the cross sections to the same temperature that is specified in the ACE file.
7. Run FIXUP on the output of SIGMA1 to reconstruct the redundant cross sections.
8. Run COMPLOT to compare the output of ACELST and SIGMA1.
9. Optionally, run COMPLOT on FIXUP outputs generated from the tested ENDF file and some other file to which the tested file might closely relate.

Each of the tasks above serves a specific purpose and provides useful information:

- Re-running ACER makes use of the checking functions built into the ACER module

to check file integrity, correct small errors and provide diagnostic messages about possible problems in the file.

- The ACELST code provides a compact listing of the contents of the ACE file, which is useful when insufficient information is provided on how the file was generated.
- The COMPLOT comparison of the ACELST and SIGMA1 output can reveal any inconsistency in the redundant reactions. For example, the total cross section in the ACELST output from the ACE file is given by the sum of the partials, but in SIGMA1 it is calculated directly from the total cross section. An inconsistency in the resonance range might indicate that the implied competitive widths in the resonance parameters are inconsistent with the pointwise data in file MF3 for the competing reaction (usually the inelastic cross section).
- Special care is required in the interpretation of the comparison of ACELST and SIGMA1 output due to inherent differences between NJOY and the Pre-Pro codes. One of the crucial differences is the list of reactions and the upper energy cutoff to which Doppler-broadening is applied. Normally, NJOY performs Doppler broadening only for the total, elastic, capture and fission reactions up to the upper energy limit of the resonance range. This is generally a good and practical approach, since any structure above the resonance range results from high-resolution measurements at room temperature and does not require Doppler broadening from zero-Kelvin temperature. Note that threshold reactions are usually excluded from Doppler broadening in NJOY. On the contrary, Pre-Pro codes Doppler-broaden all cross sections over the entire energy range. The user must be very careful how he performs Doppler broadening to higher temperatures when strong resonance structure is given in the file above the resolved resonance range.

2.3 Output

For archival purposes the following information is required:

1. List file from the ACELST code to provide summary information on the contents of the analysed ACE file.
2. List file from COMPLOT comparing the contents of the ACE file with an equivalent file generated from the same source evaluated nuclear data file with the PrePro codes.
3. Plots generated by COMPLOT (if any) for the above comparison.
4. Comments on the observed discrepancies.

Batch procedures and programs for automated execution of the test sequence on Windows were developed and are available from the IAEA-NDS web site http://www-nds.iaea.org/ads/. An example of the integrated output file for archival is shown in Appendix B.

Test case refers to the verification of the ADS-Lib/V1.0 library based on uncorrected JEFF-3.1 data. For the full library and the updates see http://www-nds.iaea.org/ads/.

APPENDIX A

Sample list file from CHECKR

```
PROGRAM CHECKR VERSION 7.02                                Run on 25-Aug-2005

Input File Specification-----------------------fe057.end
Check the Entire File

TAPE BEING PROCESSED IS NUMBERED    1
    LABEL IS  FE-57 FROM JEFF-3.1

 CHECK MATERIAL 2634
```

Sample list file from FIZCON

```
PROGRAM FIZCON VERSION 7.02                                Run on 25-Aug-2005

Input File Specification-----------------------fe057.end
Check the Entire File
Sum Up Tests will be Omitted
Deviant Point Check will be Omitted
Consecutive Equal Value Check will be Omitted

TAPE BEING PROCESSED IS NUMBERED    1
   LABEL IS  FE-57 FROM JEFF-3.1

   CHECK MATERIAL 2634


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=600
     NO distribution given for total (n,p) cross section distribution
         with   4 subsections given for MT 600


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=601
     NO distribution given for total (n,p) cross section distribution
         with   2 subsections given for MT 601


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=602
     NO distribution given for total (n,p) cross section distribution
         with   3 subsections given for MT 602


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=603
     NO distribution given for total (n,p) cross section distribution
         with   3 subsections given for MT 603


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=604
     NO distribution given for total (n,p) cross section distribution
         with   3 subsections given for MT 604


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=605
     NO distribution given for total (n,p) cross section distribution
         with   3 subsections given for MT 605


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=606
     NO distribution given for total (n,p) cross section distribution
         with   3 subsections given for MT 606


  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=607
     NO distribution given for total (n,p) cross section distribution
         with   3 subsections given for MT 607
```

```
ERROR(S) FOUND IN MAT=2634, MF= 6, MT=608
   NO distribution given for total (n,p) cross section distribution
       with   3 subsections given for MT 608


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=609
   NO distribution given for total (n,p) cross section distribution
       with   3 subsections given for MT 609


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=610
   NO distribution given for total (n,p) cross section distribution
       with   3 subsections given for MT 610


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=649
   NO distribution given for total (n,p) cross section distribution
       with   3 subsections given for MT 649


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=800
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 800


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=801
   NO distribution given for total (n,alpha) cross section distribution
       with   2 subsections given for MT 801


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=802
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 802


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=803
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 803


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=804
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 804


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=805
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 805


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=806
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 806


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=807
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 807


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=808
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 808


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=809
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 809


ERROR(S) FOUND IN MAT=2634, MF= 6, MT=810
   NO distribution given for total (n,alpha) cross section distribution
       with   3 subsections given for MT 810
```

```
  ERROR(S) FOUND IN MAT=2634, MF= 6, MT=849
     NO distribution given for total (n,alpha) cross section distribution
         with   3 subsections given for MT 849
```

