ENDF-201
ENDF/B-VI SUMMARY DOCUMENTATION
SUPPLEMENT I
ENDF/HE-VI SUMMARY DOCUMENTATION

Victoria McLane
and Members of the
Cross Section Evaluation Working Group

December 1996

NATIONAL NUCLEAR DATA CENTER
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973-5000

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency, contractor, or subcontractor thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency, contractor, or subcontractor thereof.
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
## Table of Contents

INTRODUCTION ................................................................. 1  
LIST OF LABORATORIES ...................................................... 2  

SECTION I. Incident neutron sublibrary (NSUB=10) evaluation summaries.  

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Release</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^1$H</td>
<td>Release 1</td>
<td>I.1</td>
</tr>
<tr>
<td>$^2$H</td>
<td>Release 3,4</td>
<td>I.2</td>
</tr>
<tr>
<td>$^3$He</td>
<td>Release 1</td>
<td>I.3</td>
</tr>
<tr>
<td>$^6$Li</td>
<td>Release 1</td>
<td>I.4</td>
</tr>
<tr>
<td>$^{10}$B</td>
<td>Release 1</td>
<td>I.5</td>
</tr>
<tr>
<td>$^{14}$N</td>
<td>Release 1</td>
<td>I.6</td>
</tr>
<tr>
<td>$^{23}$Na</td>
<td>Release 1</td>
<td>I.7</td>
</tr>
<tr>
<td>$^{27}$Al</td>
<td>Release 3,4</td>
<td>I.8</td>
</tr>
<tr>
<td>$^{45}$Sc</td>
<td>Release 2</td>
<td>I.10</td>
</tr>
<tr>
<td>Chromium isotopes, Release 1</td>
<td></td>
<td>I.14</td>
</tr>
<tr>
<td>Iron isotopes, Release 1</td>
<td></td>
<td>I.15</td>
</tr>
<tr>
<td>$^{59}$Co</td>
<td>Release 2</td>
<td>I.16</td>
</tr>
<tr>
<td>Nickel isotopes, Release 1</td>
<td></td>
<td>I.17</td>
</tr>
<tr>
<td>$^{63,65}$Cu</td>
<td>Release 2</td>
<td>I.18</td>
</tr>
<tr>
<td>$^{73}$Ge</td>
<td>Release 2</td>
<td>I.19</td>
</tr>
<tr>
<td>$^{89}$Y</td>
<td>Release 4</td>
<td>I.20</td>
</tr>
<tr>
<td>$^{93}$Zr</td>
<td>Release 1</td>
<td>I.22</td>
</tr>
<tr>
<td>$^{93}$Nb</td>
<td>Release 1</td>
<td>I.23</td>
</tr>
<tr>
<td>$^{101}$Ru</td>
<td>Release 2</td>
<td>I.26</td>
</tr>
<tr>
<td>$^{103}$Ru</td>
<td>Release 2</td>
<td>I.27</td>
</tr>
<tr>
<td>Cadmium isotopes, Release 2,3,4</td>
<td></td>
<td>I.30</td>
</tr>
<tr>
<td>$^{112,114}$Sn</td>
<td>Release 1</td>
<td>I.33</td>
</tr>
<tr>
<td>$^{127}$I</td>
<td>Release 2</td>
<td>I.36</td>
</tr>
<tr>
<td>$^{138}$Ba</td>
<td>Release 3</td>
<td>I.37</td>
</tr>
<tr>
<td>$^{146}$Ba</td>
<td>Release 3</td>
<td>I.41</td>
</tr>
<tr>
<td>$^{149}$La</td>
<td>Release 1</td>
<td>I.43</td>
</tr>
<tr>
<td>$^{143}$Nd</td>
<td>Release 2</td>
<td>I.44</td>
</tr>
<tr>
<td>$^{145}$Nd</td>
<td>Release 2</td>
<td>I.45</td>
</tr>
<tr>
<td>$^{147}$Nd</td>
<td>Release 1</td>
<td>I.48</td>
</tr>
<tr>
<td>$^{147}$Pm</td>
<td>Release 1</td>
<td>I.51</td>
</tr>
<tr>
<td>$^{144}$Sm</td>
<td>Release 3</td>
<td>I.53</td>
</tr>
<tr>
<td>$^{150}$Sm</td>
<td>Release 2</td>
<td>I.54</td>
</tr>
<tr>
<td>$^{151}$Sm</td>
<td>Release 1</td>
<td>I.56</td>
</tr>
<tr>
<td>$^{152}$Sm</td>
<td>Release 2</td>
<td>I.58</td>
</tr>
<tr>
<td>$^{153}$Eu</td>
<td>Release 1</td>
<td>I.59</td>
</tr>
<tr>
<td>$^{155}$Eu</td>
<td>Release 1</td>
<td>I.61</td>
</tr>
<tr>
<td>Element</td>
<td>Release</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>152Gd</td>
<td>Release 4</td>
<td>I.62</td>
</tr>
<tr>
<td>154Gd</td>
<td>Release 4</td>
<td>I.64</td>
</tr>
<tr>
<td>174Hf</td>
<td>Release 2</td>
<td>I.66</td>
</tr>
<tr>
<td>176Hf</td>
<td>Release 2</td>
<td>I.68</td>
</tr>
<tr>
<td>177Hf</td>
<td>Release 2</td>
<td>I.70</td>
</tr>
<tr>
<td>178Hf</td>
<td>Release 2</td>
<td>I.71</td>
</tr>
<tr>
<td>179Hf</td>
<td>Release 2</td>
<td>I.72</td>
</tr>
<tr>
<td>180Hf</td>
<td>Release 1,2</td>
<td>I.73</td>
</tr>
<tr>
<td>184W</td>
<td>Release 1</td>
<td>I.74</td>
</tr>
<tr>
<td>191,193Ir</td>
<td>Release 4</td>
<td>I.75</td>
</tr>
<tr>
<td>197Au</td>
<td>Release 1</td>
<td>I.77</td>
</tr>
<tr>
<td>207Pb</td>
<td>Release 1</td>
<td>I.78</td>
</tr>
<tr>
<td>209Bi</td>
<td>Release 3</td>
<td>I.79</td>
</tr>
<tr>
<td>234U</td>
<td>Release 1,2,3,4</td>
<td>I.80</td>
</tr>
<tr>
<td>235U</td>
<td>Release 2</td>
<td>I.82</td>
</tr>
<tr>
<td>238U</td>
<td>Release 1,2</td>
<td>I.84</td>
</tr>
<tr>
<td>237Np</td>
<td>Release 1</td>
<td>I.85</td>
</tr>
<tr>
<td>239Np</td>
<td>Release 2</td>
<td>I.86</td>
</tr>
<tr>
<td>236Pu</td>
<td>Release 4</td>
<td>I.88</td>
</tr>
<tr>
<td>239Pu</td>
<td>Release 2</td>
<td>I.90</td>
</tr>
<tr>
<td>240Pu</td>
<td>Release 1,2</td>
<td>I.92</td>
</tr>
<tr>
<td>241Pu</td>
<td>Release 1,3</td>
<td>I.93</td>
</tr>
<tr>
<td>242Pu</td>
<td>Release 2</td>
<td>I.98</td>
</tr>
<tr>
<td>241Am</td>
<td>Release 2,3</td>
<td>I.100</td>
</tr>
<tr>
<td>242Am</td>
<td>Release 1</td>
<td>I.104</td>
</tr>
<tr>
<td>242mAm</td>
<td>Release 1</td>
<td>I.106</td>
</tr>
<tr>
<td>245Cm</td>
<td>Release 2</td>
<td>I.107</td>
</tr>
<tr>
<td>246Cm</td>
<td>Release 2</td>
<td>I.108</td>
</tr>
<tr>
<td>247Cm</td>
<td>Release 2</td>
<td>I.109</td>
</tr>
<tr>
<td>250Cf</td>
<td>Release 2</td>
<td>I.111</td>
</tr>
<tr>
<td>251Cf</td>
<td>Release 2</td>
<td>I.113</td>
</tr>
<tr>
<td>252Cf</td>
<td>Release 1,2</td>
<td>I.115</td>
</tr>
<tr>
<td>253Cf</td>
<td>Release 2</td>
<td>I.117</td>
</tr>
</tbody>
</table>

**SECTION II. Photo-Atomic Interaction Data (NSUB=3)**

**SECTION III. Radioactive Decay Data (NSUB=4)**

**SECTION IV. Spontaneous Fission Product Yields (NSUB=5)**

**SECTION V. Neutron-Induced Fission Product Yields (NSUB=11)**
<table>
<thead>
<tr>
<th>Section</th>
<th>Material/Isotope</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION VI. Thermal Neutron Scattering Data (NSUB=12) evaluation summaries</td>
<td>H (H2O)</td>
<td>VI.1</td>
</tr>
<tr>
<td></td>
<td>Liquid Para Hydrogen</td>
<td>VI.2</td>
</tr>
<tr>
<td></td>
<td>Liquid Ortho Hydrogen</td>
<td>VI.3</td>
</tr>
<tr>
<td></td>
<td>H (ZrH)</td>
<td>VI.4</td>
</tr>
<tr>
<td></td>
<td>D (D2O)</td>
<td>VI.5</td>
</tr>
<tr>
<td></td>
<td>Para Deuterium</td>
<td>VI.6</td>
</tr>
<tr>
<td></td>
<td>Ortho Deuterium</td>
<td>VI.7</td>
</tr>
<tr>
<td></td>
<td>Be metal</td>
<td>VI.8</td>
</tr>
<tr>
<td></td>
<td>BeO</td>
<td>VI.9</td>
</tr>
<tr>
<td></td>
<td>Graphite</td>
<td>VI.10</td>
</tr>
<tr>
<td></td>
<td>Liquid Methane</td>
<td>VI.11</td>
</tr>
<tr>
<td></td>
<td>Solid Methane</td>
<td>VI.12</td>
</tr>
<tr>
<td></td>
<td>H (Polyethylene)</td>
<td>VI.13</td>
</tr>
<tr>
<td></td>
<td>Benzene</td>
<td>VI.14</td>
</tr>
<tr>
<td></td>
<td>Zr (ZrH)</td>
<td>VI.15</td>
</tr>
<tr>
<td>SECTION VII. Incident proton sublibrary (NSUB=10010) evaluation summaries.</td>
<td>1H, Release 1</td>
<td>VII.1</td>
</tr>
<tr>
<td></td>
<td>3He, Release 1</td>
<td>VII.2</td>
</tr>
<tr>
<td>SECTION VIII. Incident deuteron sublibrary (NSUB=10020) evaluation summaries.</td>
<td>2H, Release 1</td>
<td>VIII.1</td>
</tr>
<tr>
<td></td>
<td>3H, Release 1</td>
<td>VIII.2</td>
</tr>
<tr>
<td></td>
<td>3He, Release 1</td>
<td>VIII.3</td>
</tr>
<tr>
<td>SECTION XI. Incident triton sublibrary (NSUB=10030) evaluation summaries.</td>
<td>3H, Release 1</td>
<td>IX.1</td>
</tr>
<tr>
<td>SECTION X. ENDF/HE-VI Incident neutron sublibrary (NSUB=10) evaluation summaries.</td>
<td>12C, Release 2</td>
<td>X.1</td>
</tr>
<tr>
<td></td>
<td>56Fe, Release 0</td>
<td>X.3</td>
</tr>
<tr>
<td></td>
<td>208Pb, Release 2</td>
<td>X.5</td>
</tr>
<tr>
<td></td>
<td>209Bi, Release 2</td>
<td>X.7</td>
</tr>
<tr>
<td>SECTION XI. ENDF/HE-VI Incident proton sublibrary (NSUB=10010) evaluation summaries.</td>
<td>12C, Release 2</td>
<td>XI.1</td>
</tr>
<tr>
<td></td>
<td>56Fe, Release 0</td>
<td>XI.2</td>
</tr>
<tr>
<td></td>
<td>208Pb, Release 2</td>
<td>XI.4</td>
</tr>
<tr>
<td></td>
<td>209Bi, Release 2</td>
<td>X.6</td>
</tr>
<tr>
<td>APPENDICIS</td>
<td>A. History of materials issued in ENDF/B-VI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B. History of materials issued in ENDF/HE-VI</td>
<td></td>
</tr>
</tbody>
</table>
INTRODUCTION

The National Nuclear Data Center (NNDC) provides coordination for and serves as the secretariat to the Cross Section Evaluation Working Group (CSEWG). CSEWG is responsible for the oversight of the ENDF/B Evaluated Nuclear Data File. All data are checked and reviewed by CSEWG, and the file is maintained at the NNDC. For a description of the ENDF/B-VI file, see the ENDF-102 Data Formats and Procedures for the Evaluated Nuclear Data File ENDF-6.

The purpose of this addendum to the ENDF/B-VI Summary Documentation is to provide documentation of Releases 1, 2, 3, and 4 for the ENDF/B-VI and ENDF/HE-VI evaluated nuclear data libraries. These releases contain many new and revised evaluations for the neutron, photo-atomic interaction, radioactive decay data, spontaneous fission product yield, neutron-induced fission product yield, thermal neutron scattering, proton, deuteron, and triton sublibraries.

The summaries have been extracted mainly from the ENDF/B-VI File 1 comments (MT=451), which have been checked, edited, and may also include supplementary information. Some summaries have been provided by the evaluators in electronic format, while others are extracted from reports on the evaluations. All references have been checked and corrected, or updated where appropriate.

A list of the laboratories which have contributed evaluations used in ENDF/B-VI is given on the following page.

Appendix A contains a history of all materials issued in ENDF/B-VI. Appendix B contains a listing of the present content of the ENDF/B-VI library.

Release 1 ........................................ distributed in September, 1991
Release 2 ........................................ distributed in June, 1993
Release 3 ........................................ distributed in May, 1995
Release 4 ........................................ distributed December, 1996

1 CSEWG, ENDF-102 Formats and Procedures for the Evaluated Nuclear Data File ENDF-6, BNL-NCS-44945 (1995), edited by V. McLane, C. L. Dunford, and P. F. Rose, National Nuclear Data Center, Brookhaven National Laboratory.

2 ENDF-201, ENDF/B-VI Summary Documentation, BNL-NCS-17541 (1991), Edited by P. F. Rose, National Nuclear Data Center, Brookhaven National Laboratory.

3 If possible, e.g., private communications could not be checked and some references were not available.
List of Laboratories

Following is the list of laboratories who have contributed to the evaluations cited in this document.

AI  ...  Atomics International (now Rockwell Int., Energy Systems) Canoga Park, CA
ANC  ...........................................  Aerojet Nuclear Corp. (see INEL)
ANL  ..................................................  Argonne National Laboratory, Argonne, IL
AWRE  ............................................  Atomic Weapons Research Laboratory, Aldermaston, U.K.
BAPL .............................................  Bettis Atomic Power Laboratory, Pittsburg, PA
BAW  .............................................  Babcock and Wilcox, Lynchburg, VA
BNL  .............................................  Brookhaven National Laboratory, Upton, NY
BNW  ...  Batelle Northwest (now Pacific Northwest National Laboratories) Richland, WA
BRC  .............................................  Centre d’Etudes Nucleaires, Bruyere-le-Chatel, FRANCE
CNDC  ............................................  Chinese Nuclear Data Center, Institute of Atomic Energy, Beijing, CHINA
GA  ..................................................  General Atomic (see GGA)
GGA  ..................................................  Gulf General Atomic, San Diego, CA
HEDL  .............................................  Hanford Engineering Development Laboratory, Richland, WA
INEL  .............................................  Idaho Nuclear Engineering Laboratory, Idaho Falls, ID
JAERI  .............................................  Japan Atomic Energy Research Institute, Tokai, JAPAN
JNDC  .............................................  Japanese Nuclear Data Committee, JAPAN
KAPL  .............................................  Knolls Atomic Power Laboratory, Schenectady, NY
LANL  .............................................  Los Alamos National Laboratory, Los Alamos, NM
LLNL  .............................................  Lawrence Livermore National Laboratory, Livermore, CA
MAPI  .............................................  Mitsubishi Atomic Power Industries, Minato, JAPAN
ORNL  .............................................  Oak Ridge National Laboratory, Oak Ridge, TN
PTB  .............................................  Physikalisch-Technische Bundesanstalt, Braunschweig, GERMANY
RCN  .............................................  Energy Research Foundation, Petten, THE NETHERLANDS
SAI  .............................................  Scientific Applications Inc., La Jolla, CA
SRL  .............................................  Savannah River Laboratory, Aiken, GA
UI  ..................................................  University of Illinois, Urbana-Champaign, IL
Part I

Incident Neutron Sublibrary (NSUB=10)

The documentation is organized by material. Each page contains a header giving the material and release number(s).
The following comments on the standards covariances were added.

STANDARDS COVARIANCES

Phase 1 reviewers of the ENDF/B-VI standards cross sections have expressed the concern that the uncertainties resulting from the combination of R-matrix and simultaneous evaluations might have led to uncertainties that are too small. As a result, the Standards Subcommittee produced (at the May, 1990, CSEWG meeting) a set of expanded covariance estimates for the standard cross section reactions. These uncertainties are estimates such that if a modern day experiment were performed on a given standard cross section using the best techniques, approximately 2/3 of the results should fall within these expanded uncertainties. The expanded uncertainties for the n+\(^1\)H total cross section are, for the energy range 0.01 eV to 20 MeV, 0.2%.

ENDF/B-VI MOD 1 NEW EVALUATION (G. Hale, D. Dodder, E. Siciliano, W. Wilson, LANL, October 1989)

Evaluation:  

2H Incident Neutron Sublibrary, Release 3, 4 (MAT 128)

Files (MF):

1, 2, 3, 4, 6, 8, 9, 12, 14

Energy Range:

10^{-5} \text{ eV} \text{ to } 100 \text{ MeV}

Evaluators:

P. G. Young, L. Stewart, A. Horsley (LANL)

ENDF/B-VI MOD 3, REVISION 2 (P.G. Young, LANL, November 1996)

A missing subsection was added to File 6, MT=16.

ENDF/B-VI MOD 2, REVISION 1 (P.G. Young, LANL, August 1994)

This evaluation is a revision of the ENDF/B-V evaluation by Stewart and Horsley [1]. The evaluation was extended to 100 MeV based on experimental total, elastic, and (n,2n) cross section measurements and elastic scattering angular distribution measurements. Additionally, the total cross section and the elastic cross section were revised between 3 and 8 MeV on the basis of newer data, and similarly the (n,2n) cross section was revised above 10 MeV.

REFERENCE


ENDF/B-VI MOD 0 (R. MacFarlane, LANL, December 1989)

ENDF/B-V MAT 1302 was converted to ENDF-6 format. For documentation of the ENDF/B-V evaluation, see ENDF-201 Summary Documentation, 4th Edition (1991), page 13.
3He Incident Neutron Library, Release 1

Evaluation: 3He Incident Neutron Library, Release 1 (MAT 225)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4
Evaluators: G. Hale, D. Dodder, P. Young (LANL)

ENDF/B-VI MOD 2 REVISION 1 (G. Hale, LANL, July 1991)
The following comments on the standards covariances were added.

STANDARDS COVARIANCES
Phase 1 reviewers of the ENDF/B-VI standards cross sections have expressed the concern that the uncertainties resulting from the combination of R-matrix and simultaneous evaluations might have led to uncertainties that are too small. As a result, the Standards Subcommittee produced (at the May, 1990, CSEWG meeting) a set of expanded covariance estimates for the standard cross section reactions. These uncertainties are estimates such that if a modern day experiment were performed on a given standard cross section using the best techniques, approximately 2/3 of the results should fall within these expanded uncertainties. The expanded uncertainties for the $^3$He(n,p) cross section are as follows:

<table>
<thead>
<tr>
<th>Energy Range (keV)</th>
<th>Estimated Uncertainty %</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-8}$ - 0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>0.1 - 1.0</td>
<td>0.7</td>
</tr>
<tr>
<td>1.0 - 10.</td>
<td>2.0</td>
</tr>
<tr>
<td>10. - 50.</td>
<td>5.0</td>
</tr>
</tbody>
</table>

ENDF/B-VI MOD 1 NEW EVALUATION (G. Hale, D. Dodder, P. Young, LANL, May 1990)
The following changes were made:

1. The comments, below, on the standards covariances were added.
2. File 3, MT=53: LF flag and Q-value corrected.

STANDARDS COVARIANCES

Phase 1 reviewers of the ENDF/B-VI standards cross sections have expressed the concern that the uncertainties resulting from the combination of R-matrix and simultaneous evaluations might have led to uncertainties that are too small. As a result, the Standards Subcommittee produced (at the May, 1990, CSEWG meeting) a set of expanded covariance estimates for the standard cross section reactions. These uncertainties are estimates such that if a modern day experiment were performed on a given standard cross section using the best techniques, approximately 2/3 of the results should fall within these expanded uncertainties. The expanded uncertainties for the $^6$Li(n,t) cross section are given in the following table and are compared to values from the combined output of the standards covariance analysis:

<table>
<thead>
<tr>
<th>Energy Range (keV)</th>
<th>Estimated Uncertainty</th>
<th>Combined Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 - 1.0</td>
<td>0.5</td>
<td>0.14</td>
</tr>
<tr>
<td>1.0 - 10.</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>10. - 50.</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>50. - 90.</td>
<td>1.1</td>
<td>0.25</td>
</tr>
<tr>
<td>90. - 150.</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>150. - 450.</td>
<td>2.0</td>
<td>0.29</td>
</tr>
<tr>
<td>450. - 650.</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>650. - 800.</td>
<td>2.0</td>
<td>0.36</td>
</tr>
<tr>
<td>800. - 1000.</td>
<td>5.0</td>
<td></td>
</tr>
</tbody>
</table>

ENDFB-VI MOD 1 NEW EVALUATION (G. Hale, P. Young, LANL, April 1989)

$^{10}$B Incident Neutron Library, Release 1

Evaluation: $^{10}$B Incident Neutron Library, Release 1 (MAT 525)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 12, 13, 14
Evaluators: G. Hale, P. Young (LANL)

ENDF/B-VI MOD 2 REVISION 1 (G. Hale, LANL, July 1991)

The following changes were made:

1. The comments below on the standards covariances were added.
2. File 3, MT=55,57,62,64,65,68,70,71,73,74,76-81,83,84: LF flag and Q-value corrected.

STANDARDS COVARIANCES

Phase 1 reviewers of the ENDF/B-VI standards cross sections have expressed the concern that the uncertainties resulting from the combination of R-matrix and simultaneous evaluations might have led to uncertainties that are too small. As a result, the Standards Subcommittee produced (at the May, 1990, CSEWG meeting) a set of expanded covariance estimates for the standard cross section reactions. These uncertainties are estimates such that if a modern day experiment were performed on a given standard cross section using the best techniques, approximately 2/3 of the results should fall within these expanded uncertainties. The expanded uncertainties for the $^{10}$B(n,α₀) and $^{10}$B(n,α₁) cross sections are given in the following tables and are compared to values from the combined output of the standards covariance analysis:

<table>
<thead>
<tr>
<th>Energy Range (keV)</th>
<th>Estimated Uncertainty %</th>
<th>Combined Analysis %</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{10}$B(n,α₀) Cross Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^{-6}$ - 0.1</td>
<td>0.5</td>
<td>0.21</td>
</tr>
<tr>
<td>0.1 - 5.0</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>5.0 - 30</td>
<td>3.0</td>
<td>0.38</td>
</tr>
<tr>
<td>30 - 90</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>90 - 150</td>
<td>10.0</td>
<td>0.86</td>
</tr>
<tr>
<td>150 - 200</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>200 - 250</td>
<td>15.0</td>
<td>0.79</td>
</tr>
<tr>
<td>$^{10}$B(n,α₁) Cross Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^{-6}$ - 0.1</td>
<td>0.2</td>
<td>0.16</td>
</tr>
<tr>
<td>0.1 - 5.0</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>5.0 - 30</td>
<td>0.6</td>
<td>0.20</td>
</tr>
<tr>
<td>30 - 90</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>90 - 150</td>
<td>1.5</td>
<td>0.48</td>
</tr>
<tr>
<td>150 - 200</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>200 - 250</td>
<td>2.5</td>
<td>0.62</td>
</tr>
</tbody>
</table>

ENDF/B-VI MOD 1 NEW EVALUATION (G. Hale, P. Young, LANL, November 1989)

\textbf{\textit{natC} Incident Neutron Library, Release 1}

\textbf{Evaluation:} \textit{\textit{natC} Incident Neutron Library, Release 1 (MAT 600)}

\textbf{Energy Range:} \(10^5\) eV to 32 MeV

\textbf{Files (MF):} 1, 2, 3, 4, 5, 12, 14, 33

\textbf{Evaluators:} C. Y. Fu, E. J. Axton, F. G. Perey (ORNL)

\textbf{ENDF/B-VI MOD 2 REVISION 1} (C. Y. Fu, ORNL, July 1991)

The following changes were made for Revision 1 of ENDF/B-VI:

1. The comments below on the standards covariances were added.
2. References were updated, see below.

\textbf{STANDARDS COVARIANCES}

Following concerns expressed at the Standards Subcommittee meeting, May, 1990, about the seemingly small standards uncertainties, the Standards Subcommittee has provided expanded uncertainties. These uncertainties are estimates such that if a modern day experiment were performed today on a given standard using the best techniques, those results would fall within these expanded uncertainties (2/3 of the time). They take into account data inconsistencies and concerns about R-matrix parameters. Note that it is not assumed that the uncertainties are totally correlated within the energy ranges given. It is recommended that these expanded uncertainties be put in File 1 and in the documentation for the standards.

\begin{center}
\begin{tabular}{l|c}
\hline
\textbf{Energy (keV)} & \textbf{Uncertainty (\%)} \\
\hline
1 - 500 & 0.46 \\
500 - 1500 & 0.53 \\
1500 - 1800 & 0.60 \\
\hline
\end{tabular}
\end{center}

\textbf{REFERENCES}


\textbf{ENDF/B-VI MOD 1 NEW EVALUATION} (C. Y. Fu, E. Axton, F. Perey, ORNL, August 1989)

$^{14}$N Incident Neutron Sublibrary, Release 2, 3

Evaluation: $^{14}$N Incident Neutron Library, Release 2, 3 (MAT 725)
Energy Range: $10^{-5}$ eV to 40 MeV
Files: 1, 2, 3, 4, 6, 12, 13, 14, 15
Evaluators: P. G. Young, G. Hale, M. Chadwick (LANL)

ENDF/B-VI MOD 3 REVISION 2 (P. Young, LANL, August 1994)
The elastic and inelastic cross sections (MT=63-90) at incident neutron energies above 13.5 MeV given in Revision 2 of ENDF/B-VI were corrected. This correction was made to improve agreement with elastic scattering measurements up to 25 MeV. The elastic neutron angular distributions above 20 MeV were also improved over the earlier data distributed in Release 2, based upon fits to experimental data.

ENDF/B-VI MOD 2 REVISION 1 (P. G. Young, LANL, September 1992)
The modified version of the ENDF/B-VI evaluation created for the Defense Nuclear Agency is extended in energy to 40 MeV. This extension was accomplished using experimental data and the September 1992 version of the GNASH code [1], which was updated for higher energy calculations. More details will be given in a later progress report.

The ENDF/B-VI evaluation was modified for DNA use to include results from Hale’s R-Matrix analysis that include Harvey’s new total cross section measurement [2]. These results are interim until the new ORNL scattering data can be incorporated. The ORNL preliminary scattering results confirm the parity of the first resonance as being positive, as used in the R-Matrix analysis.

REFERENCES

ENDF/B-VI MOD 1 NEW EVALUATION (P. Young, G. Hale, M. Chadwick, LANL, May 1990)
\( ^{23}\text{Na} \) Incident Neutron Library, Release 1

**Evaluation:**

\( ^{23}\text{Na} \) Incident Neutron Library, Release 1 (MAT 1125)

**Energy Range:**

10\(^{-5}\) eV to 40 MeV

**Files:**

1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15, 32, 33

**Evaluators:**

D. C. Larson (ORNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, July 1991)

The number of energy ranges in File 32, MT = 151 was corrected to be 1.

ENDF/B-VI MOD 0 (NNDC, January 1990)

ENDF/B-V MAT 1125 was converted to ENDF-6 format by NNDC.

ENDF/B-V NEW EVALUATION (D. C. Larson, ORNL, December 1977)

**RESONANCE PARAMETERS** (File 2)

Resonance region is 600 eV to 500 keV. The thermal neutron capture cross section is in agreement with the experimental results of 526.9\(\pm\)4.5 mb [Ry71], as well as earlier results summarized in [Ry71]. Using resonance parameters \( \Gamma_n=376 \) eV and \( \Gamma_\gamma=0.353 \) eV for the large 2.81 keV resonance gives the correct thermal capture value using a Breit-Wigner shape, and this form is used to calculate the capture cross section from 1.0\(\times\)10\(^{-5}\) to 600 eV. The capture width \( \Gamma_\gamma=0.353 \) eV is consistent with a recent result by Wilson, et al. [Wi77] where they find 0.24<\( \Gamma_\gamma \)<0.4 eV with a 90\% confidence level, and with a recent preliminary result of Macklin [Ma76] where he found \( \Gamma_\gamma=0.385\pm0.04 \) eV. The \( \Gamma_n \) and \( E_{res} \) values are taken from Seltzer and Firk [Se74]. From 600 eV to 500 keV, the capture cross section is generated from resonance areas reported by Musgrove, et al. [Mu77], and neutron widths and spins obtained from a multilevel analysis of the transmission data of Larson and Hill [La76].

**Thermal neutron capture cross section** = 528 mb.

**SMOOTH CROSS SECTION** (File 3)

- **Elastic cross section** calculated as total - nonelastic.
- **Nonelastic** calculated as sum \( (n,n') + (n,2n) + (n,\gamma) + (n,p) + (n,\alpha) \).
- **Inelastic** calculated as the sum of the inelastic to discrete levels (MT=51-68), plus the continuum (MT=91).

**Capture cross section**, as discussed above, the shape from 10\(^{-5}\) eV to 600 eV was taken from a single-level Breit-Wigner form; from 600 eV to 500 keV, File 3 gives no contribution. From 500 keV to 20 MeV, the capture file is the same as the ENDF/B-IV file by Pitterle & Paik [Pi72].

- \( (n,p) \) taken from ENDF/B-IV modified above 8 MeV based on 2 step Hauser-Feshbach calculations.
- \( (n,\alpha) \) taken from ENDF/B-IV.
23Na Incident Neutron Library, Release 1

ANGULAR DISTRIBUTIONS (File 4)
Elastic taken mainly from [Ki76], ENDF-IV and Optical Model calculations.
All other angular distributions are assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (file 5)
(n,2n) taken from ENDF-IV.
For the continuum (MT=91), temperatures were adjusted to fit neutron production data of Hermsdorf [He75].

RADIOACTIVITY (File 8)
Data from ENDF/B-V (Reich), and Endt and VanderLeun.

PHOTON PRODUCTION (Files 12, 13, 14, 15)
MF=12 Capture data taken from ENDF-IV.
MF=13 Nonelastic: (n,γ) data taken from Larson and Morgan [La77].
MF=14 All angular distributions are assumed isotropic.
MF=15 Nonelastic: (n,γ) data are taken from Larson and Morgan.

COVARIANCES (Files 32, 33)
MF=32 Uncertainty files for the resonance parameters below 32 keV are estimated from the literature for the 2.81 keV resonance, and an area analysis for the 7.6 keV resonance. Results from the multilevel analysis, capture areas, and area analysis form the basis for the remainder of the resonance parameter uncertainties. The uncertainties in the resonance parameters are most useful in self-shielding work.
MF=33 Uncertainty files for the capture cross section are estimated from the literature, and the spread of the various data sets.

REFERENCES
He75 H. Hermsdorf, et al., ZFK-277 (1975) Zentralinst. Kernforschung, Rossendorf bei Dresden, Germany
Ki76 W. E. Kinney and F. G. Perey, private communication
La77 D. C. Larson and G. L. Morgan, to be published
Ma76 R. L. Macklin, private communication (1976)
Pi72 T. A. Pitterle and N. C. Paik, WARD 304ST4B-2, Appendix A (1972) Westinghouse Advanced Reactor Division
27Al Incident Neutron Sublibrary, Release 3, 4

Evaluation: 27Al Incident Neutron Library, Release 3, 4 (MAT 1325)
Energy Range: $10^{-5}$ eV to 40 MeV
Files: 1, 2, 3, 4, 6, 8, 9, 12, 14, 15
Evaluators: P. G. Young (LANL)

ENDF/B-VI MOD 2 REVISION 1 (P. G. Young (LANL), V. McLane (NNDC) August 1996)
File 1: The thermal cross section were added to MT=451.
File 3: The interpolation code on the first 3 points of MT=1 and the first 10 points on MT=102 was changed to 5.

ENDF/B-VI MOD 1 NEW EVALUATION (P. G. Young, LANL)
GENERAL COMMENTS

This evaluation is based on a theoretical analysis that utilizes Hauser-Feshbach statistical theory, with corrections for preequilibrium and stripping processes. Spherical optical model calculations are used to obtain particle transmission coefficients for the Hauser-Feshbach calculations, as well as for the elastic neutron angular distributions. Some data from ENDF/B-VI (MOD=0), are retained, in particular, the neutron total cross section below 20 MeV and the radiative capture cross section and photon multiplicities below about 100 keV.

Cross sections and spectra for individual reactions are included for reactions that exceed a cross section of approximately 1 mb at any energy. Multiplicities and emission energy spectra are given for gamma rays, particles, and recoil nuclei emitted in each reaction. Energy-angle-correlated spectra are given for all outgoing particles.

2200 m/sec Cross Sections
Total = 1.58 barns
Elastic = 1.348 barns
Capture = 0.232 barns

Capture resonance integral = 0.13377 barns

HAUSER-FESHBACH STATISTICAL THEORY CALCULATIONS

The GNASH code [Yo92] was used for all Hauser-Feshbach statistical theory calculations. Preequilibrium corrections were performed in the course of the GNASH calculations using the exciton model of Kalbach [Ka77,Ka85]. Discrete level data from nuclear data sheets were matched to continuum level densities using the formulation of Ignatyuk [Ig75] and pairing and shell parameters from the Cook [Co67] analysis. Neutron and charged-particle transmission coefficients were obtained from the optical potentials, as discussed below. Gamma-ray transmission coefficients were calculated using the Kopecky-Uhl model [Ko90]. Calculations were performed for all significant reactions producing neutrons, protons, deuterons, tritons, $\alpha$ particles, and $\gamma$ rays for incident neutrons between $10^{-11}$ and 40 MeV. At the highest energies, approximately 30 compound nuclei had to be included, leading to ~180 reaction paths. The angular distribution systematics by Kalbach [Ka88] were used to describe the angular distributions for all continuum particles.
OPTICAL MODEL POTENTIALS

For incident and exiting neutrons, the phenomenological optical potential by Petler, et al. [Pe85], based on a microscopic optical model analysis of experimental data, was utilized at all energies. A modified version of Perey's potential [Pe63] was used to calculate transmission coefficients for protons below 44 MeV, switching to the Madland potential [Ma88] at higher energies. The potential by Perey and Perey [Pe63] was utilized to calculate deuteron transmission coefficients for deuterons at all energies. Similarly, a triton potential by Becchetti and Greenlees [Be71] and an alpha potential determined by Arthur and Young [Ar80] for n + 56Fe reactions were used at all energies for those particles.

DIRECT REACTIONS

Energy-dependent cross sections of inelastic neutrons from 27Al(n,n') direct reactions were calculated using the DWUCK code [Ku70], normalized to values of the angle-integrated cross sections in ENDF/B-VI at 14 MeV.

ENDF/B-V CARRYOVERS

The following reactions/data were carried over unchanged from ENDF/B-V:
- MF=2, MT=151: Resonance Parameters: effective scattering radius = 0.32752x10^-12 cm. (Resonance parameters not given.)

CALCULATIONAL RESULTS

The MF=3 cross sections and MF=6 energy/angle distributions based completely on calculations are:

- MT = 11, (n,2nd) MT = 104, (n,d)
- MT = 16, (n,2n) MT = 105, (n,t)
- MT = 17, (n,3n) MT = 107, (n,α) (MF=6 only)
- MT = 22, (n,nα) MT = 108, (n,2α)
- MT = 24, (n,2nα) MT = 111, (n,2p)
- MT = 28, (n,np) MT = 112, (n,poα)
- MT = 29, (n,n2α) MT = 115, (n,nd)
- MT = 32, (n,nd) MT = 116, (n,pt)
- MT = 33, (n,nt) MT = 117, (n,dα)
- MT = 41, (n,2np) MT = 649, (n,p) Continuum
- MT = 42, (n,3np) MT = 650-669, (n,d) Discrete Levels
- MT = 44, (n,n2p) MT = 699, (n,d) Continuum
- MT = 45, (n,npoα) MT = 700-710, (n,t) Discrete Levels
- MT = 64-89, (n,n') Discrete Levels
- MT = 91, (n,n') Continuum
- MT = 103, (n,p) (MF=6 only)

Kalbach systematics [Ka88] are used to specify all continuum particle angular distributions. All continuum photon angular distributions are assumed isotropic.

Additionally, the radioactive nuclei formation data in MF = 8 and 9 were obtained directly from the GNASH calculations.
OTHER REACTIONS

The following reactions are based on combinations of experimental data and theoretical calculations or other techniques:

SMOOTH CROSS SECTIONS (File 3)

**Total Cross Section:** Below 20 MeV, carried over from ENDF/B-V. At higher energies based on data of Perey [Pe72] and optical model calculation.

**Elastic Cross Section:** Obtained by subtracting sum of nonelastic cross sections from the total. Mainly results from the optical model calculations above 14 MeV. At lower energies the nonelastic cross sections are a combination of experimental data (ENDF/B-V evaluations) and the theoretical calculations.

**Inelastic Cross Section:** Summation of MT=51-91.

**Inelastic Cross Section to Discrete States:** Combination of experimental data below 14 MeV, (especially the (n,n') data of Kinney and Perey [Ki70], the (n,γ) data of Orphan and Hoot [Or71] and Dickens, et al. [Di71,Di73]), and calculated excitation functions, with a rough match to the ENDF/B-V evaluation near 14 MeV.

**(n,γ) Cross Section:** Below 1 keV, ENDF/B-V was adopted. At higher energies, calculations from GNASH code used, including a semidirect model.

**(n,p) and (n,α) Cross Section:** Taken directly from the International Reactor Dosimetry File IRDF-90 of the IAEA, obtained by Wagner, et al. (IRK) [Wa90]. At higher energies, calculated excitation function were used, normalized to the IRK data at 20 MeV.

ANGULAR DISTRIBUTIONS (File 4)

**Elastic Angular Distributions:** ENDF/B-V adopted below 6 MeV. At higher energy optical model calculations used (see above). Tabulated distributions given in the center-of-mass system.

ENERGY-ANGLE DISTRIBUTIONS (File 6)

**Inelastic Level Neutron & Photon Distributions:** For MT=51-62, neutron angular distributions are combination of experimental data and calculated shapes below 14 MeV and are represented by Legendre expansions in the center-of-mass system. At higher energies, calculated shapes are used. For MT=63-89, calculated angular distributions are used at all energies. Photon multiplicities based on experimental branching ratios and GNASH calculations. Photon angular distributions assumed isotropic.

PHOTON PRODUCTION (Files 12, 15)

**Radiative Capture Photon Multiplicities:** Below 1 keV, ENDF/B-V adopted. At higher energies, based on GNASH calculations.

**Radiative Capture Photon Energy Distributions:** Below 1 keV, ENDF/B-V adopted. At higher energies, based on GNASH calculations.
REFERENCES


Be92  O. Bersillon, *Computation and Analysis of Nuclear Data Relevant to Nuclear Energy and Safety*, ICTP Workshop, 10 February-13 March, 1992, Trieste, Italy, to be published, World Scientific Press


Ka85  C. Kalbach, LA-10248-MS (1985) Los Alamos National Laboratory


45Sc Incident Neutron Data Sublibrary, Release 2

Evaluation: 45Sc Incident Neutron Sublibrary, Release 2 (MAT 2125)

Energy Range: 10<sup>5</sup> eV to 20 MeV

Files: 1, 2, 3, 4, 5, 12, 13, 14, 15

Evaluators: A. B. Smith (ANL), R. J. Howerton (LLNL)

ENDF/B-VI MOD 1 NEW EVALUATION (A. B. Smith (ANL), R. J. Howerton (LLNL), July 1992)

This evaluation provides a reasonable basic scandium evaluated data file; no equivalent file was previously available. The available experimental data is far from definitive, thus, considerable reliance had to be placed on calculational extrapolation. See Smith, et al. [1] for detailed information.

RESONANCE PARAMETERS (File 2)

Resonance parameters taken from Mughabghab, et al. [2]; no adjustments were made to these parameters.

SMOOTH CROSS SECTIONS (File 3)

The total and elastic scattering cross section evaluation relies primarily upon the model calculations of Smith and Guenther [3], slightly adjusted to improve agreement with the measured values of Barnard, et al. [4].

The capture cross section evaluation uses the results calculated using ABAREX [5], slightly adjusted at ≈ 100 keV to match the resonance region.

(n,p) cross sections modified as per P. Young and D. Muir (LANL). Thermal value may be large.

REFERENCES
Chromium isotopes Incident Neutron Data Sublibrary, Release 1

Evaluation: Chromium Isotopes Incident Neutron Sublibrary, Release 1
MAT 2425 ($^{50}$Cr), 2431 ($^{52}$Cr), 2434 ($^{53}$Cr), 2437 ($^{54}$Cr)

Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 6, 12, 14, 15, 33

ENDF/B-VI MOD 2 REVISION 1
The elastic transformation matrix was removed.
The secondary particle distributions for File 6, $^{50}$Cr MT=51-56, $^{53}$Cr MT=51-62, and $^{54}$Cr MT=51-54, were corrected to center-of-mass coordinates (from laboratory coordinates).

ENDF/B-VI MOD 1 NEW EVALUATION
Iron Isotopes Incident Neutron Sublibrary, Release 1

Evaluation: Iron Isotopes Incident Neutron Sublibrary, Release 1
MAT 2625 (54Fe), 2631 (56Fe), 2634 (57Fe), 2637 (58Fe)

Energy Range: 10^5 eV to 20 MeV

Files: 1, 2, 3, 4, 6, 12, 14, 15, 33

Evaluators: D. M. Hetrick, C. Y. Fu, N. M. Larson (ORNL)

ENDF/B-VI MOD 2 REVISION 1 (D. Hetrick, C. Fu, N. Larson, ORNL, July 1991)
The elastic transformation matrix was removed.
The secondary particle distributions for File 6, for 57Fe MT=51-55 and 58Fe MT=51-52, were corrected to center-of-mass coordinates (from laboratory coordinates).

ENDF/B-VI MOD1 NEW EVALUATION (D. Hetrick, C. Fu, N. Larson, ORNL, November 1989)
Evaluation: 59Co Incident Neutron Sublibrary, Release 2 (MAT 2725)
Energy Range: 10^5 eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 13, 14, 15, 33
Evaluators: A. B. Smith, ET AL. (ANL), G. DeSaussure, et al. (ORNL), R. Howerton (LLNL), M. Sugimoto (JAERI)

ENDF/B-VI MOD 2 REVISION 1 (G. de Saussure, N. M. Larson, J. A. Harvey, N. W. Hill, ORNL, June 1992)
Resonance parameters reevaluated by analyzing six ORELA transmission measurements (described in [1]) using a Reich-Moore approximation and the resonance analysis code SAMMY. See reference [1] for complete documentation.

REFERENCES

ENDF/B-VI MOD1 NEW EVALUATION (A. Smith, D. Smith, P. Guenther, J. Meadows, R. Lawson (ANL), R. Howerton (LLNL), M. Sugimoto (JAERI), July 1989)
**59Co Incident Neutron Sublibrary, Release 2**

**Evaluation:** Nickel Isotopes Incident Neutron Sublibrary, Release 1  
MAT 2825 ($^{58}$Ni), 2831 ($^{60}$Ni), 2834 ($^{61}$Ni), 2837 ($^{62}$Ni), 2843 ($^{64}$Ni)

**Energy Range:** 10$^3$ eV to 20 MeV  
**Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33  
**Evaluators:** D. C. Larson, C. M. Perey, D. M. Hetrick, C. Y. Fu (ORNL)


$^{58}$Ni Capture widths corrected for 58.7 and 439.52 keV resonances. The elastic transformation matrix was removed.

$^{60}$Ni The resonance region from 10 eV to 450 keV has been changed, based on SAMMY analysis by F. G. Perey [1] of the $^{60}$Ni ORELA data up to 100 keV of Harvey, et al. (described in [1]). This work reproduces the thermal cross sections and includes the small resonances inadvertently left out in the original file. No Background cross sections are required in File 3 in the resonance region. The elastic transformation matrix was removed.

REFERENCES

$^{61}$Ni The secondary particle distributions for File 6 MT=51-58 were corrected to center-of-mass, not laboratory coordinates. The elastic transformation matrix was removed.

$^{62}$Ni The secondary particle distributions for File 6 MT=51-54 were corrected to center-of-mass, not laboratory coordinates. The elastic transformation matrix was removed.

$^{64}$Ni The secondary particle distributions for File 6 MT=51-52 were corrected to center-of-mass, not laboratory coordinates. The elastic transformation matrix was removed.

Evaluation:  

\(^{63,65}\text{Cu Incident Neutron Sublibrary, Release 2}\)

MAT 2925 \((^{63}\text{Cu})\), 2931 \((^{65}\text{Cu})\)

Energy Range: \(10^{-5}\) eV to 20 MeV

Files: 1, 2, 3, 4, 6, 12, 14, 15, 33

Evaluators: D. M. Hetrick, C. Y. Fu, D. C. Larson (ORNL)


\(^{63}\text{Cu}\) The following changes were made:

1) Corrections to MF=6, MT=65 at 17.0 MeV to prevent negative values in the angular distribution.

2) Corrections to MF=33, MT=102

\(^{65}\text{Cu}\) Corrections to MF=6, MT=63 at 17.5 MeV to prevent negative values in the angular distribution.


This work employed several nuclear model codes including the Optical-Model code GENOA [1], the Distorted-Wave Born Approximation (DWBA) program DWUCK [2], and the Hauser-Feshbach code TNG [3,4]. The TNG code provides energy and angular distributions of particles emitted in the compound and pre-compound reactions, ensures consistency among all reactions, and maintains energy balance.


REFERENCES

2. P.D. Kunz, Distorted Wave Code DWUCK72, unpublished (1972) Univ. of Colorado
Evaluation: 73Ge Incident Neutron Sublibrary, Release 2 (MAT 3234)
Energy Range: 10^-eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. E. Schenter and F. Schmittroth (HEDL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, February 1993)
Q-value for MT=53 corrected from 98.6 keV to 68.75 keV.

ENDF/B-VI MOD 0 (NNDC, February 1993)
ENDF/B-V MAT 9051 translated to ENDF/B-VI format.

ENDF/B-V NEW EVALUATION (R. E. Schenter, F. Schmittroth, HEDL, April 1974)
Evaluated for ENDF/B-IV, MAT 49. Translated to ENDF/B-V format by NNDC, July, 1980.

RESONANCE PARAMETERS (File 2)
Resonance parameters taken from Mughabghab, et al. [3].

2200 m/sec capture cross section (barns)
(from resonance parameters) = 6.066
(from 1/v component) = 8.934
Total = 15.000
Computed capture resonance integral = 69.915

SMOOTH CROSS SECTIONS (File 3)
Total cross sections, above the resonance region, calculated using Moldauer Potential [4],
elastic cross section from \( \sigma_{\text{total}} - \sigma_{\text{n,\gamma}} - \sigma_{\text{inel}} \).
Inelastic cross sections calculated using COMNUC-3 [5].
Neutron capture evaluated using methods (NCAP code) in Refs.[1,2] for energies above the
resonance region. A 1/v component was added in the resonance region to give the 2200 m/sec
cross section of Mughabghab [3].

ANGULAR DISTRIBUTIONS (File 4)
The elastic angular distribution were assumed to be isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
For MT= 91 the evaporation spectrum (LF=9) parameters obtained using NCAP code [2].
REFERENCES

1. F. Schmittroth and R. E. Schenter, HEDL TME 73-63 (1973) Hanford Engineering and Development Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering and Development Laboratory
Evaluation:  
89Y Incident Neutron Sublibrary, Release 4 (MAT 3925)

Energy Range:  
$10^5$ eV to 20 MeV

Files:  
1, 2, 3, 4, 5, 12, 13, 14, 15, 33

Evaluators:  
A. B. Smith, D. L. Smith, P. Rousset, R. D. Lawson (ANL), R. J. Howerton (LLNL)

ENDF/B-VI MOD 2 REVISION 1 (V. McLane, NNDC, October 1996)
Changes included:
File 1: Update of comments; thermal values added.
File 5, MT=91: Last energy range modified to fix problem of outgoing neutron having an energy greater than incoming neutron.

ENDF/B-VI MOD 0 (NNDC, January 1990)
Converted from ENDF/B-V MAT 9202 to ENDF-6 format. The ENDF/B-V evaluation is fully documented in reference [1].

2200n/sec cross sections (barns)
Total = 8.992
Elastic = 7.707
Capture = 1.285

Capture resonance integral = 10.917

REFERENCE
Evaluation: nat\(^{90}\)Zr Incident Neutron Sublibrary, Release 1 (MAT 4000)
Energy Range: \(10^3\) eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: M. Drake, D. Sargis, T. Maung (SAI); P. Rose (BNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, August 1991)
An error in the parameter U for the continuum inelastic energy distribution (MF=5,MT=91) has been corrected.

ENDF/B-VI MOD 0 (NNDC, January 1990)
ENDF/B-V MAT 4000 converted to ENDF-6 format by NNDC.

ENDF/B-V EVALUATION

RESONANCE REGION (Re-evaluated by P.F. Rose, BNL for revision 2)
Resolved resonance parameters were taken from the output of BNLNDF [34] which is based on the recommended values given Mughabghab, et al. [1]. The upper boundary of the resonance region = 90 keV.

2200 m/sec capture cross sections and resonance parameters

<table>
<thead>
<tr>
<th>Material</th>
<th>MAT #</th>
<th>(\sigma_{\gamma}) (barns)</th>
<th>(I_{\text{res}}) (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^{90})Zr</td>
<td>1385</td>
<td>0.011</td>
<td>0.179</td>
</tr>
<tr>
<td>(^{91})Zr</td>
<td>1386</td>
<td>1.188</td>
<td>4.913</td>
</tr>
<tr>
<td>(^{92})Zr</td>
<td>1387</td>
<td>0.221</td>
<td>0.655</td>
</tr>
<tr>
<td>(^{94})Zr</td>
<td>1388</td>
<td>0.049</td>
<td>0.311</td>
</tr>
<tr>
<td>(^{96})Zr</td>
<td>1389</td>
<td>0.023</td>
<td>5.629</td>
</tr>
<tr>
<td>nat(^{90})Zr</td>
<td>1340</td>
<td>0.186</td>
<td>0.965</td>
</tr>
</tbody>
</table>

Unresolved parameters given for \(^{91}\)Zr only.

SMOOTH CROSS SECTIONS (File 3)
The total cross section was smoothly joined to the resonance region cross sections for the individual isotopes. Between 90 keV and 500 keV, the data of Seth [3] were used. Between 500 keV and 2 MeV, the evaluated data were based on the measurements of Green and Mitchell [4], and Stooksberry and Anderson [5]. Above 2 MeV, the measurements of Green and Mitchell [4], Foster and Glasgow [6], Carlson and Barschall [7], and Peterson, et al. [8] were used.

The \((n,2n)\) cross section was based on estimates for the separated isotopes. Except for \(^{90}\)Zr, the results from a statistical model were used. The \((n,2n)\) cross section for \(^{90}\)Zr was based on measurements by Prestwood and Bayhurst [9], Nethaway [10], and several measurements near 14 MeV.

I.23
The \((n,\alpha)\) cross section was based on estimates for the separated isotopes. The energy dependent measurements by Bayhurst and Prestwood [11], statistical model calculations, and several measurements at 14 MeV were used.

The \((n,p)\) cross section for \(^{90}\)Zr was based on measurements by Carroll and Stooksberry [12] and Bayhurst and Prestwood [11]; for \(^{91}\)Zr, on measurements by Carroll and Stooksberry [12], Reed [13], and Levkovskii [14]; for \(^{92}\)Zr and \(^{94}\)Zr, on measurements by Carroll and Stooksberry (12), Reed (13), Bramlitt and Fink [15], Lu, et al. [16] Levkovskii [14], Prasad and Sarkar [16], and Paul and Clarke [17].

For the \((n,\gamma)\) cross section the data recommended by Benzi [18] were used.

For inelastic scattering, 19 level excitation cross sections and a continuum cross section have been given. The cross sections were based on a previous evaluation by KAPL and the experimental data of Tessler, et al [19], Day [20], McDaniel, et al. [21], Brandenberger and Glasgow, Smith and Whalen [22], Lind and Day [23], Tessler and Glickstein [24], Guenther, et al. [22], and Glazkov [25].

The elastic scattering cross section was taken, basically, as the difference between the total cross section and the non-elastic cross section. The experimental data used includes Engelbrecht and Smith [26], Hans and Snowdon [27], Kent, et al. [28], Walt and Beyster [29], Walt and Barschall [30], Gilboy and Towle [31], and Clark and Cross [32].

REFERENCES
8. J. M. Peterson, A. Bratenahl, and J. P. Stoering, Phys. Rev. 120, 521 (1960)
18. V. Benzi, et al., CEC(71) 9 (1971) CNEN, Bologna, Italy
34. S. F. Mughabghab, private communication (1981)
93\text{Nb} Incident Neutron Sublibrary, Release 1

**Evaluation:** 93\text{Nb} Incident Neutron Sublibrary, Release 1 (MAT 4125)

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 15, 33, 40

**Evaluators:** A. B. Smith, D. L. Smith, L. P. Gerardo (ANL); R. J. Howerton (LLNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC August 1991)
The section MOD numbers have been corrected in the directory.

ENDF/B-VI MOD 1 NEW EVALUATION (A. Smith, D. Smith, L. Gerardo, ANL, R. Howerton, LLNL, March 1990)
101Ru Incident Neutron Sublibrary, Release 2

Evaluation: 101Ru Incident Neutron Sublibrary, Release 2 (MAT 4440)
Energy Range: $10^{-5}$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

ENDF/B-VI, REVISION 1 (R. Q. Wright, ORNL, October 1991)

RESONANCE PARAMETERS (File 2)

The resolved resonance range is revised and extended to 1 keV using the MLBW formalism. The highest energy resonance included is 1035 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]. For resonances for which the value of $\Gamma_r$ is not specified in [1], the value 0.180 eV is used. The thermal capture cross section is 3.41 barns and is 10% higher than the ENDF/B-V value. The thermal capture is computed from the positive resonances; a bound level is not included. The capture resonance integral of 111.68 barns is about 11 barns higher than the ENDF/B-V value, and is in good agreement with the value given by Anufriev, et al. [2] of 108±15 barns and with the Mughabghab, et al., value of 100±20 barns.

Unresolved resonance parameters have been added for the range 1 to 100 keV. The unresolved range fit is based on the average capture cross sections from Macklin, et al. [3], see Table 1, following page. The parameters are based on:

$$D_0 = 20.42 \text{ eV}, \quad S_0 = 0.59 \times 10^4, \quad S_1 = 6.0 \times 10^4, \quad S_2 = 2.0 \times 10^4$$

$$D_1 = 8.75 \text{ eV}, \quad S_{\gamma 0} = 8.815 \times 10^4, \quad S_{\gamma 1} = 20.57 \times 10^4$$

**2200 m/sec capture cross section (barns)**

(from resonance parameters) = 3.41

**Computed capture resonance integral (barns)**

(0.5 eV - 1 keV) = 102.63

(above 1 keV) = 9.05

Total = 111.68

SMOOTH CROSS SECTIONS (File 3)

Total, elastic, and capture are set to zero in the resolved and unresolved resonance ranges ($10^{-5}$ eV to 100 keV). The capture cross section is also revised for energies above 100 keV. The total cross section is unchanged from ENDF/B-V and elastic is revised to reflect the change in the capture cross section. The revised capture cross section follows the data of Macklin [3] between 3 and 700 keV. The capture cross section at 30 keV is about 1007 mb. The revised capture is also compared to the data of Macklin and with ENDF/B-V in Table 1. Macklin’s data have been multiplied by a factor of 0.985 to correct for a processing code error. Shown in Table 1 is the change for the new evaluation relative to ENDF/B-V (%DIFF.).


**101Ru Incident Neutron Sublibrary, Release 2**

**TABLE 1. 101Ru Capture (barns)**

<table>
<thead>
<tr>
<th>E (keV)</th>
<th>Macklin</th>
<th>MAT 4440</th>
<th>ENDF/B-V</th>
<th>% DIFF.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 4</td>
<td>2.612</td>
<td>2.427</td>
<td>2.462</td>
<td>-1.42</td>
</tr>
<tr>
<td>4 - 6</td>
<td>2.043</td>
<td>2.110</td>
<td>2.217</td>
<td>-4.83</td>
</tr>
<tr>
<td>6 - 8</td>
<td>1.852</td>
<td>1.861</td>
<td>1.993</td>
<td>-6.62</td>
</tr>
<tr>
<td>8 - 10</td>
<td>1.720</td>
<td>1.699</td>
<td>1.840</td>
<td>-7.66</td>
</tr>
<tr>
<td>10 - 15</td>
<td>1.498</td>
<td>1.506</td>
<td>1.624</td>
<td>-7.27</td>
</tr>
<tr>
<td>15 - 20</td>
<td>1.280</td>
<td>1.308</td>
<td>1.404</td>
<td>-6.84</td>
</tr>
<tr>
<td>20 - 30</td>
<td>1.111</td>
<td>1.109</td>
<td>1.196</td>
<td>-7.27</td>
</tr>
<tr>
<td>30 - 40</td>
<td>0.919</td>
<td>0.926</td>
<td>1.003</td>
<td>-7.68</td>
</tr>
<tr>
<td>40 - 60</td>
<td>0.751</td>
<td>0.755</td>
<td>0.820</td>
<td>-7.92</td>
</tr>
<tr>
<td>60 - 80</td>
<td>0.601</td>
<td>0.613</td>
<td>0.670</td>
<td>-8.51</td>
</tr>
<tr>
<td>80 -100</td>
<td>0.518</td>
<td>0.525</td>
<td>0.574</td>
<td>-8.54</td>
</tr>
<tr>
<td>100 -150</td>
<td>0.434</td>
<td>0.441</td>
<td>0.467</td>
<td>-5.57</td>
</tr>
<tr>
<td>150 -200</td>
<td>0.337</td>
<td>0.352</td>
<td>0.370</td>
<td>-4.86</td>
</tr>
<tr>
<td>200 -300</td>
<td>0.273</td>
<td>0.275</td>
<td>0.296</td>
<td>-7.09</td>
</tr>
<tr>
<td>300 -400</td>
<td>0.1940</td>
<td>0.1982</td>
<td>0.2164</td>
<td>-8.41</td>
</tr>
<tr>
<td>400 -500</td>
<td>0.1469</td>
<td>0.1523</td>
<td>0.1507</td>
<td>+1.06</td>
</tr>
<tr>
<td>500 -600</td>
<td>0.1215</td>
<td>0.1229</td>
<td>0.1119</td>
<td>+9.83</td>
</tr>
<tr>
<td>600 -700</td>
<td>0.1001</td>
<td>0.1009</td>
<td>0.0877</td>
<td>+15.05</td>
</tr>
</tbody>
</table>

**REFERENCES**


**ENDF/B-VI MOD 0** (NNDC, January 1990)
converted from ENDF/B-V MAT 9330, Fission Product Special Purpose Library.

**ENDF/B-V EVALUATION** (R. Schenter, F. Schmittroth, F. Mann, et al., HEDL, RCN, February 1980)

**SMOOTH CROSS SECTIONS** (File 3) (for energy region above resonance region)

Total cross section calculated using Moldauer potential [3].
Elastic cross section calculated as $\sigma_{tot} - \sigma_{inel}$.
Inelastic cross section calculated using COMNUC-3 [4].
Neutron capture evaluated using methods (NCAP code) of Schmittroth [1,2], updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [5].

ANGULAR DISTRIBUTIONS (File 4)
Elastic angular distributions were calculated from Moldauer potential. Nonelastic angular distribution assumed to be isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
The evaporation spectrum (LF=9) parameters were obtained using NCAP code [2].

REFERENCES
1. F. Schmittroth and R. E. Schenter, HEDL TME 73-63 (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
5. F. Schmittroth, HEDL-TME 77-51 (1978) Hanford Engineering Development Laboratory
**Evaluation:**

**102Ru Incident Neutron Sublibrary, Release 2 (MAT 4443)**

**Energy Range:** 10^{-5} eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

**ENDF/B-VI MOD 2 Revision 1** (R. Q. Wright, ORNL, October 1991)

**RESONANCE PARAMETERS** (File 2)

Resolved resonance range is revised and extended to 13.4 keV using the MLBW formalism; the highest resonance included is 13.446 keV. The resolved resonance parameters are taken from Mughabghab, et al. [1] and from Table V of Macklin and Halperin [2]. 42 s-wave and 107 p-wave resonances are assigned. The bound level at -146 eV has Γ_n^0 of 55 meV and Γ_r of 112 meV and accounts for about 92% of the thermal capture cross section. The following data has been used:

- 0 - 1700 eV: 14 levels from Anufriev [3]
- 1700-2660 eV: Parameters are fictitious
- 2.66-13.4 keV: Based on data of Macklin and Halperin [2], Tables V and VI.

The unresolved resonance region (13.4 to 100 keV) fit is based on the average capture cross sections and strength functions from Macklin and Halperin. The parameters are based on:

\[ D_0 = 360 \text{ eV}, \ S_0 = 0.45 \times 10^4, \ S_1 = 5.0 \times 10^4, \ S_2 = 0.94 \times 10^4 \]
\[ D_1 = 116 \text{ eV}, \ S_{n0} = 2.917 \times 10^4, \ S_{n1} = 9.91 \times 10^4 \]

2200 m/sec cross sections (barns)

- Total = 6.793
- Elastic = 5.565
- Capture = 1.228

Computed capture resonance integral = 4.316 barns

**SMOOTH CROSS SECTION** (File 3)

Total, elastic, and capture are set to zero in the resolved and unresolved resonance regions (10^{-5} eV to 100 keV). The cross sections above 100 keV are unchanged from the previous evaluation.

The average capture cross sections from the revised evaluation are compared with the previous evaluation and with the data of Macklin and Halperin in Table I.
Table I. Ru-102 Average Capture (mb)

<table>
<thead>
<tr>
<th>E (keV)</th>
<th>Macklin [2]</th>
<th>ENDF/B-VI MOD 0</th>
<th>ENDF/B-VI MOD 2</th>
<th>% change Macklin</th>
<th>% change MOD 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>683.5</td>
<td>561.6</td>
<td>829.2</td>
<td>21.3</td>
<td>47.6</td>
</tr>
<tr>
<td>4-6</td>
<td>501.3</td>
<td>522.8</td>
<td>501.7</td>
<td>0.08</td>
<td>-4.04</td>
</tr>
<tr>
<td>6-8</td>
<td>445.6</td>
<td>443.2</td>
<td>432.7</td>
<td>-2.89</td>
<td>-2.37</td>
</tr>
<tr>
<td>8-10</td>
<td>464.9</td>
<td>418.6</td>
<td>457.3</td>
<td>-1.63</td>
<td>9.25</td>
</tr>
<tr>
<td>10-15</td>
<td>349.9</td>
<td>347.3</td>
<td>379.0</td>
<td>8.32</td>
<td>9.13</td>
</tr>
<tr>
<td>15-20</td>
<td>265.8</td>
<td>278.2</td>
<td>276.5</td>
<td>4.03</td>
<td>-0.61</td>
</tr>
<tr>
<td>20-30</td>
<td>218.8</td>
<td>219.2</td>
<td>218.0</td>
<td>-0.37</td>
<td>-0.55</td>
</tr>
<tr>
<td>30-40</td>
<td>157.6</td>
<td>172.5</td>
<td>171.4</td>
<td>8.76</td>
<td>-0.64</td>
</tr>
<tr>
<td>40-50</td>
<td>131.9</td>
<td>144.5</td>
<td>143.3</td>
<td>8.64</td>
<td>-0.83</td>
</tr>
<tr>
<td>50-60</td>
<td>122.0</td>
<td>127.0</td>
<td>125.1</td>
<td>2.54</td>
<td>-1.50</td>
</tr>
<tr>
<td>60-80</td>
<td>111.5</td>
<td>109.2</td>
<td></td>
<td>-2.06</td>
<td></td>
</tr>
<tr>
<td>80-100</td>
<td>98.9</td>
<td>96.7</td>
<td></td>
<td>-2.22</td>
<td></td>
</tr>
</tbody>
</table>

% change Macklin = % difference for revised evaluation relative to Macklin values.
% Change MOD 0 = % difference for revised evaluation relative to previous evaluation.

REFERENCES

ENDF/B-VI MOD 0 (NNDC, January 1990)
Converted from ENDF/B-V t 9331 Fission Product Special Purpose Library.


SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)
Total cross sections were calculated using Moldauer potential [3].
Elastic cross sections were calculated as \( \sigma_{\text{tot}} - \sigma_{\text{n},n} - \sigma_{\text{int}} \).
Inelastic cross sections were calculated using COMNUC-3 [4].
Neutron capture was evaluated using methods (NCAP code) of Schmittroth [1,2], updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [5].
ANGULAR DISTRIBUTIONS (File 4)
Elastic angular distribution were calculated from Moldauer potential. The nonelastic angular distributions were assumed to be isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters were obtained using NCAP code [2].

REFERENCES
1. F. Schmittroth and R. E. Schenter, HEDL TME 73-63 (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
5. F. Schmittroth, HEDL-TME 77-51 (1978) Hanford Engineering Development Laboratory
Cadmium Isotopes Incident Neutron Sublibrary, Release 2, 3, 4

Evaluation: Cadmium Isotopes Incident Neutron Library, Release 2, 3, 4
MAT 4825 (\(^{106}\)Cd), 4831 (\(^{108}\)Cd), 4837 (\(^{110}\)Cd), 4840 (\(^{111}\)Cd), 4843 (\(^{112}\)Cd), 4846 (\(^{113}\)Cd), 4849 (\(^{114}\)Cd), 4855 (\(^{116}\)Cd)

Energy Range: 10\(^{-5}\) eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: J. McCabe, A. B. Smith, J. W. Meadows (ANL); R. Q. Wright (ORNL)

ENDF/B-VI MOD 4, Revision 2 (R. Q. Wright, ORNL, and V. McLane, NNDC)

The File 1 comments for the even isotopes were updated.
\(^{112}\)Cd An obsolete code was deleted in File 3, MT=4.

\(^{114}\)Cd The unresolved resonance range scattering width was changed to 6.19 fm in order to eliminate a discontinuity in the total cross section at 100 keV.

\(^{116}\)Cd The unresolved resonance parameters were revised in order to eliminate a discontinuity in the total cross section at 100 keV. The s- and p-wave strength functions were increased to 0.2E-4 and 3.4E-4, respectively, for both the resolved and unresolved resonance regions. The calculated resolved resonance thermal scattering cross section is 5.806 barns. The revised evaluation has higher total and elastic cross sections between 9 and 100 keV, but the capture is almost identical (within +1.2 to -2.0%) to the previous evaluation.