Sample list file from PSYCHE

```
PROGRAM PSYCHE VERSION 7.02                                Run on 25-Aug-2005

Input File Specification-----------------------fe057.end
Check the Entire File

TAPE BEING PROCESSED IS NUMBERED    1
    LABEL IS  FE-57 FROM JEFF-3.1

   CHECK MATERIAL 2634
                  (NO WARNINGS DETECTED IN SECTIONS WITHOUT COMMENTS)

-------------------------------------------------------------------------------
FILE  1
   SECTION 451
      26-Fe- 57 NRG        EVAL-OCT04 A.J. Koning
      NRG-2004             DIST-MAY05 REV0-MAY05          20050504
     ----JEF-31            MATERIAL 2634         REVISION 0
     -----INCIDENT NEUTRON DATA
     ------ENDF-6 FORMAT

-------------------------------------------------------------------------------
FILE  2
   SECTION 151


     ISOTOPE MASS =  57. L =  0

         TOTAL NUMBER OF RESONANCES IS                    21
         NUMBER OF RESONANCES IN THE ENERGY REGION ARE   21

         AT RESONANCE ENERGY  1.69000E+05 EV. THE GAMMA WIDTH  5.00000E-01 DEVIATES
TOO MUCH FROM THE AVERAGE    1.86143E+00
         AVERAGE REDUCED NEUTRON WIDTH IS  8.17159E+00
              THE NUMBER OF DEGREES OF FREEDOM IS  2.964 +OR- 0.776
         AVERAGE GAMMA WIDTH IS  1.86143E+00
              THE NUMBER OF DEGREES OF FREEDOM IS  4.812 +OR- 1.357
         AVERAGE LEVEL SPACING IS  1.00000E+04
         STRENGTH FUNCTION IS  4.55871E-04


     ISOTOPE MASS =  57. L =  1

         TOTAL NUMBER OF RESONANCES IS                    29
         NUMBER OF RESONANCES IN THE ENERGY REGION ARE   29

         AVERAGE REDUCED NEUTRON WIDTH IS  6.45447E-01
              THE NUMBER OF DEGREES OF FREEDOM IS  1.408 +OR- 0.243
         AVERAGE GAMMA WIDTH IS  3.98621E-01
              NU IS GREATER THAN 10.
         AVERAGE LEVEL SPACING IS  7.14286E+03
         STRENGTH FUNCTION IS  2.14951E-05

     CHECK ON ISOTOPE PROPERTIES

         ELEMENT NOT NATURALLY OCCURRING, NUCLIDE TESTS DISCONTINUED

-------------------------------------------------------------------------------
FILE  3
   SECTION   1

     THERMAL CROSS SECTIONS AND RESONANCE INTEGRALS
              E = THERMAL                                SIGMA   =  2.66445E+00

     RESONANCE REGION BOUNDARY TESTS
```

```
          E =  1.00000E-05                                SIGMA+  =  1.24055E+02

          E =  2.00000E+05                                SIGMA-  =  1.05073E+01
                                                          SIGMA+  =  6.93730E+00
SECTION   2

  THERMAL CROSS SECTIONS AND RESONANCE INTEGRALS
          E = THERMAL                                     SIGMA   =  2.02128E-01

  RESONANCE REGION BOUNDARY TESTS

          E =  1.00000E-05                                SIGMA+  =  2.02132E-01

          E =  2.00000E+05                                SIGMA-  =  8.90078E+00
                                                          SIGMA+  =  5.96620E+00
SECTION   3
SECTION   4
SECTION   5
SECTION  16
SECTION  17
SECTION  22
SECTION  24
SECTION  28
SECTION  32
SECTION  41
SECTION  51
SECTION  52
SECTION  53
SECTION  54
SECTION  55
SECTION  56
SECTION  57
SECTION  58
SECTION  59
SECTION  60
SECTION  61
SECTION  62
SECTION  63
SECTION  64
SECTION  65
SECTION  66
SECTION  67
SECTION  68
SECTION  69
SECTION  70
SECTION  91
SECTION 102

  THERMAL CROSS SECTIONS AND RESONANCE INTEGRALS
          E = THERMAL                                     SIGMA   =  2.46233E+00
          RESONANCE INTEGRAL, 0.5 EV CUTOFF IS                       1.42698E+00

  RESONANCE REGION BOUNDARY TESTS

          E =  1.00000E-05                                SIGMA+  =  1.23853E+02

          E =  2.00000E+05                                SIGMA-  =  5.54936E-04
                                                          SIGMA+  =  5.56329E-03
SECTION 103
SECTION 104
SECTION 105
SECTION 106
SECTION 107
SECTION 108
SECTION 111
SECTION 112
SECTION 600
SECTION 601
SECTION 602
SECTION 603
SECTION 604
SECTION 605
SECTION 606
```

```
   SECTION 607
   SECTION 608
   SECTION 609
   SECTION 610
   SECTION 649
   SECTION 650
   SECTION 651
   SECTION 652
   SECTION 653
   SECTION 654
   SECTION 655
   SECTION 699
   SECTION 700
   SECTION 701
   SECTION 702
   SECTION 703
   SECTION 704
   SECTION 705
   SECTION 749
   SECTION 750
   SECTION 751
   SECTION 752
   SECTION 753
   SECTION 754
   SECTION 755
   SECTION 799
   SECTION 800
   SECTION 801
   SECTION 802
   SECTION 803
   SECTION 804
   SECTION 805
   SECTION 806
   SECTION 807
   SECTION 808
   SECTION 809
   SECTION 810
   SECTION 849

--------------------------------------------------------------------------------
FILE  4
   SECTION   2

--------------------------------------------------------------------------------
FILE  6
   SECTION   5
     TOO MANY SUBSECTIONS, NK =  115 --UNION CHECK SUPRESSED
   SECTION  16

         ENERGY BALANCE SUMMARY: Q =  -7.64603E+06

                       TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
      E       AVAIL   %DIFF     SUM     00001     26056     00000
  7.78E+06  0.00E+00 ******  1.50E+00  1.00E+00  5.00E-01  0.00E+00
  7.80E+06  1.82E+04 142.88  4.42E+04  4.42E+04  5.00E-01  8.60E-01
  8.50E+06  7.06E+05   0.72  7.01E+05  7.01E+05  5.00E-01  3.33E+01
  9.50E+06  1.69E+06   1.13  1.67E+06  1.31E+06  5.00E-01  3.55E+05
  1.05E+07  2.67E+06   1.16  2.64E+06  1.99E+06  5.00E-01  6.53E+05
  1.15E+07  3.65E+06   1.14  3.61E+06  2.57E+06  5.00E-01  1.05E+06
  1.25E+07  4.64E+06   1.02  4.59E+06  2.97E+06  5.00E-01  1.62E+06
  1.35E+07  5.62E+06   0.93  5.57E+06  3.33E+06  5.00E-01  2.24E+06
  1.45E+07  6.60E+06   0.88  6.54E+06  3.71E+06  5.00E-01  2.84E+06
  1.60E+07  8.08E+06   0.85  8.01E+06  4.27E+06  5.00E-01  3.74E+06
  1.80E+07  1.00E+07   0.80  9.96E+06  4.98E+06  5.00E-01  4.98E+06
  2.00E+07  1.20E+07   0.79  1.19E+07  5.68E+06  5.00E-01  6.23E+06
  2.00E+08  1.89E+08  93.69  1.19E+07  5.68E+06  5.00E-01  6.23E+06

   SECTION  17

         ENERGY BALANCE SUMMARY: Q =  -1.88433E+07

                       TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
      E       AVAIL   %DIFF     SUM     00001     26055     00000
  1.92E+07  7.17E+01  97.21  2.00E+00  1.50E+00  5.00E-01  0.00E+00
```

```
2.00E+07  8.09E+05   2.84  8.32E+05  8.27E+05  5.00E-01  4.07E+03
2.00E+08  1.78E+08  99.53  8.32E+05  8.27E+05  5.00E-01  4.07E+03

 SECTION  22

       ENERGY BALANCE SUMMARY: Q =  -7.31998E+06

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     00001     02004     24053     00000
7.45E+06  0.00E+00 ******  1.50E+00  5.00E-01  5.00E-01  5.00E-01  0.00E+00
9.50E+06  2.01E+06   5.11  1.91E+06  9.20E+04  1.82E+06  5.00E-01  2.89E+00
1.05E+07  3.00E+06   5.92  2.82E+06  1.55E+05  2.66E+06  5.00E-01  4.86E+02
1.15E+07  3.98E+06   5.38  3.77E+06  2.35E+05  3.53E+06  5.00E-01  4.33E+03
1.25E+07  4.96E+06   4.76  4.73E+06  3.08E+05  4.40E+06  5.00E-01  1.66E+04
1.35E+07  5.95E+06   5.34  5.63E+06  4.18E+05  5.15E+06  5.00E-01  5.92E+04
1.45E+07  6.93E+06   5.72  6.53E+06  5.21E+05  5.87E+06  5.00E-01  1.39E+05
1.60E+07  8.40E+06   5.87  7.91E+06  6.85E+05  6.87E+06  5.00E-01  3.49E+05
1.80E+07  1.04E+07   5.57  9.79E+06  1.04E+06  7.80E+06  5.00E-01  9.51E+05
2.00E+07  1.23E+07   5.11  1.17E+07  1.41E+06  8.45E+06  5.00E-01  1.83E+06
2.00E+08  1.89E+08  93.82  1.17E+07  1.41E+06  8.45E+06  5.00E-01  1.83E+06

 SECTION  24

       ENERGY BALANCE SUMMARY: Q =  -1.52591E+07

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     00001     02004     24052     00000
1.55E+07  6.93E+01  97.11  2.00E+00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
1.80E+07  2.43E+06   4.12  2.33E+06  2.46E+05  2.08E+06  5.00E-01  0.00E+00
2.00E+07  4.39E+06   5.26  4.16E+06  8.10E+05  3.35E+06  5.00E-01  0.00E+00
2.00E+08  1.81E+08  97.70  4.16E+06  8.10E+05  3.35E+06  5.00E-01  0.00E+00

 SECTION  28

       ENERGY BALANCE SUMMARY: Q =  -1.05591E+07

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     00001     01001     25056     00000
1.07E+07  3.49E+01  95.70  1.50E+00  5.00E-01  5.00E-01  5.00E-01  0.00E+00
1.15E+07  7.41E+05   3.78  7.69E+05  3.91E+04  7.22E+05  5.00E-01  7.42E+03
1.25E+07  1.72E+06   1.38  1.70E+06  1.26E+05  1.53E+06  5.00E-01  4.78E+04
1.35E+07  2.71E+06   1.26  2.67E+06  2.46E+05  2.31E+06  5.00E-01  1.16E+05
1.45E+07  3.69E+06   1.46  3.63E+06  4.22E+05  3.01E+06  5.00E-01  2.01E+05
1.60E+07  5.16E+06   1.47  5.09E+06  7.99E+05  3.86E+06  5.00E-01  4.28E+05
1.80E+07  7.13E+06   1.41  7.03E+06  1.30E+06  4.70E+06  5.00E-01  1.03E+06
2.00E+07  9.09E+06   1.28  8.98E+06  1.67E+06  5.35E+06  5.00E-01  1.96E+06
2.00E+08  1.86E+08  95.17  8.98E+06  1.67E+06  5.35E+06  5.00E-01  1.96E+06

 SECTION  32

       ENERGY BALANCE SUMMARY: Q =  -1.56050E+07

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     00001     01002     25055     00000
1.59E+07  4.18E+01  96.41  1.50E+00  5.00E-01  5.00E-01  5.00E-01  0.00E+00
1.80E+07  2.08E+06   2.52  2.03E+06  1.33E+05  1.87E+06  5.00E-01  2.96E+04
2.00E+07  4.05E+06   2.72  3.94E+06  3.11E+05  3.57E+06  5.00E-01  5.93E+04
2.00E+08  1.81E+08  97.82  3.94E+06  3.11E+05  3.57E+06  5.00E-01  5.93E+04

 SECTION  41

       ENERGY BALANCE SUMMARY: Q =  -1.78296E+07

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     00001     01001     25055     00000
1.81E+07  3.11E+01  93.57  2.00E+00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
2.00E+07  1.82E+06   1.00  1.84E+06  4.50E+05  1.33E+06  5.00E-01  6.28E+04
2.00E+08  1.79E+08  98.97  1.84E+06  4.50E+05  1.33E+06  5.00E-01  6.28E+04

 SECTION  51
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  52
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
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 SECTION  53
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  54
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  55
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  56
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  57
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  58
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  59
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  60
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  61
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  62
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  63
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  64
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  65
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  66
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  67
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  68
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  69
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  70
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION  91

       ENERGY BALANCE SUMMARY: Q =   0.00000E+00

                     TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM      00001     26057     00000
2.37E+06  2.33E+06 100.00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
2.60E+06  2.55E+06  45.99  1.38E+06  1.39E+05  5.00E-01  1.24E+06
3.00E+06  2.95E+06  35.24  1.91E+06  3.66E+05  5.00E-01  1.54E+06
3.40E+06  3.34E+06  27.36  2.43E+06  5.96E+05  5.00E-01  1.83E+06
3.80E+06  3.73E+06  21.87  2.92E+06  8.10E+05  5.00E-01  2.11E+06
4.20E+06  4.13E+06  18.85  3.35E+06  9.64E+05  5.00E-01  2.38E+06
4.60E+06  4.52E+06  16.02  3.80E+06  1.13E+06  5.00E-01  2.67E+06
5.00E+06  4.91E+06  13.39  4.26E+06  1.28E+06  5.00E-01  2.97E+06
5.40E+06  5.31E+06  11.23  4.71E+06  1.44E+06  5.00E-01  3.27E+06
5.80E+06  5.70E+06   9.53  5.16E+06  1.57E+06  5.00E-01  3.58E+06
6.20E+06  6.09E+06   8.19  5.59E+06  1.70E+06  5.00E-01  3.89E+06
6.60E+06  6.49E+06   6.54  6.06E+06  1.85E+06  5.00E-01  4.21E+06
7.00E+06  6.88E+06   5.42  6.51E+06  1.97E+06  5.00E-01  4.53E+06
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7.40E+06	7.27E+06	5.72	6.86E+06	1.99E+06	5.00E-01	4.87E+06
7.80E+06	7.66E+06	4.78	7.30E+06	2.10E+06	5.00E-01	5.20E+06
8.50E+06	8.35E+06	3.59	8.05E+06	2.38E+06	5.00E-01	5.67E+06
9.50E+06	9.33E+06	3.41	9.02E+06	2.95E+06	5.00E-01	6.07E+06
1.05E+07	1.03E+07	4.14	9.89E+06	3.72E+06	5.00E-01	6.17E+06
1.15E+07	1.13E+07	4.53	1.08E+07	4.72E+06	5.00E-01	6.07E+06
1.25E+07	1.23E+07	5.06	1.17E+07	5.82E+06	5.00E-01	5.84E+06
1.35E+07	1.33E+07	5.46	1.25E+07	7.00E+06	5.00E-01	5.54E+06
1.45E+07	1.42E+07	5.70	1.34E+07	8.19E+06	5.00E-01	5.24E+06
1.60E+07	1.57E+07	5.61	1.48E+07	9.93E+06	5.00E-01	4.90E+06
1.80E+07	1.77E+07	5.19	1.68E+07	1.21E+07	5.00E-01	4.70E+06
2.00E+07	1.97E+07	4.75	1.87E+07	1.41E+07	5.00E-01	4.63E+06
2.00E+08	1.97E+08	90.48	1.87E+07	1.41E+07	5.00E-01	4.63E+06

SECTION 102

ENERGY BALANCE SUMMARY: Q = 1.00445E+07

		TOTAL	SECONDARY	ENERGY BY EMITTED PARTICLE	
E	AVAIL	%DIFF	SUM	26058	00000
1.00E-05	1.00E+07	45.85	5.44E+06	5.00E-01	5.44E+06
2.53E-02	1.00E+07	45.85	5.44E+06	5.00E-01	5.44E+06
2.00E+02	1.00E+07	45.85	5.44E+06	5.00E-01	5.44E+06
2.00E+03	1.00E+07	46.35	5.39E+06	5.00E-01	5.39E+06