ENDF/B-VI MOD 3 Evaluation (J. McCabe, A. B. Smith, J. W. Meadows, ANL, August 1994)

Comprehensive neutronically evaluated data files for the naturally-occurring isotopes of cadmium are deduced from the experimental data and nuclear models. Particular attention is given to those processes relevant to fuel-cycle and fission-product applications. Comparisons are made with prior evaluations of the cadmium isotopes, and discrepancies and consistencies cited. Some discrepancies are very large (e.g., as much as 100%), and the differences have the potential for a pronounced impact on applications usage. The present files are comprehensive, including many important processes that are not represented in the previous ENDF/B-VI evaluation.

The resonance region evaluation was carried over from the MOD 2 update to the ENDF/B-V evaluations, R. Q. Wright [2]. See McCabe, et al. [1] for complete documentation.

REFERENCES

ENDF/B-VI MOD 2 NEW EVALUATION, R. Q. Wright (December 1991)

This evaluation is a modification of the ENDF/B-V evaluation.

RESOLVED RESONANCE RANGE

The MLBW formalism is used for this evaluation. The resolved resonance parameters are taken from Mughabghab [1] and Musgrove, et al. [2].

\(^{1}\) Also at the University of Arizona, Tempe, AZ.

1.33
Cadmium Isotopes Incident Neutron Sublibrary, Release 2, 3, 4

\(^{106}\text{Cd}\) The upper limit of the resolved resonance range is 6.0 keV; the highest energy resonance included is 5881 eV. In Mughabghab [1] there is a gap between about 700 and 2500 eV where no resolved resonance data is available. 14 fictitious s-wave resonances were inserted in this region. Above 2500 eV, 25 resonances were assigned as s-wave and 27 were assigned as p-wave. Also 4 fictitious s-wave resonances were inserted above 6 keV. For s-wave resonances the average gamma width is 0.1612 eV; the average level spacing is 142.6 eV; the s-wave strength function is \(0.834 \times 10^{-4}\). The p-wave capture width is set to 0.175 eV for all 27 resonances.

\(^{108}\text{Cd}\) The upper limit of the resolved resonance range is 6.1 keV; the highest energy resonance included is 5970 eV. In Mughabghab [1] there is a gap between about 500 and 2500 eV where no resolved resonance data is available. 18 fictitious s-wave resonances were inserted in this region. Above 2500 eV, 31 resonances were assigned as s-wave and 29 were assigned as p-wave. For s-wave resonances the average gamma width is 0.1055 eV; the average level spacing is 119.6 eV; the s-wave strength function is \(1.446 \times 10^{-4}\). The p-wave capture width is set to 0.125 eV for all 29 resonances.

\(^{110}\text{Cd}\) The upper limit of the resolved resonance range is 7.1758 keV; the highest energy resonance included is 9860 eV. 55 resonances were assigned as s-wave (including 11 s-wave resonances above 7175.8 eV) and 48 were assigned as p-wave. The bound level at -110 eV has a \(\Gamma_n^0\) of 304.44 meV\(^2\) and accounts for about 92% of the thermal capture cross section. The total cross section at thermal is 29.24 barns.

\(^{112}\text{Cd}\) The upper limit of the resolved resonance range is increased to 7.35 keV; the highest energy resonance included is 11455 eV. 64 s-wave and 54 p-wave resonances were assigned including 24 s-wave resonances above 7350 eV. The bound level at -125 eV has a \(\Gamma_n^0\) of 93.91 meV and \(\Gamma_\gamma\) of 83 meV (Mughabghab [1]), and accounts for about 95% of the thermal capture cross section. The elastic cross section at thermal is 6.31 barns.

\(^{114}\text{Cd}\) The upper limit of the resolved resonance range is increased to 8.0 keV; the highest energy resonance included is 10088 eV. 40 s-wave and 45 p-wave resonances were assigned including 5 s-wave resonances above 8000 eV. The bound level at -225 eV has a \(\Gamma_n^0\) of 34.53 meV and \(\Gamma_\gamma\) of 53.0 meV, and accounts for about 43% of the thermal capture cross section. The elastic cross section at thermal is 4.461 barns.\(^3\)

\(^{115}\text{Cd}\) The upper limit of the resolved resonance range is increased to 9.0 keV; the highest energy resonance included is 8825 eV. 27 s-wave and 21 p-wave resonances are assigned. The bound level at -550 eV has \(\Gamma_n^0\) of 101 meV and \(\Gamma_\gamma\) of 48 meV, and accounts for about 90% of the thermal capture cross section. The elastic cross section at thermal is 5.39 barns.

\(^2\) Note that the Mughabghab [1] reduced neutron width of the bound level should be half the quoted value (302.5 meV), see page D-2 of Mughabghab [4]. Also the calculated capture resonance integral is 42 barns. In addition, one of the double entries of the 89.5 eV resonance should be deleted.

\(^3\) Note that the value of the capture resonance integral given on page 48-22 of Mughabghab [1] should read 13±2 barns (see Mughabghab [4]).
UNRESOLVED RESONANCE RANGE

The unresolved resonance range fit is based on the average capture cross sections from page 449 of Musgrove, et al. [3]. The unresolved resonance parameters are based on:

<table>
<thead>
<tr>
<th>D_0 (eV)</th>
<th>S_0 (10^4)</th>
<th>S_1 (10^4)</th>
<th>S_2 (10^4)</th>
<th>D_1 (eV)</th>
<th>S_0 (10^4)</th>
<th>S_1 (10^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>106Cd</td>
<td>110</td>
<td>1.0</td>
<td>5.0</td>
<td>0.5</td>
<td>42.</td>
<td>14.09</td>
</tr>
<tr>
<td>108Cd</td>
<td>100</td>
<td>1.44</td>
<td>4.4</td>
<td>0.5</td>
<td>46.67</td>
<td>10.5</td>
</tr>
<tr>
<td>110Cd</td>
<td>155</td>
<td>0.5</td>
<td>3.0</td>
<td>1.0</td>
<td>53.33</td>
<td>4.58</td>
</tr>
<tr>
<td>112Cd</td>
<td>190</td>
<td>0.5</td>
<td>4.4</td>
<td>1.5</td>
<td>75.</td>
<td>4.05</td>
</tr>
<tr>
<td>114Cd</td>
<td>235</td>
<td>0.64</td>
<td>3.5</td>
<td>1.0</td>
<td>90.</td>
<td>2.26</td>
</tr>
<tr>
<td>116Cd</td>
<td>390</td>
<td>0.16</td>
<td>2.8</td>
<td>1.0</td>
<td>150</td>
<td>1.205</td>
</tr>
</tbody>
</table>

FILE 3 CHANGES:

Total, elastic, and capture are set to zero in the resolved and unresolved resonance ranges (1.0×10^-5 eV to 100 keV). For 106,108,110,112Cd, the cross sections are unchanged from the previous evaluation for energies above 100 keV. The capture cross section is reduced by about 40% for 114Cd and 20% for 116Cd between 100 keV and 5 MeV. The elastic cross section is increased by a small amount in this range such that the total cross section is unchanged.

2200 m/s Capture cross section (barns)
(from resonance parameters)

Computation resonance integral (barns)

REFERENCES

2. A. Musgrove et al., J. of Physics, G 4, 771 (1978)

ENDF/B-VI MOD 0 EVALUATION (NNDC, January, 1990)

Converted to ENDF-6 format from ENDF/B-V: 106Cd (MAT 9440), 108Cd (MAT 9442), 110Cd (MAT 9444), 112Cd (MAT 9447), 114Cd (MAT 9450), 116Cd (MAT 9453).
Evaluation: 112,114Sn Incident Neutron Library, Release 1
MAT 5025 (112Sn), MAT 5031 (114Sn)

Energy Range: 10^-5 eV to 20 MeV

Files (MF): 1, 2, 3, 4, 5

Evaluators: F. M. Mann (HEDL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, August 1991)
The low energy interpolation code changed to log-log for the total and capture cross section (MF=3, MT=1,102).

ENDF/B-VI MOD 0 (NNDC, January 1990)
ENDF/B-V MAT 9513 (112Sn) and MAT 9516 (114Sn) converted to ENDF-6 format.

ENDF/B-V EVALUATION (F. Mann, HEDL, February 1980)
File 2 resonance parameters taken from Mughabghab [1].
File 3 cross sections are from Hauser-Feshbach calculations using the Moldauer potential.
Low energy data determined from thermal cross section using a 1/v tail.
File 4 angular distributions assumed isotropic.
File 5 evaporation temperatures from 3.2*E/AWR.

REFERENCE
127I Incident Neutron Sublibrary, Release 2

Evaluation: 127I Incident Neutron Sublibrary, Release 2 (5325)
Energy Range: 10^-5 eV to 30 MeV
Files: 1, 2, 3, 4, 6, 8, 9, 12, 14, 15
Evaluators: P. G. Young, R. E. Macfarlane (LANL)

ENDF/B-VI MOD 1 NEW EVALUATION (P. Young, R. MacFarlane, LANL, March 1991)

GENERAL COMMENTS
Resolved resonance parameters from an analysis of Mughabghab [Mu81] were used with a multi-level Breit-Wigner representation to represent the total, elastic, and capture data up to an incident neutron energy of 1 keV.

The evaluation above the resonance region (E>1 keV) is based on a theoretical analysis using the SCAT2 optical model code [Be81], the COMNUC [Du70] and GNASH [Yo77, Ar88] Hauser-Feshbach statistical theory codes, the DWUCK [Ku70] distorted-wave Born approximation code, and the ECIS [Ra70] coupled-channel deformed optical model code.

OPTICAL MODEL POTENTIAL
The spherical optical model potential of Yamamuro [Ya90] which utilizes Walter’s [Wa85] potential above 20 MeV, was utilized with slight modification at low energies, similar to Yamamuro [Ya88]. For protons, the potential of Perey [Pe63] was modified to include an energy-dependent term in the surface imaginary potential. The alpha potential used by Arthur and Young in Fe calculations [Ar80] was adopted for alpha particles. The above potentials were used to supply transmission coefficients for neutrons, protons, and alpha particles in the Hauser-Feshbach statistical calculations. Of course, all the neutron cross sections depend on the potentials through the transmission coefficients. It was necessary only to adjust the neutron total and capture cross sections to improve agreement with experimental data. The neutron potential was used to obtain all the shape elastic components of the neutron elastic scattering angular distributions, as well as the compound elastic and inelastic scattering angular distribution components.

DIRECT REACTION ANALYSIS
The coupled-channel calculations of Matoba [Ma75] for 126Te were repeated with ECIS in order to verify the importance of vibrational states and to confirm the validity of using simple DWBA calculations. The deformation parameters beta(l=2,J=2+) and beta(l=3,J=3-) from Matoba, together with B(E2) and B(E3) values for 127I in Nuclear Data Sheets [Ha82], were used to infer deformation parameters for 127I levels. The E2 strength was distributed among known levels in 127I; the E3 strength was distributed among 5 arbitrarily assumed negative parity levels between E_x=1.3 and 2.1 MeV in 127I. The deformation parameters from the above analysis were used in DWBA calculations with DWUCK to provide cross section and angular distributions for the discrete 127I(n,n') reactions to relevant levels in 127I. The compound nucleus reaction cross section was decreased appropriately for the direct reaction components.
HAUSER-FESHBACH STATISTICAL CALCULATIONS

The GNASH code was used for all Hauser-Feshbach statistical theory calculations between 0.001 and 30 MeV. Width fluctuation corrections were obtained from the COMNUC code [Du70], which utilizes the model of Moldauer [Mo76]. Preequilibrium corrections are carried out in GNASH with the exciton model of Kalbach [Ka77,Ka85]. Discrete level data were obtained from Nuclear Data Sheets [Ha82]; continuum level densities were represented with the Gilbert-Cameron [Gi65] model using the Cook parameters [Co67]. Particle transmission coefficients were obtained from the optical model calculations described above. Transmission coefficients for γ rays were calculated using the Brink-Axel model [Br55,Ax62]. Normalization of the γ-ray strength function was carried out using the compilation of Mughabghab [Mu81]. Calculations were carried out for all reactions that produce neutrons, protons, α particles, or γ rays for incident neutron energies between 1 keV and 30 MeV. The RECOIL code by MacFarlane [Ma84] was used to analyze and unfold the GNASH output for representation in ENDF/B MF=6 format. Angular distribution systematics by Kalbach [Ka88] were used to describe angular distributions for continuum particles, as well as discrete reactions where direct reaction data were lacking.

RESONANCE PARAMETERS (File 2)

Resolved Resonance Parameters: Zero to 1 keV, MLBW representation used with the resonance parameters of Mughabghab [Mu81]. Smooth cross section background included for the capture cross section to improve agreement with experimental data in range 20 to 1000 eV.

<table>
<thead>
<tr>
<th>2200 m/sec cross sections (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Capture</td>
</tr>
<tr>
<td>Elastic</td>
</tr>
</tbody>
</table>

SMOOTH CROSS SECTIONS (File 3)

Total Cross Section: From 1 keV to 14 MeV, the optical model calculation was adjusted to agree with bulk of experimental data. Below 100 keV, the cross section was smoothly joined with resonance range. From 0.1 to 3 MeV, the data of Tabony, et al., [Ta68], Miller, et al. [Mi52], Bockelman, et al. [Bo49] was emphasized. From 3 to 14 MeV, mainly Foster and Glasgow [Fo71] was used. Near 30 MeV, experimental data of Deconninck [De61] was used to adjust optical model calculations.

Elastic Scattering Cross Section: The cross section was obtained by subtracting all nonelastic cross sections from total. It is essentially equal to combination of shape elastic cross section from SCAT2 and compound elastic cross section from COMNUC calculation. Optical model potential and other parameters were taken from the analysis described above.

Inelastic Scattering Cross Section: Sum of MT=51-91 Cross Sections.

MT=16,17,22,28,37,64,84,91: Based on GNASH calculations.

(n,n') Discrete Inelastic Cross Sections: Based on compound nucleus calculations using GNASH code, with DWBA direct reaction components added for E2 vibrational contributions in MT= 51-58,60,63-65 and E3 contributions in MT=67-71. Note that MT=67-71 are assumed levels for the purpose of including the E3 strength, which must be present.

(n,n') Cross Section to Continuum States: Based on GNASH calculations.
Incident Neutron Sublibrary, Release 2

Capture Cross Section: From 1 to 100 keV, essentially GNASH calculation, with small adjustment for data, especially [Gi61]. From 100 keV to 3.5 MeV, calculated values adjusted significantly to match data, especially [St61]. From 3.5 to 30 MeV, based on GNASH calculations, in agreement with experimental data.

\( (n,p) \) and \( (n,\alpha) \) Cross Section: Sum of MT=600-649 and MT=800-849, respectively.

\( (n,p) \) and \( (n,\alpha) \) to Discrete States: Based on GNASH calculations. Note that, for \( (n,\alpha) \), data for first 29 levels lumped into a single level (MT=801) due to small cross sections. Decay scheme of thirteenth excited state assumed.

\( (n,\alpha) \) Cross Section to Continuum States: Based on GNASH calculations.

ANGULAR DISTRIBUTIONS (File 4)

Elastic angular distributions were obtained by combining shape elastic calculations using the SCAT2 code [Be81] with compound elastic contributions calculated with COMNUC [Du70]. Optical model and other parameters were taken from the analysis described above. Legendre polynomial representation used.

CORRELATED ENERGY-ANGLE DISTRIBUTIONS (File 6)

Continuum energy distributions for MT=16, 17, 22, 28, 37, 91, 649, and 849 were calculated with the GNASH reaction theory code (see above). Energy-angle correlations are given using the updated angular distribution systematics of Kalbach [Ka88]. Recoil angular distributions are given as P1 Legendre expansions. Multiplicities angular (and implicit energy) distributions are also provided for discrete reactions in MT=51-71, 600-622, and 800-829. Data are given for outgoing particles, gamma rays, and recoil nuclei.

\( (n,n') \) Discrete Inelastic Cross Sections: Discrete data taken from compound nucleus and pre-equilibrium calculations with GNASH, and from DWBA calculations with DWUCK. MT=51-54, 56-58, 60, 63-65 include direct components with compound nucleus and pre-equilibrium, MT=55, 59, 61, 62, 66 include compound nucleus and pre-equilibrium, and MT=67-71 are pure direct reaction data. Angular distributions are given as Legendre expansions.

\( (n,n') \) Cross Section to Continuum States: GNASH Hauser-Feshbach statistical/preequilibrium calculations. Energy-angle distributions are given for secondary neutrons and recoil nuclei.

\( (n,p) \) and \( (n,\alpha) \) to Discrete States: Discrete data taken from compound nucleus and pre-equilibrium calculations with GNASH. Angular distributions assumed isotropic because of very small cross sections. Note that, for \( (n,\alpha) \), data for first 29 levels lumped into a single level (MT=801) due to small cross sections. Decay scheme of thirteenth excited state assumed. Energy-angle distributions are given for secondary alphas and recoil nuclei.

Radioactive Nuclide Data

\( (n,p) \) Information on ground and 88-keV isomeric states.

\( (n,\alpha) \) Information on ground, 11-, and 37-keV isomeric states.

MULTIPlicITIES FOR RADIOACTIVE NUCLIDES (File 9)

Branching ratios obtained from GNASH calculations. NOTE: Isomeric transition contributions are not included in \( \gamma \) cascades so that multiplicities add to unity.
PHOTON PRODUCTION (Files 12, 13, and 15)

Photon multiplicities from radiative capture. Note that γ rays from (n,γn') reactions are included so that multiplicities become nonphysically large above neutron energies of a few hundred keV.

Photon angular distributions are from radiative capture; assumed isotropic.
Photon gamma-ray energy distributions are obtained from GNASH calculations.

REFERENCES
Ax62 P. Axel, Phys.Rev. 126, 671 (1962)
Be81 O. Bertsillon, CEA-N-2227, (1981) Centre d’Etudes de Bruyeres-le-Chatel
Du70 C. L. Dunford, AI-AEC-12931 (1970) Atomics International
Gi65 A. Gilbert and A. Cameron, Can. J. Phys. 43, 1446 (1965)
Ku70 P. D. Kunz, DWUCK: A Distorted-Wave Born Approximation Program, unpublished report (1970) Univ. of Colorado
Ma84 R. E. MacFarlane and D. G. Foster, Jr., J. Nucl. Mat. 122 & 123, 1047 (1984)
Mi52 D. W. Miller, et al., Phys. Rev. 88, 83 (1952)
Pe63 F. G. Perey, Phys. Rev. 131, 745 (1963)
Ya90 N. Yamamuro, JAERI-M 90-006 (1990) Japan Atomic Energy Research Institute

I.40


**ENDF/B-VI MOD 1 NEW EVALUATION** (R. Q. Wright, ORNL, December 1994)

**RESONANCE REGION**

Resolved resonance parameters were added in the range from 0.4 to 198 keV using the MLBW formalism; the highest resonance included is 194.78 keV. The principal source for the resolved resonance parameters in this evaluation is the data of Brusegan, et al. [1] which has 11 s-wave and 29 p-wave resonances. An additional 20 p-wave resonances have been included from Musgrove, et al. [2].

The average $\Gamma_s$ for s-wave is 0.089 eV, $D_0 = 18.7$ keV, and $S_0 = 0.73 \times 10^{-4}$. The average $\Gamma_p$ for p-wave is 0.066 eV, $D_1 = 3.95$ keV, and $S_1 = 1.07 \times 10^{-4}$. The scattering radius, $R = 5.083$ fm.

2200 m/sec cross sections (barns)

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3.342</td>
</tr>
<tr>
<td>Elastic</td>
<td>2.982</td>
</tr>
<tr>
<td>Capture</td>
<td>0.360</td>
</tr>
</tbody>
</table>

**Capture Resonance Integral** = 0.267 barns

**FILE 3 CHANGES**

File 3 Cross Sections are revised below 400 eV. The low energy total cross section is based on the measured data of Koester, et al. [3]. The low energy capture is $1/\nu$ up to 400 eV with a thermal value of 0.36 barns taken from Mughabghab, et al. [4]. The elastic cross section has been set to zero in the resolved resonance range but for capture a small $1/\nu$ background has been used.

(n,p) and (n,α) were revised to be the same as the JENDL3.2 evaluation.

**AVERAGE CAPTURE CROSS SECTIONS**

The average capture cross sections, flat weighting, calculated with NJOY, using this evaluation are compared with the measured values from Musgrove, et al. [2] for the energy range 0.1 to 100 keV in Table 1, below.
Table 1. $^{138}\text{Ba}$ Average Capture (mb)

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>Measured</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1-0.4</td>
<td>3.82</td>
<td></td>
</tr>
<tr>
<td>0.4-1.0</td>
<td>51.38</td>
<td></td>
</tr>
<tr>
<td>1 - 3</td>
<td>34.74</td>
<td></td>
</tr>
<tr>
<td>3 - 4</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td>4 - 5</td>
<td>13.9 ±1.8</td>
<td>15.63</td>
</tr>
<tr>
<td>5 - 6</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>6 - 8</td>
<td>13.0 ± 2.0</td>
<td>13.66</td>
</tr>
<tr>
<td>8 - 10</td>
<td>5.5 ± 0.8</td>
<td>9.21</td>
</tr>
<tr>
<td>10 - 15</td>
<td>2.7 ± 0.4</td>
<td>3.00</td>
</tr>
<tr>
<td>15 - 20</td>
<td>5.6 ± 0.7</td>
<td>5.86</td>
</tr>
<tr>
<td>20 - 30</td>
<td>3.0 ± 0.6</td>
<td>2.69</td>
</tr>
<tr>
<td>30 - 40</td>
<td>3.3 ± 0.7</td>
<td>3.77</td>
</tr>
<tr>
<td>40 - 50</td>
<td>2.1 ± 0.7</td>
<td>2.54</td>
</tr>
<tr>
<td>50 - 60</td>
<td>6.4 ± 1.3</td>
<td>6.39</td>
</tr>
<tr>
<td>60 - 80</td>
<td>3.3 ± 1.0</td>
<td>2.99</td>
</tr>
<tr>
<td>80 - 100</td>
<td>2.5 ± 1.0</td>
<td>2.50</td>
</tr>
</tbody>
</table>

REFERENCES

ENDF/B-VI MOD 0 (NNDC, January 1990)
Originally evaluated by R. Howerton [1] for ENDL. Converted to ENDF/B-V then to ENDF/B-VI format by NNDC.

REFERENCE
140Ba Incident Neutron Sublibrary, Release 3

Evaluation: 140Ba Incident Neutron Library, Release 3 (MAT 5655)
Energy Range: 10^5 eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

ENDF/B-VI MOD RELEASE 3 (NNDC, May 1995)
Minor correction to File 1 comments.

ENDF/B-VI MOD 0 (NNDC, January 1990)
ENDF/B-V material converted to ENDF-6 format by NNDC.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, HEDL, April 1974)

RESONANCE PARAMETERS (File 2)
No resonance parameters given except AP.

2200m/s capture cross section (barns)
(from resonance parameters) = 0.000
(from 1/v component) = 1.600
total = 1.600
Computed resonance integral = 12.740

SMOOTH CROSS SECTIONS (File 3)
Total cross section calculated using Moldauer potential [4] for energies above the resonance region.
Elastic cross section above resonance region calculated from \( \sigma_{tot} - \sigma_{n,\gamma} - \sigma_{inel} \).
Inelastic cross sections calculated using COMNUC-3 [5].
Neutron capture evaluated using methods (NCAP code) [1,2] for energies above the resonance region. A 1/v component was added to give the 2200 m/s cross section of Mughabghab [3] for lower energies. The calculated resonance integral agrees (to within 1 \( \sigma \)) with the value given in Mughabghab.

ANGULAR DISTRIBUTIONS (File 4)
Angular distribution assumed isotropic.

SECONDARY ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters obtained using NCAP code [2].

REFERENCES
1. F. Schmittroth, R. E. Schenter, HEDL TME 73-63 (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
139La Incident Neutron Sublibrary, Release 1

Evaluation: 139La Incident Neutron Library, Release 1 (MAT 5728)
Energy Range: 10^5 eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 9
Evaluators: R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, July 1991)
Converted MAT 9707 from ENDF/B-V to ENDF-6 format and added to evaluation.

ENDF/B-VI MOD 0 (NNDC, July 1991)
Converted from ENDF/B-V MAT 7579 to ENDF-6 format.

ENDF/B-V EVALUATION (R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN), February 1980)
RESONANCE PARAMETERS (File 2)
Taken from Mughabghab [3].

SMOOTH CROSS SECTIONS (File 3)
Elastic cross section above resonance region calculated from \( \sigma_{\text{tot}} - \sigma_{\gamma} + \sigma_{\text{inel}} \).
Inelastic cross sections calculated using COMNUC-3 [5].
Neutron capture evaluated above the resonance region using methods (NCAP code) [1,2]. A 1/n component was added to give the 2200 m/s cross section of Mughabghab. Energy region above the resonance region was updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [6].
Average logarithmic energy decrement for elastic scattering of neutrons calculated from \( \mu \) (MT 251).

ANGULAR DISTRIBUTIONS (File 4)
Angular distribution assumed to be isotropic.

SECONDARY ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters obtained using NCAP code[2].

REFERENCES
1. F. Schmittroth and R. E. Schenter, HEDL TME 73-63 (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
**143Nd Incident Neutron Sublibrary, Release 2**

**Evaluation:**

143Nd Incident Neutron Sublibrary, Release 2 (MAT 6028)

**Energy Range:**

$10^{-5}$ eV to 20 MeV

**Files:**

1, 2, 3, 4, 5

**Evaluators:**

R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

**ENDF/B-VI MOD 2 REVISION 1** (R. Q. Wright, ORNL, January 1992)

**RESONANCE PARAMETERS (File 2)**

The resolved resonance region is revised and extended 5285 eV using the MLBW formalism; the highest energy resonance included is 5503 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]. For resonances for which a value of $\Gamma_\gamma$ is not specified, the value 0.080 eV is used. The s-wave strength function, as determined by PSYCHE, is $3.36 \times 10^{-4}$ compared to $(3.2 \pm 0.3) \times 10^{-4}$ in [1].

The thermal capture cross section is slightly lower than ENDF/B-V. The capture resonance integral is in good agreement with the value given in [1], 128±30 barns, which is calculated from the resonance parameters, and agrees with the ENDF/B-V value of about 129.5 barns. Negative scattering cross sections encountered in the ENDF/B-V evaluation are eliminated.

Unresolved resonance parameters have been added in the unresolved range of 5.285 to 100 keV. The unresolved range fit is based on the average capture cross sections from Nakajima, et al. [2] and Musgrove, et al. [3].

The unresolved parameters are based on (in eV):

- $D_0 = 32.48$, $S_0 = 3.5$, $S_1 = 0.8$, $S_2 = 1.0$
- $D_1 = 18.41$, $S_{\gamma 0} = 24.63$, $S_{\gamma 1} = 43.45$

**2200 m/sec cross sections (barns)**

- Total = 402.90
- Elastic = 79.83
- Capture = 323.07

Computed capture resonance integral (barns) = 129.56

**SMOOTH CROSS SECTIONS (File 3)**

Elastic, and capture are set to zero in the resolved resonance range ($1.0 \times 10^{-5}$ eV to 5285 eV). The capture is also revised by small amounts at 130 and 160 keV and above 1 MeV. The energy mesh for the capture above 1 MeV is revised to be the same as for the total cross section. The total is small but non-zero due to small cross sections for $(n,\alpha)$ and $(n,n\alpha)$.

The inelastic cross section is also revised.
143Nd Incident Neutron Sublibrary, Release 2

TABLE 1. 143Nd Capture Cross Section (mb)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - 6</td>
<td>870</td>
<td>936</td>
<td>869</td>
</tr>
<tr>
<td>6 - 8</td>
<td>770</td>
<td>818</td>
<td>738</td>
</tr>
<tr>
<td>8 - 10</td>
<td>645</td>
<td>665</td>
<td>619</td>
</tr>
<tr>
<td>10 - 15</td>
<td>514</td>
<td>504</td>
<td>500</td>
</tr>
<tr>
<td>15 - 20</td>
<td>364</td>
<td>380</td>
<td>400</td>
</tr>
<tr>
<td>20 - 30</td>
<td>345</td>
<td>309</td>
<td>257</td>
</tr>
<tr>
<td>40 - 60</td>
<td>212</td>
<td>174</td>
<td>206</td>
</tr>
<tr>
<td>60 - 80</td>
<td>164</td>
<td>114</td>
<td>168</td>
</tr>
<tr>
<td>80 - 100</td>
<td>168</td>
<td>86</td>
<td>146</td>
</tr>
</tbody>
</table>

REFERENCES


ENDF/B-VI MOD 0 (NNDC, January 1990)

The ENDF/B-V MAT 9764 evaluation was translated to ENDF-6 format.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, F. Mann, et al. (HEDL); H. Gruppelaar (RCN), A. Prince (BNL), February 1980)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)

- Total cross sections calculated using Moldauer potential [3].
- Elastic cross sections from $\sigma_{el} = \sigma_{tot} - \sigma_{in}$.
- Inelastic cross sections calculated using COMNUC-3 [4]. Level scheme data taken from Nuclear Data Tables and Igarasi [5].
- $(n,2n)$, $(n,3n)$, $(n,nd)$, $(N,np)$, $(n,p)$, $(n,d)$, $(n,t)$, $(n,^3$He), $(n,\alpha)$ calculated using the THRESH code [6].
- Neutron capture evaluated using COMNUC-3 and (NCAP code) of Schmittroth [1,2]; updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [7].

ANGULAR DISTRIBUTIONS (File 4)

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

Energy distributions of secondary neutrons given as histogram using calculations of nuclear temperature from Gilbert and Cameron [8].

REFERENCES
1. T. Tamura, ORNL-4152 (1967) Oak Ridge National Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
5. S. Igarasi, private communication.
6. S. Pearlstein, J. Nucl. En. 27, 81 (1973)
8. F. Schmittroth, HEDL-TME 77-51 (1978) Hanford Engineering Development Laboratory
145Nd Incident Neutron Sublibrary, Release 2

Evaluation: 145Nd Incident Neutron Sublibrary, Release 2 (MAT 6034)
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, January 1992)

RESONANCE PARAMETERS (File 2)
The resolved resonance region is revised and extended from 1457 to 4140 eV using the MLBW formalism; the highest energy resonance included is 4637 eV. The resolved resonance parameters are taken from Mughabghab, et al. \cite{13}. For resonances for which a value of $\Gamma_r$ is not specified, the value 0.075 eV is used. The s-wave strength function, as determined by PSYCHE, is $4.27 \times 10^{-4}$ compared to $(4.4 \pm 0.4) \times 10^{-4}$ in Mughabghab.

The thermal capture cross section is slightly lower than ENDF/B-V. The revised capture resonance integral is about 1.1% lower than the ENDF/B-V value of 232.3 barns, and is in good agreement with the value given in Mughabghab of 1240$\pm$35 barns. The negative scattering cross sections encountered in the ENDF/B-V evaluation were eliminated.

Unresolved resonance parameters have been added in the unresolved range of 4.140 to 50 keV. The unresolved range fit is based on the average capture cross sections from Nakajima, et al. \cite{2} and Musgrove, et al. \cite{3}. Average capture cross sections computed from the evaluation are compared with the average values from these references in Table I.

For the energy range 3 to 30 keV, the revised capture is fairly close to the Musgrove values; for 30 to 100 keV, the evaluation is higher than Musgrove but lower than the Nakajima data, and is also fairly close to the ENDF/B-V evaluation for the energy range 4.140 to 100 keV.

The unresolved parameters are based on (in eV):
\[
D_0 = 17.32, \quad S_0 = 4.0, \quad S_1 = 0.8, \quad S_2 = 1.0
\]
\[
D_1 = 8.66, \quad S_{\gamma} = 43.29, \quad S_{\alpha} = 86.58
\]

2200 m/s cross sections (barns)
Total = 59.08
Elastic = 17.19
Capture = 41.89

Computed resonance integral (barns)
0.5 - 4140 eV = 227.07
Above 4140 eV = 2.59
Total = 229.66

SMOOTH CROSS SECTIONS (File 3)
Elastic, and capture are set to zero in the resolved resonance range (1.0$\times$10^{-5} eV to 50 keV).
The total is small but non-zero due to small cross sections for (n,\alpha) and (n,\alpha).

The revised total and elastic cross sections are slightly lower than ENDF/B-V between 50 and 100 keV. All other cross sections are unchanged above 50 keV.
### TABLE I. $^{143}\text{Nd}$ Capture Cross Section (mb)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 4</td>
<td>1.901</td>
<td>1.436</td>
<td>2.032</td>
</tr>
<tr>
<td>4 - 5</td>
<td>1.360</td>
<td>1.436</td>
<td>1.506</td>
</tr>
<tr>
<td>5 - 6</td>
<td>1.420</td>
<td>1.360</td>
<td>1.367</td>
</tr>
<tr>
<td>6 - 8</td>
<td>1.335</td>
<td>1.236</td>
<td>1.143</td>
</tr>
<tr>
<td>8 - 10</td>
<td>1.010</td>
<td>0.970</td>
<td>0.952</td>
</tr>
<tr>
<td>10 - 15</td>
<td>1.052</td>
<td>0.799</td>
<td>0.765</td>
</tr>
<tr>
<td>15 - 20</td>
<td>0.774</td>
<td>0.642</td>
<td>0.614</td>
</tr>
<tr>
<td>20 - 30</td>
<td>0.655</td>
<td>0.475</td>
<td>0.494</td>
</tr>
<tr>
<td>30 - 40</td>
<td>0.525</td>
<td>0.361</td>
<td>0.402</td>
</tr>
<tr>
<td>40 - 50</td>
<td>0.440</td>
<td>0.295</td>
<td>0.345</td>
</tr>
<tr>
<td>50 - 60</td>
<td>0.390</td>
<td>0.280</td>
<td>0.298</td>
</tr>
<tr>
<td>60 - 80</td>
<td>0.380</td>
<td>0.162</td>
<td>0.256</td>
</tr>
<tr>
<td>80 -100</td>
<td>0.405</td>
<td>0.124</td>
<td>0.218</td>
</tr>
</tbody>
</table>

### REFERENCES


### ENDF/B-VI MOD 0 (NNDC, January 1990)

Converted from ENDF/B-V MAT 9766 to ENDF-6 format.

### ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, F. Mann, et al., HEDL; H. Gruppelaar, RCN, February 1980)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)
- Total cross sections calculated using the Moldauer potential [3].
- Elastic cross sections from $\sigma_{\text{tot}} - \sigma_{\gamma\gamma} - \sigma_{\text{inel}}$.
- Inelastic cross sections calculated using COMNUC-3 [4]. Level scheme data taken from Nuclear Data Tables and Igarasi [5].
- $(n,2n)$, $(n,3n)$, $(n,nd)$, $(n,np)$, $(n,p)$, $(n,d)$, $(n,t)$, $(n,^3\text{He})$, $(n,\alpha)$ calculated using the THRESH code [6].

Neutron capture evaluated using COMNUC-3 and (NCAP code) of Schmittroth [1,2]; updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [7].
ANGULAR DISTRIBUTIONS (File 4)
Elastic angular distribution calculated from Moldauer potential. Nonelastic angular distribution assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
Energy distributions of secondary neutrons given as histogram using calculations of nuclear temperature from Gilbert and Cameron [8].

REFERENCES
1. T. Tamura, ORNL-4152 (1967) Oak Ridge National Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
5. S. Igarasi, private communication.
6. S. Pearlstein, J. Nucl. En. 27, 81 (1973)
8. F. Schmittroth, HEDL-TME 77-51 (1978) Hanford Engineering Development Laboratory
ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)
Illegal J-values in file 2 corrected.

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, December 1988)
This evaluation is an update of the ENDF/B-V evaluation of Schenter and Mann.
Resolved resonance parameters have been added to define the total, elastic, and capture cross sections below 35 eV; above 35 eV, the evaluation is unchanged from ENDF/B-V. The resolved resonance parameters are taken from Mughabghab [1]. The MLBW representation was used with the smooth background set to zero in the resonance region.
The largest contribution to the thermal capture cross section (about 98%) is from the bound level at -5 eV. The thermal capture cross section is higher than the ENDF/B-V value by about a factor of 9; the capture resonance integral is slightly lower.

2200 m/s capture cross section (barns)
(from resonance parameters) = 439.9

Computed resonance integral (barns)
(from resonance parameters) = 429.5
(above 35 eV) = 144.0
total = 573.5

REFERENCES

ENDF/B-V EVALUATION (R. Schenter, F. Mann, HEDL, January 1980)

SMOOTH CROSS SECTIONS File 3)
Total cross section calculated using Moldauer potential [4] above the resonance region.
Elastic cross section from \( \sigma_{\text{tot}} - \sigma_{\alpha,\gamma} - \sigma_{\text{in}} \) above the resonance region, from \( 4\pi x A P^2 \) at lower energies.
Inelastic cross section calculated using COMNUC-3 [5].
Neutron capture evaluated using methods (NCAP code) [1,2] above the resonance region.
A \( 1/\nu \) component was added to give the 2200 m/s cross section of Mughabghab. Low energy capture also adjusted to give resonance integral (to within 1 \( \sigma \)) of Ribon and Krebs [6].

ANGULAR DISTRIBUTIONS (File 4)
Angular distribution assumed isotropic.
SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters obtained using NCAP code [2].

REFERENCES
1. F. Schmitroth and R. E. Schenter, HEDL TME 73-63 (1973) Hanford Engineering Development Laboratory
2. F. Schmitroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
$^{147}$Pm Incident Neutron Sublibrary, Release 1

Evaluation:  $^{147}$Pm Incident Neutron Library, Release 1 (MAT 6149)
Energy Range:  $10^2$ eV to 20 MeV
Files:  1, 2, 3, 4, 5
Evaluators:  R. Q. Wright (ORNL); R. E. Schenter, F. Schmitroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)
Illegal J-values in File 2 were corrected.

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, April 1989)
**144Sm Incident Neutron Sublibrary, Release 3**

**Evaluation:** 144Sm Incident Neutron Library, Release 3 (MAT 6225)

**Energy Range:** $10^5$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL), F. M. Mann (HEDL)

**ENDF/B-VI MOD 2 REVISION 1** (R. Q. Wright, ORNL, October 1994)

**RESONANCE PARAMETERS** (File 2)

Resonance parameters have been added for the resolved resonance range from 0.4 to 12 keV using the MLBW formalism; the highest resonance included is 39.117 keV. The principal source for the resolved resonance parameters is the data of Macklin, et al. [1]; 18 s-wave and 56 p-wave resonances are included from Table II of this reference. An additional 26 s-wave resonances and 2 p-wave resonances are included from Table III. These additional resonances are above the cutoff and are only used to calculate the cross sections below 12 keV.

Unresolved resonance parameters have been added in the range is 12 to 80 keV. The fit is based on average $\Gamma_r$ of 0.074 eV for s-wave, and 0.089 eV for both p-wave and d-wave, scattering radius $(R) = 5.617$ fm, $D_0 = 670$ eV, $S_0 = 3.6 \times 10^4$, $S_1 = 1.0 \times 10^4$, $S_2 = 2.4 \times 10^4$.

The revised values represent a change of 134% for the thermal capture and -93.8% for the capture resonance integral. The measured values of Alexander [2] are 1.64±0.10 barns for the thermal capture and 2.38±0.17 barns for the capture resonance integral.

**2200 m/sec Cross Sections**

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2.813 barns</td>
</tr>
<tr>
<td>Elastic</td>
<td>1.173 barns</td>
</tr>
<tr>
<td>Capture</td>
<td>1.640 barns</td>
</tr>
</tbody>
</table>

**Capture Resonance Integral** = 1.861 barns

**SMOOTH CROSS SECTIONS** (File 3)

Cross sections are revised below 400 eV. The low energy elastic cross section is calculated from the resolved resonance parameters. The low energy capture is $1/\nu$ up to 400 eV with a thermal value of 1.64 barns [2]. The elastic cross section has been set to zero in the resolved resonance range but for the capture a small $1/\nu$ background has been used.

**Changes above 80 keV**

- Total cross section above 1 MeV is based on the $^{148}$Sm total of Shamu, et al. [3,4].
- The elastic is calculated by subtracting the nonelastic from the total.
- The (n,2n) cross section is based on measured data as shown in McLane, et al. [4]. (n,2n) was not included in the previous evaluation but was included in the inelastic.
- The inelastic above 11 MeV is revised to remove the (n,2n) contribution. In the continuum, it is also revised to be the same as the total inelastic scattering.

The capture is based on Macklin, et al. [1], Table IV, for the energy range 80-500 keV. The extension to 20 MeV is based on shape of $^{144}$Sm capture. The average capture cross sections, calculated with NJOY, flat weighting, for this evaluation are compared with the measured values of Macklin, et al. [1] for the energy range 6 to 500 keV in Table I.

1.54
Table I. Sm-144 Average Capture (mb)

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>Measured</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 8</td>
<td>130</td>
<td>113.7</td>
</tr>
<tr>
<td>8 - 10</td>
<td>143</td>
<td>134.9</td>
</tr>
<tr>
<td>10 - 12</td>
<td>176</td>
<td>163.5</td>
</tr>
<tr>
<td>12 - 15</td>
<td>185</td>
<td>124.2</td>
</tr>
<tr>
<td>15 - 20</td>
<td>120</td>
<td>108.7</td>
</tr>
<tr>
<td>20 - 30</td>
<td>84</td>
<td>91.8</td>
</tr>
<tr>
<td>30 - 40</td>
<td>77</td>
<td>79.8</td>
</tr>
<tr>
<td>40 - 60</td>
<td>73</td>
<td>70.3</td>
</tr>
<tr>
<td>60 - 80</td>
<td>65</td>
<td>62.7</td>
</tr>
<tr>
<td>80 - 100</td>
<td>57</td>
<td>56.4</td>
</tr>
<tr>
<td>100 - 150</td>
<td>49.1</td>
<td>49.2</td>
</tr>
<tr>
<td>150 - 200</td>
<td>48.2</td>
<td>48.2</td>
</tr>
<tr>
<td>200 - 300</td>
<td>45.0</td>
<td>45.0</td>
</tr>
<tr>
<td>300 - 400</td>
<td>40.9</td>
<td>41.0</td>
</tr>
<tr>
<td>400 - 500</td>
<td>41.7</td>
<td>41.5</td>
</tr>
</tbody>
</table>

ANGULAR DISTRIBUTIONS (File 4)
The elastic angular distributions used data from $^{152}\text{Sm}$, MAT 6249.
The (n,2n) was assumed to be isotropic.

SECONDARY ENERGY DISTRIBUTIONS (File 5)
The (n,2n) used data from $^{152}\text{Sm}$, MAT 6249.

REFERENCES

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 9083 converted to ENDF6 format by NNDC.
\textsuperscript{150}Sm Incident Neutron Sublibrary, Release 2

**Evaluation:** \textsuperscript{150}Sm Incident Neutron Sublibrary, Release 2 (MAT 6243)

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth (HEDL)

\textbf{ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, October 1991)}

**RESONANCE PARAMETERS (File 2)**

The resolved resonance region is revised and extended from 581.7 to 1600 eV using the MLBW formalism; the highest energy resonance included is 1563 eV.

The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level at -3.2 eV is not included. Including both the -10.2 and -3.2 eV bound levels gives a value for the thermal capture cross section which is much too high. Including only the -10.2 eV level gives a thermal capture cross section of 103.4 barns and a total cross section of 122.2 barns; this would appear to indicate an error in [1]. For resonances for which a value of \( \Gamma_\gamma \) is not specified in [1], the value 0.060 eV is used.

The s-wave strength function is $3.79 \times 10^4$ compared to $(3.6 \pm 1.1) \times 10^4$ in [1]. The thermal capture cross section is only about 1.4\% higher than ENDF/B-V. The capture resonance integral is in good agreement with the value given in [1], 358±50 barns, but somewhat higher than the value of 310±15 barns given by Eiland, et al. [2]. The revised capture resonance integral is 5.6\% higher than the ENDF/B-V value of about 320 barns. Negative scattering cross sections were encountered in the ENDF/B-V evaluation; since the revised evaluation uses MLBW, rather than SLBW parameters, this problem is eliminated.

Unresolved resonance parameters have been added in the unresolved range of 1.6 to 100 keV. The unresolved resonance parameters are based on (in eV):

\begin{align*}
D_0 &= 48, \quad S_0 = 3.6, \quad S_1 = 0.6, \quad S_2 = 2.9 \\
D_1 &= 15, \quad S_\infty = 12.5, \quad S_\gamma = 40
\end{align*}

2200 m/s cross sections (barns)

From resonance parameters = 103.42

Computed resonance integral (barns)

\begin{align*}
0.5 - 1600 \text{ eV} &= 334.00 \\
Above 1600 \text{ eV} &= 3.78 \\
Total &= 337.78
\end{align*}

**SMOOTH CROSS SECTIONS (File 3)**

Elastic, and capture are set to zero in the resolved and unresolved resonance range ($1.0 \times 10^{-5}$ eV to 100 keV). Total, elastic, and capture cross sections are revised above 100 keV. The revised total cross section is based on the measurements of Shamu, et al. [3]. \( ^{150}\text{Sm} \sigma_{tot} = ^{148}\text{Sm} \sigma_{tot} \times R \), where R is defined as: \( R = 1.0 + (^{150}\text{Sm} \sigma_{tot} - ^{148}\text{Sm} \sigma_{tot})/^{148}\text{Sm} \sigma_{tot} \).

The data for total inelastic scattering and scattering to the 5th excited state are revised. The revised data below 3 MeV is based on the work of Efrosinin, et al. [4]. The inelastic continuum data was revised above 7 MeV.

The \((n,2n)\) cross section was added to the file and is based on the data of Frehaut, et al. [5].
SECONDARY PARTICLE DISTRIBUTIONS (File 4 and File 5)

Angular distributions (File 4) and secondary energy distributions (File 5) were added for the 
(n,2n) reaction.

REFERENCES
1. S. F. Mughabghab, Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and 
4. V. P. Efrosinin, et al., Nuclear Spectroscopy and Nuclear Structure, 19th Conference, 

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 9809 converted to ENDF-6 format.

ENDF/B-V EVALUATION (R. E. Schenter and F. Schmitroth, HEDL, April 1974)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)
Total cross sections calculated using Moldauer potential [3].
Elastic cross sections from $\sigma_{tot} - \sigma_{n\gamma} - \sigma_{inel}$.
Inelastic cross sections calculated using COMNUC-3 [4].
Neutron capture evaluated using NCAP code of Schmitroth [1,2].

ANGULAR DISTRIBUTIONS (File 4)
Elastic and nonelastic angular distributions assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters obtained using NCAP code [2].

REFERENCES
1. T. Tamura, ORNL-4152 (1967) Oak Ridge National Laboratory
2. F. Schmitroth, HEDL TME 73-79 (1973) Hanford Engineering and Development 
   Laboratory
$^{151}$Sm Incident Neutron Sublibrary, Release 1

**Evaluation:** $^{151}$Sm Incident Neutron Sublibrary, Release 1 (MAT 6246)

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDFB-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)
Illegal J-values in File 2 were corrected.

ENDFB-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, March 1980)
**152Sm Incident Neutron Sublibrary, Release 2**

**Evaluation:** 152Sm Incident Neutron Sublibrary, Release 2 (MAT 6249)

**Energy Range:** $10^5$ eV to $20$ MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

**ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, July 1992))**

**RESONANCE PARAMETERS (File 2)**

The resolved resonance region is revised and extended from to $5025$ eV using the MLBW formalism; the highest energy resonance included is $5100$ eV.

The resolved resonance parameters are taken from Mughabghab, et al. [1]. 92 s-wave resonances are assigned. The bound level at $-136$ eV has $\Gamma_\gamma$ of $161.6$ meV and $\Gamma_\gamma$ of $61$ meV, and accounts for only about $1.1\%$ of the thermal capture cross section. For resonances for which the value of $\Gamma_\gamma$ is not given in [1], the value $0.061$ eV is used.

The capture resonance integral is in good agreement with the value of $2970\pm100$ barns in Mughabghab. The thermal capture cross section is equivalent to the Mughabghab value of $206\pm6$ barns.

Unresolved resonance parameters have been added in the unresolved range of $5.025$ to $100$ keV and are based on the average capture cross sections of Kononov [2]. These parameters (at $30$ keV) result in the following values:

$$
D_0 = 28 \text{ eV}, \quad S_0 = 2.5 \times 10^{-4}, \quad S_1 = 0.6 \times 10^{-4}, \quad S_2 = 3.0 \times 10^{-4} \\
D_1 = 9.33 \text{ eV}, \quad S_{\gamma\gamma} = 21.79 \times 10^{-4}, \quad S_{\gamma} = 65.36 \times 10^{-4}
$$

The scattering radius is $7.665$ fm.

**2200 m/s cross sections (barns)**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>209.0</td>
</tr>
<tr>
<td>Elastic</td>
<td>3.1</td>
</tr>
<tr>
<td>Capture</td>
<td>205.9</td>
</tr>
</tbody>
</table>

**Computed resonance integral (barns)** = 2983

**SMOOTH CROSS SECTIONS (File 3)**

The total cross section is small but non-zero due to small cross sections for MT = 22 and 107. The total cross section is revised above $100$ keV, based on the measurements of Shamu, et al., [4].

$$152\text{Sm } \sigma_{\text{tot}} = 148\text{Sm } \sigma_{\text{tot}} \times R,$$

where $R$ is defined as:

$$R = 1.0 + (152\text{Sm } \sigma_{\text{tot}} - 148\text{Sm } \sigma_{\text{tot}}) / 148\text{Sm } \sigma_{\text{tot}}$$

Elastic and capture are set to zero in the resonance range ($1.0 \times 10^{-5}$ eV to 100 keV). The elastic cross section is revised above 100 keV; the capture cross section is revised between 100 keV and 3.5 MeV to agree with the experimental values of Kononov, et al [2], and Zhou, et al. [3].

1.59
REFERENCES

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 9811 converted to ENDF-6 format.


SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)
Total cross section calculated using the Moldauer potential [3].
Elastic cross section from σo - σn,γ - σint.
Inelastic cross section calculated using COMNUC-3 [4]. Level scheme data taken from Nuclear Data Tables and Igarasi [5]
(n,2n), (n,3n), (n,nd), (n,p), (n,d), (n,t), (n,3He), (n,α) calculated using the THRESH code [6].
Neutron capture was evaluated using COMNUC-3 and (NCAP code) of Schmittroth [1,2], updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [8].

ANGULAR DISTRIBUTIONS (File 4)
Elastic angular distribution calculated from Moldauer potential. Nonelastic angular distribution assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
Energy distributions of secondary neutrons given as histogram using calculations of nuclear temperature from Gilbert and Cameron [7].

REFERENCES
1. T. Tamura, ORNL-4152 (1967) Oak Ridge National Laboratory
2. F. Schmittroth, HEDL TME 73-79 (1973) Hanford Engineering Development Laboratory
5. S. Igarasi, private communication
6. S. Pearlstein, J. Nucl. En. 27, 81 (1973)
8. F. Schmittroth, HEDL-TME 77-51 (1978) Hanford Engineering Development Laboratory
**Evaluation:**

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL), R. Schenter (HEDL), A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)
Illegal J-values in File 2 were corrected.

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, August 1991)
**Evaluation:** 152Gd Incident Neutron Sublibrary, Release 4 (MAT 6425)

**Energy Range:** 10^5 eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL), Fission Product Working Group (JNDC)

ENDF/B-VI MOD 1 (R. Q. Wright, ORNL, December 1994)

This evaluation is a revision of the JENDL-3.2 evaluation below 100 keV, and includes the resolved and unresolved resonance data, and (n,α) below 2,660 eV. Small changes in the (n,γ) cross section between 100 and 700 keV were also made.

RESOLVED RESONANCE RANGE

Resonance parameters are given for the resolved resonance range 1.0×10^5 to 2,660 eV using the MLBW formalism; the highest resonance included is 2,657.7 eV. The resolved resonance parameters are based on the data of Macklin [2]. Macklin gives values of Γ α and Γ γ for 30 resonances and gΓ α/Γ values for a total of 128 resonances. For the 98 resonances which do not have values given for Γ α and Γ γ, the strategy used is to assign a value for Γ γ and then pick Γ α to match the values of gΓ α/Γ given in Macklin. For many resonances, Macklin's average value for Γ γ = 58.6 meV is used. All resonances are assumed to be s-wave. In the JENDL-3.2 evaluation, which is also based on Macklin, 17 resonances were assigned as p-wave. The low energy resonances at 3.31, 8.00, and 9.55 eV given in Mughabghab [3] were not found by Macklin [2] and are not included in this evaluation. The parameters for the bound level at -1.0 eV given in Mughabghab [3] are revised to give the desired value of the thermal capture cross section; Γ γ is taken as 58.6 meV, Γ α as 4.516 meV. The scattering radius, R = 8.2 fm.

UNRESOLVED RESONANCE RANGE

For the unresolved resonance range, 2.66 to 50 keV, the average Γ γ is 58.6 meV. D₀ = 11.25 eV, S₀ = 3.3×10^4, S₁ = 1.1×10^4, and S₂ = 2.4×10^4; scattering radius, R = 5.40 fm. Unresolved parameters are energy independent.

SMOOTH CROSS SECTIONS (File 3)

The total, elastic, and capture cross sections are given as zero for energies up to 50 keV. The capture cross section is revised to 700 keV based on average capture of Beer and Macklin [4]. The elastic cross section was also revised to keep the total unchanged. Above 700 keV, the evaluation is unchanged from the JENDL-3.2.

The (n,α) cross section below 2,660 eV has been changed. The histogram interpolation region was eliminated and (n,α) is given in pointwise form with log-log interpolation. An attempt was made to preserve the infinitely dilute (n,α) resonance integral between 10 eV and 2,660 eV.

<table>
<thead>
<tr>
<th>2200 m/sec Cross Sections (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Elastic</td>
</tr>
<tr>
<td>Capture</td>
</tr>
</tbody>
</table>

Capture resonance integral (barns) = 474.7
The revised thermal capture cross section is based on the measured total cross section of Vertebniy [5] and on JENDL-3.2 thermal capture of 1056 barns. The revised capture resonance integral is about 19% higher than Holden’s [6] recommended value of 400 barns, but is 52% lower than the JENDL-3.2 evaluation, therefore, the resonance integral should be considered uncertain at present. The difference is primarily due to eliminating the three low energy resonances. It should also be noted that 99.3% of the thermal capture cross section is due to the bound level at -1 eV.

The average capture cross sections, flat weighting, calculated with NJOY, using this evaluation are compared with the measured values of Beer and Macklin [4] for the energy range 3 to 700 keV in Table I.

Table I. Gd-152 Average Capture (mb)

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>Measured</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 4</td>
<td>3664</td>
<td>3400</td>
</tr>
<tr>
<td>4 - 6</td>
<td>2730</td>
<td>2782</td>
</tr>
<tr>
<td>6 - 8</td>
<td>2246</td>
<td>2158</td>
</tr>
<tr>
<td>8 -10</td>
<td>1785</td>
<td>1808</td>
</tr>
<tr>
<td>10 -15</td>
<td>1426</td>
<td>1480</td>
</tr>
<tr>
<td>15 -20</td>
<td>1186</td>
<td>1217</td>
</tr>
<tr>
<td>20 -30</td>
<td>1008</td>
<td>1019</td>
</tr>
<tr>
<td>30 -40</td>
<td>905</td>
<td>869</td>
</tr>
<tr>
<td>40 -60</td>
<td>784</td>
<td>763</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>Measured</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 -80</td>
<td>658</td>
<td>662</td>
</tr>
<tr>
<td>80-100</td>
<td>622</td>
<td>611</td>
</tr>
<tr>
<td>100-150</td>
<td>569</td>
<td>570</td>
</tr>
<tr>
<td>150-200</td>
<td>538</td>
<td>542</td>
</tr>
<tr>
<td>200-300</td>
<td>531</td>
<td>530</td>
</tr>
<tr>
<td>300-400</td>
<td>461</td>
<td>452</td>
</tr>
<tr>
<td>400-500</td>
<td>398</td>
<td>406</td>
</tr>
<tr>
<td>500-600</td>
<td>393</td>
<td>393</td>
</tr>
<tr>
<td>600-700</td>
<td>390</td>
<td>393</td>
</tr>
</tbody>
</table>

REFERENCES

4 The evaluator (RQW) believes that 475 barns is a much better estimate than 991 barns (JENDL-3.2).
154Gd Incident Neutron Sublibrary, Release 4

Evaluation: 154Gd Incident Neutron Sublibrary, Release 4 (MAT 6431)
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL), JNDC Fission Product Working Group

ENDFB-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, December 1994)

This evaluation is a revision of the JENDL-3.2 evaluation below 100 keV. Small changes were also made in the (n,γ) cross section between 100 keV and 1.152 MeV.

RESOLVED RESONANCE REGION

Resonance parameters are given for the resolved resonance range 1.0×10^{-5} to 2.680 eV using the MLBW formalism; the highest resonance included is 2751.8 eV. The resolved resonance parameters are based on the data of Mughabghab [2] for energies below 486 eV and of Macklin [3] above 486 eV. Mughabghab has values of Γ_n for 28 resonances below 486 eV; nine of these resonances have values for Γ_γ, the others assume an average value of 0.088 eV. Macklin [3] gives values of Γ_n and Γ_γ for 18 resonances and values of g*Γ_γ/Γ are given in for a total of 134 resonances. For the 116 resonances which do not have values given for Γ_n and Γ_γ, the strategy used is to assign a value for Γ_γ, and then pick Γ_n to match the values of gΓ_γ/Γ given in Macklin. For most resonances, an average value of 0.088 eV is used for Γ_γ. All resonances are assumed to be s-wave. The parameters of the bound level at -3.0 eV [2] give the desired value of the thermal capture cross section; Γ_γ = 88 meV, and Γ_n = 3.55 meV. The scattering radius, R = 8.0 fm.

UNRESOLVED RESONANCE REGION

The unresolved resonance range is 2.68 to 50 keV. The average Γ_γ = 0.088 eV. D_0 = 19.2 eV, S_0 = 2.0×10^4, S_1 = 1.110^4, and S_2 = 2.410^4, S_γ0 = 45.810^4; scattering radius = 6.78 fm. The unresolved parameters are energy independent.

SMOOTH CROSS SECTIONS (File 3)

Total, elastic, and capture cross sections are zero for energies up to 50 keV. Capture cross section is revised up to 1.152 MeV based on the average capture of Beer and Macklin [4]. Elastic cross section was also revised to keep total cross section unchanged. The total cross section is unchanged above 100 keV.

2200 m/sec Cross Sections (barns)

| Total      | 92.34 |
| Elastic    | 7.29  |
| Capture    | 85.05 |

Capture resonance integral (barns) = 215.91

The revised thermal capture cross section is based on the recommended value from Mughabghgab [2]. The capture resonance integral is 6.5% lower than the previous evaluation. About 96% of the thermal capture cross section is from the bound level at -3 eV.

I.64
The average capture cross sections, flat weighting, calculated with NJOY, using this evaluation are compared with the measured values from Beer and Macklin for the energy range 3 to 500 keV in Table I.

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>Measured</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 4</td>
<td>2818</td>
<td>2931</td>
</tr>
<tr>
<td>4 - 6</td>
<td>2196</td>
<td>2258</td>
</tr>
<tr>
<td>6 - 8</td>
<td>1692</td>
<td>1781</td>
</tr>
<tr>
<td>8 -10</td>
<td>1640</td>
<td>1512</td>
</tr>
<tr>
<td>10 -15</td>
<td>1239</td>
<td>1258</td>
</tr>
<tr>
<td>15 -20</td>
<td>1044</td>
<td>1055</td>
</tr>
<tr>
<td>20 -30</td>
<td>914</td>
<td>898</td>
</tr>
<tr>
<td>30 -40</td>
<td>771</td>
<td>777</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>Measured</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 -60</td>
<td>682</td>
<td>680</td>
</tr>
<tr>
<td>60 -80</td>
<td>591</td>
<td>594</td>
</tr>
<tr>
<td>80-100</td>
<td>560</td>
<td>559</td>
</tr>
<tr>
<td>100-150</td>
<td>486</td>
<td>490</td>
</tr>
<tr>
<td>150-200</td>
<td>393</td>
<td>392</td>
</tr>
<tr>
<td>200-300</td>
<td>337</td>
<td>337</td>
</tr>
<tr>
<td>300-400</td>
<td>302</td>
<td>303</td>
</tr>
<tr>
<td>400-500</td>
<td>292</td>
<td>293</td>
</tr>
</tbody>
</table>

REFERENCES

174Hf Incident Neutron Sublibrary, Release 2

Evaluation: 174Hf Incident Neutron Sublibrary, Release 2 (MAT 7225)
Energy Range: 10⁻⁵ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, April 1992)

RESONANCE PARAMETERS (File 2)
Resonance parameters are given using a MLBW formalism in the resolved resonance range up to 230 eV. A bound level at -0.99 eV [1] is used in this evaluation. Values of $\Gamma_{\gamma}$ except for the bound level, are set to 0.060 eV. The value for the scattering radius is 7.7 fm [1].
The unresolved resonance range is 230 eV to 90 keV. The thermal capture cross section is 44% higher than in the previous evaluation, while the capture resonance integral is 26% lower. The unresolved resonance parameters have been revised based on:

- $D_0 = 21$ eV, $S_0 = 2.8 \times 10^4$, $S_1 = 0.910^4$, and $S_2 = 2.510^4$
- $D_1 = 6$ eV, $S_{\gamma\gamma} = 28.5710^4$, $S_{\gamma\gamma} = 10010^4$

2200 m/s cross sections (barns)
Total = 577.36
Elastic = 15.51
Capture = 561.85

Computed resonance integral (barns) = 355.18

SMOOTH CROSS SECTIONS (File 3)
Elastic, and capture are set to zero in the resolved and unresolved resonance range (10⁻⁵ eV to 90 keV).

REFERENCES

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)
ENDF/B-V MAT 1374 converted to ENDF-6 format.
SMOOTH CROSS SECTIONS (FILE 3)

Total cross section:
- < 1.0 eV: elemental data of Moore [1] and Joki [2], isotopic data of Conrad, et al. [3]
- 100 - 500 keV: data of Sherwood, et al. [4]
- > 2.5 MeV: data of Foster and Glasgow [6]

Elastic scattering cross section:
- < 500 keV and >2.5 MeV: $\sigma_{\text{tot}} - \sigma_{\text{non}}$

Inelastic scattering cross section: 12 level excitation cross sections based on data of Sherwood, et al. [4].

Capture cross section: extended from 15 to 20 MeV by S. Pearlstein (BNL), following total cross-section measurements [8] for Ta and W, corrected for Hf size.

ANGULAR DISTRIBUTIONS (File 4)
- Elastic scattering taken from $^{182}$W, ENDF/B-V MAT 1128.

REFERENCES
5. L. Green and J. A. Mitchell, WAPD-TM-1073 (1973) Bettis Atomic Power Laboratory
176Hf Incident Neutron Sublibrary, Release 2

Evaluation: 176Hf Incident Neutron Sublibrary, Release 2 (MAT 7231)
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargs, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1992)

RESONANCE PARAMETERS (File 2)
The resolved resonance region is revised to 1080.0 eV using the MLBW formalism; the highest energy resonance included is 1563 eV.
The resolved resonance parameters are taken from Mughabghab, et al. [1]. Bound levels at -80 and -20 eV are used in this evaluation. Values of $\Gamma_p$ except for the first three levels, are set to 0.051 eV. The value for the scattering radius is 7.6 fm [1].
The parameters of the 7.886 eV resonance are based on the data of Moxon [3]: $E_o = 7.886\pm0.01$ eV; $\Gamma_n = 4.71 (\pm5.50 -2.57)$ MeV; $\Gamma_\gamma = 57\pm12$ MeV. The parameters of the two bound levels are also changed.
The thermal capture cross section is 67% lower than in the previous evaluation and is in good agreement with the data of Pavlenko, et al. [4] which is $11.30\pm5.0$ barns, and with the unpublished M. C. Moxon [3] value of $13.7\pm3.2$ barns. The capture resonance integral is 15% higher than in the previous evaluation.
The unresolved resonance range is 1080 eV to 90 keV. The thermal capture cross section is 44% higher than in the previous evaluation, while the capture resonance integral is 26% lower. The unresolved resonance range fit is based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

\[
\begin{align*}
D_0 &= 35 \text{ eV}, S_0 = 2.5\times10^4, S_1 = 0.87\times10^4, S_2 = 2.0\times10^4 \\
D_1 &= 10 \text{ eV}, S_{\gamma 0} = 15.43\times10^4, S_{\gamma 1} = 54\times10^4 \\
\end{align*}
\]

2200 m/s cross sections (barns)
Elastic = 6.70
Capture = 13.76
Total = 20.46

Computed resonance integral (barns) = 401.33

SMOOTH CROSS SECTIONS (File 3)
Elastic, and capture are set to zero in the resolved and unresolved resonance range ($10^{-5}$ eV to 90 keV). Capture cross sections for the energy range 90 to 700 keV are taken from Beer, et al. [2], Table IV.
REFERENCES
3. M. C. Moxon, private communication to R. Q. Wright, August 1992

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)
ENDF/B-V MAT 1376 converted to ENDF-6 format. See $^{174}$Hf for documentation of the ENDF/B-V evaluation.
\(^{177}\text{Hf}\) Incident Neutron Sublibrary, Release 2

Evaluation: \(^{177}\text{Hf}\) Incident Neutron Sublibrary, Release 2 (MAT 7234)  
Energy Range: \(10^{-5}\) eV to 20 MeV  
Files: 1, 2, 3, 4, 5  
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, September 1991)

RESONANCE PARAMETERS (File 2)  
The resolved resonance region is revised and extended from 300 to 700 eV using the MLBW formalism; the highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level is not included. Values of \(\Gamma_i\) not given explicitly in Mughabghab are set to 0.065 eV.

The value for the scattering radius is 8.0 fm. The thermal capture cross section is about 1% lower than in the previous evaluation and the capture resonance integral is about 1.6% lower. The negative elastic scattering cross section below 0.8 eV in the previous evaluation has been eliminated.

The unresolved resonance range is 700 eV to 90 keV. The resonance parameters are based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

\[
D_0 = 2.3625 \text{ eV, } S_0 = 1.7 \times 10^{-4}, S_1 = 1.0 \times 10^{-4}, S_2 = 2.1 \times 10^{-4}
\]

\[
D_1 = 1.4175 \text{ eV, } S_{\gamma 0} = 275 \times 10^{-4}, S_{\gamma 1} = 459 \times 10^{-4}
\]

\[2200 \text{ m/s cross sections (barns)}\]

| Total     | 373.49 |
| Elastical | 0.02  |
| Capture   | 373.47 |

\text{Compueted resonance integral (barns)} = 7175

SMOOTH CROSS SECTIONS (File 3)  
Elastic, and capture are set to zero in the resolved and unresolved resonance range (\(1.0 \times 10^{-5}\) eV to 90 keV). Capture cross sections for the energy range 90 to 700 keV from Beer, et al. [2].

REFERENCES

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)  
ENDF/B-V MAT 1377 converted to ENDF-6 format. See \(^{174}\text{Hf}\) for documentation of the ENDF/B-V evaluation.
178Hf Incident Neutron Sublibrary, Release 2

**Evaluation:** 178Hf Incident Neutron Sublibrary, Release 2 (MAT 7237)

**Energy Range:** 10^{-5} eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

**ENDF/B-VI MOD 2 REVISION 1** (R. Q. Wright, ORNL, September 1991)

**RESONANCE PARAMETERS (File 2)**

The resolved resonance region is revised to 2100 eV using the MLBW formalism; the upper limit is unchanged from the previous evaluation. The highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1], except for the value of $\Gamma_{\gamma}$ for the 446.5 eV level; the bound level at -54.5 eV [1] is used in this evaluation.

The value for the scattering radius is 7.77 fm. The thermal capture cross section is 13% higher than in the previous evaluation and the capture resonance integral is 7.6% higher. The negative elastic scattering cross section in the previous evaluation below 4 eV has been eliminated.