1.00E+04	1.01E+07	48.24	5.20E+06	5.00E-01	5.20E+06
5.00E+04	1.01E+07	48.16	5.23E+06	5.00E-01	5.23E+06
2.00E+05	1.02E+07	48.57	5.27E+06	5.00E-01	5.27E+06
4.00E+05	1.04E+07	47.86	5.44E+06	5.00E-01	5.44E+06
6.00E+05	1.06E+07	47.05	5.63E+06	5.00E-01	5.63E+06
8.00E+05	1.08E+07	46.83	5.76E+06	5.00E-01	5.76E+06
1.00E+06	1.10E+07	46.52	5.90E+06	5.00E-01	5.90E+06
1.40E+06	1.14E+07	46.35	6.13E+06	5.00E-01	6.13E+06
1.80E+06	1.18E+07	46.26	6.35E+06	5.00E-01	6.35E+06
2.20E+06	1.22E+07	46.36	6.55E+06	5.00E-01	6.55E+06
2.60E+06	1.26E+07	47.00	6.68E+06	5.00E-01	6.68E+06
3.00E+06	1.30E+07	47.38	6.84E+06	5.00E-01	6.84E+06
3.40E+06	1.34E+07	47.78	6.99E+06	5.00E-01	6.99E+06
3.80E+06	1.38E+07	48.46	7.10E+06	5.00E-01	7.10E+06
4.20E+06	1.42E+07	49.12	7.21E+06	5.00E-01	7.21E+06
4.60E+06	1.46E+07	50.09	7.27E+06	5.00E-01	7.27E+06
5.00E+06	1.50E+07	51.20	7.30E+06	5.00E-01	7.30E+06
5.40E+06	1.54E+07	52.21	7.34E+06	5.00E-01	7.34E+06
5.80E+06	1.57E+07	53.97	7.25E+06	5.00E-01	7.25E+06
6.20E+06	1.61E+07	55.58	7.17E+06	5.00E-01	7.17E+06
6.60E+06	1.65E+07	57.71	6.99E+06	5.00E-01	6.99E+06
7.00E+06	1.69E+07	59.93	6.78E+06	5.00E-01	6.78E+06
7.40E+06	1.73E+07	61.68	6.64E+06	5.00E-01	6.64E+06
7.80E+06	1.77E+07	63.67	6.43E+06	5.00E-01	6.43E+06
8.50E+06	1.84E+07	67.41	6.00E+06	5.00E-01	6.00E+06
9.50E+06	1.94E+07	71.23	5.58E+06	5.00E-01	5.58E+06
1.05E+07	2.04E+07	73.37	5.42E+06	5.00E-01	5.42E+06
1.15E+07	2.13E+07	74.01	5.55E+06	5.00E-01	5.55E+06
1.25E+07	2.23E+07	73.34	5.95E+06	5.00E-01	5.95E+06
1.35E+07	2.33E+07	72.18	6.48E+06	5.00E-01	6.48E+06
1.45E+07	2.43E+07	71.00	7.04E+06	5.00E-01	7.04E+06
1.60E+07	2.58E+07	69.80	7.78E+06	5.00E-01	7.78E+06
1.80E+07	2.77E+07	70.29	8.24E+06	5.00E-01	8.24E+06
2.00E+07	2.97E+07	72.79	8.08E+06	5.00E-01	8.08E+06
2.00E+08	2.07E+08	96.09	8.08E+06	5.00E-01	8.08E+06

SECTION 108

ENERGY BALANCE SUMMARY: Q = -5.52836E+06

		TOTAL	SECONDARY	ENERGY BY EMITTED PARTICLE		
E	AVAIL	%DIFF	SUM	02004	22050	00000
5.63E+06	0.00E+00	******	1.50E+00	1.00E+00	5.00E-01	0.00E+00
1.05E+07	4.79E+06	6.16	4.49E+06	4.49E+06	5.00E-01	9.38E+00
1.15E+07	5.77E+06	6.39	5.40E+06	5.40E+06	5.00E-01	1.13E+01
1.25E+07	6.75E+06	6.64	6.31E+06	6.31E+06	5.00E-01	1.32E+01
1.35E+07	7.74E+06	6.26	7.25E+06	7.25E+06	5.00E-01	1.38E+02
1.45E+07	8.72E+06	6.28	8.17E+06	8.17E+06	5.00E-01	1.12E+03
1.60E+07	1.02E+07	6.62	9.52E+06	9.51E+06	5.00E-01	1.18E+04
1.80E+07	1.22E+07	6.83	1.13E+07	1.12E+07	5.00E-01	8.50E+04

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2.00E+07  1.41E+07   6.84  1.32E+07  1.29E+07  5.00E-01  3.01E+05
2.00E+08  1.91E+08  93.11  1.32E+07  1.29E+07  5.00E-01  3.01E+05

 SECTION 111

       ENERGY BALANCE SUMMARY: Q =  -1.13937E+07

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     01001     24056     00000
1.16E+07  4.89E+01  96.93  1.50E+00  1.00E+00  5.00E-01  0.00E+00
1.35E+07  1.87E+06   1.64  1.84E+06  1.84E+06  5.00E-01  8.47E+01
1.45E+07  2.85E+06   1.65  2.81E+06  2.81E+06  5.00E-01  1.29E+02
1.60E+07  4.33E+06   1.64  4.26E+06  4.23E+06  5.00E-01  2.94E+04
1.80E+07  6.29E+06   1.63  6.19E+06  5.88E+06  5.00E-01  3.12E+05
2.00E+07  8.26E+06   1.51  8.13E+06  7.25E+06  5.00E-01  8.84E+05
2.00E+08  1.85E+08  95.61  8.13E+06  7.25E+06  5.00E-01  8.84E+05

 SECTION 112

       ENERGY BALANCE SUMMARY: Q =  -9.97366E+06

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     01001     02004     23053     00000
1.02E+07  4.63E+01  96.76  1.50E+00  5.00E-01  5.00E-01  5.00E-01  0.00E+00
1.35E+07  3.29E+06   4.04  3.16E+06  1.01E+06  2.12E+06  5.00E-01  2.72E+04
1.45E+07  4.27E+06   4.91  4.06E+06  1.33E+06  2.70E+06  5.00E-01  3.53E+04
1.60E+07  5.75E+06   4.83  5.47E+06  1.79E+06  3.63E+06  5.00E-01  5.26E+04
1.80E+07  7.71E+06   4.79  7.34E+06  2.45E+06  4.80E+06  5.00E-01  9.14E+04
2.00E+07  9.68E+06   4.88  9.21E+06  3.07E+06  5.93E+06  5.00E-01  2.04E+05
2.00E+08  1.87E+08  95.07  9.21E+06  3.07E+06  5.93E+06  5.00E-01  2.04E+05

 SECTION 600
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
    NO GAMMAS

 SECTION 601
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 602
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 603
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 604
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 605
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 606
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 607
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 608
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 609
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 610
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 649

       ENERGY BALANCE SUMMARY: Q =  -1.90850E+06

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     01001     25057     00000
3.59E+06  1.62E+06 100.00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
4.20E+06  2.22E+06  66.92  7.34E+05  5.84E+05  5.00E-01  1.50E+05
4.60E+06  2.61E+06  57.56  1.11E+06  8.60E+05  5.00E-01  2.48E+05
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5.00E+06  3.00E+06  47.02  1.59E+06  1.21E+06  5.00E-01  3.77E+05
5.40E+06  3.40E+06  37.84  2.11E+06  1.56E+06  5.00E-01  5.53E+05
5.80E+06  3.79E+06  31.35  2.60E+06  1.85E+06  5.00E-01  7.57E+05
6.20E+06  4.18E+06  24.75  3.15E+06  2.18E+06  5.00E-01  9.72E+05
6.60E+06  4.58E+06  19.61  3.68E+06  2.49E+06  5.00E-01  1.19E+06
7.00E+06  4.97E+06  15.37  4.21E+06  2.80E+06  5.00E-01  1.41E+06
7.40E+06  5.36E+06  12.24  4.71E+06  3.08E+06  5.00E-01  1.63E+06
7.80E+06  5.76E+06   8.42  5.27E+06  3.43E+06  5.00E-01  1.84E+06
8.50E+06  6.44E+06   7.54  5.96E+06  3.72E+06  5.00E-01  2.24E+06
9.50E+06  7.43E+06   4.96  7.06E+06  4.21E+06  5.00E-01  2.84E+06
1.05E+07  8.41E+06   3.51  8.11E+06  4.60E+06  5.00E-01  3.52E+06
1.15E+07  9.39E+06   2.68  9.14E+06  4.90E+06  5.00E-01  4.24E+06
1.25E+07  1.04E+07   2.19  1.01E+07  5.16E+06  5.00E-01  4.99E+06
1.35E+07  1.14E+07   1.90  1.11E+07  5.47E+06  5.00E-01  5.67E+06
1.45E+07  1.23E+07   1.79  1.21E+07  6.04E+06  5.00E-01  6.08E+06
1.60E+07  1.38E+07   1.91  1.35E+07  7.35E+06  5.00E-01  6.20E+06
1.80E+07  1.58E+07   2.06  1.55E+07  9.42E+06  5.00E-01  6.03E+06
2.00E+07  1.77E+07   2.04  1.74E+07  1.15E+07  5.00E-01  5.93E+06
2.00E+08  1.95E+08  91.07  1.74E+07  1.15E+07  5.00E-01  5.93E+06

 SECTION 650
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
    NO GAMMAS

 SECTION 651
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 652
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 653
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 654
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 655
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 699

       ENERGY BALANCE SUMMARY: Q =  -8.33455E+06

                    TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     01002     25056     00000
8.82E+06  3.36E+05 100.00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
9.50E+06  1.00E+06  35.45  6.46E+05  5.79E+05  5.00E-01  6.69E+04
1.05E+07  1.98E+06  16.65  1.65E+06  1.48E+06  5.00E-01  1.72E+05
1.15E+07  2.97E+06  10.02  2.67E+06  2.36E+06  5.00E-01  3.13E+05
1.25E+07  3.95E+06   7.33  3.66E+06  3.32E+06  5.00E-01  3.41E+05
1.35E+07  4.93E+06   5.36  4.67E+06  3.98E+06  5.00E-01  6.86E+05
1.45E+07  5.91E+06   4.41  5.65E+06  4.56E+06  5.00E-01  1.09E+06
1.60E+07  7.39E+06   3.65  7.12E+06  5.42E+06  5.00E-01  1.70E+06
1.80E+07  9.35E+06   3.13  9.06E+06  6.55E+06  5.00E-01  2.51E+06
2.00E+07  1.13E+07   4.22  1.08E+07  7.62E+06  5.00E-01  3.22E+06
2.00E+08  1.88E+08  94.24  1.08E+07  7.62E+06  5.00E-01  3.22E+06

 SECTION 700
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
    NO GAMMAS

 SECTION 701
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
   GAMMA ERROR  E= 9.6416E+06  EBAR= 1.2595E+05  QI=-9.4737E+06
   GAMMA ERROR  E= 2.0000E+08  EBAR= 1.2595E+05  QI=-9.4737E+06

 SECTION 702
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 703
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 704
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
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 SECTION 705
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 749

       ENERGY BALANCE SUMMARY: Q =  -9.34780E+06

                     TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     01003     25055     00000
1.08E+07  1.29E+06 100.00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
1.25E+07  2.93E+06  41.14  1.73E+06  1.47E+06  5.00E-01  2.60E+05
1.35E+07  3.92E+06  28.45  2.80E+06  2.33E+06  5.00E-01  4.78E+05
1.45E+07  4.90E+06  20.75  3.88E+06  3.14E+06  5.00E-01  7.47E+05
1.60E+07  6.37E+06  13.83  5.49E+06  4.15E+06  5.00E-01  1.34E+06
1.80E+07  8.34E+06   9.13  7.58E+06  5.23E+06  5.00E-01  2.34E+06
2.00E+07  1.03E+07   6.61  9.62E+06  6.27E+06  5.00E-01  3.35E+06
2.00E+08  1.87E+08  94.86  9.62E+06  6.27E+06  5.00E-01  3.35E+06

 SECTION 750
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
    NO GAMMAS

 SECTION 751
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
   GAMMA ERROR  E= 1.2390E+07  EBAR= 2.4191E+05  QI=-1.2174E+07
   GAMMA ERROR  E= 2.0000E+08  EBAR= 2.4191E+05  QI=-1.2174E+07

 SECTION 752
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 753
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 754
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 755
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 799

       ENERGY BALANCE SUMMARY: Q =  -1.19323E+07

                     TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
    E       AVAIL   %DIFF     SUM     02003     24055     00000
1.33E+07  1.13E+06 100.00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
1.60E+07  3.79E+06  19.86  3.04E+06  2.43E+06  5.00E-01  6.06E+05
1.80E+07  5.75E+06  11.27  5.11E+06  4.18E+06  5.00E-01  9.27E+05
2.00E+07  7.72E+06   8.61  7.05E+06  5.81E+06  5.00E-01  1.25E+06
2.00E+08  1.85E+08  96.18  7.05E+06  5.81E+06  5.00E-01  1.25E+06

 SECTION 800
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
    NO GAMMAS

 SECTION 801
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
   GAMMA ERROR  E= 1.0000E-05  EBAR= 8.3486E+05  QI= 1.5642E+06
   GAMMA ERROR  E= 2.0000E+08  EBAR= 8.3486E+05  QI= 1.5642E+06

 SECTION 802
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
 SECTION 803
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 804
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 805
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

 SECTION 806
   NO ENERGY-BALANCE TEST FOR TWO-BODY LAW
```
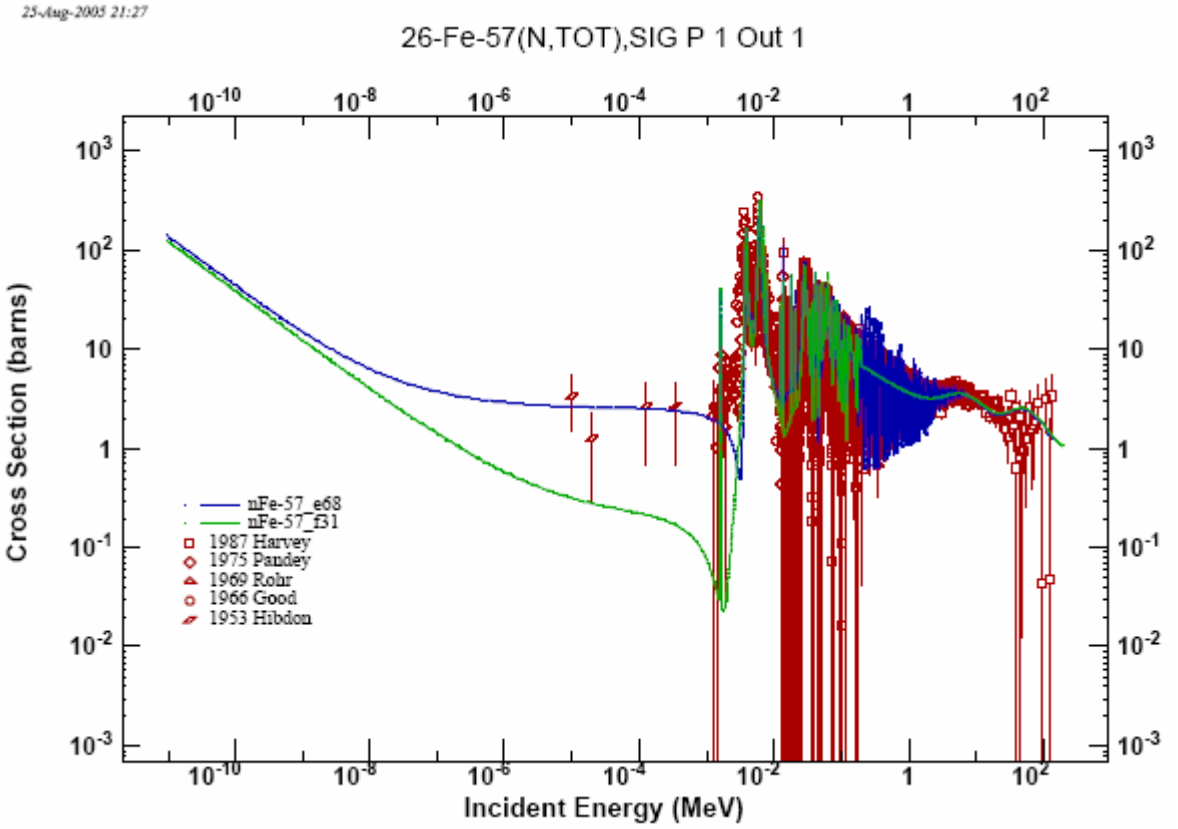
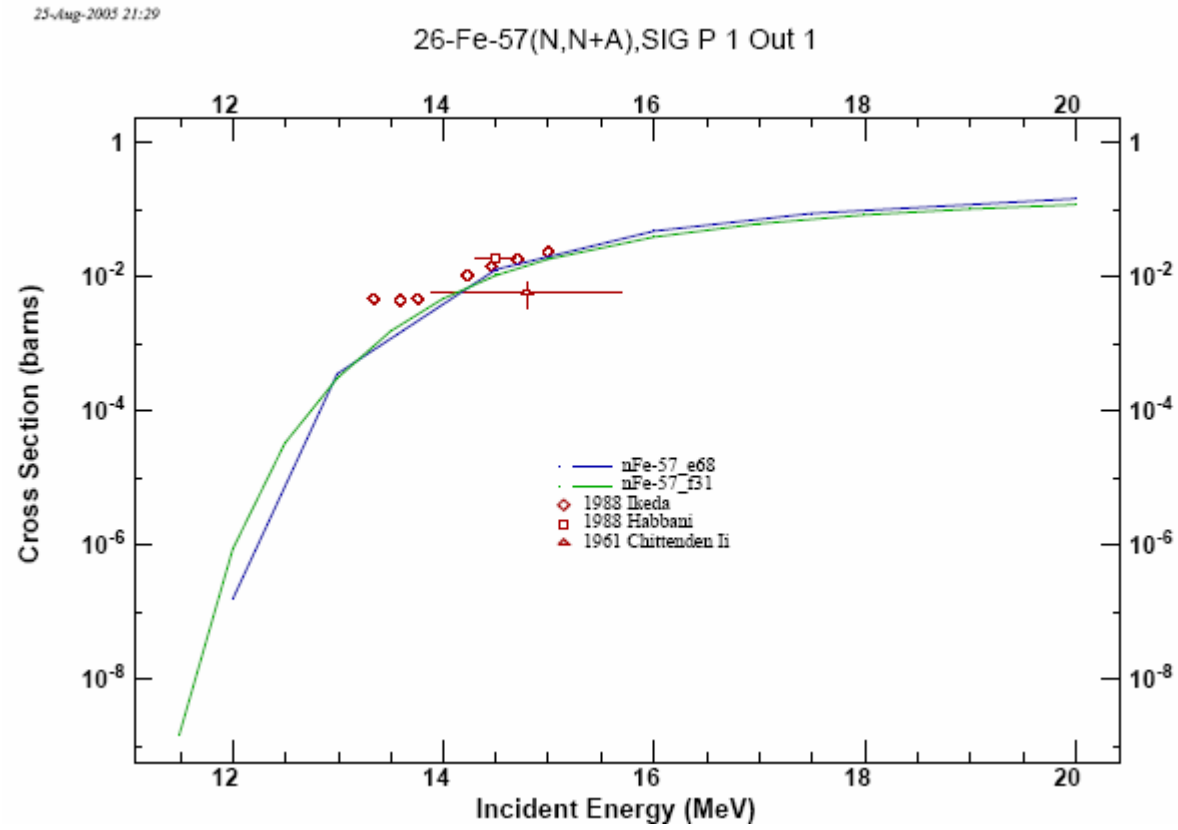

```
   SECTION 807
     NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

   SECTION 808
     NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

   SECTION 809
     NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

   SECTION 810
     NO ENERGY-BALANCE TEST FOR TWO-BODY LAW

   SECTION 849

         ENERGY BALANCE SUMMARY: Q =   2.39902E+06

                      TOTAL SECONDARY ENERGY BY EMITTED PARTICLE
     E       AVAIL   %DIFF     SUM     02004     24054     00000
  1.09E+06  3.47E+06 100.00  1.00E+00  5.00E-01  5.00E-01  0.00E+00
  3.80E+06  6.13E+06   9.75  5.53E+06  2.40E+06  5.00E-01  3.14E+06
  4.20E+06  6.53E+06  34.52  4.27E+06  2.75E+06  5.00E-01  1.52E+06
  4.60E+06  6.92E+06  28.21  4.97E+06  3.10E+06  5.00E-01  1.86E+06
  5.00E+06  7.31E+06  26.51  5.37E+06  3.45E+06  5.00E-01  1.92E+06
  5.40E+06  7.71E+06  26.56  5.66E+06  3.71E+06  5.00E-01  1.95E+06
  5.80E+06  8.10E+06  23.97  6.16E+06  4.14E+06  5.00E-01  2.02E+06
  6.20E+06  8.49E+06  21.63  6.65E+06  4.56E+06  5.00E-01  2.10E+06
  6.60E+06  8.88E+06  23.96  6.76E+06  4.56E+06  5.00E-01  2.20E+06
  7.00E+06  9.28E+06  20.98  7.33E+06  4.98E+06  5.00E-01  2.35E+06
  7.40E+06  9.67E+06  18.44  7.89E+06  5.39E+06  5.00E-01  2.50E+06
  7.80E+06  1.01E+07  15.90  8.46E+06  5.78E+06  5.00E-01  2.69E+06
  8.50E+06  1.08E+07  14.16  9.23E+06  6.17E+06  5.00E-01  3.06E+06
  9.50E+06  1.17E+07  10.40  1.05E+07  6.93E+06  5.00E-01  3.59E+06
  1.05E+07  1.27E+07   8.31  1.17E+07  7.53E+06  5.00E-01  4.13E+06
  1.15E+07  1.37E+07   7.12  1.27E+07  8.00E+06  5.00E-01  4.73E+06
  1.25E+07  1.47E+07   6.32  1.38E+07  8.39E+06  5.00E-01  5.37E+06
  1.35E+07  1.57E+07   5.73  1.48E+07  8.75E+06  5.00E-01  6.02E+06
  1.45E+07  1.66E+07   5.32  1.58E+07  9.14E+06  5.00E-01  6.62E+06
  1.60E+07  1.81E+07   5.03  1.72E+07  9.99E+06  5.00E-01  7.22E+06
  1.80E+07  2.01E+07   5.06  1.91E+07  1.16E+07  5.00E-01  7.43E+06
  2.00E+07  2.21E+07   5.23  2.09E+07  1.35E+07  5.00E-01  7.40E+06
  2.00E+08  1.99E+08  89.49  2.09E+07  1.35E+07  5.00E-01  7.40E+06


--------------------------------------------------------------------------------
FILE 33
   SECTION   1
   SECTION   2
   SECTION   3
   SECTION   4
   SECTION  16
   SECTION  22
   SECTION  28
   SECTION  51
   SECTION  52
   SECTION  53
   SECTION  54
   SECTION  55
   SECTION  91
   SECTION 102
   SECTION 103
   SECTION 107
```