The upper limit for the unresolved resonance range is 2100 eV to 90 keV. The unresolved resonance range fit is based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

- $D_0 = 51$ eV, $S_0 = 2.2 \times 10^{-4}$, $S_1 = 0.51 \times 10^{-4}$, $S_2 = 1.66 \times 10^{-4}$
- $D_1 = 14.67$ eV, $S_\rho = 10.59 \times 10^{-4}$, $S_\gamma = 36.82 \times 10^{-4}$

**2200 m/s cross sections (barns)**

- Total = 88.90
- Elastic = 4.87
- Capture = 84.03

**Computed resonance integral (barns) = 1905**

**SMOOTH CROSS SECTIONS (File 3)**

Elastic, and capture are set to zero in the resolved and unresolved resonance range (1.0\times10^{-5} eV to 90 keV). Capture cross sections for the energy range 90 to 2 MeV are taken from Beer, et al. [2], Table IV.

**REFERENCES**


**ENDF/B-VI MOD 0** (R. Q. Wright, ORNL, February 1990)

ENDF/B-V MAT 1378 converted to ENDF-6 format. See 174Hf for documentation of the ENDF/B-V evaluation.


\textbf{\textit{179}Hf Incident Neutron Sublibrary, Release 2}

Evaluation: \textbf{179}Hf Incident Neutron Sublibrary, Release 2 (MAT 7240)

Energy Range: $10^{-5}$ eV to 20 MeV

Files: 1, 2, 3, 4, 5

Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

\begin{center}
\textbf{ENDF/B-VI MOD 2 REVISION 1} (R. Q. Wright, ORNL, September 1991)
\end{center}

\textbf{RESONANCE PARAMETERS} (File 2)

The resolved resonance region is revised to 450 eV using the MLBW formalism; the upper limit is unchanged from the previous evaluation. The highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level at -6.1 eV [1] is included. Values of $\Gamma_\gamma$ not given explicitly in [1] are set to 0.066 eV.

The thermal capture cross section is 6.5% lower than in the previous evaluation while the capture resonance integral is 2.2% higher.

The upper limit for the unresolved resonance range is 450 eV to 90 keV. The unresolved resonance range fit is based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

\begin{align*}
D_0 &= 4.356 \text{ eV, } S_0 = 1.8 \times 10^{-4}, S_1 = 0.83 \times 10^{-4}, S_2 = 2.1 \times 10^{-4} \\
D_1 &= 2.512 \text{ eV, } S_{\rho_0} = 152 \times 10^{-4}, S_{\rho_1} = 263 \times 10^{-4}
\end{align*}

\begin{itemize}
\item \textbf{2200 m/s cross sections (barns)}
\item Total = 49.83
\item Elastic = 7.23
\item Capture = 42.60
\item Scattering Radius = 7.83 fm
\item \textbf{Computed resonance integral (barns)} = 548
\end{itemize}

\textbf{SMOOTH CROSS SECTIONS} (File 3)

Total, elastic, and capture are set to zero in the resolved and unresolved resonance range ($1.0 \times 10^{-5}$ eV to 90 keV). Capture cross sections for the energy range 90 to 2 MeV are taken from Beer, et al. [2], Table IV.

\textbf{REFERENCES}


\textbf{ENDF/B-VI MOD 0} (R. Q. Wright, ORNL, February 1990)

ENDF/B-V MAT 1383 converted to ENDF-6 format. See \textit{174}Hf for documentation of the ENDF/B-V evaluation.

1.72
180Hf Incident Neutron Sublibrary, Release 1, 2

Evaluation: 180Hf Incident Neutron Sublibrary, Release 1, 2 (MAT 7243)
Energy Range: 10^5 eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, September 1991)

RESONANCE PARAMETERS (File 2)
The resolved resonance region is revised using the MLBW formalism and the upper limit is reduced from 12 to 10 keV; the highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level at -48.7 eV is included. Values of r_r not explicitly given in [1], are set to 0.051 eV, or in some cases a different value is used in order to preserve the value of g_TJP, given in [2].
The thermal capture cross section is 1.3% lower than in the previous evaluation and the capture resonance integral is 0.3% lower.
The upper limit for the unresolved resonance range is 10 to 90 keV. The resonance parameters are fit to the average capture cross sections from Beer, et al. [2]; the parameters are based on:

\[ \begin{align*}
D_0 &= 100 \text{ eV, } \quad S_0 = 1.9 \times 10^4, \quad S_1 = 0.44 \times 10^4, \quad S_2 = 1.08 \times 10^4 \\
D_1 &= 30 \text{ eV, } \quad S_10 = 5.10 \times 10^4, \quad S_{11} = 17.0 \times 10^4
\end{align*} \]

2200 m/s cross sections (barns)
Total = 34.16
Elastic = 21.15
Capture = 13.01
Scattering radius = 8.0 fm [1]

Computed resonance integral (barns) = 34.48

SMOOTH CROSS SECTIONS (File 3)
Total, elastic, and capture are set to zero in the resolved and unresolved resonance range (1.0 \times 10^5 eV to 90 keV). Capture cross sections for the energy range 90 to 2 MeV are taken from Beer, et al. [2], Table IV.

REFERENCES

ENDF/B-VI MOD 2 REVISION 1 (NNDC, August 1991)
The second J-value for L=1 in the unresolved resonance region. (Note that the revised evaluation from Release 2 has also been labeled as MOD 2, Revision 1).

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 1384 converted to ENDF-6 format. See 174Hf for documentation of the ENDF/B-V evaluation.
\textsuperscript{nat}W Incident Neutron Sublibrary, Release 1

Evaluation: \textsuperscript{nat}W Incident Neutron Library, Release 1 (MAT 7400)

Energy Range: \(10^{-5}\) eV to 20 MeV

Files: 1, 2, 3, 4, 5, 12, 13, 14, 15

Evaluators: E. D. Arthur, P. G. Young, R. Boicourt (LANL)

ENDF/B-VI MOD 2 REVISION 1 (E. D. Arthur, LANL, July 1991)

File 3: For total, elastic, and capture, unequal energies at several discontinuities marking resonance region boundaries were corrected.

File 14: For inelastic scattering, NK(N1) corrected.

ENDF/B-VI MOD 0 (NNDC, February 1990)

ENDF/B-V MAT 1474 converted to ENDF-6 format.

191,193Ir Incident Neutron Sublibrary, Release 4

Evaluation: 191,193Ir Incident Neutron Library, Release 4 (MAT 7725)
Energy Range: 10^{-5} \, \text{eV} \text{ to } 20 \, \text{MeV}
Files: 1, 2, 3, 4, 5, 12, 14, 15
Evaluators: R. Q. Wright, R. R. Spencer (ORNL)

ENDF/B-VI MOD 1 NEW EVALUATION (R.Q.Wright, R. R. Spencer, ORNL, March 1995)
This evaluation uses the BROND natural iridium evaluation, and includes resolved and unresolved resonance data. Changes for this evaluation are given following.

RESOLVED RESONANCE RANGE
The MLBW resonance formalism is used in this evaluation. The resonance parameters are taken from Mughabghab [1] and are unchanged from the BROND evaluation with the exception of the bound level in 192Ir.

191Ir Resolved resonance range upper limit is 160 eV; the highest energy resonance included is at 171 eV. 51 s-wave (1 bound level) resonances are given. The last five (highest energy) resonances are fictitious resonances above the upper cutoff of the resolved resonance range. The scattering radius is 9.9 fm which gives a thermal scattering cross section of 13.92 barns.

193Ir Resolved resonance range upper limit is 300 eV; the highest energy resonance included is at 336 eV. 45 s-wave (1 bound level) resonances are included; the last five (highest energy) resonances are fictitious resonances above the upper cutoff of the resolved resonance range. The scattering radius is 11.3 fm which gives a thermal scattering cross section of 19.34 barns.

The parameters for the bound level at -21.7 eV [1] are not the same as those in the BROND evaluation. This change gives a thermal capture cross section of 112 b which is adopted for this evaluation.

UNRESOLVED RESONANCE RANGE
The unresolved resonance range includes parameters for s-wave and p-wave resonances. Unresolved parameters are energy independent but are specified using an energy dependent format (energies given in the file). The SESH program [2] was used to determine the total, elastic, and capture cross sections in the unresolved range in order to compare calculated cross sections with measurements.

191Ir The unresolved resonance range is 160 eV to 10 keV. The average $\Gamma_\gamma$ is 0.077 eV.
$D_0 = 2.15 \, \text{eV}, \, S_0 = 2.2 \times 10^4, \, S_1 = 0.4 \times 10^4, \, S_{\infty} = 358.14$ and the scattering radius = 8.8 fm.

193Ir The unresolved resonance range is 300 eV to 10 keV. The average $\Gamma_\gamma$ is 0.093 eV.
$D_0 = 5.54 \, \text{eV}, \, S_0 = 2.0 \times 10^4, \, S_1 = 0.4 \times 10^4, \, S_{\infty} = 167.87$ and the scattering radius = 9.0 fm.

SMOOTH CROSS SECTIONS (File 3)
The total cross section for 191Ir was modified from 10 to 130 keV; it is 19\% higher than natural iridium at 10 keV and unchanged above 130 keV. The total cross section for 193Ir was modified from 10 to 150 keV; it is 17\% higher than natural iridium at 10 keV and unchanged above 150 keV.

The elastic cross section is taken from total - nonelastic.
The inelastic cross section was obtained from the sum of $MT = 51, 52, 53, 54,$ and 91. The discrete inelastic levels correspond to $MT = 53, 54, 56,$ and 57 for $^{191}\text{Ir}$, and to $MT = 51, 52, 55,$ and 58, respectively, for $^{193}\text{Ir}$ in the BROND natural iridium evaluation.

The capture cross section is based on Macklin, et al., [3] from 10 keV to 2 MeV. From 2 to 20 MeV, the capture was obtained by renormalizing the natural iridium capture to the Macklin capture value at 2 MeV.

<table>
<thead>
<tr>
<th>2200 m/s cross sections (barns)</th>
<th>$^{191}\text{Ir}$</th>
<th>$^{193}\text{Ir}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>968.26</td>
<td>131.34</td>
</tr>
<tr>
<td>Elastic</td>
<td>13.92</td>
<td>19.34</td>
</tr>
<tr>
<td>Capture</td>
<td>954.34</td>
<td>112.00</td>
</tr>
<tr>
<td>Resonance integral (barns)</td>
<td>3551.5</td>
<td>1373.0</td>
</tr>
</tbody>
</table>

PHOTON PRODUCTION (File 12)

The separation of the natural element into $^{191}\text{Ir}$ and $^{193}\text{Ir}$ is based on information given in the file 1 comments for $MF = 12$, $MT = 102$ in the original BROND evaluation and on Kruger [4].

REFERENCES
197Au Incident Neutron Sublibrary, Release 1

Evaluation: 197Au Incident Neutron Library, Release 1 (MAT 7925)
Energy Range: 10^4 eV to 30 MeV
Files: 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 15, 33
Evaluators: P. G. Young, E. D. Arthur (LANL)

ENDF/B-VI MOD 2 REVISION 1 (P. G. Young, LANL, July 1991)
File 1: The comments following were added regarding estimated (expanded) covariance for the Standards Cross Sections.
File 3: Q-value corrected for capture cross section.

STANDARDS COVARIANCES
Phase 1 reviewers of the ENDF/B-VI standards cross sections have expressed the concern that the uncertainties resulting from the combination of R-matrix and simultaneous evaluations might have led to uncertainties that are too small. As a result, the Standards Subcommittee produced (at the May, 1990 CSEWG meeting) a set of expanded covariance estimates for the standard cross section reactions. These uncertainties are estimates such that if a modern day experiment were performed on a given standard cross section using the best techniques, approximately 2/3 of the results should fall within these expanded uncertainties. The expanded uncertainties for the 197Au(n,γ) cross section are given in the following table and are compared to values from the combined output of the standards covariance analysis:

<table>
<thead>
<tr>
<th>Energy Range (keV)</th>
<th>Estimated Uncertainty %</th>
<th>Combined Analysis %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.53×10^3</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>200 - 500</td>
<td>3.0</td>
<td>1.31</td>
</tr>
<tr>
<td>500 - 1000</td>
<td>3.5</td>
<td>2.1</td>
</tr>
<tr>
<td>1000 - 2500</td>
<td>4.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

ENDF/B-VI MOD 1 NEW EVALUATION (P. G. Young, E. D. Arthur, LANL, January 1984)
207Pb Incident Neutron Sublibrary, Release 1

Evaluation: 207Pb Incident Neutron Library, Release 1 (MAT 8234)
Energy Range: 10^{-3} eV to 20 MeV
Files: 1, 2, 3, 4, 6, 12, 14, 15, 33
Evaluators: C. Y. Fu, N. M. Larson, D. C. Larson (ORNL)

Resonance parameters have been revised.

Evaluation: 209Bi Incident Neutron Sublibrary, Release 3 (MAT 8325)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 13, 14, 15, 33
Evaluators: A. B. Smith, D. Smith, P. T. Guenther (ANL)

ENDF/B-VI MOD 1 REVISION 1 (V. McLane, NNDC, May 1995)
Minor correction to File 1 comments made in Release 3; MOD not changed.

ENDF/B-VI MOD 1 NEW EVALUATION (A. Smith, D. Smith, P. Guenther, et al., ANL, August 1989)

REFERENCE
**Evaluation:**  
**235U Incident Neutron Library, Release 1, 2, 3, 4 (MAT 9228)**

**Energy Range:**  
$10^{-5}$ eV to 20 MeV

**Files:**  
1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 31

**Evaluators:**  
L. Weston (ORNL), P. G. Young (LANL), W. Poenitz (ANL), C. Lubitz (KAPL)

**ENDF/B-VI MOD 5 REVISION 4** (V. McLane, NNDC, November 1996)

The following changes were made in File 1.
MT=455: Obsolete fields on second LIST record set to zero.
MT=456, prompt $\bar{\nu}$ updated.

**ENDF/B-VI MOD 4 REVISION 3** (C. R. Lubitz, KAPL, November 1993)

The resonance parameters below 900 eV were adjusted as described in Lubitz [1]. The principal change was to increase the capture areas under the resonance so that the average capture cross section agreed with the data of Perez, et al. [4]. A smaller adjustment has been made to make the fission averages agree with the lower of several measurements, principally the work of Schrack [2], Weston [3], and Todd [5]. The thermal parameter $K_t = (\nu-1)\ast$ fission-capture (Maxwellian averages) was increased slightly by making small changes to the resonances below 0.5 eV. $\bar{\nu}$ and the fission widths were increased, and the capture widths were decreased iteratively, until the desired value of $K_t$ was reached, subject to the constraint that the 2200 m/sec values of $\bar{\nu}$, $\sigma_t$ and $\sigma_n$, all differed from the Standards Committee recommendations (quoted below) by equal fractions of their uncertainties. This fraction ended up being 0.5 of one standard deviation.

The following thermal cross sections (0.0253 eV) and the resonance integrals for a 1/E spectrum (0.5 eV to 20 MeV) were computed using NJOY 91.38, at 293°K, with the following convergence criteria:

| RECONR* | 0.001 | 0 | 6 | .01 | 1.E-6 / ERR TEMPR NDIGITS ERRMAX ERRINT |
| BROADR* | 0.001 | 1.E6 | .01 | 1.0E-6 / ERRTHN THNMAX ERRMAX ERRINT |

Other choices will give slightly different values.\(^5\)

<table>
<thead>
<tr>
<th>Thermal (b)</th>
<th>Resonance Integral (b)</th>
<th>g-factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_{n,\gamma}$</td>
<td>98.59</td>
<td>143.4</td>
</tr>
<tr>
<td>$\sigma_t$</td>
<td>584.81</td>
<td>277.5</td>
</tr>
<tr>
<td>$\sigma_{n,\gamma}/\sigma_t$</td>
<td>0.517</td>
<td></td>
</tr>
<tr>
<td>$\bar{\nu}$</td>
<td>2.4338</td>
<td></td>
</tr>
<tr>
<td>$K_t$</td>
<td>723.0</td>
<td></td>
</tr>
</tbody>
</table>

The uncertainties attached to the above values are the same as given by the Standards Committee and by Mughabghab [6]. For the g-factors, the Committee gives ±.0008 and for $\bar{\nu}$, ±.0036 [7].

\(^5\) Some of these numbers are slightly different from those given in Ref. [1], and supersede them, although the underlying data are the same.
REFERENCES

ENDF/B-VI MOD 3 REVISION 2 (L. W. Weston, February 1993)
Missing File 1 section added.

ENDF/B-VI MOD 1 NEW EVALUATION (L. Weston (ORNL), P. Young (LANL), W. Poenitz (ANL), April 1989)

GENERAL INFORMATION (File 1)
The uncertainties on the fission cross section recommended by the CSEWG Standards Committee are listed. The updated description of File 2, the resolved resonance parameters, is given.

RESONANCE PARAMETERS (File 2)
The resolved resonance parameters were changed extensively. The neutron energy region below 4 eV was made a separate group. η decreases with decreasing neutron energy below 0.1 eV. At the higher neutron energies, the resonance parameters are more refined.

SMOOTH CROSS SECTIONS (File 3)
Smooth cross sections above 100 keV have minor corrections.

COVARIANCE FILES
File 31: ν covariance files were updated.
File 33: All covariance files were removed as correct new files were not yet available.

The following reference is missing from the file 1 comments.

---

6 These measurements done on a flight path of 80 m. have a much better resolution than those of [3] and have been used above 110 eV.
237U Incident Neutron Sublibrary, Release 2

**Evaluation:** 237U Incident Neutron Sublibrary, Release 2 (MAT 9234)

**Energy Range:** 10^5 eV to 20 MeV

**Files:** 1, 2, 3, 4, 5, 8, 12, 13, 14, 15

**Evaluators:** R. Benjamin, F. McCrosson (SRL); R. Howerton (LLNL) (Assembled by R. Kinsey NNDC)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, May 1993)

Missing fission neutron angular distribution added; assumed to be isotropic.

ENDF/B-VI MOD 1 EVALUATION (NNDC, February 1990)

ENDF/B-V MAT 8237 converted to ENDF-6 format. The ENDF/B-V evaluation is a combination of the evaluation of Benjamin and McCrosson (SRL) and the ENDL evaluation of Howerton [5]. Important changes or modifications are noted.

GENERAL INFORMATION (File 1)

The thermal value is computed from the semi-empirical work of Gordeeva and Smirenkin [1] as revised by Manero and Konshin [2]. The energy dependence is based on Howerton. Renormalization of the Howerton shape was done at BNL.

\( V_d \) taken from Brady and England [6].

RESONANCE PARAMETERS (File 2)

The resolved region is 0 to 102.5 eV. Resolved resonance parameters are determined by the GENPAR code [3] based on the SRL data set and an average level spacing of 3.5 eV [4]. A bound level at -2.109 eV was removed from the SRL parameters and appropriate backgrounds were inserted into the total, fission, and capture cross sections.

The unresolved resonances were evaluated on the same basis as the resolved over the region is 102.5 eV to 10 keV.

### 2200 m/s cross sections and resonance integrals

<table>
<thead>
<tr>
<th></th>
<th>( \sigma ) (0.0253 eV)</th>
<th>( I ) (0.5 eV - 20 MeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>487.106</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>9.131</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>2.000</td>
<td>9.209</td>
</tr>
<tr>
<td>Capture</td>
<td>475.975</td>
<td>309.585</td>
</tr>
</tbody>
</table>

SMOOTH CROSS SECTIONS (File 3)

**Total cross section** The sum of capture and fission bound level backgrounds up to 10 keV are joined at 10 keV to the Howerton evaluation.

**Elastic scattering**, a zero background file up to 10 keV was joined to the Howerton evaluation.

---

7 Unable to locate documentation for this evaluation (VM).


\[ \text{Inelastic scattering, (n,2n), and (n,3n) Taken from Howerton evaluation; threshold points inserted.} \]

\text{Fission and capture cross sections} \ The background from the deleted bound level up to 10 keV was joined to the Howerton evaluation.

\textbf{ANGULAR DISTRIBUTIONS (File 4)}

\text{Elastic taken from Howerton.}

\text{For (n,2n), (n,3n), and neutron production, dummy isotropic distributions were inserted.}

\textbf{SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)}

\text{Inelastic scattering, (n,2n), and (n,3n) taken from Howerton evaluation.}

\text{Fission taken from McCrossen evaluation, simple Maxwellian with energy dependent temperature.}

\textbf{PHOTON PRODUCTION (Files 12, 13, 14, and 15)}

\text{The energy ranges of Howerton were extended to agree with File 3 ranges.}

\textbf{REFERENCES}


\textbf{Evaluation:} \textit{\textsuperscript{238}U Incident Neutron Sublibrary, Release 1, 2 (MAT 9237)}

\textbf{Energy Range:} 10^5 \text{ eV} \text{ to } 20 \text{ MeV}

\textbf{Files:} 1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 31, 33

\textbf{Evaluators:} L. W. Weston (ORNL), P. G. Young (LANL), W. Poenitz (ANL)

\textbf{ENDF/B-VI MOD 3 REVISION 2} (L. Weston, ORNL, January 1993)

The preliminary evaluation of Moxon and Sowerby in the resolved resonance region has been replaced with the final version \cite{1}. Fröhner’s evaluation \cite{2} of the unresolved resonance region up to 149 keV is used in this evaluation.


\textbf{ENDF/B-VI MOD 2 REVISION 1} (NNDC, July 1991)

Covariance files for total, fission, and capture were removed, since the correct files are not yet available.

\textbf{ENDF/B-VI MOD 1 NEW EVALUATION} (L. Weston (ORNL), P. Young (LANL), W. Poenitz (ANL), et al., November 1989)


\footnote{This evaluation is identical to that in JEF-2.2 up to 149 keV.}

I.84
$^{237}$Np Incident Neutron Sublibrary, Release 1

Evaluation: $^{237}$Np Incident Neutron Sublibrary, Release 1 (MAT 9346 )

Energy Range: $10^{-5}$ eV to 20 MeV

Files: 1, 2, 3, 4, 5, 6, 8, 9, 12, 13, 14, 15

Evaluators: P. G. Young, E. D. Arthur (LANL); F. M. Mann (HEDL)

ENDF/B-VI MOD 2 REVISION 1 (P. G. Young, E. D. Arthur (LANL), F. M. Mann (HEDL), July 1991)

Angular distribution data (isotropic) for 1st-, 2nd-, 3rd- and 4th-chance fission removed from File 4 because no energy spectra are available.

ENDF/B-VI MOD 1 NEW EVALUATION (P. G. Young, E. D. Arthur (LANL), F. M. Mann (HEDL), April 1990)

\(^{238}\)Np Incident Neutron Sublibrary, Release 2

**Evaluation:**  \(^{238}\)Np Incident Neutron Sublibrary, Release 2 (MAT 9349)

**Energy Range:**  \(10^{-5}\) eV to 20 MeV

**Files:**  1, 2, 3, 4, 5, 8

**Evaluators:**  R. W. Benjamin, F. J. McCrosson (SRL)

ENDF/B-VI MOD 2 REVISION 1  (NNDC, May 1993)

The missing fission neutron angular distributions are added; assumed to be isotropic.

ENDF/B-VI MOD 0  (NNDC, February 1990)

ENDF/B-V MAT 8338 was converted to ENDF-6 format.

ENDF/B-V EVALUATION  (R. W. Benjamin and F. J. McCrosson, SRL, August 1975)

**GENERAL INFORMATION (File 1)**


\(\nu_4\) taken from M. C. Brady and T. R. England [5].

**RESONANCE PARAMETERS (File 2)**

Resolved resonance parameters in the region 0 to 100.2 eV are determined by the GENRPAR code [4] based on the SRL data set and an average level spacing of 1.05 eV.

Unresolved resonance parameters in the region 100.2 to 10 keV are determined on the same basis as the resolved with average resonance parameters.

**2200 m/s cross sections and resonance integrals**

<table>
<thead>
<tr>
<th></th>
<th>(\sigma(0.0253\text{ eV}))</th>
<th>(I(0.5\text{ eV - 20 MeV}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2250.99</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>21.25</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>2026.90</td>
<td>895.60</td>
</tr>
<tr>
<td>Capture</td>
<td>202.83</td>
<td>100.03</td>
</tr>
</tbody>
</table>

**SMOOTH CROSS SECTIONS (File 3)**

The data in File 3 are given only so that the various processing codes will work. Continuity with the unresolved region is provided, but the cross sections drop immediately to zero. The elastic scattering cross section above 10 keV is the potential scattering cross section calculated with a spherical optical model potential at 10 keV.

**ANGULAR DISTRIBUTIONS (File 4)**

The elastic distributions are taken from ENDF/B-V \(^{238}\)U.

**SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)**

A simple fission Maxwellian with energy dependent temperature is used.
REFERENCES
236Pu Incident Neutron Sublibrary, Release 4

Evaluation: 236Pu Incident Neutron Sublibrary, Release 4 (MAT 9428)
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); T. Hojuyama (MAPI); Y. Kikuchi, T. Nakagawa (JAERI)

ENDF/B-VI MOD 1 NEW EVALUATION (R.Q. Wright, ORNL, September 1995)
This evaluation is an update of the JENDL-3.2 Evaluation. The following changes were made.

GENERAL COMMENTS (File 1)
\( v_p \) Tabulated data added.

RESONANCE PARAMETERS (File 2)
Resolved resonance parameters are given in the range 1.0 \times 10^{-5} \text{ to } 10 \text{ eV} using a MLBW formalism. Parameters are given for the -1.27, 3.16, 6.30, 12.0 \text{ eV} resonances.
Average \( \Gamma_\gamma = 0.044 \text{ meV}, \Gamma_\gamma = 0.325 \text{ meV}, \Gamma_0 = 5.71193 \times 10^{-4} \text{ meV}, \Gamma_0 = 4.42333 \text{ eV}, \Gamma_0 = 1.72176 \times 10^{-4} \text{ eV}, \text{ and the scattering radius } = 9.46 \text{ fm.}

SMOOTH CROSS SECTIONS (File 3)
Total cross section (MT=1) Revised from 10 eV to 20 MeV. The cross section was obtained by addition of all partial cross sections in the revised evaluation. The total cross section was reduced by 0.6 barns for the energy range 7-20 MeV; this change is due to the lower fission cross section (see discussion of the revised fission cross section).

Comparison of revised total with 239Pu total

<table>
<thead>
<tr>
<th>Energy (MeV)</th>
<th>(^{236}\text{Pu}/^{239}\text{Pu}) total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>1.000</td>
</tr>
<tr>
<td>5.0</td>
<td>0.966</td>
</tr>
<tr>
<td>7.0</td>
<td>0.981</td>
</tr>
<tr>
<td>10.0</td>
<td>0.979</td>
</tr>
<tr>
<td>12.0</td>
<td>0.986</td>
</tr>
<tr>
<td>14.0</td>
<td>1.008</td>
</tr>
<tr>
<td>16.0</td>
<td>1.037</td>
</tr>
<tr>
<td>20.0</td>
<td>1.050</td>
</tr>
</tbody>
</table>

Elastic cross section (MT=2) Revised from 10 eV to 50 keV, based on the unresolved resonance calculation described above. Above 50 keV, the elastic from the JENDL-3.2 evaluation is revised to get the final elastic cross section.

Inelastic cross section Revised from 5 to 7 MeV.

Fission cross section Revised:
a) from 10 eV to 6 MeV based on measured data Gromova, et al., [1], tables 2 and 3.
b) above 6 MeV, revised based on the measured value at 5.78 MeV of Gromova, et al. [1], table 3.
c) for the energy range 7-20 meV, the fission cross section is reduced by 0.6 barns.
Comparison of evaluated fission with Gromova, et al. [1]

<table>
<thead>
<tr>
<th>Maximum energy (eV)</th>
<th>Ref. 1 (barns)</th>
<th>Evaluation (barns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.5×10³</td>
<td>4.3 ± 0.2</td>
<td>4.270</td>
</tr>
<tr>
<td>21.5×10³</td>
<td>5.2 ± 0.3</td>
<td>5.225</td>
</tr>
<tr>
<td>10.0×10³</td>
<td>6.8 ± 0.3</td>
<td>6.686</td>
</tr>
<tr>
<td>4.65×10³</td>
<td>8.9 ± 0.4</td>
<td>8.913</td>
</tr>
<tr>
<td>2.15×10³</td>
<td>13.5 ± 0.8</td>
<td>13.43</td>
</tr>
<tr>
<td>1.000×10³</td>
<td>20.9 ± 0.8</td>
<td>21.11</td>
</tr>
<tr>
<td>465</td>
<td>33.3 ± 1.5</td>
<td>33.12</td>
</tr>
<tr>
<td>215</td>
<td>46.0 ± 1.3</td>
<td>42.35</td>
</tr>
<tr>
<td>100</td>
<td>47.2 ± 1.5</td>
<td>50.88</td>
</tr>
<tr>
<td>46.5</td>
<td>72.0 ± 2.0</td>
<td>72.31</td>
</tr>
<tr>
<td>21.5</td>
<td>91.0 ± 2.0</td>
<td>91.09</td>
</tr>
<tr>
<td>10.0</td>
<td>50.0 ± 3.0</td>
<td>250.1</td>
</tr>
<tr>
<td>4.65</td>
<td>615.0 ± 6.0</td>
<td>614.3</td>
</tr>
<tr>
<td>2.15</td>
<td>25.0 ± 2.0</td>
<td>32.05</td>
</tr>
<tr>
<td>1.0</td>
<td>33.0 ± 3.0</td>
<td>29.62</td>
</tr>
</tbody>
</table>

In the range 10 eV to 50 keV, the elastic scattering and $\alpha$ were obtained from an unresolved resonance calculation using the following parameters: $S_0 = 9.92 \times 10^{-5}$, $<D_\phi> = 2.5$ eV, $<\Gamma_r> = 0.044$ eV, $<\Gamma_\gamma> = 0.400$ eV, scattering radius = 9.33 fm.

First-chance fission cross section (MT=19) Revised to reflect the changes in MT=18.

Capture cross section (MT=102) Revised from 10 eV to 300 keV based on the estimated value of $\alpha$ (capture/fission ratio) obtained from an unresolved resonance calculation for the energy range 10 eV to 50 keV. The value of $\alpha$ obtained from this calculation is almost constant; thus a value of 0.17 is used.

For the range 20-300 keV, the capture cross section is obtained by log-log interpolation using the following values: (20 kev, 799 mb) and (300 kev, 419 mb). The corresponding values of $\alpha$ are 0.170 and 0.166, at 20 and 300 keV, respectively.

Calculated 2200 m/s cross sections and resonance integrals

<table>
<thead>
<tr>
<th></th>
<th>$\sigma (0.0253 \text{ eV})$</th>
<th>$I (0.5 \text{ eV - 20 MeV})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>205.4</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>165.0</td>
<td>992</td>
</tr>
<tr>
<td>Capture</td>
<td>31.2</td>
<td>286</td>
</tr>
<tr>
<td>Absorption</td>
<td>196.2</td>
<td>1278</td>
</tr>
</tbody>
</table>

REFERENCES
239Pu Incident Neutron Sublibrary, Release 2

Evaluation: 239Pu Incident Neutron Sublibrary, Release 2 (MAT 9437)
Energy Range: 10⁻⁵ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 6, 12, 13, 14, 15
Evaluators: P. Young (LANL); L. W. Weston, H. Derrien (ORNL); W. Poenitz (ANL); T. Nakagawa (JAERI)

ENDF/B-VI MOD 2 REVISION 1 (L. Weston, H. Derrien (ORNL); T. Nakagawa (JAERI), January 1993)

The resonance region evaluation by H. Derrien and T. Nakagawa has been added, and has extended the resonance region to 2.5 keV. The resonance parameters have been obtained from a SAMMY [1] fit analysis of high resolution experimental data. The file contains three independent sections:

1) Energy range 0 to 1 keV. The set of resonance parameters contains 398 resonances in the energy range 0 to 1 keV, 4 fictitious negative energy resonances and 3 fictitious resonances above 1 keV;
2) Energy range 1 to 2 keV. The set of resonance parameters contains 435 resonances in the energy range 0.980 to 2.02 keV, 3 fictitious resonances below 0.9 keV and 3 fictitious resonances above 2.02 keV;
3) Energy range 2 to 2.5 keV. The set of resonance parameters contains 218 resonances in the energy range 1.98 to 2.53 keV, 3 fictitious resonances below 1.98 keV and 3 fictitious resonances above 2.53 keV.

In all sections, the fictitious resonance parameters take into account the contribution of all the external truncated resonances in such a way that no total, scattering, fission and capture smooth files are needed in the corresponding energy ranges for the reproduction of the cross sections within the experimental errors.

The following experimental data base has been used in the SAMMY fits: absorption and fission from Gwin, et al. [2,4]; fission from Gwin et al. [5,6], Blons [3], Weston, et al. [7,8]; transmission from Spencer, et al. [10], Harvey, et al. [9].

Prior to the fits, the experimental fission and absorption cross sections were normalized, directly or indirectly, to the 0.0253 eV values obtained by the ENDF/B-VI standard evaluation group [11]. The transmission data were considered as accurate absolute measurements (the Spencer total cross section at 0.0253 ev is 1025.0 b, in excellent agreement with the 1027.3 b standard value). Details on the analysis are found in references [8,12,13].

| 293°K cross sections calculated from resonance parameters |
|---------------------|-------------------|-------------------|
|                     | SAMMY             | RESEND            | Proposed          |
| Fission             | 747.64            | 747.90            | 747.99±1.87       |
| Capture             | 271.10            | 270.73            | 271.43±2.14       |
| Scattering          | 7.97              | 7.99              | 7.88±0.97         |
| Total               | 1026.71           | 1026.62           | 1027.30±5.00      |

9 Performed at ORNL by H. Derrien and G. deSaussure and at JAERI by H. Derrien and T. Nakagawa
REFERENCES

8. L. W. Weston, et al., to be published (high resolution 1988 data)
9. J. A. Harvey, et al., Nuclear Data for Science and Technology, Int. Conference, Mito,
   Japan, 30 May - 3 June '83 (Saikon Publishing 1988) p. 115

ENDF/B-VI MOD 1 NEW EVALUATION (P. Young (LANL), L. Weston (ORNL), W. Poenitz (ANL), April 1989)

See Summary Documentation, 4th Edition (1991), page 415, for summary documentation of
ENDF/B-VI evaluation.
Evaluation:  

Energy Range:  $10^5$ eV to 20 MeV  

Files:  1, 2, 3, 4, 5, 8, 12, 13, 14, 15, 31, 32, 33  

Evaluators:  L. W. Weston, E. D. Arthur  

Laboratory:  ORNL, LANL  

ENDF/B-VI MOD 3 REVISION 2  (L. Weston, ORNL, January 1993)  

- Added missing fission neutron angular distributions in File 4 (MT=19, MT=20 and MT=21); assumed to be isotropic.  
- Corrected U value for File 5, MT=20.  
- Fixed incorrect NER value in File 32, MT=151.  