Sample list file from EXFOR retrieval

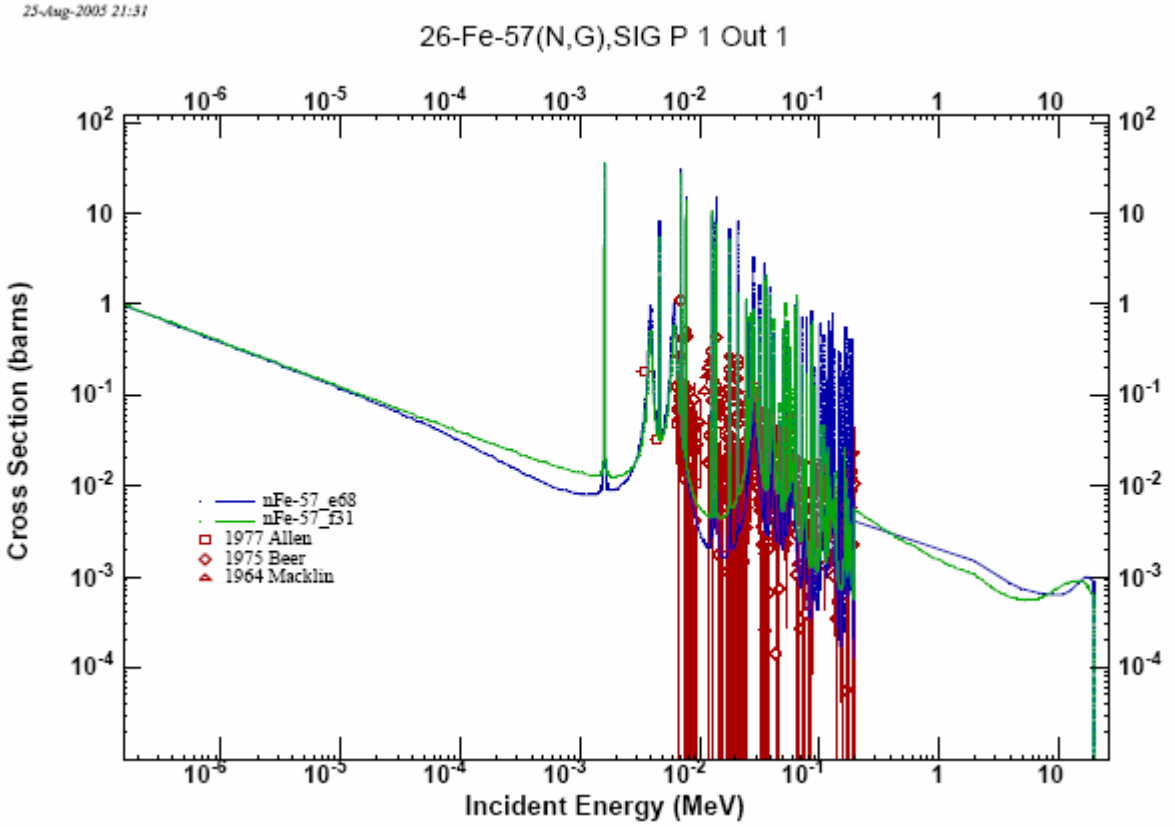
MATERIAL	ZAOUT	MF	MT	EVAL. PNTS.	EXPR. PNTS.	EXPR. REF.	E-INC EV	ANG-OUT DEG	ELV/E-OUT EV	IDX	PROJ
26-Fe- 57	1	3	1		12839					1	1
26-Fe- 57	1	3	28		9					2	1
26-Fe- 57	1	3	102		462					3	1
26-Fe- 57	1	3	103		26					4	1
26-Fe- 57	2004	3	9000		3					5	1
26-Fe- 57	25056	3	9000		4					6	1
26-Fe- 57	2004	4	9000		9		1.470E+7			7	1

Sample comparison plots

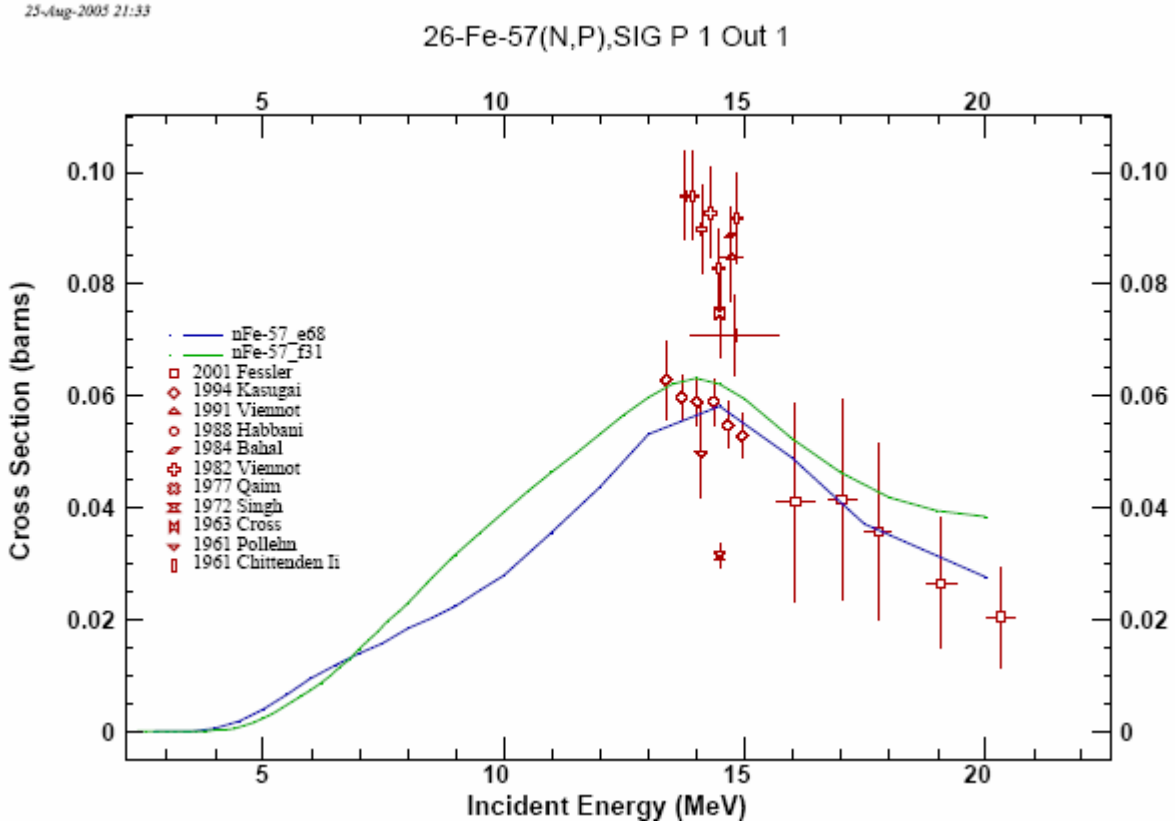




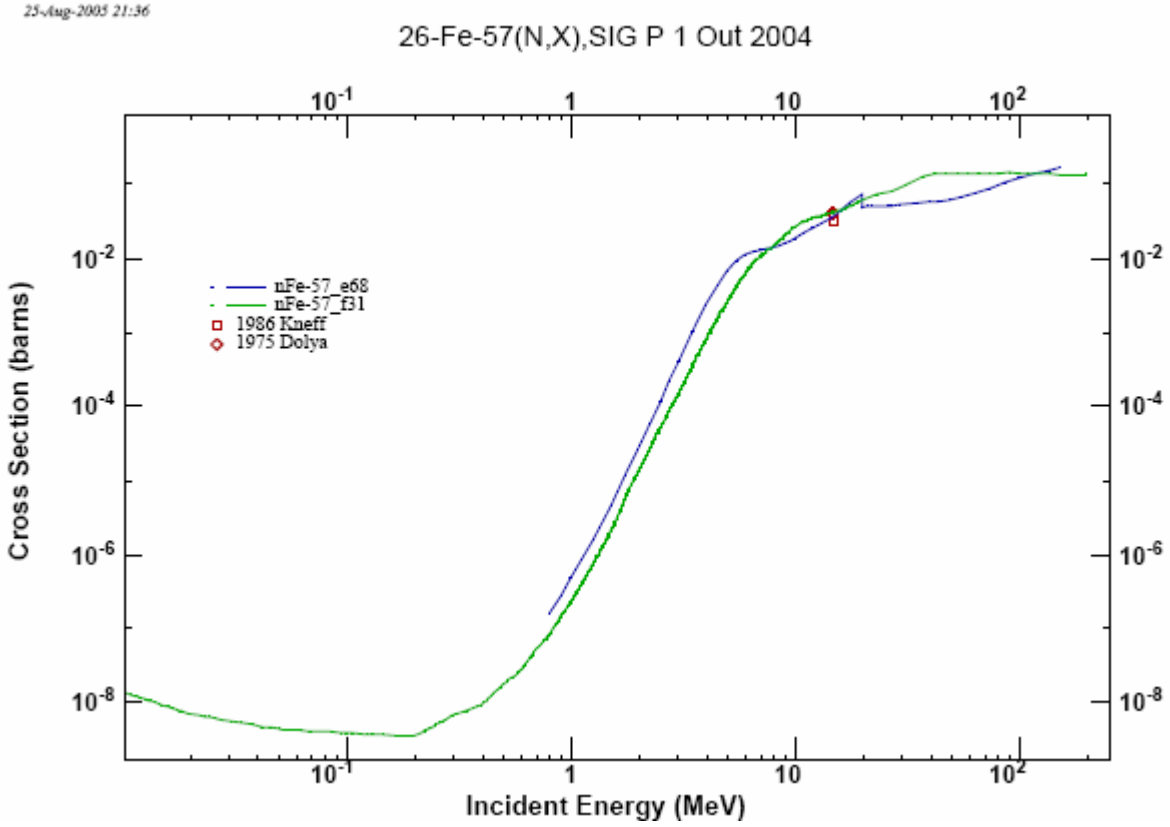
25-Aug-2005 21:31



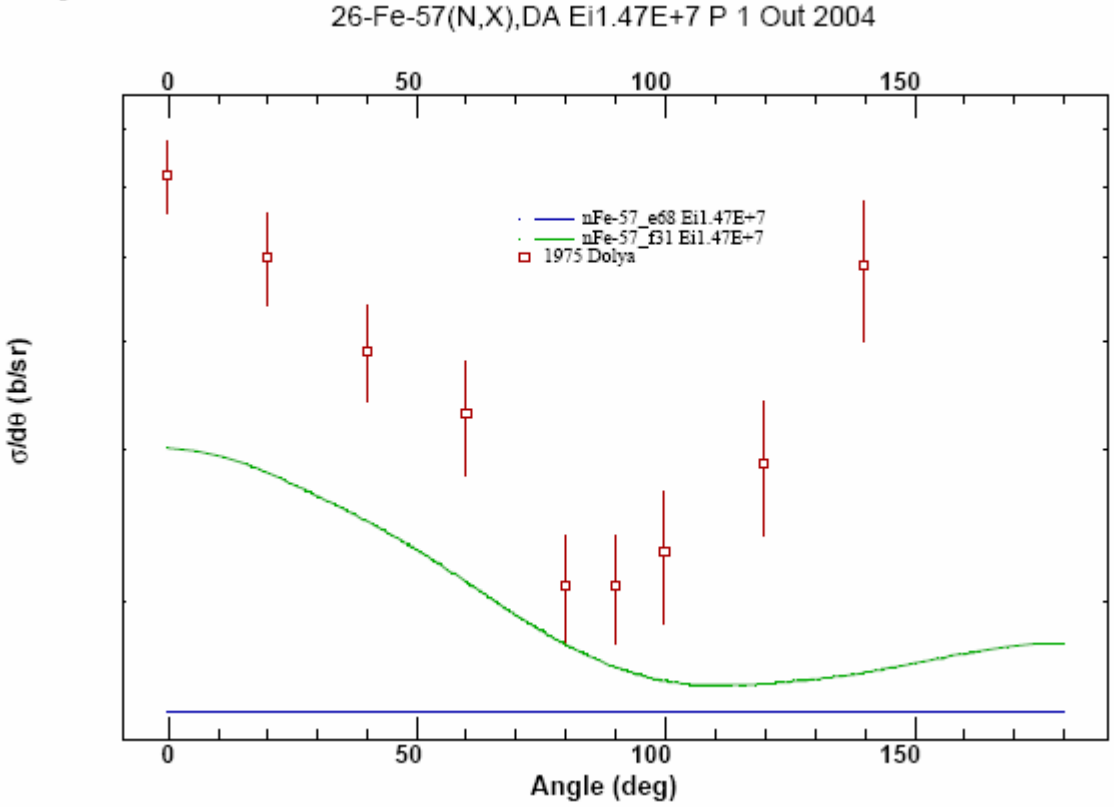
25-Aug-2005 21:33



25-Aug-2005 21:36



25-Aug-2005 21:35



APPENDIX B

Sample list file from the ACE library verification sequence

```
***** QA file for fe057 *****
Thu 2005-08-25
14:07

***** ACELST messages *****

ACELST - List contents of an ACE-lib
====================================

Default source filename              : lib.ace
          Enter new name to redefine :
Default output filename              : ACELST.LOG
          Enter new name to redefine :
 Enter filename to convert to ENDF-6 :
ACELST WARNING - Processing Ang.Dist.MT         2
                 E-grid non-monotonic   1.000000000E-11 1.000000000E-11
                 E-grid non-monotonic   2.000000000E+01 2.000000000E+01
 Formatting of MF6 not coded for MT 5  Law 44
 Formatting of MF6 not coded for MT 16  Law 44
 Formatting of MF6 not coded for MT 17  Law 44
 Formatting of MF6 not coded for MT 22  Law 44
 Formatting of MF6 not coded for MT 24  Law 44
 Formatting of MF6 not coded for MT 28  Law 44
 Formatting of MF6 not coded for MT 32  Law 44
 Formatting of MF6 not coded for MT 41  Law 44
 Formatting of MF6 not coded for MT 91  Law 44

***** ACELST logged output *****

 ACELST - List contents of an ACE-lib
 ====================================

  26-Fe-57 293.6 K fast data for ADS library
                          Source file : fe057.ace
             Material ZAID identifier :  26057.31c
                         Processed on :   07/31/05
                    MAT identifier :    mat2634
                Atomic weight ratio :   56.44630
                    Temperature [K] :        293.6
             Upper energy limit [MeV] :        200.0
                   Data table length :     398361
              Number of energy points :       8981
               Photon production data : Discrete reactions given
             WARNING - also specified : Matrix of secondary photon energies

 Summary table legend:
    MT -ENDF reaction MT number
     Q -Reaction Q value
     n -number of outgoing neutrons and cordinate system for angular distrib.
        (CM=centre-of-mass, LA=lab)
 Angle -Type of distribution (Isotr. or Law 44)
        or "Aen mm" for tabulated distributions at mm energy points
 E-law -Secondary neutron energy distribution law index list
    Ty -Photon production cross section source (12=MF12, 13=MF13, 16=MF 6)

 Cross sections (excluding elastic)       Photon Production
   MT    Q [MeV]     n  Angle E-law       MT Ty  Angle E-law
 ----------------------------------     ----------------------------
    2  0.0000E+00 CM 1 Aen103  0          5 16 Isotr. 4
    5  0.0000E+00 CM01 Isotr. 44         16 16 Isotr. 4
   16 -7.6460E+00 CM 2 Isotr. 44         17 16 Isotr. 4
   17 -1.8843E+01 CM 3 Isotr. 44         22 16 Isotr. 4
   22 -7.3200E+00 CM 1 Isotr. 44         24 16 Isotr. 4
   24 -1.5259E+01 CM 2 Isotr. 44         28 16 Isotr. 4
   28 -1.0559E+01 CM 1 Isotr. 44         32 16 Isotr. 4
   32 -1.5605E+01 CM 1 Isotr. 44         41 16 Isotr. 4
   41 -1.7830E+01 CM 2 Isotr. 44         51 16 Isotr. 4
```

```
 51 -1.4413E-02 CM 1 Aen 35  3
 52 -1.3647E-01 CM 1 Aen 34  3
 53 -3.6676E-01 CM 1 Aen 33  3
 54 -7.0642E-01 CM 1 Aen 31  3
 55 -1.0071E+00 CM 1 Aen 29  3
 56 -1.1399E+00 CM 1 Aen 29  3
 57 -1.1978E+00 CM 1 Aen 29  3
 58 -1.2655E+00 CM 1 Aen 29  3
 59 -1.3568E+00 CM 1 Aen 29  3
 60 -1.6273E+00 CM 1 Aen 28  3
 61 -1.7254E+00 CM 1 Aen 28  3
 62 -1.9766E+00 CM 1 Aen 27  3
 63 -1.9897E+00 CM 1 Aen 27  3
 64 -1.9910E+00 CM 1 Aen 27  3
 65 -2.1131E+00 CM 1 Aen 27  3
 66 -2.1186E+00 CM 1 Aen 27  3
 67 -2.2069E+00 CM 1 Aen 26  3
 68 -2.2177E+00 CM 1 Aen 26  3
 69 -2.2202E+00 CM 1 Aen 26  3
 70 -2.3304E+00 CM 1 Aen 26  3
 91 -2.3304E+00 CM 1 Isotr. 44
102  1.0044E+01
103 -1.9085E+00
104 -8.3346E+00
105 -9.3478E+00
106 -1.1932E+01
107  2.3990E+00
108 -5.5284E+00
111 -1.1394E+01
112 -9.9737E+00
203  0.0000E+00
204  0.0000E+00
205  0.0000E+00
206  0.0000E+00
207  0.0000E+00
444  0.0000E+00
600 -1.9085E+00
601 -1.9917E+00
602 -2.7586E+00
603 -2.9643E+00
604 -2.9814E+00
605 -3.1360E+00
606 -3.2835E+00
607 -3.3855E+00
608 -3.4012E+00
609 -3.4433E+00
610 -3.5265E+00
649 -3.5265E+00
650 -8.3346E+00
651 -8.3612E+00
652 -8.4451E+00
653 -8.5466E+00
654 -8.5497E+00
655 -8.6701E+00
699 -8.6701E+00
700 -9.3478E+00
701 -9.4737E+00
702 -1.0332E+01
703 -1.0637E+01
704 -1.0640E+01
705 -1.0641E+01
749 -1.0641E+01
750 -1.1932E+01
751 -1.2174E+01
752 -1.2450E+01
753 -1.2498E+01
754 -1.2813E+01
755 -1.3063E+01
799 -1.3063E+01
800  2.3990E+00
801  1.5642E+00
802  5.7510E-01
803 -2.2066E-01
804 -4.3060E-01

 52 16 Isotr. 4
 53 16 Isotr. 4
 54 16 Isotr. 4
 55 16 Isotr. 4
 56 16 Isotr. 4
 57 16 Isotr. 4
 58 16 Isotr. 4
 59 16 Isotr. 4
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 61 16 Isotr. 4
 62 16 Isotr. 4
 63 16 Isotr. 4
 64 16 Isotr. 4
 65 16 Isotr. 4
 66 16 Isotr. 4
 67 16 Isotr. 4
 68 16 Isotr. 4
 69 16 Isotr. 4
 70 16 Isotr. 4
 91 16 Isotr. 4
102 16 Isotr. 4
108 16 Isotr. 4
111 16 Isotr. 4
112 16 Isotr. 4
601 16 Isotr. 4
602 16 Isotr. 4
603 16 Isotr. 4
604 16 Isotr. 4
605 16 Isotr. 4
606 16 Isotr. 4
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608 16 Isotr. 4
609 16 Isotr. 4
610 16 Isotr. 4
649 16 Isotr. 4
651 16 Isotr. 4
652 16 Isotr. 4
653 16 Isotr. 4
654 16 Isotr. 4
655 16 Isotr. 4
699 16 Isotr. 4
701 16 Isotr. 4
702 16 Isotr. 4
703 16 Isotr. 4
704 16 Isotr. 4
705 16 Isotr. 4
749 16 Isotr. 4
751 16 Isotr. 4
752 16 Isotr. 4
753 16 Isotr. 4
754 16 Isotr. 4
755 16 Isotr. 4
799 16 Isotr. 4
801 16 Isotr. 4
802 16 Isotr. 4
803 16 Isotr. 4
804 16 Isotr. 4
805 16 Isotr. 4
806 16 Isotr. 4
807 16 Isotr. 4
808 16 Isotr. 4
809 16 Isotr. 4
810 16 Isotr. 4
849 16 Isotr. 4
```

```
  805 -6.7505E-01
  806 -7.6054E-01
  807 -8.2326E-01
  808 -9.9439E-01
  809 -1.0379E+00
  810 -1.0690E+00
  849 -1.0690E+00

***** LINEAR output *****

  Linearize ENDF/B Cross Sections (LINEAR 2002-1)
  ------------------------------------------------------------------------------
  Retrieval Criteria----------         ZA
  Monitor Mode----------------        Off
  Minimum Cross Section-------- 1.0000E-10 (Default Option)
  Keep Evaluated Data Points---        Yes
  ------------------------------------------------------------------------------
  ENDF/B Input and Output Data Filenames
  fe057.dat
  ENDF6.LIN
  ------------------------------------------------------------------------------
  Requested Ranges
  ------------------------------------------------------------------------------
       Minimum       Maximum
      ZA MF  MT     ZA MF  MT
  ------------------------------------------------------------------------------
   26057  0   0  26057 99 999
  ------------------------------------------------------------------------------
  Allowable Uncertainty
  ------------------------------------------------------------------------------
      Energy Uncertainty   per-cent
  ------------------------------------------------------------------------------
  0.0         .001000000     0.1000 (Default Option)
  ------------------------------------------------------------------------------
  ENDF/B Tape Label
  ------------------------------------------------------------------------------
  FE-57 FROM JEFF-3.1                                                      1
  ------------------------------------------------------------------------------
    Material  MAT  MF  MT  ENDF/B      Kelvin     Q-Value Points Points
                           Format                    eV     In    Out
  ------------------------------------------------------------------------------
   26-Fe-57  2634   3   1   VI     0.0         0.0           464    464
   26-Fe-57  2634   3   2   VI     0.0         0.0           255    255
   26-Fe-57  2634   3   3   VI     0.0         0.0           464    464
   26-Fe-57  2634   3   4   VI     0.0        -14413.0000     88     88
   26-Fe-57  2634   3   5   VI     0.0         0.0           196    197
   26-Fe-57  2634   3  16   VI     0.0        -7646030.00     24     24
   26-Fe-57  2634   3  17   VI     0.0        -18843300.0      4      4
   26-Fe-57  2634   3  22   VI     0.0        -7319980.00     22     22
   26-Fe-57  2634   3  24   VI     0.0        -15259100.0      8      8
   26-Fe-57  2634   3  28   VI     0.0        -10559100.0     17     17
   26-Fe-57  2634   3  32   VI     0.0        -15605000.0      8      8
   26-Fe-57  2634   3  41   VI     0.0        -17829600.0      5      5
   26-Fe-57  2634   3  51   VI     0.0        -14413.0000     88     88
   26-Fe-57  2634   3  52   VI     0.0        -136474.000     84     84
   26-Fe-57  2634   3  53   VI     0.0        -366759.000     81     81
   26-Fe-57  2634   3  54   VI     0.0        -706416.000     76     76
   26-Fe-57  2634   3  55   VI     0.0        -1007130.00     72     72
   26-Fe-57  2634   3  56   VI     0.0        -1139900.00     71     71
   26-Fe-57  2634   3  57   VI     0.0        -1197810.00     69     69
   26-Fe-57  2634   3  58   VI     0.0        -1265520.00     68     68
   26-Fe-57  2634   3  59   VI     0.0        -1356830.00     67     67
   26-Fe-57  2634   3  60   VI     0.0        -1627260.00     64     64
   26-Fe-57  2634   3  61   VI     0.0        -1725380.00     63     63
   26-Fe-57  2634   3  62   VI     0.0        -1976630.00     60     60
   26-Fe-57  2634   3  63   VI     0.0        -1989660.00     59     59
   26-Fe-57  2634   3  64   VI     0.0        -1991000.00     58     58
   26-Fe-57  2634   3  65   VI     0.0        -2113110.00     57     57
   26-Fe-57  2634   3  66   VI     0.0        -2118600.00     56     56
   26-Fe-57  2634   3  67   VI     0.0        -2206880.00     54     54
   26-Fe-57  2634   3  68   VI     0.0        -2217660.00     53     53
   26-Fe-57  2634   3  69   VI     0.0        -2220200.00     52     52
   26-Fe-57  2634   3  70   VI     0.0        -2330410.00     51     51
   26-Fe-57  2634   3  91   VI     0.0        -2330410.00     51     51
```

```
  26-Fe-57  2634   3 102   VI     0.0         10044500.0     72    411
  26-Fe-57  2634   3 103   VI     0.0        -1908500.00     61     61
  26-Fe-57  2634   3 104   VI     0.0        -8334550.00     27     27
  26-Fe-57  2634   3 105   VI     0.0        -9347800.00     24     24
  26-Fe-57  2634   3 106   VI     0.0        -11932300.0     12     12
  26-Fe-57  2634   3 107   VI     0.0         2399020.00     84    560
  26-Fe-57  2634   3 108   VI     0.0        -5528360.00     19     19
  26-Fe-57  2634   3 111   VI     0.0        -11393700.0     14     14
  26-Fe-57  2634   3 112   VI     0.0        -9973660.00     13     13
  26-Fe-57  2634   3 600   VI     0.0        -1908500.00     61     61
  26-Fe-57  2634   3 601   VI     0.0        -1991690.00     61     61
  26-Fe-57  2634   3 602   VI     0.0        -2758570.00     56     56
  26-Fe-57  2634   3 603   VI     0.0        -2964330.00     52     52
  26-Fe-57  2634   3 604   VI     0.0        -2981400.00     52     52
  26-Fe-57  2634   3 605   VI     0.0        -3136000.00     50     50
  26-Fe-57  2634   3 606   VI     0.0        -3283500.00     50     50
  26-Fe-57  2634   3 607   VI     0.0        -3385500.00     45     45
  26-Fe-57  2634   3 608   VI     0.0        -3401170.00     45     45
  26-Fe-57  2634   3 609   VI     0.0        -3443330.00     45     45
  26-Fe-57  2634   3 610   VI     0.0        -3526500.00     44     44
  26-Fe-57  2634   3 649   VI     0.0        -3526500.00     43     43
  26-Fe-57  2634   3 650   VI     0.0        -8334550.00     27     27
  26-Fe-57  2634   3 651   VI     0.0        -8361161.00     25     25
  26-Fe-57  2634   3 652   VI     0.0        -8445060.00     21     21
  26-Fe-57  2634   3 653   VI     0.0        -8546580.00     21     21
  26-Fe-57  2634   3 654   VI     0.0        -8549680.00     21     21
  26-Fe-57  2634   3 655   VI     0.0        -8670080.00     21     21
  26-Fe-57  2634   3 699   VI     0.0        -8670080.00     21     21
  26-Fe-57  2634   3 700   VI     0.0        -9347800.00     24     24
  26-Fe-57  2634   3 701   VI     0.0        -9473740.00     23     23
  26-Fe-57  2634   3 702   VI     0.0        -10332100.0     20     20
  26-Fe-57  2634   3 703   VI     0.0        -10636900.0     17     17
  26-Fe-57  2634   3 704   VI     0.0        -10639900.0     17     17
  26-Fe-57  2634   3 705   VI     0.0        -10640800.0     17     17
  26-Fe-57  2634   3 749   VI     0.0        -10640800.0     16     16
  26-Fe-57  2634   3 750   VI     0.0        -11932300.0     12     12
  26-Fe-57  2634   3 751   VI     0.0        -12174200.0     12     12
  26-Fe-57  2634   3 752   VI     0.0        -12450000.0     11     11
  26-Fe-57  2634   3 753   VI     0.0        -12498200.0     11     11
  26-Fe-57  2634   3 754   VI     0.0        -12813000.0     11     11
  26-Fe-57  2634   3 755   VI     0.0        -13063300.0     10     10
  26-Fe-57  2634   3 799   VI     0.0        -13063300.0      9      9
  26-Fe-57  2634   3 800   VI     0.0         2399020.00     84    573
  26-Fe-57  2634   3 801   VI     0.0         1564170.00     84    708
  26-Fe-57  2634   3 802   VI     0.0         575104.000     84    695
  26-Fe-57  2634   3 803   VI     0.0        -220656.000     56    580
  26-Fe-57  2634   3 804   VI     0.0        -430596.000     55    581
  26-Fe-57  2634   3 805   VI     0.0        -675046.000     54    609
  26-Fe-57  2634   3 806   VI     0.0        -760536.000     53    582
  26-Fe-57  2634   3 807   VI     0.0        -823256.000     53    615
  26-Fe-57  2634   3 808   VI     0.0        -994386.000     52    571
  26-Fe-57  2634   3 809   VI     0.0        -1037860.00     52    599
  26-Fe-57  2634   3 810   VI     0.0        -1068980.00     52    642
  26-Fe-57  2634   3 849   VI     0.0        -1068980.00     47    311
 ---------------------------------------------------------------------------
                                              MAT Totals   4932  12088
 ---------------------------------------------------------------------------
===========================================================================
Total Execution Time               0.52 Seconds
===========================================================================
 ---------------------------------------------------------------------------
                                             Tape Totals   4932  12088
 ---------------------------------------------------------------------------
===========================================================================
Total Execution Time               0.52 Seconds
===========================================================================

***** RECENT output *****

Calculate Cross Sections from Resonance Parameters (RECENT 2002-1)
===========================================================================
Retrieval Criteria----------         ZA
File 2 Mimimum Cross Section- 1.0000E-10 (Standard Option)
Reactions with No Background-     Output (Resonance Contribution)
```

```
Calculate/Edit Mode----------  Calculate. Minimum Output Listing.
Negative Cross Sections------   No Change (Allow Negative Output)
Monitor Mode-----------------        Off
================================================================================
ENDF/B Input and Output Data Filenames
ENDF6.LIN
ENDF6.REC
================================================================================
Requested ZA Ranges
================================================================================
   Mimimum    Maximum
================================================================================
     26057      26057
================================================================================
File 2 Reconstruction Error
================================================================================
     Energy      Error   per-cent
================================================================================
 0.0         .001000000      0.100 (Default Option)
================================================================================
ENDF/B Tape Label
================================================================================
FE-57 FROM JEFF-3.1                                                        1
********************************************************************************
Processing  26-Fe-57  MAT= 2634
********************************************************************************
Based on the Format and Contents of MF=1, MT=451