ENDF/B-VI MOD 2 REVISION 1  (L. Weston, ORNL, July 1991)  

- Covariance File 33 for fission (MT=18) deleted.  

ENDF/B-VI MOD 1 NEW EVALUATION 1  (L. Weston (ORNL), E. Arthur (LANL), August 1993)  

241Pu Incident Neutron Sublibrary, Release 1.3

Evaluation: 241Pu Incident Neutron Data, Release 1, 3 (MAT 9443)
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15, 31
Evaluators: L. W. Weston, R. Q. Wright, H. Derrien, et al. (ORNL)

ENDF/B-VI MOD 3 REVISION 2 (L. Weston, ORNL, August 1994)

Covariances, which are dependent in the 235U covariances which are not completed, were stripped off the file.

ENDF/B-VI MOD 2 REVISION 1 (L. Weston, ORNL, June 1991)

The following changes were made for Revision 2:
1. insertion of revised resonance parameters by Derrien;
2. renormalization of capture above the resolved resonance region to be 4.8% lower than ENDF/B-V and upward from 14% down in original ENDF/B-VI evaluation. Scattering was adjusted to make up difference. The renormalization was the suggestion of Demen after study of the new measurements by Wagemans, et al. [1].

Revision of the 241Pu (H. Derrien, Japanese Atomic Energy Research Institute)

Resonance parameters of the neutron cross sections of 241Pu were obtained by Derrien and de Saussure [2] in the energy range from thermal to 300 eV by a Bayesian fit of selected experimental effective total, fission, and capture cross sections using the Reich-Moore fitting code SAMMY [3]. The results of this work were used in the ENDF/B-VI MOD1 evaluated data file. Some difficulties were encountered in the normalization of the experimental fission cross sections due to the discrepancies in the shape of the available experimental data both in thermal and high energy ranges. The consistency among the experimental data base could not be obtained without large renormalization and background correction parameters in the SAMMY fits. Particularly, it was shown that the discrepancy between the fission cross sections in the thermal energy range was due to a deviation from the 1/\nu shape below about 0.05 eV.

New fission cross section measurements were recently performed by Wagemans, et al. [1,4][10 in the energy range from 0.002 eV to 20 eV in order to check the shape of the cross section in the thermal energy range. They showed a shape which was a contradiction to all the previous measurements reported in the literature. Consequently, the normalization of all the previous results using the low energy region could be erroneous. Particularly, the discrepancy observed in the average fission cross section over the 0.26 eV resonance could be due to the errors of normalization in the thermal region. Wagemans, et al., compared the ENDF/B-VI MOD1 data to their 1991 results and concluded that the evaluated data files using the evaluation of Derrien and de Saussure should be revised in the energy range up to 300 eV.

In the energy range from 0.01 eV to 3 eV the 1991 data of Wagemans are on average 2.2% smaller than ENDF/B-VI MOD1. This difference is mainly due a difference of 3% between the 1976 Wagemans, et al. [5] and 1991 Wagemans, et al. [1]. The 1976 Wagemans data were used in the evaluation of Derrien and de Saussure in the low energy region.

---

10Hereinafter called Wagemanns 1991.
In the intermediate energy range from 3 eV to 12 eV, the average fission of ENDF/B-VI MOD1 is in excellent agreement with the 1991 Wagemans data. In this energy range, the SAMMY fits of Derrien and de Saussure were performed on the fission cross section of Weston and Todd [6], of Blons [7] and of Migneco, et al. [8], with an adjustment of the normalization factor and of the background correction parameters of all the experimental data; the agreement between the 1991 Wagemans data and ENDF/B-VI MOD1 shows that, at least in this energy range, SAMMY performed on the data of Weston and Todd a renormalization equivalent to that recommended by 1991 Wagemans.

In the higher range up to 300 eV, the SAMMY fits relied mainly on the high resolution measurements of Blons and of Migneco, et al., for the accurate determination of the resonance parameters. Quite large normalization coefficients and background correction parameters were also needed in this energy range to obtain the consistency between the calculated cross sections and the experimental data. However, the result of the fits was in quite good agreement with the data of Weston and Todd normalized to the 1976 Wagemans data in the low energy region, which is also equivalent to the normalization to the 1983 Wagemans, et al. [9] data. Since the 1976 Wagemans data should decrease by 3% to be consistent with the 1991 data, it is likely that the ENDF/B-VI MOD1 fission cross section could be too large by about 3% in the energy range above 12 eV.

**REVISION OF THE RESONANCE PARAMETERS**

An accurate up-dating of the $^{241}$Pu resonance parameters could be obtained by renormalizing the fission experimental data base according to the 1991 Wagemans data, and by redoing the SAMMY fits of the new experimental data base, including the high resolution transmission data of Harvey and Simpson [10]. Due to lack of time a new SAMMY analysis was performed only in the energy range from 0.002 eV to 3 eV. In the energy range above 3 eV, the updating was performed by applying some small corrections to the resonance parameters.

The SAMMY analysis of the 1991 Wagemans data along with the total cross section of Young and Smith [11] was performed in the energy range from 0.002 eV to 3 eV, by starting with the ENDF/B-VI MOD1 resonance parameters. Only the parameters of the 3+ resonances at 0.122 eV and at 0.265 eV were adjusted in this energy range. The values of the cross sections calculated at 0.0253 eV are compared to the standard data [12] in Table 1. The average total, fission and capture cross sections calculated with the new resonance parameters are displayed on Table 2, 3 and 4 with the corresponding experimental data and the values obtained from ENDF/B-VI MOD1. One should point out that an energy shift of $dE/E = +0.00384$ was applied to the data of Young and Smith in order to achieve a good consistency with the energy scale of the fission 1991 Wagemans data over the resonance at 0.0265 eV.

In the energy range above 3 eV, the small corrections applied to the resonance parameters result in a decrease of the average fission cross section and in an increase of the average capture cross section, with a variation of the average total cross section smaller than the errors of the experimental data of Harvey and Simpson. The average values of the fission and capture cross sections calculated with the new resonance parameters are shown in Table 5 and 6 along with the renormalized fission cross section of Weston and Todd and the values calculated from ENDF/B-VI MOD1.
Table 1
Cross sections at 0.0253 eV

<table>
<thead>
<tr>
<th></th>
<th>Present results</th>
<th>ENDF/B-VI Standard [14]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fission</td>
<td>1012.50(-0.0%)</td>
<td>1012.68±6.58</td>
</tr>
<tr>
<td>Capture</td>
<td>361.52(+0.1%)</td>
<td>361.29±4.95</td>
</tr>
<tr>
<td>Scattering</td>
<td>11.36(-7.1%)</td>
<td>12.17±2.62</td>
</tr>
<tr>
<td>Total</td>
<td>1385.38(-0.1%)</td>
<td>1386.14±8.64</td>
</tr>
</tbody>
</table>

Table 2
The total cross section integral in the energy range from 0.0021 eV to 3 eV.

<table>
<thead>
<tr>
<th>Energy range (eV)</th>
<th>Present work (b.eV)</th>
<th>ENDF/B-VI (b.eV)</th>
<th>Young and Smith [13] (b.eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0021-0.020</td>
<td>43.54</td>
<td>43.09(-1.0%)</td>
<td>43.25(-0.7%)</td>
</tr>
<tr>
<td>0.0200-0.030</td>
<td>14.03</td>
<td>14.02(-0.1%)</td>
<td>14.01(-0.1%)</td>
</tr>
<tr>
<td>0.0300-0.100</td>
<td>65.09</td>
<td>66.17(+1.7%)</td>
<td>64.99(-0.1%)</td>
</tr>
<tr>
<td>0.1000-0.500</td>
<td>378.38</td>
<td>385.27(+1.8%)</td>
<td>380.10(+0.4%)</td>
</tr>
<tr>
<td>0.5000-1.000</td>
<td>29.74</td>
<td>29.41(-1.1%)</td>
<td>31.19(+4.4%)</td>
</tr>
<tr>
<td>1.0000-3.000</td>
<td>83.36</td>
<td>83.92(+0.7%)</td>
<td>82.50(-1.0%)</td>
</tr>
<tr>
<td>0.0021-3.000</td>
<td>614.14</td>
<td>621.88(+1.3%)</td>
<td>616.04(+0.3%)</td>
</tr>
</tbody>
</table>

Table 3
The fission cross section integral in the energy range from 0.0021 eV to 3 eV.

<table>
<thead>
<tr>
<th>Energy range (eV)</th>
<th>This work (b.eV)</th>
<th>ENDF/B-VI (b.eV)</th>
<th>Wagemans, et al. [1] (b.eV)</th>
<th>Weston and Todd [8] (b.eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0021-0.020</td>
<td>31.06</td>
<td>30.61(-1.5%)</td>
<td>31.09(+0.1%)</td>
<td></td>
</tr>
<tr>
<td>0.0200-0.030</td>
<td>10.24</td>
<td>10.22(-0.2%)</td>
<td>10.24( 0.0%)</td>
<td></td>
</tr>
<tr>
<td>0.0300-0.100</td>
<td>49.02</td>
<td>50.02(+2.0%)</td>
<td>48.70(-0.6%)</td>
<td></td>
</tr>
<tr>
<td>0.1000-0.500</td>
<td>262.76</td>
<td>270.84(+3.1%)</td>
<td>264.58(+0.7%)</td>
<td>262.53(-0.1%)</td>
</tr>
<tr>
<td>0.5000-1.000</td>
<td>17.93</td>
<td>17.64(-1.6%)</td>
<td>17.60(-1.8%)</td>
<td>17.67(-1.4%)</td>
</tr>
<tr>
<td>1.0000-3.000</td>
<td>54.88</td>
<td>55.62(+1.3%)</td>
<td>54.40(-0.9%)</td>
<td>55.06(+0.3%)</td>
</tr>
<tr>
<td>0.0021-3.000</td>
<td>425.89</td>
<td>434.95(+2.1%)</td>
<td>426.61(+0.2%)</td>
<td></td>
</tr>
<tr>
<td>0.1000-3.000</td>
<td>335.57</td>
<td>344.10(+2.5%)</td>
<td>336.58(+0.3%)</td>
<td>335.26(-0.1%)</td>
</tr>
</tbody>
</table>

Weston and Todd experimental data were normalized to 1991 Wagemans in the energy range from 0.1 eV to 12 eV.
Table 4
The capture cross section integral in the energy range from 0.0021 eV to 3 eV.

<table>
<thead>
<tr>
<th>Energy range (eV)</th>
<th>Present work (b.eV)</th>
<th>ENDF/B-VI (b.eV)</th>
<th>Weston and Todd [8] (b.eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0200-0.030</td>
<td>3.67</td>
<td>3.68(+0.3%)</td>
<td></td>
</tr>
<tr>
<td>0.0300-0.100</td>
<td>15.28</td>
<td>15.39(+0.7%)</td>
<td>15.27(-0.1%)</td>
</tr>
<tr>
<td>0.1000-0.500</td>
<td>110.58</td>
<td>109.47(-1.0%)</td>
<td>110.49(-0.1%)</td>
</tr>
<tr>
<td>0.5000-1.000</td>
<td>5.90</td>
<td>5.87(-0.5%)</td>
<td>6.51</td>
</tr>
<tr>
<td>1.0000-3.000</td>
<td>7.30</td>
<td>7.14(-2.2%)</td>
<td>8.96</td>
</tr>
<tr>
<td>0.0021-3.000</td>
<td>154.98</td>
<td>153.83(-0.7%)</td>
<td></td>
</tr>
<tr>
<td>0.0300-3.000</td>
<td>139.06</td>
<td>137.87(-0.9%)</td>
<td>141.29(+1.6%)</td>
</tr>
</tbody>
</table>

Weston and Todd experimental data were normalized to the calculated average capture cross section over the resonance at 0.264 eV; in the energy range from 0.5 eV to 3 eV the experimental data are not accurate due to large corrections for the impurities.

Table 5
The fission cross section integral in the energy range from 3 eV to 300 eV.

<table>
<thead>
<tr>
<th>Energy range (eV)</th>
<th>Present work (b.eV)</th>
<th>ENDF/B-VI (b.eV)</th>
<th>Weston and Todd [8] (b.eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-20</td>
<td>3038.63</td>
<td>3066.37(+0.9%)</td>
<td>3036.23(-0.1%)</td>
</tr>
<tr>
<td>20-50</td>
<td>1683.69</td>
<td>1739.68(+3.3%)</td>
<td>1705.50(+1.3%)</td>
</tr>
<tr>
<td>50-100</td>
<td>1971.15</td>
<td>2030.10(+3.0%)</td>
<td>1931.50(-2.0%)</td>
</tr>
<tr>
<td>100-200</td>
<td>2554.85</td>
<td>2628.39(+2.9%)</td>
<td>2531.00(-0.9%)</td>
</tr>
<tr>
<td>200-300</td>
<td>2741.23</td>
<td>2820.75(+2.9%)</td>
<td>2747.00(+0.2%)</td>
</tr>
<tr>
<td>3-300</td>
<td>11989.55</td>
<td>12285.29(+2.5%)</td>
<td>1951.23(-0.3%)</td>
</tr>
</tbody>
</table>

Weston and Todd experimental data were normalized to 1991 Wagemans in the energy range from 0.1 eV to 12 eV.

Table 6
The capture cross section integral in the energy range from 3 eV to 300 eV.

<table>
<thead>
<tr>
<th>Energy range (eV)</th>
<th>Present work (b.eV)</th>
<th>ENDF/B-VI (b.eV)</th>
<th>Weston and Todd [8] (b.eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-20</td>
<td>1213.07</td>
<td>1138.52(-6.5%)</td>
<td>1192.90(-1.7%)</td>
</tr>
<tr>
<td>20-50</td>
<td>330.34</td>
<td>307.48(-7.5%)</td>
<td>338.09(+2.3%)</td>
</tr>
<tr>
<td>50-100</td>
<td>605.40</td>
<td>585.88(-3.2%)</td>
<td>594.83(-1.8%)</td>
</tr>
<tr>
<td>100-200</td>
<td>609.83</td>
<td>581.77(-4.8%)</td>
<td>652.68(+7.0%)</td>
</tr>
<tr>
<td>200-300</td>
<td>684.97</td>
<td>661.12(-3.6%)</td>
<td>700.53(+2.3%)</td>
</tr>
<tr>
<td>3-300</td>
<td>3443.36</td>
<td>3274.77(-5.1%)</td>
<td>3479.04(+1.0%)</td>
</tr>
</tbody>
</table>

Weston and Todd experimental data normalized to the calculated average capture cross section over the resonance at 0.265 eV.
CONCLUSION

The results of the 1991 Wagemans fission cross section measurements in the energy range from 0.002 eV to 4 eV were used in a new evaluation of the resonance parameters. The accuracy of the calculated cross sections was greatly improved in the resonance at 0.265 eV. The cross sections averaged over this resonance should have the same accuracy as the standard values at 0.0253 eV. In the high energy region up to 300 eV the SAMMY analysis of the new experimental data base obtained by the renormalization of the experimental data is recommended in order to improve the corrections to the resonance parameters performed in the present work.

REFERENCES
11. T. B. Young and J. R. Smith, WASH-1093, p. 60 (1968) AEC Nuclear Cross Section Advisory Committee

ENDF/B-VI MOD 1 NEW EVALUATION (L. Weston, ORNL, October 1988)
243Pu Incident Neutron Sublibrary, Release 2

Evaluation: 243Pu Incident Neutron Sublibrary, Release 2 (MAT 9449)
Energy Range: 10⁵ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: R. Benjamin, F. McCrosson (SRL); R. Howerton (LLNL) (assembled by R. Kinsey, BNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, May 1993)
Added missing fission neutron angular distribution; assumed to be isotropic.

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 8443 converted to ENDF-6 format.

ENDF/B-V EVALUATION (assembled by R. Kinsey, NNDC, February 1990)
ENDF/B-V MAT 8443 was converted to ENDF-6 format. This evaluation is, in general, a combination of the August 1975 evaluation of Benjamin and McCrosson at SRL and the ENDL evaluation of Howerton at LLNL [5]. Important changes or additions are noted.

GENERAL INFORMATION (File 1)
\( V \) thermal value computed from semi-empirical work of Gordeeva and Smirenkin [1] as revised by Manero and Konshin [2]. Energy dependence based on work of Howerton [3].

RESONANCE PARAMETERS (File 2)
Resolved resonance region (0 to 101.7 eV). Resonance parameters are determined by the GENRPAR code [3] based on the estimated resonance integrals and thermal cross sections from production studies [4].
Unresolved region (101.7 eV to 10 keV). Unresolved resonances are determined with average parameters by GENRPAR.

2200 m/s cross sections and resonance integrals

<table>
<thead>
<tr>
<th></th>
<th>( \sigma(0.0253 \text{ eV}) )</th>
<th>( I(0.5 \text{ eV} - 20 \text{ MeV}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>289.252</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>19.752</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>181.394</td>
<td>557.436</td>
</tr>
<tr>
<td>Capture</td>
<td>88.106</td>
<td>274.163</td>
</tr>
</tbody>
</table>

SMOOTH CROSS SECTIONS (File 3) (1.5 EV TO 20 MEV)
For total, elastic, fission, and capture, zero background files up to 10 keV are joined to the Howerton evaluation.
\((n,2n), (n,3n), \text{ and } (n,4n)\), are taken from the Howerton evaluation with threshold calculated from the \( Q \) value.
ANGULAR DISTRIBUTIONS (File 4)
  Elastic is taken from the Howerton evaluation, culled to 101 points per distribution and
  renormalized.
  (n,2n), (n,3n), (n,4n), and the inelastic scattering to the continuum are dummy distributions.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
  (n,2n), (n,3n), (n,4n), and the inelastic scattering to the continuum are taken from the
  Howerton evaluation.
  Fission is a simple fission Maxwellian with energy-dependent temperature taken from the
  SRL evaluation.

REFERENCES
   14, 530 (1963)
   March 1971, Knoxville, TN (National Technical Information Service 1971) p.714
   National Laboratory
Evaluation:  
\([^{241}\text{Am Incident Neutron Data, Release 2, 3 (MAT 9543)}\]

Energy Range:  
\(10^5\text{ eV to 30 MeV}\)

Files:  
1, 2, 3, 4, 5, 6, 8, 9, 12, 13, 14, 15, 32, 33

Evaluators:  
P. G. Young, D. W. Madland (LANL); Zhou Delin, Yu Baosheng, et al. (CNW)

ENDF/B-VI MOD 3 REVISION 2 (P. G. Young, D. G. Madland, LANL, August 1994)

The cross section data file for neutron reactions with \(^{241}\text{Am}\) has been reevaluated over the incident neutron energy range from 0.01 to 30 MeV. Details of the analysis are given in the sections that follow. Some general features of the work are:

1. The ENDF/B-VI MOD 2, resonance parameters were adopted at neutron energies below 30 keV, suitably joined with the results of the present analysis at 30 keV.

2. A coupled-channel optical model potential was developed from analyses of nearby actinides that is consistent with measurements of the neutron total cross section. This potential was used to calculate the neutron total cross section, elastic and inelastic scattering cross sections and angular distributions, and reaction cross sections and transmission coefficients for a theoretical analysis of the reaction channels. The direct cross sections from the coupled-channel analysis were combined with compound nucleus calculations at lower energies and with preequilibrium theory calculations at higher energies. Angular distributions for the first 40 excited states of \(^{241}\text{Am}\) were obtained from the direct, compound-nucleus, and preequilibrium calculations, and energy-angle correlated distributions are provided for all continuum neutrons.

3. The evaluated fission and total cross sections were obtained by adjusting the theoretical cross sections as needed to match the available experimental data.

4. The fission neutron spectra were obtained using Madland-Nix theory.

ENDF/B-VI MOD 2 REVISION 1 (NNDC, June 1992)

Energy release per fission added from ENDF/B-V.

ENDF/B-VI MOD 2 NEW EVALUATION (P. G. Young, D. G. Madland, LANL, February 1988)

THEORETICAL ANALYSIS

The primary goal of the theoretical analysis was to provide a consistent set of data for all reactions over the energy range 30 keV to 30 MeV. In the case of \(n^{+241}\text{Am}\), there are reasonable experimental data available for the neutron total and fission cross sections. Therefore, the function of the theoretical analysis was to provide the elastic, inelastic, \((n,2n)\), \((n,3n)\) and \((n,4n)\) cross sections, as well as the angular and energy distributions of secondary neutrons. To accomplish this, a theoretical analysis was performed, adjusting the relevant parameters to match the total, fission, and \((n,\gamma)\) cross sections. Additionally, a theoretical analysis was performed to obtain the average neutron multiplicity from fission and the energy spectra of fission neutrons as a function of incident energy.
Coupled-channel deformed optical model calculations were performed with the ECIS code [Ra70] over the incident neutron energy range from 0.001 to 30 MeV. Hauser-Feshbach reaction theory calculations were carried out with the LANL version of the COMNUC code [Du70] at lower energies and the GNASH statistical/preequilibrium code [Yo92a] at higher energies to obtain all partial reaction cross section data. Both reaction theory codes used neutron transmission coefficients from the optical model analysis.

A. Optical Model

The optical model potential was obtained by considering several coupled-channel parameterizations developed from n+235,238U and 239Pu experimental data [Ma78, Yo88, Yo92a]. Parameters were adjusted until a reasonable fit to experimental data for the neutron total cross section of 241Am was obtained. The lowest five members of the 5/2- ground state rotational band were included in the calculations, that is, the 7/2-, 9/2-, 11/2- and 13/2- excited states at E_x = 41, 94, 159 and 235 keV were coupled with the 5/2- ground state.

B. Reaction Theory Calculations

The Hauser-Feshbach statistical calculations were performed with the COMNUC and GNASH codes. Both codes include a double-humped fission barrier model, using uncoupled oscillators for the barrier representation in GNASH and coupled or uncoupled oscillators in COMNUC, as described by Arthur [Ar82a]. The COMNUC calculations include the possibility of width-fluctuation corrections and corrections for class II fluctuations [Ly74], which are needed at lower energies, whereas GNASH provides the preequilibrium corrections that are required at higher energies. Accordingly, COMNUC was used in the calculations below about 2 MeV, utilizing a non-resonant model and including class II fluctuations, and the GNASH code was employed at higher energies using two uncoupled oscillators in the fission calculations.

Each compound nucleus formed in the calculations is permitted to decay through the fission channel, by neutron emission, and by gamma-ray emission. Neutron transmission coefficients for the Hauser-Feshbach calculations are obtained from the coupled-channel optical model. Gamma-ray transmission coefficients are obtained from gamma-ray strength functions calculated with the generalized Lorentzian model of Kopecky and Uhl [Ko90]. Transmission coefficients for fission are calculated from the fission model summarized here and detailed in [Yo92b]. Gilbert and Cameron [Gi70] phenomenological level density functions were used to represent continuum levels at ground-state deformations, appropriately matched to available experimental structure data at lower excitation energies. Multiplicative factors were applied to the level density functions to account for enhancements in the fission transition state densities at the fission barriers due to increased asymmetry conditions, and the continuum level densities were matched to the discrete fission transition states at each barrier. The discrete fission transition state spectra were calculated from bandhead information taken from calculations and compilations by Britt [Br82] and by Nagel [Na91].

DESCRIPTION OF EVALUATED DATA BASE

A. Total Cross Section

The evaluated total cross section below 30 keV is obtained from the ENDF/B-VI MOD 2 resonance parameter evaluation, suitably matched to the results of the current analysis at 30 keV. From 30 keV to 30 MeV, the coupled-channel deformed optical model calculations described above were modified to agree with the experimental data of Phillips [Ph70].
B. Elastic Cross Section

The elastic cross section at all energies is obtained from the difference of the total and nonelastic cross sections. Below 30 keV it comes from the ENDF/B-VI MOD 2 resonance parameters and at higher energies it is mainly determined by the coupled-channel optical model calculations. Angular distributions for elastic neutrons were obtained at all energies from the coupled-channel calculations and are given as Legendre expansions.

C. Fission Cross Section

The fission cross section was obtained by adjusting the results of the theoretical analysis to optimize agreement with experimental data. At most energies the adjustment was less than a few percent. Above 8 MeV, the theoretical values were used directly. Neutrons from fission are assumed to isotropic in the laboratory system.

D. Radiative Capture Cross Section

The radiative capture cross section is calculated using the generalized Lorentzian model of Kopecky and Uhl [Ko90]. The normalization of the strength function was set by requiring the calculated (n,γ) cross section be consistent with measured values.

E. Inelastic Neutron Cross Sections

Discrete (n,n') cross sections are included for the lowest 40 excited states. The first, second, third, and fifth excited states are members of the K = 5/2 ground-state rotational band and include coupled-channel as well as compound nucleus contributions. The remaining discrete-state cross sections through the 40th excited state are combinations of compound nucleus and preequilibrium contributions and were calculated with the GNASH code. Angular distributions for all the discrete inelastic neutrons are appropriate combinations of the compound nucleus, direct reaction, and preequilibrium contributions and are represented by Legendre expansions.

The inelastic data corresponding to excitation energies in ^241^Am above 0.508 MeV are given as energy-angle correlated continuous spectra and were calculated with the GNASH code. The results are given in File 6 and utilize systematics by Kalbach [Ka88] for angular distribution information, parameterized in terms of preequilibrium ratios calculated in GNASH.

F. Cross Sections for ^241^Am(n,xn) Reactions

The (n,2n), (n,3n), and (n,4n) cross sections result entirely from the theoretical analysis and GNASH calculations. Energy-angle correlated distributions are given for all the (n,xn) reactions, making use of Kalbach's systematics [Ka88] and the ENDF-6 File 6 representation.

G. ν

The evaluation of delayed ν was carried over directly from ENDF/B-VI MOD 2. The prompt νv evaluation was obtained using Madland-Nix theory.

H. Fission Neutron Spectra

The fission neutron spectra was determined using Madland-Nix theory and are consistent with νv.
REFERENCES
Br82 H. C. Britt, personal communication, 1982
Du70 C. L. Dunford, AI-AEC-12931 (1970) Atomics International
Gi65 A. Gilbert and A. Cameron, Can. J. Phys. 43, 1446 (1965)
242\textsuperscript{Am} Incident Neutron Sublibrary, Release 1

Evaluation: 242\textsuperscript{Am} Incident Neutron Data, Release 1 (MAT 9546)

Energy Range: \(10^{-5} \text{ eV to } 20 \text{ MeV}\)

Files: 1, 2, 3, 4, 5, 8

Evaluators: R. W. Benjamin, F. J. McCrosson (SRL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, August 1991)
Delayed fission neutron spectrum which was intended for 242mAm was removed.

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDFB-V MAT 8542 converted to ENDF-6 format.

ENDFB-V EVALUATION (R. W. Benjamin, F. J. McCrosson, SRL, August 1975)

GENERAL INFORMATION (File 1)
\(\bar{\nu}\) thermal value computed from the semi-empirical work of Gordeeva and Smirenkin [1]
as revised by Manero and Konshin [2]. Energy dependence is taken from Howerton [3].
\(\nu_d\) is taken from Brady and England [4].

RESONANCE PARAMETERS (File 2)
Resolved resonance region is 0 to 101.2 eV. Resonance parameters are determined using the GENRPAR code [5] based upon the SRL data set and an average level spacing of 1.2 eV.
Unresolved resonances are determined on same basis as the resolved parameters using average resonance parameters.

\[
\begin{align*}
\sigma(0.0253 \text{ ev}) & \quad I_{\text{res}} (0.5 \text{ eV - 20 MeV}) \\
\text{total} & \quad 2549.91 \\
\text{elastic} & \quad 28.95 \\
\text{fission} & \quad 2268.88 \quad 620.15 \\
\text{capture} & \quad 252.08 \quad 71.88
\end{align*}
\]

SMOOTH CROSS SECTIONS (File 3)
The data in file 3 are given only so that the various processing codes can work. Continuity with the unresolved region is provided, but the cross sections drop immediately to zero. The elastic scattering cross section above 10 keV is the potential scattering cross section calculated with a Spherical Optical Model potential at 10 keV.

ANGULAR DISTRIBUTIONS (File 4)
Elastic distributions taken from ENDF/B-V 242mAm.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS
Simple fission Maxwellian with energy-dependent temperature used.
REFERENCES

2. F. Manero and V. A. Konshin, At. En. Rev. 10, 637 (1972)
242mAm Incident Neutron Sublibrary, Release 1

Evaluation:  
242mAm Incident Neutron Data, Release 1 (MAT 9547)

Energy Range:  
$10^{-5}$ eV to 20 MeV

Files:  
1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15

Evaluators:  
F. Mann, R. Schenter (HEDL); R. Benjamin (SRL); R. Howerton (LLNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, February 1990)
The delayed fission neutron spectrum was added.

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 1369 converted to ENDF-6 format.

ENDF/B-V (F. Mann, R. Schenter (HEDL), R. Benjamin (SRL), R. Howerton (LLNL), August 1975)
Evaluation: 245Cm Incident Neutron Sublibrary, Release 2 (MAT 9640)
Energy Range: 10^{-5} \text{ eV} \text{ to } 20 \text{ MeV}
Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: R. W. Benjamin (SRL), R. J. Howerton (LLNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, May 1993)
Added missing fission neutron angular distribution to file 4; assumed to be isotropic.

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 1345 was converted to ENDF-6 format.

ENDF/B-V (R.W. Benjamin (SRL), R. J. Howerton (LLNL), January 1979)
See ENDF-102 Summary Documentation, 3rd Edition (1979), page 96-245-1, for documentation of ENDF/B-V evaluation.
$^{246}\text{Cm}$ Incident Neutron Sublibrary, Release 2

**Evaluation:** $^{246}\text{Cm}$ Incident Neutron Sublibrary, Release 2 (MAT 9643)

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5, 8, 12, 13, 14, 15

**Evaluators:** R. W. Benjamin, F. McCrosson (SRL); R. J. Howerton (LLNL) (assembled by R. Kinsey, BNL)

**ENDF/B-VI MOD 2 REVISION 1** (NNDC, May 1993)
- Added missing fission neutron angular distribution to file 4; assumed to be isotropic.

**ENDF/B-VI MOD 0** (NNDC, February 1990)
- ENDF/B-V MAT 1346 was converted to ENDF-6 format.

**ENDF/B-V** (R.W. Benjamin (SRL), R. J. Howerton (LLNL), January 1979)
- See ENDF-102 Summary Documentation, 3rd Edition (1979), page 96-246-1, for documentation of ENDF/B-V evaluation.
Evaluation: \(^{247}\text{Cm Incident Neutron Sublibrary, Release 2 (MAT 9646)}\)

Energy Range: \(10^5\) eV to 20 MeV

Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15

Evaluators: R. W. Benjamin, F. J. McCrosson (SRL); R. J. Howerton (LLNL)
(assembled by R. Kinsey, BNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, May 1993)
Added missing fission neutron angular distribution to file 4; assumed to be isotropic.

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 8647 was converted to ENDF-6 format.

This evaluation is in general a combination of the August 1975 evaluation, documented here, of Benjamin and McCrosson (SRL) and the ENDL evaluation of Howerton (LLNL). Important changes or additions are noted.

GENERAL INFORMATION (File 1)
\(v\) thermal value is computed from the semi-empirical work of Gordeeva and Smirenkin \([1]\) as revised by Manero and Konshin \([2]\). The energy dependence is based on work of Howerton \([3]\) renormalized to the thermal value.

RESONANCE PARAMETERS (File 2)
The resolved region is 0 to 61.7 eV and includes 34 resolved resonances plus one bound level. The first 5 resolved resonances were determined by the GENRPAR code \([4]\) to fit integral and production results \([5,6]\). The bound level was added. 29 additional resonances were added from the measurements of Moore and Keyworth \([7]\).
The unresolved region is 61.7 eV to 10 keV. Unresolved resonances are determined on the same basis as the resolved, using average resonance parameters.

\[\text{2200 m/s cross sections and resonance integrals}\]

<table>
<thead>
<tr>
<th></th>
<th>(\sigma(0.0253 \text{ eV}))</th>
<th>(I (0.5 \text{ eV} - 20 \text{ MeV}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>150.010</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>8.404</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>83.435</td>
<td>749.670</td>
</tr>
<tr>
<td>Capture</td>
<td>58.171</td>
<td>491.197</td>
</tr>
</tbody>
</table>
SMOOTH CROSS SECTIONS (File 3)

For total, elastic, fission, and capture, zero background files up to 10 keV were joined to the LLNL evaluation.

The inelastic (MT=4,91) are taken from the LLNL evaluation with \( Q \) calculated from threshold.

\((n,2n),(n,3n),\) and \((n,4n)\) are taken from the LLNL evaluation with threshold calculated from the \( Q \) value.

ANGULAR DISTRIBUTIONS (File 4)

Elastic from the LLNL evaluation culled to 101 points per distribution and renormalized. \((n,2n),(n,3n),(n,4n),\) and the inelastic continuum are dummy isotropic distributions.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

\((n,2n),(n,3n),(n,4n),\) and the inelastic continuum are taken from the LLNL evaluation.