(1) ENDF/B-VI Format.
(2) Material is NOT Fissile (LFI=0).
(3) Resonance Parameters are Given (LRP=1).
(4) Projectile ZA =      1 (Neutron).
(5) Temperature of Background  0.0        Kelvin.
WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING
L Dependent Scattering Radius in the Evaluation is Zero.
Have Defined it to be Equal to the Scattering Radius.
(see, ENDF/B-VI Formats and Procedures Manual, page 2.11)
WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING
L Dependent Scattering Radius in the Evaluation is Zero.
Have Defined it to be Equal to the Scattering Radius.
(see, ENDF/B-VI Formats and Procedures Manual, page 2.11)
--------------------------------------------------------------------------------
WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING
L= 1 J =  1.000 Corresponds to 2 Resonance Sequences.
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING
FOR L =  1 Expect Sum of Statistical Weights (GJ) to Equal
(2*L + 1) =  3.000
Found     =  2.250
Corrective Action Will be Taken to Correctly Calculate
the Potential Scattering Cross Section - This Procedure is
Based on the Decision of the National Nuclear Data Center,
Brookhaven National Laboratory, Private Communication,
Charles Dunford, (April 1991)
================================================================================
Reconstructing Cross Sections from Resonance Parameters
================================================================================
       E-Low     E-High   Points   Type of Resonance Region
       (eV)       (eV)   Generated Messages
================================================================================
  1.00000E-5 200000.000      15503 Resolved
================================================================================
Entire Resonance Region      15503 Points
================================================================================
Combining File 2 and File 3 Data
================================================================================
Reaction  File 2  File 3  Combined
          Points  Points    Points Comments
================================================================================
   Total   15503     464     15958
 Elastic   15503     255     15754
 Capture   15503     411     15909
================================================================================
================================================================================
```

```
 Total Execution Time                1.02 Seconds
 ================================================================================
 ********************************************************************************
 End of ENDF/B Input Data
 ********************************************************************************
 Core Allocation and Requirements
 ================================================================================
         Sections   Nodes Parameter
                           Storage
 ================================================================================
 Allocated    200  120000    120000
 Required       3      53        51
 ================================================================================
 End of Run
 ================================================================================
 ================================================================================
 Total Execution Time                1.02 Seconds
 ================================================================================

***** SIGMA1 output *****

 Doppler Broaden ENDF/B Cross Sections (SIGMA1 2002-1)
 --------------------------------------------------------------------------------
 Retrieval Criteria----------         ZA
 Monitor Mode----------------        Off
 Temperature------------------ 293.600000 Kelvin
 Minimum Cross Section-------- 1.0000E-10 (Default Option)
 --------------------------------------------------------------------------------
 ENDF/B Input and Output Data Filenames
 ENDF6.REC
 PP02ENDF.DAT
 --------------------------------------------------------------------------------
 Requested ZA Ranges
 --------------------------------------------------------------------------------
     Minimum    Maximum
 --------------------------------------------------------------------------------
       26057      26057
 --------------------------------------------------------------------------------
 Allowable Uncertainty
 --------------------------------------------------------------------------------
      Energy Unceryainty   per-cent
 --------------------------------------------------------------------------------
  0.0         .001000000     0.1000 (Default Option)
 --------------------------------------------------------------------------------
 ENDF/B Tape Label
 --------------------------------------------------------------------------------
 FE-57 FROM JEFF-3.1                                                        1
 --------------------------------------------------------------------------------
 Projectile      MAT  MT ENDF/B     Kelvin     Q-Value Points Points
       Material          Format         In          eV     In    Out
 --------------------------------------------------------------------------------
 n    26-Fe-57  2634   1  VI    0.0         0.0         15958   3403
 n    26-Fe-57  2634   2  VI    0.0         0.0         15754   3867
 n    26-Fe-57  2634   3  VI    0.0         0.0           464    466
 n    26-Fe-57  2634   4  VI    0.0        -14413.0000     88     88
 n    26-Fe-57  2634   5  VI    0.0         0.0           197    195
 n    26-Fe-57  2634  16  VI    0.0        -7646030.00     24     24
 n    26-Fe-57  2634  17  VI    0.0        -18843300.0      4      4
 n    26-Fe-57  2634  22  VI    0.0        -7319980.00     22     21
 n    26-Fe-57  2634  24  VI    0.0        -15259100.0      8      7
 n    26-Fe-57  2634  28  VI    0.0        -10559100.0     17     16
 n    26-Fe-57  2634  32  VI    0.0        -15605000.0      8      7
 n    26-Fe-57  2634  41  VI    0.0        -17829600.0      5      5
 n    26-Fe-57  2634  51  VI    0.0        -14413.0000     88     88
 n    26-Fe-57  2634  52  VI    0.0        -136474.000     84     84
 n    26-Fe-57  2634  53  VI    0.0        -366759.000     81     81
 n    26-Fe-57  2634  54  VI    0.0        -706416.000     76     76
 n    26-Fe-57  2634  55  VI    0.0        -1007130.00     72     72
 n    26-Fe-57  2634  56  VI    0.0        -1139900.00     71     71
 n    26-Fe-57  2634  57  VI    0.0        -1197810.00     69     69
 n    26-Fe-57  2634  58  VI    0.0        -1265520.00     68     68
 n    26-Fe-57  2634  59  VI    0.0        -1356830.00     67     67
 n    26-Fe-57  2634  60  VI    0.0        -1627260.00     64     64
 n    26-Fe-57  2634  61  VI    0.0        -1725380.00     63     63
```

```
n    26-Fe-57  2634  62  VI    0.0        -1976630.00     60     60
n    26-Fe-57  2634  63  VI    0.0        -1989660.00     59     59
n    26-Fe-57  2634  64  VI    0.0        -1991000.00     58     58
n    26-Fe-57  2634  65  VI    0.0        -2113110.00     57     57
n    26-Fe-57  2634  66  VI    0.0        -2118600.00     56     56
n    26-Fe-57  2634  67  VI    0.0        -2206880.00     54     54
n    26-Fe-57  2634  68  VI    0.0        -2217660.00     53     53
n    26-Fe-57  2634  69  VI    0.0        -2220200.00     52     52
n    26-Fe-57  2634  70  VI    0.0        -2330410.00     51     51
n    26-Fe-57  2634  91  VI    0.0        -2330410.00     51     51
n    26-Fe-57  2634 102  VI    0.0         10044500.0  15909   7372
n    26-Fe-57  2634 103  VI    0.0        -1908500.00     61     60
n    26-Fe-57  2634 104  VI    0.0        -8334550.00     27     26
n    26-Fe-57  2634 105  VI    0.0        -9347800.00     24     24
n    26-Fe-57  2634 106  VI    0.0        -11932300.0     12     11
n    26-Fe-57  2634 107  VI    0.0         2399020.00    560    774
n    26-Fe-57  2634 108  VI    0.0        -5528360.00     19     18
n    26-Fe-57  2634 111  VI    0.0        -11393700.0     14     13
n    26-Fe-57  2634 112  VI    0.0        -9973660.00     13     12
n    26-Fe-57  2634 600  VI    0.0        -1908500.00     61     60
n    26-Fe-57  2634 601  VI    0.0        -1991690.00     61     60
n    26-Fe-57  2634 602  VI    0.0        -2758570.00     56     56
n    26-Fe-57  2634 603  VI    0.0        -2964330.00     52     51
n    26-Fe-57  2634 604  VI    0.0        -2981400.00     52     51
n    26-Fe-57  2634 605  VI    0.0        -3136000.00     50     49
n    26-Fe-57  2634 606  VI    0.0        -3283500.00     50     49
n    26-Fe-57  2634 607  VI    0.0        -3385500.00     45     44
n    26-Fe-57  2634 608  VI    0.0        -3401170.00     45     44
n    26-Fe-57  2634 609  VI    0.0        -3443330.00     45     44
n    26-Fe-57  2634 610  VI    0.0        -3526500.00     44     43
n    26-Fe-57  2634 649  VI    0.0        -3526500.00     43     42
n    26-Fe-57  2634 650  VI    0.0        -8334550.00     27     26
n    26-Fe-57  2634 651  VI    0.0        -8361160.00     25     25
n    26-Fe-57  2634 652  VI    0.0        -8445060.00     21     20
n    26-Fe-57  2634 653  VI    0.0        -8546580.00     21     20
n    26-Fe-57  2634 654  VI    0.0        -8549680.00     21     20
n    26-Fe-57  2634 655  VI    0.0        -8670080.00     21     20
n    26-Fe-57  2634 699  VI    0.0        -8670080.00     21     20
n    26-Fe-57  2634 700  VI    0.0        -9347800.00     24     24
n    26-Fe-57  2634 701  VI    0.0        -9473740.00     23     22
n    26-Fe-57  2634 702  VI    0.0        -10332100.0     20     20
n    26-Fe-57  2634 703  VI    0.0        -10636900.0     17     16
n    26-Fe-57  2634 704  VI    0.0        -10639900.0     17     16
n    26-Fe-57  2634 705  VI    0.0        -10640800.0     17     16
n    26-Fe-57  2634 749  VI    0.0        -10640800.0     16     15
n    26-Fe-57  2634 750  VI    0.0        -11932300.0     12     11
n    26-Fe-57  2634 751  VI    0.0        -12174200.0     12     11
n    26-Fe-57  2634 752  VI    0.0        -12450000.0     11     10
n    26-Fe-57  2634 753  VI    0.0        -12498200.0     11     10
n    26-Fe-57  2634 754  VI    0.0        -12813000.0     11     10
n    26-Fe-57  2634 755  VI    0.0        -13063300.0     10      9
n    26-Fe-57  2634 799  VI    0.0        -13063300.0      9      8
n    26-Fe-57  2634 800  VI    0.0         2399020.00    573    712
n    26-Fe-57  2634 801  VI    0.0         1564170.00    708    707
n    26-Fe-57  2634 802  VI    0.0         575104.000    695    773
n    26-Fe-57  2634 803  VI    0.0        -220656.000    580    579
n    26-Fe-57  2634 804  VI    0.0        -430596.000    581    580
n    26-Fe-57  2634 805  VI    0.0        -675046.000    609    608
n    26-Fe-57  2634 806  VI    0.0        -760536.000    582    581
n    26-Fe-57  2634 807  VI    0.0        -823256.000    615    614
n    26-Fe-57  2634 808  VI    0.0        -994386.000    571    570
n    26-Fe-57  2634 809  VI    0.0        -1037860.00    599    598
n    26-Fe-57  2634 810  VI    0.0        -1068980.00    642    641
n    26-Fe-57  2634 849  VI    0.0        -1068980.00    311    310
--------------------------------------------------------------------------------
No Unresolved Region                        MAT Totals  58579  25982
--------------------------------------------------------------------------------
================================================================================
Total Execution Time               1.91 Seconds
================================================================================
--------------------------------------------------------------------------------
                                           Tape Totals  58579  25982
--------------------------------------------------------------------------------
================================================================================
```

```
 Total Execution Time                1.91 Seconds
 ================================================================================

***** COMHARD output *****

 Comparison of Evaluated Data (COMPLOT 2002-1)
 --------------------------------------------------------------------------------
 Description of Plotter and Frame Layout
 --------------------------------------------------------------------------------
 Plotter X Dimensions----------     0.0000 to     13.0000
 Plotter Y Dimensions----------     0.0000 to     10.5000
 Plots per Frame (X by Y)------          1 by           1
 Character Size Multiplier-----       2.00
 Plot Orientation-------------- X Horizontal/Y Vertical
 --------------------------------------------------------------------------------
 Data Filenames
 --------------------------------------------------------------------------------
 Data1=PP02ENDF.DAT
 Data2=ACE2ENDF.DAT
 --------------------------------------------------------------------------------
 Retrieval Criteria------------         ZA
 Grid Type---------------------Tick Marks
 Border on Plots---------------        Yes
 Line Thickness----------------          0
 Plot Mode---------------------- Cross Section Plus Cross Section Over Ratio
 Starting Plot Number----------          1
 On Screen Background Color----White
 --------------------------------------------------------------------------------
 Maximum Ratio on Plots--------     1.0500 (   5.0000 per-cent)
 --------------------------------------------------------------------------------
 Data Identifications
 --------------------------------------------------------------------------------
 Data1=ENDF
 Data2=ACE
 --------------------------------------------------------------------------------
 Request Ranges
 --------------------------------------------------------------------------------
          Mimimum                        Maximum                Identify   Interact
      ZA MF  MT    Energy-eV       ZA MF  MT    Energy-eV    POINTS
 --------------------------------------------------------------------------------
   26057  1   1   0.00000+ 0    26057 99 999   1.00000+12       No         No
 --------------------------------------------------------------------------------
 No Equivalences
 --------------------------------------------------------------------------------
 ENDF/B Tape Labels
 --------------------------------------------------------------------------------
 Data1=FE-57 FROM JEFF-3.1                                                    1
 Data2= Converted form Ace file: ACE2ENDF.DAT                                 0
 --------------------------------------------------------------------------------
 Material    MAT MF  MT Energy Range      Maximum per-cent Differences
                        Minimum  Maximum  Maximum  Negative  Maximum  Positive
                        eV       eV       eV       per-cent  eV       per-cent
 --------------------------------------------------------------------------------
  26-Fe-57  2634  3   1 1.000- 5 2.000+ 8 3.965+ 4  -74.829* 1.800+ 6    1.101*
  26-Fe-57  2634  3   2 1.000- 5 2.000+ 8 2.000+ 5  -19.682* 3.928+ 4    0.384*
  26-Fe-57  2634  3   3 No Comparable Data
  26-Fe-57  2634  3   4 No Comparable Data
  26-Fe-57  2634  3   5 1.999+ 5 2.000+ 8 2.000+ 5  -25.143* 6.775+ 6    0.000
  26-Fe-57  2634  3  16 7.781+ 6 2.000+ 8 1.553+ 7    0.000  1.637+ 7    0.000
  26-Fe-57  2634  3  17 1.918+ 7 2.000+ 8 2.000+ 7    0.000  2.000+ 7    0.000
  26-Fe-57  2634  3  22 8.500+ 6 2.000+ 8 9.513+ 6   -0.001  1.625+ 7    0.000
  26-Fe-57  2634  3  24 1.600+ 7 2.000+ 8 1.800+ 7    0.000  1.700+ 7    0.003
  26-Fe-57  2634  3  28 1.100+ 7 2.000+ 8 1.918+ 7    0.000  1.462+ 7    0.000
  26-Fe-57  2634  3  32 1.600+ 7 2.000+ 8 1.700+ 7   -0.001  1.878+ 7    0.000
  26-Fe-57  2634  3  41 1.815+ 7 2.000+ 8 1.950+ 7    0.000  1.999+ 7    0.000
  26-Fe-57  2634  3  51 1.465+ 4 2.000+ 8 2.000+ 4   -0.033* 1.000+ 5    0.002
  26-Fe-57  2634  3  52 1.388+ 5 2.000+ 8 2.000+ 5   -0.002  1.725+ 7    0.000
  26-Fe-57  2634  3  53 3.733+ 5 2.000+ 8 3.584+ 6    0.000  3.750+ 6    0.000
  26-Fe-57  2634  3  54 7.189+ 5 2.000+ 8 3.956+ 6    0.000  4.188+ 6    0.000
  26-Fe-57  2634  3  55 1.025+ 6 2.000+ 8 1.942+ 6    0.000  2.038+ 6    0.000
  26-Fe-57  2634  3  56 1.160+ 6 2.000+ 8 1.759+ 7    0.000  6.500+ 6    0.000
  26-Fe-57  2634  3  57 1.219+ 6 2.000+ 8 1.604+ 6    0.000  6.350+ 6    0.000
  26-Fe-57  2634  3  58 1.288+ 6 2.000+ 8 5.463+ 6    0.000  5.500+ 6    0.000
  26-Fe-57  2634  3  59 1.381+ 6 2.000+ 8 1.052+ 7    0.000  6.550+ 6    0.000
```