The fission spectrum is a simple fission Maxwellian with energy dependent temperature taken from the SRL evaluation.

PHOTON PRODUCTION (Files 12,13,14,15)

The data are taken from the LLNL evaluation with ranges extended at BNL to agree with File 3.

REFERENCES


250\textsuperscript{Cf} Incident Neutron Sublibrary, Release 2

Evaluation: 250\textsuperscript{Cf} Incident Neutron Sublibrary, Release 2 (MAT 9855)

Energy Range: 10\textsuperscript{-5} eV to 20 MeV

Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15

Evaluators: R. W. Benjamin, F. McCrosson (SRL); R. J. Howerton (LLNL) (assembled by R. Kinsey, BNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, May 1993)
Added missing fission neutron angular distribution to file 4; assumed to be isotropic.

ENDF/B-VI MOD 0 (Assembled by R. Kinsey, NNDC, February 1990)
ENDF/B-V MAT 8850 was converted to ENDF-6 format.

This evaluation is in general a combination of the August 1975 evaluation of Benjamin and McCrosson at SRL, documented here, and the ENDL evaluation of Howerton at LLNL [4]. Important changes or additions are noted.

GENERAL INFORMATION (File 1)
\nu taken from LLNL evaluation.

RESONANCE PARAMETERS (File 2) (0 TO 10 KEV)
The resolved region is 0 to 286.1 eV. Resonance parameters were determined by the GENRPAR code [1], based upon resonance integrals and cross sections from production measurements of Benjamin, et al. [2] and ORR irradiations of Halperin, et al. [3]. A bound level at -2.115 eV was removed from the SRL evaluation. Appropriate backgrounds were included in the total cross sections in order that the (n,\gamma) curve would remain the same.
The unresolved region is 286.1 eV to 10 keV. Unresolved resonances are determined on the same basis as the resolved, using average resonance parameters.

2200 m/s cross sections and resonance integrals

<table>
<thead>
<tr>
<th>\sigma (0.0253 eV)</th>
<th>I_{res} (0.5 eV - 20 MeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total 1619.88</td>
<td></td>
</tr>
<tr>
<td>Elastic 8.90</td>
<td></td>
</tr>
<tr>
<td>Fission 0.00</td>
<td>10.79</td>
</tr>
<tr>
<td>Capture 1610.98</td>
<td>11200.1</td>
</tr>
</tbody>
</table>

SMOOTH CROSS SECTIONS (File 3)
The total cross section is the sum of the elastic and (n,\gamma) background files up to 10 keV joined to the LLNL evaluation.

I.111
The elastic background is a constant up to the first resonance which then goes rapidly to zero. The constant chosen to give a thermal cross section in combination with the resonance parameters which is equal to 90% of the Spherical Optical Model value. Above the first resonance, this background does not prevent the cross section from going negative for the next dozen or so resonances. Above 10 keV, the cross section is from the LLNL evaluation.

For fission, a zero background file up to 10 keV was joined to the LLNL evaluation.

For capture, the background was calculated to give the same curve after the bound level was deleted as was obtained with the original SRL parameters up to 10 keV; it was then joined to the LLNL evaluation.

The inelastic data are taken from the LLNL evaluation with Q calculated from the threshold. (n,2n), (n,3n), and (n,4n) are taken from the LLNL evaluation with threshold calculated from the Q value.

ANGULAR DISTRIBUTIONS (File 4)
Elastic from LLNL evaluation are culled to 101 points per distribution and renormalized. (n,2n), (n,3n), (n,4n), and the inelastic continuum are dummy isotropic distributions.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
(n,2n), (n,3n), (n,4n), and the inelastic continuum are taken from LLNL evaluation.
The fission spectrum is a simple fission Maxwellian distribution with energy dependent temperature from the LLNL evaluation has been converted from a tabular representation and extended down to $10^{-5}$ eV.

REFERENCES
Evaluation: \( ^{251}\text{Cf} \) Incident Neutron Sublibrary, Release 2 (MAT 9858)

Energy Range: \( 10^3 \text{ eV to 20 MeV} \)

Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15

Evaluators: R. W. Benjamin, F. McCrosson (SRL); R. J. Howerton (LLNL) (assembled by R. Kinsey, BNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, May 1993)
Added missing fission neutron angular distribution to file 4; assumed to be isotropic.

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 8851 converted to ENDF-6 format.

This evaluation is in general a combination of the August 1975 evaluation of Benjamin and McCrosson at SRL, documented here, and the ENDL evaluation of Howerton at LLNL [3]. Important changes or additions are noted.

GENERAL INFORMATION (File 1)
\( \bar{v} \) thermal value is computed from the semi-empirical work of Gordeeva and Smirenkin [1] as revised by Manero and Konshin [2]. The energy dependence is based on work of Howerton [3] renormalized to the thermal value at BNL.
\( \bar{v}_d \) is taken from Brady and England [7].

RESONANCE PARAMETERS (File 2)
The resolved region is 0 to 163.9 eV. Resolved resonance parameters determined by the GENRPAR Code [4] based upon resonance integrals and cross sections from production measurements [5] and ORR irradiations [6]. A bound level at -2.035 eV was removed from the SRL evaluation. Appropriate backgrounds were included in File 3 in order that the capture and fission curves would remain the same.
The unresolved region is 163.9 eV to 10 keV. Unresolved resonances are determined on the same basis as the resolved, using average resonance parameters.

2200 m/s cross sections and resonance integrals

<table>
<thead>
<tr>
<th></th>
<th>( \sigma(0.0253 \text{ eV}) )</th>
<th>( I_{res}(0.5 \text{ eV} - 20 \text{ MeV}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>8191.73</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>8.84</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>5321.28</td>
<td>4949.63</td>
</tr>
<tr>
<td>Capture</td>
<td>2861.61</td>
<td>1629.34</td>
</tr>
</tbody>
</table>
SMOOTH CROSS SECTIONS (File 3)

The total is sum of the elastic, fission and capture background files up to 10 keV, joined to the LLNL evaluation.

Elastic background is a constant up to the first resonance which then goes rapidly to zero. The constant is chosen to give a thermal cross section in combination with the resonance parameters which is equal to 90% of the spherical optical model value. Above 10 keV, the cross section is from the LLNL evaluation.

The fission and capture backgrounds were calculated to give the same curve after the bound level was deleted as was obtained with the original SRL parameters up to 10 keV joined to the LLNL evaluation.

The inelastic data is taken from LLNL evaluation with Q calculated from threshold.
(n,2n), (n,3n), and (n,4n) is from LLNL evaluation with threshold calculated from the Q value.

ANGULAR DISTRIBUTIONS (File 4)

Elastic from LLNL evaluation culled to 101 points per distribution and renormalized.
(n,2n), (n,3n), (n,4n), and inelastic to the continuum are dummy isotropic distributions.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS

(n,2n), (n,3n), (n,4n), and inelastic to the continuum from LLNL evaluation.
Fission is a simple fission Maxwellian distribution with energy dependent temperature taken from the SRL evaluation.

REFERENCES

\textit{\textsuperscript{252}Cf Incident Neutron Sublibrary, Release 1, 2}

\textbf{Evaluation:} \textit{\textsuperscript{252}Cf Incident Neutron Sublibrary, Release 1, 2 (MAT 9861)}

\textbf{Energy Range:} \(10^5\) eV to 20 MeV

\textbf{Files:} 1, 2, 3, 4, 5, 8, 12, 13, 14, 15

\textbf{Evaluators:} R. W. Benjamin, F. McCrosson (SRL); R. J. Howerton (LLNL) (assembled by R. Kinsey, BNL)

\textbf{ENDF/B-VI MOD 3 REVISION 2} (NNDC, May 1993)

Added missing fission neutron angular distribution to file 4; assumed to be isotropic.

\textbf{ENDF/B-VI MOD 2 REVISION 1} (NNDC, August 1991)

Removed delayed fission neutron spectra which were for spontaneous fission.

\textbf{ENDF/B-VI MOD 0} (Assembled by R. Kinsey, NNDC, February 1990)

ENDF/B-V MAT 8851 converted to ENDF-6 format.


This evaluation is in general a combination of the August 1975 evaluation of Benjamin and McCrosson at SRL, documented here, and the ENDL evaluation of Howerton at LLNL [3]. Important changes or additions are noted.

\textbf{GENERAL INFORMATION} (File 1)

\(v_\text{thermal}\) value is computed from the semi-empirical work of Gordeeva and Smirenkin [1] as revised by Manero and Konshin [2]. The energy dependence is based on work of Howerton [3] renormalized to the thermal value at BNL.

\(\bar{v}_a\) is taken from Brady and England [8].

\textbf{RESONANCE PARAMETERS} (File 2)

The resolved region is 0 to 366.5 eV. Resolved resonance parameters determined by the GENRPAR Code [4] based upon resonance integrals and cross sections from production measurements [5] and ORR irradiations [6,7]. A bound level at -2.035 eV was removed from the SRL evaluation. Appropriate backgrounds were included in File 3 in order that the capture and fission curves would remain the same.

The unresolved region is 366.5 eV to 10 keV. Unresolved resonances are determined on the same basis as the resolved, using average resonance parameters.
2200 m/s cross sections and resonance integrals

<table>
<thead>
<tr>
<th></th>
<th>$\sigma$(0.0253 eV)</th>
<th>$I_{res}$ (0.5 eV - 20 MeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>63.881</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>11.213</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>32.174</td>
<td>119.198</td>
</tr>
<tr>
<td>Capture</td>
<td>20.493</td>
<td>47.292</td>
</tr>
</tbody>
</table>

SOOTH CROSS SECTIONS (File 3)

The total is sum of the elastic, fission and capture background files up to 10 keV joined to the LLNL evaluation.

The inelastic data is taken from LLNL evaluation with Q calculated from threshold.

($n,2n$), ($n,3n$), and ($n,4n$) are taken from LLNL evaluation with threshold calculated from the Q value.

ANGULAR DISTRIBUTIONS (File 4)

The elastic is taken from LLNL evaluation, culled to 101 points per distribution, and renormalized.

The ($n,2n$), ($n,3n$), ($n,4n$), and inelastic to the continuum are dummy isotropic distributions.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

The ($n,2n$), ($n,3n$), ($n,4n$), and inelastic to the continuum are taken from LLNL evaluation.

The fission is a simple fission Maxwellian distribution with energy dependent temperature taken from the SRL evaluation.

REFERENCES
2. F. Manero and V. A. Konshin, At. En. Rev. 10, 637 (1972)
253Cf Incident Neutron Sublibrary, Release 2

**Evaluation:**

253Cf Incident Neutron Sublibrary, Release 2 (MAT 9864)

**Energy Range:**

10^5 eV to 20 MeV

**Files:**

1, 2, 3, 4, 5

**Evaluators:**

R. W. Benjamin, F. McCrosson (SRL); R. J. Howerton (LLNL) (assembled by R. Kinsey, BNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, May 1993)

Added missing fission neutron angular distribution; assumed to be isotropic.

ENDF/B-VI MOD 0 (NNDC, February 1990)

ENDF/B-V MAT 8853 converted to ENDF-6 format.


This evaluation is, in general, the December 1975 evaluation of Benjamin and McCrosson at SRL documented here.

**GENERAL INFORMATION (File 1)**

\( \bar{v} \) thermal value is computed from the semi-empirical work of Gordeeva and Smirenkin [1] as revised by Manero and Konshin [2]. The energy dependence is based on work of Howerton [3].

**RESONANCE PARAMETERS (File 2)**

The resolved region is 0 to 100.4 eV. Resolved resonance parameters determined by the GENRPAR code [4] based upon resonance integrals and thermal cross sections from production [5] and integral [6,7] measurements. The effective 253Cf capture-to-fission ratio, derived from the measurements of Bemis, et al. [8], is well below the range expected from nuclear systematics. In the present evaluation, alpha has been assumed to be 0.3 over the entire energy range, in accordance with the work of Prince [8].

The unresolved region 100.4 eV to 10 keV. Unresolved resonances are determined on the same basis as the resolved, giving average resonance parameters.

2200 m/s cross sections and resonance integrals

<table>
<thead>
<tr>
<th></th>
<th>( \sigma(0.0253 \text{ eV}) )</th>
<th>( I_{\text{res}} (0.5 \text{ eV} - 20 \text{ MeV}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>542.22</td>
<td></td>
</tr>
<tr>
<td>Elastic</td>
<td>64.82</td>
<td></td>
</tr>
<tr>
<td>Fission</td>
<td>1136.12</td>
<td>1244.84</td>
</tr>
<tr>
<td>Capture</td>
<td>341.28</td>
<td>379.19</td>
</tr>
</tbody>
</table>

I.117
SMOOTH CROSS SECTIONS (File 3)

The data in File 3 are given only so that the various processing codes can work. Continuity with the unresolved region is provided, but the cross sections drop immediately to zero. The elastic cross section is the potential scattering cross section calculated with a Spherical Optical Model potential at 10 keV.

ANGULAR DISTRIBUTIONS (File 4)

Elastic distributions are taken from the ENDF/B-V evaluation for $^{253}\text{Cf}$.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

The fission is a simple fission Maxwellian distribution with energy dependent temperature.

REFERENCES

2. F. Manero and V. A. Konshin, At. En. Rev. 10, 637 (1972)
Photon interaction cross sections and atomic form factors or scattering functions for 100 materials have been converted from the Livermore Evaluated Photon Data Library (EPDL) Library [1].

From 1 eV to 1 MeV, the photon interaction cross section is based on the total photoelectric cross sections of Scofield [2,3]; from 1 MeV to 100 GeV, the cross sections of Hubbell [4,5] are used. The sets were joined at 1 MeV, where the total photoelectric cross sections from both sources are identical.

The coherent and incoherent form factors are taken from the nonrelativistic data of Hubbell [4,5].

REFERENCE
2. J. H. Scofield, UCRL-51326 (1973) Lawrence Livermore National Laboratory

¹ The XCOM data is available through the NNDC Online Service XRAY database.
Radioactive Decay Data Sublibrary

Part III

Radioactive Decay Data (NSUB=4)

The Radioactive Decay Data Sublibrary contains evaluations for 799 materials, which were distributed in Release 1. A modification to $^{98}$Tc was distributed in Release 2 to correct the MAT number.

Most evaluations were contributed by C. W. Reich (INEL), F. Mann and F. Schmittroth (HEDL), and T. England (LANL, with contributions from B. Magurno (BNL), W. Mannhart (PTB), and R. Schenter (HEDL). See individual evaluations for more detail.
Spontaneous Fission Product Yield Sublibrary

Part IV

Spontaneous Fission Product Yields (NSUB=15)

Evaluation: Spontaneous Fission-Product Yields, Release 1,2
Energy: Spontaneous fission
Files: 1, 8
Evaluators: T. R. England and B. F. Rider (LANL)

Independent and cumulative yield data are given for 9 materials in Release 1 and 2. See England and Rider [1] for complete documentation.

Yields are given for: $^{238}$U, $^{244,246,248}$Cm, $^{250,252}$Cf, $^{253}$Es, $^{254,256}$Fm.

REFERENCE
Neutron-Induced Fission Product Yield Sublibrary

Part V

Neutron-Induced Fission Product Yields (NSUB=11)

Evaluation: Neutron Induced Fission-Product Yields, Release 1,2,3
Energy: Thermal, Fission Spectrum, 14-MeV
Files: 1, 8
Evaluators: T. R. England and B. F. Rider (LANL)

Independent and cumulative yield data are given for 51 materials at energies in the thermal range, fission spectrum range, and at 14 MeV in Release 1 and 2. See England and Rider [1] for complete documentation.

An update for $^{241}$Pu was made in Release 3 to correct for missing yields.

Thermal yields are given for: $^{227,229}$Th, $^{232,233,235}$U, $^{237}$Np, $^{239,240,242}$Pu, $^{241,242m}$Am, $^{243,245}$Cm, $^{249,251}$Cf, $^{254}$Es, $^{255}$Fm.

Fission spectrum yields are given for: $^{232}$Th, $^{233,234,235,236,237,238}$U, $^{237,238}$Np, $^{238,239,240,241,242}$Pu, $^{241,243}$Am, $^{242,243,244,246,248}$Cm.

Yields at 14 MeV are given for: $^{232}$Th, $^{233,234,235,236,238}$U, $^{237}$Np, $^{239,240,242}$Pu, $^{241}$Am.

REFERENCE
Part VI

Thermal Neutron Scattering Sublibrary (NSUB=12)

All materials in the thermal neutron scattering sublibrary are documented here, including those issued in Release 0, since they have not been documented previously.
Thermal Neutron Scattering Sublibrary

**Evaluation:** H (H₂O) Thermal Neutron Scattering Sublibrary, Release 3 (MAT 1)
**Temperatures:** 296 350 400 450 500 600 800 1000 °K
**Files:** 1, 7
**Evaluators:** R. E. MacFarlane (LANL)

This evaluation was generated using the LEAPR module of NJOY [4]. The physical model is very similar to the one used at General Atomic to produced the original ENDF/B-III evaluations [1]. The α and β grids were extended, and the constants were changed to match the values in the previous ENDF/B-VI evaluation.

Water is represented by freely recoiling H₂O molecules of mass 18. Each molecule can undergo torsional harmonic oscillations (hindered rotations) with a broad spectrum of distributed modes. Between 0.04 and 0.165 eV, the rotation spectrum is taken from the work of Haywood and Thorson [2] joined to a quadratic law below 0.04 eV. In addition, there are two internal vibrations at frequencies of 0.205 and 0.48 eV taken over from the Nelkin model [3] with slightly readjusted masses of 6 and 3, respectively. The torsional band is normalized to a mass of 18/8. The scattering by the oxygen atoms is not included in the tabulated scattering law data. It should be taken into account by adding the scattering for free oxygen of mass 16.

**REFERENCES**
Liquid para hydrogen at 20 °K computed using the LEAPR module of NJOY [1]. The scattering law is based on the model of Keinert and Sax [2], which includes spin correlations from the Young and Koppel model [3], diffusion and local hindered motions from an effective translational scattering law based on a frequency distribution, and intermolecular coherence after Vinyard [4].

REFERENCES
Liquid ortho hydrogen at 20 °K computed using the LEAPR module of NJOY [1]. The scattering law is based on the model of Keinert and Sax [2], which includes spin correlations from the Young and Koppel model [3], diffusion and local hindered motions from an effective translational scattering law based on a frequency distribution, and intermolecular coherence after Vinyard [4].

REFERENCES
Thermal Neutron Scattering Sublibrary

Evaluation:  H (ZrH) Thermal Neutron Scattering Sublibrary, Release 3 (MAT 7)
Temperatures:  296 400 500 600 700 800 1000 1200 °K
Files:  1, 7
Evaluators:  R. E. MacFarlane (LANL)

This evaluation was generated using the LEAPR module of NJOY [3]. The physical model is very similar to the one used at General Atomic to produced the original ENDF/B-III evaluations [1]. The α and β grids were extended lightly, and the constants were changed to match the values in the previous ENDF/B-VI evaluation.

The lattice dynamics of ZrH were computed from a central force model. The slightly tetragonal lattice of ZrH₂ was approximated by a face-centered-cubic lattice. Four force constants (μ, γ, ν, and δ) were introduced describing respectively the interaction of a zirconium atoms with its nearest neighbors (8 H atoms) and its next nearest neighbors (12 Zr atoms), and the interaction of a hydrogen atom with its next nearest neighbors (6 H atoms) and its third nearest atoms (12 H atoms). Eigenvalues and eigenvectors of the dynamical matrix were calculated, and a phonon frequency spectrum was obtained by means of a root sampling technique. Weighted frequency spectra for hydrogen in ZrH were then obtained by appropriate use of the dynamical matrix eigenvectors [2].

The final values of the four force constants were obtained by fitting both specific heat and neutron data. The position of an optical peak observed by neutron scattering techniques to be centered roughly around 0.14 eV determines the constant μ, while the overall width and shape of this peak determine ν and δ respectively. Existing neutron data are not sufficiently precise to confirm the structure predicted in the optical peak by the central force model. Specific heat data were used to determine the force constant γ, which primarily determines the upper limit on the phonon energies associated with acoustic modes.

REFERENCES
Thermal Neutron Scattering Sublibrary

Evaluation: D (D_2O) Thermal Neutron Scattering Sublibrary, Release 0 (MAT 11)
Temperatures: 296 350 400 450 500 600 800 1000 °K
Files: 1, 7
Evaluators: J. U. Koppel and D. H. Houston (GA)

This evaluation was produced at General Atomic in 1969 using the GA code gasket [1]. It was converted to ENDF-6 format at Los Alamos in 1989. The only changes made to the contents were adjustments of cross sections to match the ENDF/B-VI values.

Whereas hydrogen is nearly a completely incoherent neutron scatterer, the scattering from deuterium is largely coherent. Although it would appear that due to this fact a treatment of D_2O analogous to the one used for H_2O would be inadequate, calculations [2] have shown that because of a great deal of cancellation between inter and intra-molecular interference scattering, integral quantities like the total cross section or thermal neutron spectra can actually be predicted quite accurately with an incoherent model.

Therefore, the scattering law for D_2O is based on a model quite similar to the one used for the General Atomic evaluation of H_2O; namely, freely recoiling D_2O molecules of mass 20. Each molecule can undergo torsional harmonic oscillations (hindered rotations) with a broad spectrum of distributed modes. Between 0.025 and 0.127 eV, the rotation spectrum is taken from the work of Haywood [3] joined to a quadratic law below 0.025 eV. In addition, there are two internal vibrations at frequencies of 0.142 and 0.305 eV (the frequencies are approximately 1/\sqrt{2} times the corresponding frequencies for H_2O as expected from the mass ratio) with masses of 6 and 3, respectively. The torsional band is normalized to a mass of 20/9. The scattering by the oxygen atoms is not included in the tabulated scattering law data. It should be taken into account by adding the scattering for free oxygen of mass 16.

REFERENCES
Liquid para deuterium at 19 °K was computed using the LEAPR module of NJOY [1]. The scattering law is based on the model of Keinert and Sax [2], which includes spin correlations from the Young and Koppel model [3], diffusion and local hindered motions from an effective translational scattering law based on a frequency distribution, and intermolecular coherence after Vinyard [4].

REFERENCES
**Evaluation:** Ortho Deuterium Thermal Neutron Scattering Sublibrary, Release 3 (MAT 13)

**Temperatures:** 19 °K

**Files:** 1, 7

**Evaluators:** R. E. MacFarlane (LANL)

Liquid ortho deuterium at 19 °K was computed using the LEAPR module of NJOY [1]. The scattering law is based on the model of Keinert and Sax [2], which includes spin correlations from the Young and Koppel model [3], diffusion and local hindered motions from an effective translational scattering law based on a frequency distribution, and intermolecular coherence after Vinyard [4].

**REFERENCES**

Thermal Neutron Scattering Sublibrary

Evaluation: Be metal Thermal Neutron Scattering Sublibrary, Release 3 (MAT 26)
Temperatures: 296, 400, 500, 600, 700, 800, 1000, 1200 °K
Files: 1, 7
Evaluators: R. E. MacFarlane (LANL)

This evaluation was generated using the LEAPR module of NJOY [3]. The physical model is very similar to the one used at General Atomic to produce the original ENDF/B-III evaluations [1]. Tighter grids and extended ranges for $\alpha$ and $\beta$ were used. A slightly more detailed calculation of the coherent inelastic scattering was generated. The various constants were updated to agree with the ENDF/B-VI evaluation of Be.

The phonon dispersion curves were fitted by Schmunk, et al. [2], using a model of central forces that extend to the fifth nearest neighbors. The phonon spectrum corresponding to this model was calculated by the root sampling method, and then used to compute $S(\alpha,\beta)$. The coherent elastic scattering cross section was computed using the known lattice structure (hexagonal close-packed) and the Debye-Waller integrals from the lattice dynamics model.

REFERENCES
This evaluation was generated using the LEAPR module of NJOY [3]. The physical model is very similar to the one used at General Atomic to produce the original ENDF/B-III evaluations [1]. Tighter grids and extended ranges for $\alpha$ and $\beta$ were used. A slightly more detailed calculation of the coherent inelastic scattering was generated. The various constants were updated to agree with the ENDF/B-VI evaluation of Be and oxygen.

Beryllium oxide consists of two interpenetrating hexagonal close-packed structures with four atoms per unit cell. The lattice dynamics [2] is described using a shell model whose parameters have been adjusted to fit the elastic constants, the measured Raman frequencies, and preliminary dispersion relations measured by neutron scattering [3]. Only the negative ions are assumed to be polarizable, and short-range repulsive forces are used for the first and second neighbors. The frequency spectra weighted by the squares of the amplitude vectors were computed separately for beryllium and oxygen and used to calculate separate scattering laws with GASKET. The scattering laws were then combined and adjusted to be used with the beryllium free-atom cross section. The oxygen free-atom cross section has been provided for use with the short-collision-time approximation (SCT). Thus, the thermal cross section computed from either $S(\alpha,\beta)$ or by the SCT approximation gives an asymptotic limit of approximately 6.15±3.75 barns. The elastic part of the scattering was calculated using the average of the Debye-Waller factors for beryllium and oxygen.

REFERENCES
2. G. Borgonovi, GA-8758 (1968) General Atomic
Thermal Neutron Scattering Sublibrary

Evaluation: Graphite Thermal Neutron Scattering Sublibrary, Release 3 (MAT 31)
Temperatures: 296, 400, 500, 600, 700, 800, 1000, 1200, 1600, 2000 °K
Files: 1, 7
Evaluators: R. E. MacFarlane (LANL)

This evaluation was generated using the LEAPR module of NJOY [3]. The physical model is very similar to the one used at General Atomic to produce the original ENDF/B-III evaluations [1]. Tighter grids and extended ranges for \( \alpha \) and \( \beta \) were used. A slightly more detailed calculation of the coherent inelastic scattering was generated. The various constants were updated to agree with the ENDF/B-VI evaluation of natural carbon.

Graphite has a hexagonal close-packed crystal structure. The lattice dynamics is represented using a model with four force constants [2,3]. One force constant is used to describe a nearest-neighbor central force that binds two hexagonal planes together, another describes a bond-bending force in an hexagonal plane, the third is for bond-stretching between nearest neighbors in a plane, and the fourth corresponds to a restoring force against bending of the hexagonal plane. The force constants were evaluated numerically using a very precise fit to the high and low temperature specific heat and compressibility of reactor grade graphite. The phonon spectrum was computed from this model using the root sampling method, and then used to compute \( S(\alpha,\beta) \). The coherent elastic scattering cross section was computed using the known lattice structure and the Debye-Waller integrals from the lattice dynamics model.

REFERENCES
2. J. A. Young, N. F. Wilkner, and D. E. Parks, Nukleonik, 7, 295 (1965)

VI.10
Liquid methane \((\text{CH}_4)\) at 100 °K was generated using the model of Agrawal and Yip [1] as implemented by Picton [2], modified to include a diffusive component. Optical measurements of methane in the gas phase show four fairly well defined vibrational modes at 162, 190, 361, and 374 meV. These have been included in this model as discrete oscillators and were used to calculate \(S(\alpha,\beta)\) using the LEAPR module of NJOY [3].

2. D. J. Picton, Ph.D. Thesis
Solid methane (CH₄) at 22 °K was generated using the model of Picton [1] and the spectrum of Harker and Brugger [2]. Optical measurements of methane in the gas phase show four fairly well defined vibrational modes at 162, 190, 361, and 374 meV. These have been included in this model as discrete oscillators and were used to calculate $S(\alpha,\beta)$ using the LEAPR module of NJOY [3].

Thermal Neutron Scattering Sublibrary

**Evaluation:** H (Polyethylene) Thermal Neutron Scattering Sublibrary, Release 0 (MAT 37)

**Temperatures:** 296 350 °K

**Files:** 1, 7

**Evaluators:** J. U. Koppel, D. H. Houston, and D. Sprevak (GA)

This evaluation was produced at General Atomic in 1969 using the code GASKET [1]. It was converted to ENDF-6 format at Los Alamos in 1989. The only changes made to the contents were adjustments of cross sections to match the ENDF/B-VI values.

Polyethylene is represented using a model of non-interacting chains of CH$_2$ radicals originally developed by Lin and Koenig [2]. The dispersion relation of polyethylene shows nine branches, the frequency in each branch being a function of the phase difference of the vibrations of corresponding atoms in neighboring CH$_2$ units. For some normal modes, the ratio of the amplitude of the hydrogen atom vibrations to the amplitude of the carbon atom vibrations also depends strongly on the phase difference. Using this model, the frequency spectrum was computed exactly for the hydrogen atoms in histogram form [3]. The low frequency part of the histogram (below 0.02 eV) was then replaced by a Debye spectrum having the same area, and the other elements of the histogram distribution were replaced by Gaussian functions of appropriate area centered at the center of each interval of the histogram. GASKET was then used to obtain S(α,β). The elastic part of the scattering law is represented using the incoherent approximation with Debye-Waller integrals from the GASKET calculation [1]. This evaluation only gives the scattering from the hydrogen in polyethylene. The carbon should be treated as a free gas with mass 12.011 amu.

**REFERENCES**

Thermal Neutron Scattering Sublibrary

Evaluation: Benzene Thermal Neutron Scattering Sublibrary, Release 0 (MAT 40)
Temperatures: 296 350 400 450 500 600 800 1000 °K
Files: 1, 7

This evaluation was produced at General Atomic in 1969 using the code GASKET [1]. It was converted to ENDF-6 format at Los Alamos in 1989. The only changes made to the contents were adjustments of cross sections to match the ENDF/B-VI values.

The benzene molecule has an hexagonal planar structure with symmetry D6H, carbon-carbon bond length of 1.39 Å, and carbon-hydrogen bond length of 1.08 Å. In constructing a model for the atomic vibrations, it was assumed [2] that there is no interaction between vibrational and rotational states of the molecule, and that the hindered rotations that describe the interactions of molecules in the liquid can be represented by translations of the whole molecule with an effective mass. Continuous frequency distributions were then obtained for the hydrogen and carbon atoms using methods described in [3]. The cluster of frequencies closely spaced around 0.38 eV was lumped into a single oscillator. The GASKET code was then used to compute separate $S(\alpha,\beta)$ functions for hydrogen and carbon. The scattering laws were combined and adjusted to be used with the hydrogen free-atom cross section. The carbon free-atom cross section has been provided for use with the short-collision-time approximation (SCT). Thus, the thermal cross section computed from either $S(\alpha,\beta)$ or by the SCT approximation gives an asymptotic limit of approximately $6*20+6*4.7$ barns.

REFERENCES
This evaluation was generated using the LEAPR module of NJOY [3]. The physical model is very similar to the one used at General Atomic to produced the original ENDF/B-III evaluations [1]. The α and β grids were extended lightly, and the constants were changed to match the values in the previous ENDF/B-VI evaluation.

The lattice dynamics of ZrH were computed from a central force model. The slightly tetragonal lattice of ZrH₂ was approximated by a face-centered-cubic lattice. Four force constants (μ, γ, ν, and δ) were introduced describing respectively the interaction of a zirconium atom with its nearest neighbors (8 H atoms) and its next nearest neighbors (12 Zr atoms), and the interaction of a hydrogen atom with its next nearest neighbors (6 H atoms) and its third nearest atoms (12 H atoms). Eigenvalues and eigenvectors of the dynamical matrix were calculated, and a phonon frequency spectrum was obtained by means of a root sampling technique. Weighted frequency spectra for hydrogen in ZrH were then obtained by appropriate use of the dynamical matrix eigenvectors [2].

The final values of the four force constants were obtained by fitting both specific heat and neutron data. The position of an optical peak observed by neutron scattering techniques to be centered roughly around 0.14 eV determines the constant μ, while the overall width and shape of this peak determine ν and δ respectively. Existing neutron data are not sufficiently precise to confirm the structure predicted in the optical peak by the central force model. Specific heat data were used to determine the force constant γ, which primarily determines the upper limit on the phonon energies associated with acoustic modes.

REFERENCES
Incident Proton Sublibrary

Part VII

Incident Proton Sublibrary (NSUB=10010)
Incident Proton Sublibrary

Evaluation:  \(^{1}\text{H} \text{ Incident Proton Sublibrary, Release 1 (MAT 125)}\)
Energy Range: 0 to 100 MeV
Files: 1, 3, 6
Evaluators: D. Dodder (LANL)

ENDF/B-VI MOD 1 EVALUATION (D. Dodder, LANL, October 1987)

The p-p elastic cross sections were calculated using an R-matrix analysis of the p-p cross section and polarization data over the energy range evaluated. The maximum nuclear partial wave allowed in the fit is \(L=6\), and the resulting chi-squared per degree of freedom is 0.793.
Incident Proton Sublibrary

**Evaluation:** ³He Incident Proton Sublibrary, Release 1 (MAT 225)
**Energy Range:** 1 keV to 20 MeV
**Files:** 1, 3, 6
**Evaluators:** G. Hale (LANL)

**ENDF/B-VI MOD 1 EVALUATION** (G. Hale, LANL, October 1983)

The p-³He elastic and ³He(p,2p)D cross sections and scattering distributions were calculated using an R-matrix analysis with code EDA. The energy-angle distributions for MT=111 are assumed to follow a 3-body phase-space law.
Incident Deuteron Sublibrary

Part VIII

Incident Deuteron Sublibrary (NSUB=10020)
Incident Deuteron Sublibrary

Evaluation: \(^2\)H Incident Deuteron Sublibrary, Release 1 (MAT 128)
Energy Range: 332.5 eV to 30 MeV
Files: 1, 3
Evaluators: R. M. White, D. A. Resler (LLNL)

ENDF/B-VI MOD 1 EVALUATION (R. M. White, D. A. Resler, LLNL, May 1991)

The D(d,n)\(^3\)He and D(d,p)\(^3\)H cross sections are evaluated based on all known experimental data published between 1946 and 1990. See White and Resler [1] for more information on evaluation.