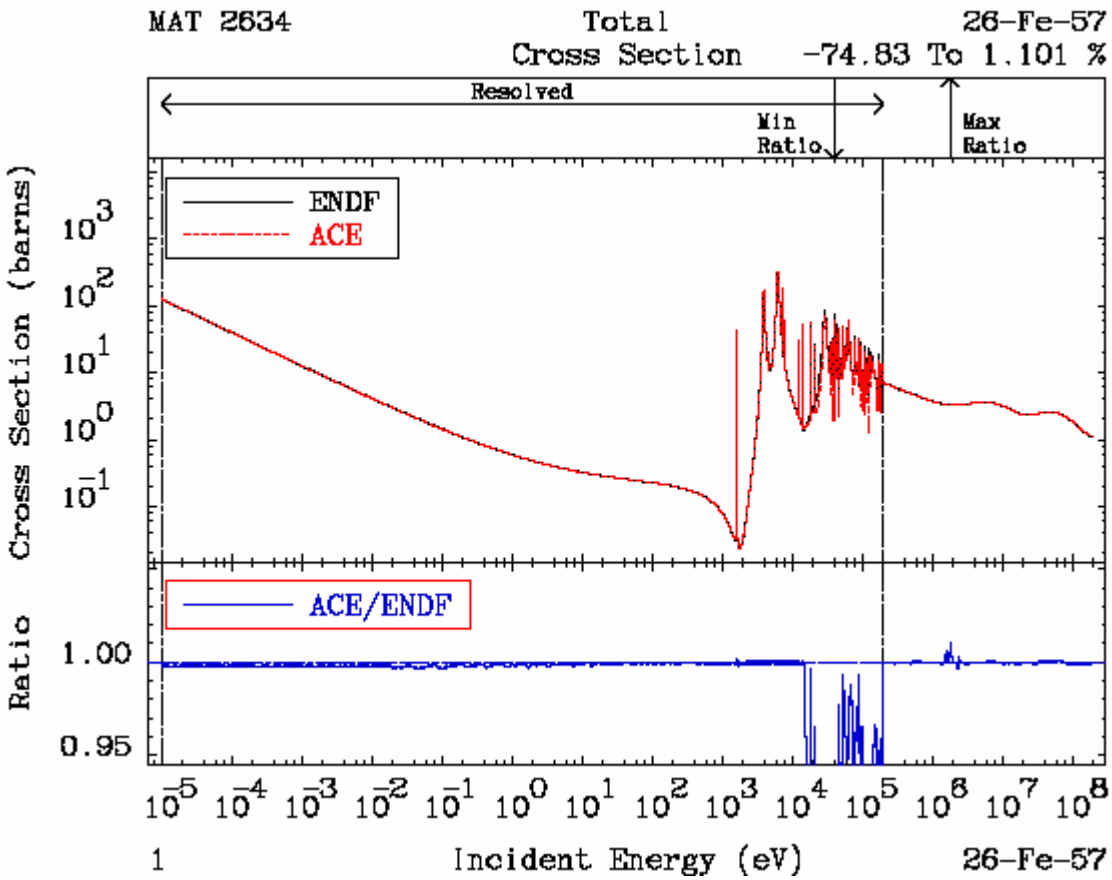
```
 26-Fe-57  2634  3  60 1.656+ 6 2.000+ 8 1.286+ 7    0.000  6.225+ 6    0.000
 26-Fe-57  2634  3  61 1.756+ 6 2.000+ 8 1.653+ 7    0.000  6.175+ 6    0.000
 26-Fe-57  2634  3  62 2.012+ 6 2.000+ 8 2.059+ 6    0.000  6.350+ 6    0.000
 26-Fe-57  2634  3  63 2.025+ 6 2.000+ 8 2.026+ 6    0.000  6.150+ 6    0.000
 26-Fe-57  2634  3  64 2.026+ 6 2.000+ 8 9.821+ 6    0.000  6.150+ 6    0.000
 26-Fe-57  2634  3  65 2.151+ 6 2.000+ 8 9.821+ 6    0.000  5.975+ 6    0.000
 26-Fe-57  2634  3  66 2.156+ 6 2.000+ 8 1.033+ 7    0.000  1.375+ 7    0.000
 26-Fe-57  2634  3  67 2.246+ 6 2.000+ 8 2.300+ 6    0.000  1.375+ 7    0.000
 26-Fe-57  2634  3  68 2.257+ 6 2.000+ 8 2.320+ 6    0.000  1.363+ 7    0.000
 26-Fe-57  2634  3  69 2.260+ 6 2.000+ 8 1.918+ 7    0.000  6.500+ 6    0.000
 26-Fe-57  2634  3  70 2.372+ 6 2.000+ 8 9.513+ 6    0.000  6.125+ 6    0.000
 26-Fe-57  2634  3  91 2.372+ 6 2.000+ 8 2.703+ 6    0.000  5.050+ 6    0.000
 26-Fe-57  2634  3 102 1.000- 5 2.000+ 8 2.000+ 7 -100.000* 2.000+ 7   94.183*
 26-Fe-57  2634  3 103 2.200+ 6 2.000+ 8 2.416+ 6   -0.001  3.342+ 6    0.000
 26-Fe-57  2634  3 104 8.500+ 6 2.000+ 8 8.509+ 6   -0.003  1.850+ 7    0.000
 26-Fe-57  2634  3 105 9.513+ 6 2.000+ 8 1.075+ 7   -0.001  1.050+ 7    0.002
 26-Fe-57  2634  3 106 1.350+ 7 2.000+ 8 1.550+ 7   -0.001  1.450+ 7    0.002
 26-Fe-57  2634  3 107 1.000- 5 2.000+ 8 2.000+ 7 -100.000* 2.000+ 7   94.214*
 26-Fe-57  2634  3 108 1.000+ 7 2.000+ 8 1.259+ 7   -0.001  1.150+ 7    0.001
 26-Fe-57  2634  3 111 1.250+ 7 2.000+ 8 1.438+ 7   -0.002  1.350+ 7    0.002
 26-Fe-57  2634  3 112 1.300+ 7 2.000+ 8 1.488+ 7   -0.001  1.600+ 7    0.001
 26-Fe-57  2634  3 600 2.200+ 6 2.000+ 8 2.416+ 6   -0.001  3.445+ 6    0.000
 26-Fe-57  2634  3 601 2.200+ 6 2.000+ 8 2.400+ 6   -0.002  3.039+ 6    0.000
 26-Fe-57  2634  3 602 2.807+ 6 2.000+ 8 3.013+ 6   -0.002  3.200+ 6    0.001
 26-Fe-57  2634  3 603 3.200+ 6 2.000+ 8 3.428+ 6   -0.003  3.600+ 6    0.001
 26-Fe-57  2634  3 604 3.200+ 6 2.000+ 8 3.417+ 6   -0.001  3.589+ 6    0.001
 26-Fe-57  2634  3 605 3.400+ 6 2.000+ 8 3.600+ 6   -0.002  3.445+ 6    0.001
 26-Fe-57  2634  3 606 3.400+ 6 2.000+ 8 3.888+ 6   -0.002  3.719+ 6    0.003
 26-Fe-57  2634  3 607 3.600+ 6 2.000+ 8 4.025+ 6   -0.001  5.225+ 6    0.000
 26-Fe-57  2634  3 608 3.600+ 6 2.000+ 8 4.025+ 6    0.000  4.000+ 6    0.001
 26-Fe-57  2634  3 609 3.600+ 6 2.000+ 8 3.894+ 6   -0.002  4.825+ 6    0.000
 26-Fe-57  2634  3 610 3.800+ 6 2.000+ 8 4.275+ 6   -0.001  4.081+ 6    0.001
 26-Fe-57  2634  3 649 4.000+ 6 2.000+ 8 4.213+ 6    0.000  4.200+ 6    0.001
 26-Fe-57  2634  3 650 8.500+ 6 2.000+ 8 9.312+ 6   -0.003  9.000+ 6    0.000
 26-Fe-57  2634  3 651 8.509+ 6 2.000+ 8 9.000+ 6   -0.003  8.698+ 6    0.001
 26-Fe-57  2634  3 652 9.000+ 6 2.000+ 8 9.642+ 6    0.000  9.500+ 6    0.002
 26-Fe-57  2634  3 653 9.000+ 6 2.000+ 8 9.577+ 6   -0.001  9.500+ 6    0.001
 26-Fe-57  2634  3 654 9.000+ 6 2.000+ 8 9.500+ 6   -0.001  9.642+ 6    0.000
 26-Fe-57  2634  3 655 9.000+ 6 2.000+ 8 9.910+ 6   -0.002  9.500+ 6    0.001
 26-Fe-57  2634  3 699 9.000+ 6 2.000+ 8 1.832+ 7    0.000  9.500+ 6    0.001
 26-Fe-57  2634  3 700 9.513+ 6 2.000+ 8 1.075+ 7   -0.001  9.642+ 6    0.001
 26-Fe-57  2634  3 701 1.000+ 7 2.000+ 8 1.083+ 7   -0.001  1.052+ 7    0.003
 26-Fe-57  2634  3 702 1.052+ 7 2.000+ 8 1.083+ 7   -0.002  1.100+ 7    0.001
 26-Fe-57  2634  3 703 1.100+ 7 2.000+ 8 1.413+ 7    0.000  1.200+ 7    0.001
 26-Fe-57  2634  3 704 1.100+ 7 2.000+ 8 1.150+ 7   -0.003  1.200+ 7    0.004
 26-Fe-57  2634  3 705 1.100+ 7 2.000+ 8 1.150+ 7    0.000  1.200+ 7    0.001
 26-Fe-57  2634  3 749 1.150+ 7 2.000+ 8 1.200+ 7   -0.002  1.250+ 7    0.000
 26-Fe-57  2634  3 750 1.350+ 7 2.000+ 8 1.413+ 7   -0.002  1.600+ 7    0.003
 26-Fe-57  2634  3 751 1.350+ 7 2.000+ 8 1.571+ 7   -0.002  1.950+ 7    0.000
 26-Fe-57  2634  3 752 1.400+ 7 2.000+ 8 1.500+ 7   -0.004  1.450+ 7    0.002
 26-Fe-57  2634  3 753 1.400+ 7 2.000+ 8 1.637+ 7   -0.001  1.450+ 7    0.001
 26-Fe-57  2634  3 754 1.400+ 7 2.000+ 8 1.637+ 7   -0.002  1.600+ 7    0.002
 26-Fe-57  2634  3 755 1.450+ 7 2.000+ 8 1.571+ 7   -0.001  1.850+ 7    0.000
 26-Fe-57  2634  3 799 1.500+ 7 2.000+ 8 1.625+ 7   -0.001  1.600+ 7    0.000
 26-Fe-57  2634  3 800 1.000- 5 2.000+ 8 2.000+ 7 -100.000* 2.000+ 7   94.213*
 26-Fe-57  2634  3 801 1.000- 5 2.000+ 8 2.000+ 7 -100.000* 2.000+ 7   94.185*
 26-Fe-57  2634  3 802 1.000- 5 2.000+ 8 2.000+ 7 -100.000* 2.000+ 7   94.184*
 26-Fe-57  2634  3 803 1.400+ 6 2.000+ 8 3.737+ 6   -0.098* 1.622+ 6    0.082*
 26-Fe-57  2634  3 804 1.600+ 6 2.000+ 8 4.388+ 6   -0.099* 1.963+ 6    0.077*
 26-Fe-57  2634  3 805 1.800+ 6 2.000+ 8 3.557+ 6   -0.099* 2.111+ 6    0.077*
 26-Fe-57  2634  3 806 2.000+ 6 2.000+ 8 2.975+ 6   -0.099* 2.381+ 6    0.069*
 26-Fe-57  2634  3 807 2.000+ 6 2.000+ 8 2.386+ 6   -0.101* 2.391+ 6    0.078*
 26-Fe-57  2634  3 808 2.200+ 6 2.000+ 8 6.575+ 6   -0.100* 3.367+ 6    0.077*
 26-Fe-57  2634  3 809 2.200+ 6 2.000+ 8 1.413+ 7   -0.100* 3.345+ 6    0.084*
 26-Fe-57  2634  3 810 2.200+ 6 2.000+ 8 4.575+ 6   -0.099* 3.359+ 6    0.088*
 26-Fe-57  2634  3 849 3.000+ 6 2.000+ 8 5.787+ 6   -0.099* 1.022+ 7    0.088*
-------------------------------------------------------------------------------
      18 Plots Generated
-------------------------------------------------------------------------------
* - Indicates Difference Exceeds   0.0100 per-cent
-------------------------------------------------------------------------------
per-cent Difference         = 100 * ((Data1-Data2)/Data1)
                              at Each Energy Point
Maximum per-cent Difference = Largest per-cent Difference at
```

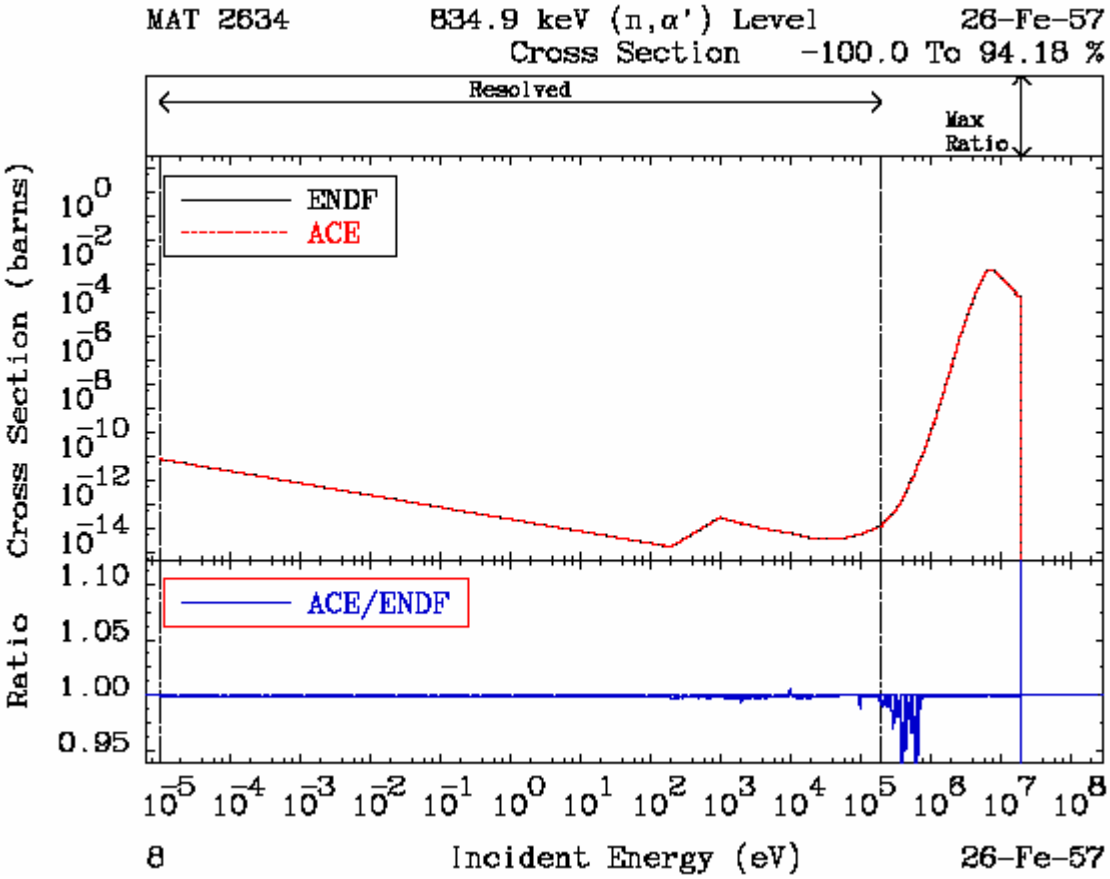
```
                                ANY One or More Energy Points
-------------------------------------------------------------------------------
===============================================================================
Total Execution Time                 3.08 Seconds
===============================================================================
```

Comparison plots to check ACE library processing

Only two plots are presented. The first plot reveals that there is a problem of consistency of the redundant cross sections (i.e. the total), caused by the inconsistency between the implicit competitive width in the resonance parameters and the corresponding pointwise data in file MF 3. The second plot shows differences at real discontinuities of cross sections in the file due to a change of data representation, which are artificially removed in ACE files, in addition to some small fluctuations most likely caused by the differences in the Doppler broadening of cross sections.

Conclusion from the first plot is that the source evaluated data file needs to be corrected, whereas the differences indicated in the second plot might be tolerated.




MAT 2634
834.9 keV (n,α') Level
26-Fe-57
Cross Section
-100.0 To 94.18 %
Resolved
Max Ratio
ENDF
ACE
ACE/ENDF
Cross Section (barns)
Ratio
Incident Energy (eV)
8
26-Fe-57

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