REFERENCE
Incident Deuteron Sublibrary

Evaluation:  
3H Incident Deuteron Sublibrary, Release 1 (MAT 131)

Energy Range:  
285 eV to 30 MeV

Files:  
1, 3

Evaluators:  
R. M. White, D. A. Resler (LLNL)

ENDF/B-VI MOD 1 EVALUATION (R. M. White, D. A. Resler, LLNL, May 1991)

The 3H(d,n)4He cross section is evaluated based on all known experimental data published between 1946 and 1990. See White, et al. [1] for more information on evaluation.

REFERENCE

Incident Deuteron Sublibrary

Evaluation: $^3$He Incident Deuteron Sublibrary, Release 1 (MAT 225)
Energy Range: 118.75 eV to 30 MeV
Files: 1, 3
Evaluators: R. M. White, D. A. Resler (LLNL)

ENDF/B-VI MOD 1 EVALUATION (R. M. White, D. A. Resler, LLNL, May 1991)
The $^3$He(d,p)$^4$He cross section is evaluated based on all known experimental data published between 1946 and 1990. See White, et al. [1] for more information on evaluation.

REFERENCE
Incident Triton Sublibrary

Part IX

Incident Triton Sublibrary (NSUB=10030)
Incident Triton Sublibrary

Evaluation:  $^3$H Incident Triton Sublibrary, Release 1 (MAT 131)
Energy Range:  475 eV to 30 MeV
Files:  1, 3
Evaluators:  R. M. White, D. A. Resler (LLNL)

ENDF/B-VI MOD 1 EVALUATION (R. M. White, D. A. Resler, LLNL, May 1991)
The $^3$H(t,2n)$^4$He cross section is evaluated based on all known experimental data published between 1946 and 1990. See White, et al. [1] for more information on evaluation.

REFERENCE
Part X

ENDF/HE-VI

Incident Neutron Sublibrary (NSUB=10)
In general, the ENDF/B-VI data [1] was used below 32 MeV. The nuclear model codes ALICE-P [2], and LAHET [4] were extensively used as well as systematics [2,5,6]. Extensive comparisons were made with experimental data for total, elastic scattering, nonelastic cross sections; residual nuclide production yields, elastic scattering angular distributions, and double-differential neutron emission. The evaluation is partially documented in Ref. [7].

**RESONANCE PARAMETERS (File 2)**
Resonance range to 100 keV; taken from ENDF/B-VI.

**SMOOTH CROSS SECTIONS (File 3)**
Total (MT=1), elastic (MT=2), nonelastic (MT=3) cross sections are taken from systematics [2].
Product yields (MT=5) below 25 MeV, used ALICE-P, above 25 MeV LAHET; these were normalized to data where available. Consistency with ENDF/B-VI below 32 MeV is not assured. Neutron production (MT=201) used ENDF/B-VI to 32 MeV, LAHET to 10 GeV. 
\( \gamma, p, d, t, ^3\text{He}, \alpha \) production (MT=202-207) used ALICE-P to 25 MeV, LAHET to 10 GeV. 
\( \pi^+, \pi^0, \pi^- \) production (MT=208-210) used LAHET to 10 GeV.

**ANGULAR DISTRIBUTIONS (File 4)**
Elastic (MT=2) taken from systematics [5].

**PRODUCT ENERGY-ANGLE DISTRIBUTIONS (File 6)**
Product yields (MT=5) below 25 MeV, used ALICE-P [2], above 25 MeV LAHET [4]. Normalized to data where available. Consistency with ENDF/B-VI below 32 MeV is not assured. Data given for \( ^{5,6}\text{He}, m ^{6,7}\text{Li}, ^{7,8,10,11}\text{Be}, ^{8,10,11,12}\text{B}, \) and \( ^{10,11}\text{C} \).
Neutron production (MT=201) used ENDF/B-VI to 32 MeV, systematics to 10 GeV. 
\( \gamma, p, d, t, ^3\text{He}, \alpha \) production (MT=202-207) used ALICE-P to 25 MeV, LAHET to 10 GeV. 
\( \pi^+, \pi^0, \pi^- \) production (MT=208-210) used LAHET to 10 GeV.

**REFERENCES**

---

1 A modification of ALICE89 [3].
2 The LANL upgrade of HETC.
ENDF/HE-VI Incident Neutron Sublibrary

ENFD/HE-VI Incident Neutron Sublibrary

Evaluation: 

56Fe ENFD/HE-VI Incident Neutron Sublibrary, Release 2 (MAT 2631)

Energy Range: 

1.0 x 10^5 eV to 1 GeV

Files: 

1, 2, 3, 4, 6

Evaluators: 

S. Pearlstein (BNL)

In general, the ENFD/B-VI data was used below 20 MeV. The nuclear model code ALICE-P [2] employed extensively, uses parameters in a Woods-Saxon potential to fit neutron total and particle reaction cross sections from data and systematics [1,14].

RESONANCE PARAMETERS (File 2)

Resonance range to 100 keV; taken from ENFD/B-VI.

SMOOTH CROSS SECTIONS (File 3)

Total cross section (MT=1) empirical fits [6] similar to the method for proton nonelastic [1].

Elastic cross section (MT=2) set equal to total - nonelastic; Rutherford-nuclear interference is ignored.

Nonelastic (MT=3) calculated by ALICE-P. Neutron and proton nonelastic cross-section similar at high energies.

ANGULAR DISTRIBUTIONS (File 4)

Elastic scattering based on the diffraction model [3] amended for relativistic effects and empirical fits to high energy data.

PRODUCT ENERGY-ANGLE DISTRIBUTIONS (File 6)

Spallation product yields (MT=5) Calculated using ALICE-P. Data compares fairly well with experimental data [10-13].

Neutron production (MT=201) calculated by ALICE-P. Below 20 MeV, equal to sum of ENFD/B-VI MT's 4, 2*16, 22, and 28; above 250 MeV, based on systematics [4] and is consistent with data [7,8].

Gamma production (MT=202) calculated by ALICE-P and MODS [9].

Particle production cross sections above 20 MeV calculated by ALICE-P. Proton production (MT=203) below 20 MeV, equal to sum of ENFD/B-VI MTs 28 and 103; d, t, 3He production (MT=204,205,206) below 20 MeV, equal to ENFD/B-VI MTs 104, 105, 106, respectively; a production (MT=207) below 20 MeV, equal to ENFD/B-VI MTs 22 and 107.

REFERENCES

ENDF/HE-VI Incident Neutron Sublibrary

11. R. Silberberg, et al., *NRL 7593* (1973) Naval Research Laboratory
Below 20 MeV the ENDF/B-VI data is used [1]. The nuclear model code ALICE-P, used extensively, uses parameters in a Woods-Saxon potential to fit neutron total and particle reaction cross-sections from data and systematics [4,5]. Tritium and 3He emission is added.

**RESONANCE PARAMETERS (File 2)**
- Resonance range to 100 keV; taken from ENDF/B-VI.

**SMOOTH CROSS SECTIONS (File 3)**
- Total cross section (MT=1) empirical fits [2] similar to the method for proton nonelastic [4].
- Elastic cross section (MT=2) set equal to total - nonelastic; Rutherford-nuclear interference is ignored.
- Nonelastic (MT=3) calculated by ALICE-P. Neutron and proton nonelastic cross-section similar at high energies.
- Spallation product yields (MT=5) Calculated using ALICE-P. Data compares fairly well with experimental data [7].
- Fission (MT=18) based on systematics [8].
- Neutron production (MT=201) calculated by ALICE-P. Below 20 MeV, equal to sum of MT's 4, 2*16, 22, and 28 [1].
- Gamma production (MT=202) calculated by ALICE-P and MODS [10].
- Particle production cross sections above 20 MeV calculated by ALICE-P. Proton production (MT=203) below 20 MeV, equal to sum of ENDF/B-VI MTs 28 and 103; d, t, 3He production (MT=204,205,206) below 20 MeV, equal to ENDF/B-VI MTs 104, 105, 106, respectively; α production (MT=207) below 20 MeV, equal to ENDF/B-VI MTs 22 and 107.

**ANGULAR DISTRIBUTIONS (File 4)**
- Elastic scattering Based on the diffraction model [6] amended for relativistic effects and empirical fits to high energy data.

**PRODUCT ENERGY-ANGLE DISTRIBUTIONS (File 6)**
- Spallation product yields (MT=5) Calculated using ALICE-P. Data compares fairly well with experimental data [7].
- Gamma production (MT=202) Calculated by ALICE-P and MODS [10].
- Particle production cross sections above 20 MeV calculated by ALICE-P. Proton production (MT=203) below 20 MeV, equal to sum of ENDF/B-VI MTs 28 and 103; d, t, 3He production (MT=204,205,206) below 20 MeV, equal to ENDF/B-VI MTs 104, 105, 106, respectively; α production (MT=207) below 20 MeV, equal to ENDF/B-VI MTs 22 and 107.
REFERENCES

8. T. Fukahori, internal memorandum (unpublished)
Below 20 MeV the ENDF/B-VI data are used [1]. The nuclear model code ALICE-P\(^1\), employed extensively, uses parameters in a Woods-Saxon potential to fit neutron total and particle reaction cross-sections from data and systematics [4,5]. Tritium and \(^3\)He emission is added.

**RESONANCE PARAMETERS** (File 2)

Resonance range to 100 keV; taken from ENDF/B-VI.

**SMOOTH CROSS SECTIONS** (File 3)

Total cross section (MT=1) empirical fits are made[2] similar to the method for proton nonelastic [4].

Elastic cross section (MT=2) Rutherford-nuclear interference is ignored; cross section set equal to total - nonelastic.

Nonelastic (MT=3) calculated by ALICE-P. Neutron and proton nonelastic cross-section similar at high energies.

Spallation product yields (MT=5) Calculated using ALICE-P. Data compares fairly well with experimental data [7].

Fission (MT=18) based on systematics [8].

Neutron production (MT=201) calculated by ALICE-P. Below 20 MeV, equal to sum of MT's 4, 2*16, 22, and 28 [1].

Gamma production (MT=202) calculated by ALICE-P and MODS [10].

Particle production cross sections above 20 MeV calculated by ALICE-P. Proton production (MT=203) below 20 MeV, equal to sum of ENDF/B-VI MTs 28 and 103; d, t, \(^3\)He production (MT=204,205,206) below 20 MeV, equal to ENDF/B-VI MTs 104, 105, 106, respectively; \(\alpha\) production (MT=207) below 20 MeV, equal to ENDF/B-VI MTs 22 and 107.

**ANGULAR DISTRIBUTIONS** (File 4)

Elastic scattering based on the diffraction model [6] amended for relativistic effects and empirical fits to high energy data.

**PRODUCT ENERGY-ANGLE DISTRIBUTIONS** (File 6)

Spallation product yields (MT=5) calculated using ALICE-P. Data compares fairly well with experimental data [7].


Gamma production (MT=202) calculated by ALICE-P and MODS [10].

Particle production cross sections above 20 MeV calculated by ALICE-P. Proton production (MT=203) below 20 MeV, equal to sum of ENDF/B-VI MTs 28 and 103; d, t, \(^3\)He production (MT=204,205,206) below 20 MeV, equal to ENDF/B-VI MTs 104, 105, 106, respectively; \(\alpha\) production (MT=207) below 20 MeV, equal to ENDF/B-VI MTs 22 and 107.
ENDF/HE-VI Incident Neutron Sublibrary

production (MT=207) below 20 MeV, equal to ENDF/B-VI MTs 22 and 107.

REFERENCES
9. T. Fukahori, internal memorandum (unpublished)
Part XI

ENDF/HE-VI

Incident Proton Sublibrary (NSUB=10010)
ENDF/HE-VI Incident Proton Sublibrary

Evaluation: 12C ENDF/HE-VI Incident Proton Sublibrary, Release 2 (MAT 625)
Energy Range: 1.0x10^{-5} eV to 10 GeV
Files: 1, 3, 6
Evaluators: S. Pearlstein (BNL)

ENDF/HE-VI MOD 2 REVISION 1 (V. McLane, NNDC, December 1996)
Comments updated.

ENDF/HE-VI MOD 2 EVALUATION (S. Pearlstein, NNDC, September 1992)
The nuclear model codes ALICE-P [1], and LAHET [3] were used extensively as well as systematics [1,4,5]. Extensive comparisons were made with experimental data for nonelastic cross sections; residual nuclide production yields, and double-differential neutron emission. The evaluation is partially documented in Ref. [6].

SMOOTH CROSS SECTIONS (File 3)
Elastic (MT=2), nonelastic (MT=3) cross sections are taken from systematics [1].
Product yields (MT=5) below 25 MeV, used ALICE-P, above 25 MeV LAHET; these were normalized to data where available.
Neutron production (MT=201) used LAHET to 10 GeV.
γ, p, d, t, 3He, α production (MT=202-207) used ALICE-P to 25 MeV, LAHET to 10 GeV.
π^+, π^- production (MT=208-210) used LAHET to 10 GeV.

PRODUCT ENERGY-ANGLE DISTRIBUTIONS (File 6)
Product yields (MT=5) below 25 MeV, used ALICE-P, above 25 MeV LAHET. Normalized to data where available. Data given for 6He, 6Li, 7Be, 7B, and 10B, and 11C.
Neutron emission spectra taken from systematics [4].
Same as File 3 for MT = 201-210.

REFERENCES
2. M. Blann, UCID 20169 (1984) Lawrence Livermore National Laboratory, and updates

1 A modification of ALICE89 [3].
2 The LANL upgrade of HETC.
ENDF/HE-VI Incident Proton Sublibrary

Evaluation: $^{56}$Fe ENDF/HE-VI Incident Proton Sublibrary, Release 2 (MAT 2631)
Energy Range: $1.0 \times 10^{-5}$ eV to 1 GeV
Files: 1, 3, 6
Evaluators: S. Pearlstein (BNL)

ENDF/HE-VI MOD 2 REVISION 1 (V. McLane, NNDC, December 1996)
Comments updated.

ENDF/HE-VI MOD 2 EVALUATION (S. Pearlstein, NNDC, June 1988)
The nuclear model code ALICE-P [2] employed extensively, uses parameters in a Woods-Saxon potential to fit neutron total and particle reaction cross sections from data and systematics [1,14].

SMOOTH CROSS SECTIONS (File 3)
Total cross section (MT=1) empirical fits [6] similar to the method for proton nonelastic [1]. Elastic cross section (MT=2) set equal to total - nonelastic; Rutherford-nuclear interference is ignored.
Nonelastic (MT=3) calculated by ALICE-P. Neutron and proton nonelastic cross-section similar at high energies.
Spallation product yields (MT=5) Calculated using ALICE-P. Data compares fairly well with experimental data [10-13].
Neutron production (MT=201) calculated by ALICE-P. Above 250 MeV, based on systematics [4] and is consistent with data [7,8].
Gamma production (MT=202) calculated by ALICE-P and MODS [9].
p, d, t, $^3$He production cross sections (MT=203-207) calculated by ALICE-P.

PRODUCT ENERGY-ANGLE DISTRIBUTIONS (File 6)
Same as File for MT = 5, and 201-207.

REFERENCES
11. R. Silberberg, et al., *NRL 7593* (1973) Naval Research Laboratory

XI.2
ENDF/HE-VI Incident Proton Sublibrary

ENDF/HE-VI Incident Proton Sublibrary

**Evaluation:** ¹⁰⁸Pb ENDF/HE-VI Incident Proton Sublibrary, Release 2 (MAT 8237)

**Energy Range:** 1.0×10⁻⁵ eV to 1 GeV

**Files:** 1, 3, 6

**Evaluators:** T. Fukahori, S. Pearlstein (BNL)

ENDF/HE-VI MOD 2 REVISION 1 (V. McLane, NNDC, December 1996)
Comments updated.

ENDF/HE-VI MOD 2 EVALUATION (T. Fukahori and S. Pearlstein, NNDC, June 1990)
The nuclear model code ALICE-P [1], employed extensively, uses parameters in a Woods-Saxon potential to fit neutron total and particle reaction cross-sections from data and systematics [4,5]. Tritium and ³He emission is added.

**SMOOTH CROSS SECTIONS** (File 3)
- Total cross section (MT=1) Empirical fits are made [1] similar to the method for nonelastic [3].
- Elastic cross section (MT=2) Rutherford-nuclear interference is ignored; set equal to total - nonelastic.
- Nonelastic (MT=3) Calculated by ALICE-P. Neutron and proton nonelastic cross-section similar at high energies.
- Spallation product yields (MT=5) Calculated using ALICE-P. Data compares fairly well with experimental data [6,7].
- Fission (MT=18) Based on systematics [8].
- Neutron production (MT=201) Calculated by ALICE-P.
- Gamma production (MT=202) Calculated by ALICE-P and MODS [10].
- p, d, t, ³He, α production (MT=203) Calculated by ALICE-P.

**ANGULAR DISTRIBUTIONS** (File 4)
- Elastic scattering Based on the diffraction model [6] amended for relativistic effects and empirical fits to high energy data.

**PRODUCT ENERGY-ANGLE DISTRIBUTIONS** (File 6)
Same as File for for MT = 5, and 201-207.

**REFERENCES**
8. T. Fukahori, internal memorandum (unpublished)
ENDF/HE-VI Incident Proton Sublibrary

Evaluation: $^{209}$Bi ENDF/HE-VI Incident Proton Sublibrary, Release 2 (MAT 8325)

Energy Range: $1.0 \times 10^{-5}$ eV to 1 GeV

Files: 1, 3, 6

Evaluators: T. Fukahori, S. Pearlstein (BNL)

ENDF/HE-VI MOD 2 REVISION 1 (V. McLane, NNDC, December 1996)

Comments updated.

ENDF/HE-VI MOD 2 EVALUATION (T. Fukahori and S. Pearlstein, NNDC, June 1990)

The nuclear model code ALICE-P, employed extensively, uses parameters in a Woods-Saxon potential to fit neutron total and particle reaction cross-sections from data and systematics [4,5]. Tritium and $^3$He emission is added.

SMOOTH CROSS SECTIONS (File 3)

Total cross section (MT=1) Empirical fits are made [1] similar to the method for nonelastic [3].

Elastic cross section (MT=2) Rutherford-nuclear interference is ignored; cross section set equal to total - nonelastic.

Nonelastic (MT=3) Calculated by ALICE-P. Neutron and proton nonelastic cross-section similar at high energies.

Spallation product yields (MT=5) Calculated using ALICE-P. Data compares fairly well with experimental data [6-18].

Fission (MT=18) Based on systematics [19].

Neutron production (MT=201) Calculated by ALICE-P.

Gamma production (MT=202) Calculated by ALICE-P and MODS [22].

p, d, t, $^3$He, $^4$He production (MT=203) Calculated by ALICE-P.

PRODUCT ENERGY-ANGLE DISTRIBUTIONS (File 6)

Same as File for for MT = 5, and 201-207.

REFERENCES

5. S. Pearlstein, Nucl. Sci. Eng., 49, 162 (1972)
11. P. J. Daly, et al., Nucl. Phys. 56, 322 (1964)
19. T. Fukahori, internal memorandum (unpublished)
Appendix A

History of Materials Issued in ENDF/B-VI

This section includes all materials issued in all releases of ENDF/B-VI. The materials are ordered by sublibrary and material. The information on the latest release is given first, and is followed by the history of that material.

<table>
<thead>
<tr>
<th>Sublibrary</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incident Neutron Sublibrary</td>
<td>A. 1</td>
</tr>
<tr>
<td>Thermal Neutron Scattering Sublibrary</td>
<td>A.85</td>
</tr>
<tr>
<td>Incident Proton Sublibrary</td>
<td>A.89</td>
</tr>
<tr>
<td>Incident Deuteron Sublibrary</td>
<td>A.90</td>
</tr>
<tr>
<td>Incident Triton Sublibrary</td>
<td>A.91</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**  

1H ENDF/B-VI Incident Neutron Sublibrary (MAT 125)  
Energy Range: $10^{-5}$ eV to 100 MeV  
Files (MF): 1, 2, 3, 4, 12, 14  

**HISTORY**  
1991 Jul  LANL  G. Hale  
ENDF/B-VI  MAT 125 MOD 2, Release 1  
 (Reviewed by Standards Subcommittee)  
ENDF/B-VI  MAT 125 MOD 1, Release 0

**Evaluation:**  

2H ENDF/B-VI Incident Neutron Sublibrary (MAT 128)  
Files (MF): 1, 2, 3, 4, 6, 8, 9, 12, 14  
Energy Range: $10^{-5}$ eV to 100 MeV  
Evaluators: P. G. Young, L. Stewart, A. Horsley (LANL)

**HISTORY**  
1996 Nov  LANL  P.G. Young  
ENDF/B-VI  MAT 128 MOD 3, Release 4  
1994 Aug  LANL  P.G. Young (Reviewed by R.Q. Wright)  
ENDF/B-VI  MAT 128 MOD 2, Release 3  
1989 Dec  LANL  R. E. MacFarlane  
ENDF/B-VI  MAT 128 MOD 1, Release 0  
1967 Nov  LANL, AWRE  B. Leonard, L. Stewart, A. Horsley  
ENDF/B-V  MAT 1302  
ENDF/B-IV  MAT 1102

**Evaluation:**  

3H ENDF/B-VI Incident Neutron Sublibrary (MAT 131)  
Energy Range: $10^{-5}$ eV to 20 MeV  
Files (MF): 1, 2, 3, 4, 5  
Evaluators: L. Stewart (LANL)

**HISTORY**  
1990 Jan  BNL  NNDC  
ENDF/B-VI  MOD 0, Release 0  
1965 Feb  LANL  L. Stewart  
ENDF/B-V  MAT 1169
**ENDF/B-VI Incident Neutron Sublibrary**

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>³He ENDF/B-VI Incident Neutron Sublibrary (MAT 225)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>Evaluators</td>
<td>G. Hale, D. Dodder, P. Young (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1990 May</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>⁴He ENDF/B-VI Incident Neutron Sublibrary (MAT 228)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. A. Nisley, G. M. Hale, P. G. Young (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1973 Oct</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>⁶Li ENDF/B-VI Incident Neutron Sublibrary (MAT 325)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5, 12, 14</td>
</tr>
<tr>
<td>Evaluators</td>
<td>G. Hale, P. Young (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1989 Apr</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>⁷Li ENDF/B-VI Incident Neutron Sublibrary (MAT 328)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5, 12, 14, 33</td>
</tr>
<tr>
<td>Evaluators</td>
<td>P. Young (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1988 Aug</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>⁹Be ENDF/B-VI Incident Neutron Sublibrary (MAT 425)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 6, 12, 14, 15</td>
</tr>
<tr>
<td>Evaluators</td>
<td>S. T. Perkins, E. F. Plechaty, R. J. Howerton (LLNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1986 Jan</td>
<td>LLNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>

A.2
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: \(^{10}\text{B} \) ENDF/B-VI Incident Neutron Sublibrary (MAT 525)
Energy Range: \(10^{-5} \text{ eV to } 20 \text{ MeV} \)
Files (MF): \(1, 2, 3, 4, 12, 13, 14 \)
Evaluators: G. Hale, P. Young (LANL)

HISTORY
1991 Jul  LANL  G. Hale
   ENDF/B-VI  MAT 525 MOD 2, Release 1
1989 Nov  LANL  G. Hale, P. Young (Reviewer: F. Mann, W. Poenitz)
   ENDF/B-VI  MAT 525 MOD 1, Release 0

Evaluation: \(^{11}\text{B} \) ENDF/B-VI Incident Neutron Sublibrary (MAT 528)
Energy Range: \(10^{-5} \text{ eV to } 20 \text{ MeV} \)
Files (MF): \(1, 2, 3, 4, 6, 12, 13, 14 \)
Evaluators: P. Young (LANL)

HISTORY
1989 May  LANL  P. G. Young (Reviewer: L. Stewart)
   ENDF/B-VI  MOD 0, Release 0

Evaluation: \(^{nat}\text{C} \) ENDF/B-VI Incident Neutron Sublibrary (MAT 600)
Energy Range: \(10^{-5} \text{ eV to } 32 \text{ MeV} \)
Files (MF): \(1, 2, 3, 4, 5, 12, 14, 33 \)
Evaluators: C. Y. Fu, E. J. Axton, F. G. Perey (ORNL)

HISTORY
1991 Jul  ORNL  C. Y. Fu
   ENDF/B-VI  MAT 600 MOD 2, Release 1
1989 Aug  ORNL  C. Fu, E. Axton, F. Perey
   ENDF/B-VI  MAT 600 MOD 1, Release 0

Evaluation: \(^{14}\text{N} \) ENDF/B-VI Incident Neutron Sublibrary (MAT 725)
Energy Range: \(10^{-5} \text{ eV to } 40 \text{ MeV} \)
Files: \(1, 2, 3, 4, 6, 12, 13, 14, 15 \)
Evaluators: P. G. Young, G. Hale, M. Chadwick (LANL)

HISTORY:
1994 Aug  LANL  P. G. Young (reviewer: M. Chadwick)
   ENDF/B-VI  MAT 725 MOD 3, Release 3
1992 Sep  LANL  P. G. Young (reviewer: D. Ressler)
   ENDF/B-VI  MAT 725 MOD 2, Release 2
1990 May  LANL  P. Young, G. Hale, M. Chadwick (reviewer: D. Larson)
   ENDF/B-VI  MAT 725 MOD 1, Release 0

A.3
## ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 728)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
<td>1, 2, 3, 4, 5, 13, 14, 15</td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
<td>E. Arthur, P. Young, G. Hale (LANL)</td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
<td></td>
</tr>
<tr>
<td>1983 Sep</td>
<td>LANL, E. Arthur, P. Young, G. Hale MOD 0, Release 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 825)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
<td>1, 2, 3, 4, 12, 13, 14</td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
<td>G. Hale, Z. Chen, P. Young (LANL)</td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>LANL, G. Hale, Z. Chen, P. Young MOD 0, Release 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 828)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
<td>B. A. Magurno (BNL)</td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL, NNDC, ENDF/B-V MOD 0, Release 0</td>
</tr>
<tr>
<td>1978 Jan</td>
<td>BNL, B. A. Magurno, ENDF/B-V MAT 1317</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 925)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
<td>1, 2, 3, 4, 6, 8, 9, 12, 14, 33</td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
<td>Z. Zhao (CNDC), C. Y. Fu, D. C. Larson (ORNL)</td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
<td></td>
</tr>
<tr>
<td>1990 Jun</td>
<td>CNDC, ORNL, Z. Zhao, C. Y. Fu, D. C. Larson MOD 1, Release 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 1125)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
<td>$10^{-5}$ eV to 40 MeV</td>
</tr>
<tr>
<td><strong>Files:</strong></td>
<td>1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15, 32, 33</td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
<td>D. C. Larson (ORNL)</td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>BNL, NNDC, ENDF/B-V MOD 2, Release 1</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL, NNDC (Translated from ENDF/B-V)</td>
</tr>
<tr>
<td>1977 Dec</td>
<td>ORNL, D. C. Larson, ENDF/B-V MAT 1311</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: ²⁴Mg ENDF/B-VI Incident Neutron Sublibrary (MAT 1225)
Energy Range: 10⁵ eV to 20 MeV
Files (MF): 1, 2, 3, 8, 9
Evaluators: F. Mann (HEDL), D. C. Larson (ORNL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MOD 0, Release 0
1979 Nov HEDL, ORNL F. Mann, D. C. Larson
ENDF/B-V MAT 7124

Evaluation: ²⁷Al ENDF/B-VI Incident Neutron Sublibrary (MAT 1325)
Energy Range: 10⁵ eV to 40 MeV
Files: 1, 2, 3, 4, 6, 8, 9, 12, 14, 15
Evaluators: P. G. Young (LANL)

HISTORY
1996 Aug LANL, BNL P. G. Young, V. McLane
ENDF/B-VI MAT 1325 MOD 2, Release 4
1994 Sep ANL P. G. Young (reviewer: M. Chadwick)
ENDF/B-VI MAT 1325 MOD 1, Release 3
1990 Jan BNL NNDC
ENDF/B-VI MAT 1325 MOD 0, Release 0
1977 Aug LANL P. G. Young, D. G. Foster, Jr.
ENDF/B-V MAT 1313

Evaluation: ²⁹Si ENDF/B-VI Incident Neutron Sublibrary (MAT 1400)
Energy Range: 10⁵ eV to 20 MeV
Files (MF): 1, 2, 3, 12, 13, 14, 15, 33
Evaluators: D. C. Larson, F. Perey (ORNL); M. K. Drake (GGA), P. G. Young (LANL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MOD 0, Release 0
ENDF/B-V MAT 1314
ENDF/B-IV MAT 1194
### ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:** $^{31}$P ENDF/B-VI Incident Neutron Sublibrary (MAT 1525)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15  
**Evaluators:** R. Howerton (LLNL)

**HISTORY**
- 1990 Jan: BNL, NNDC  
- 1977 Oct: LLNL, R. Howerton  
- ENDF/B-VI, MOD 0, Release 0  
- ENDF/B-V, MAT 1315

**Evaluation:** $^{32}$S ENDF/B-VI Incident Neutron Sublibrary (MAT 1600)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 12, 13, 14, 15  
**Evaluators:** M. Divideenum (BNL)

**HISTORY**
- 1990 Jan: BNL, NNDC  
- 1979 Apr: BNL, M. Divideenum  
- ENDF/B-VI, MOD 0, Release 0  
- ENDF/B-V, MAT 1347

**Evaluation:** $^{35}$Cl ENDF/B-VI Incident Neutron Sublibrary (MAT 1625)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15  
**Evaluators:** R. Howerton (LLNL)

**HISTORY**
- 1990 Jan: BNL, NNDC  
- 1977 Oct: LLNL, R. Howerton  
- ENDF/B-VI, MOD 0, Release 0  
- ENDF/B-V, MAT 1316

**Evaluation:** $^{36}$Cl ENDF/B-VI Incident Neutron Sublibrary (MAT 1700)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 12, 13, 14, 15  
**Evaluators:** M. S. Allen, M. K. Drake (GGA)

**HISTORY**
- 1990 Jan: BNL, NNDC  
- 1967 Feb: GGA, M. S. Allen, M. K. Drake  
- ENDF/B-V, MAT 1149 (γ production representation revised)  
- ENDF/B-IV, MAT 1149 (energy range extended to 20 MeV)  
- ENDF/B-III, MAT 1149 (low-energy capture and (n,p) revised)
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**

\(^{40}\text{Ar}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 1837)

**Material:**

1837 MOD 0 (January 1990)

**Energy Range:**

\(10^5\) eV to 20 MeV

**Files (MF):**

1, 2, 3, 8, 9

**Evaluators:**

F. Mann (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1979 Jan</td>
<td>HEDL</td>
<td>F. Mann</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 7180</td>
</tr>
</tbody>
</table>

**Evaluation:**

\(^{nat}\text{K}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 1900)

**Energy Range:**

\(10^5\) eV to 20 MeV

**Files (MF):**

1, 2, 3, 4, 5, 12, 14, 15

**Evaluators:**

M. K. Drake (GGA)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1967 Feb</td>
<td>GGA</td>
<td>M. K. Drake</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1150</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 1150 (extended to 20 MeV)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-III</td>
<td>MAT 1150</td>
</tr>
</tbody>
</table>

**Evaluation:**

\(^{41}\text{K}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 1931)

**Energy Range:**

\(10^5\) eV to 20 MeV

**Files (MF):**

1, 2, 3, 8, 9

**Evaluators:**

F. Mann (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1979 Jan</td>
<td>HEDL</td>
<td>F. Mann</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 7191</td>
</tr>
</tbody>
</table>

**Evaluation:**

\(^{nat}\text{Ca}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 2000)

**Energy Range:**

\(10^5\) eV to 20 MeV

**Files (MF):**

1, 2, 3, 4, 5, 12, 13, 14

**Evaluators:**

C. Y. Fu, D. M. Hetrick (ORNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Oct</td>
<td>ORNL</td>
<td>C. Y. Fu, D. M. Hetrick</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1320 (energy range 8-20 MeV reevaluated)</td>
</tr>
<tr>
<td>1971 Aug</td>
<td>ORNL</td>
<td>F. G. Perey, M. K. Drake</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 1195</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-III</td>
<td>MAT 1152</td>
</tr>
</tbody>
</table>
### Evaluation: $^{45}\text{Sc}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 2125)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5, 12, 13, 14, 15  
**Evaluators:**  
A. B. Smith (ANL), R. J. Howerton (LLNL)

#### HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992 Jul</td>
<td>ANL, LLNL</td>
<td>A. B. Smith, R. J. Howerton</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 2145 MOD 1, Release 2</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1979 Jul</td>
<td>BNL</td>
<td>B. A. Magurno, S. Mughabghab</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 279, 343</td>
</tr>
</tbody>
</table>

### Evaluation: $^{46}\text{Ti}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 2220)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 12, 13, 14, 15  
**Evaluators:** C. Philis (BRC), A. Smith (ANL), R. Howerton (LLNL)

#### HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1979 Aug</td>
<td>BRC, ANL, LLNL</td>
<td>C. Philis, R. Howerton, A. B. Smith</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 5322</td>
</tr>
</tbody>
</table>

### Evaluation: $^{47}\text{Ti}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 2225)

**Files (MF):** 1, 2, 3, 8, 9, 33  
**Evaluators:** C. Philis, O. Bersillon (BRC); D. Smith, et al. (ANL)

#### HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1977 Jan</td>
<td>BRC, ANL, LLNL</td>
<td>C. Philis, O. Bersillon, D. Smith</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 6227</td>
</tr>
</tbody>
</table>

### Evaluation: $^{47}\text{Ti}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 2228)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 8, 9, 33  
**Evaluators:** C. Philis, O. Bersillon (BRC); D. Smith, et al. (ANL)

#### HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MOD 0, Release 0</td>
</tr>
<tr>
<td>1977 Jan</td>
<td>BRC, ANL, LLNL</td>
<td>C. Philis, O. Bersillon, D. Smith</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 6228</td>
</tr>
</tbody>
</table>
### 54Ti ENDF/B-VI Incident Neutron Sublibrary (MAT 2231)

**Evaluation:**

- **Energy Range:** 10<sup>5</sup> eV to 20 MeV
- **Files (MF):** 1, 2, 3, 8, 9
- **Evaluators:** C. Philis, O. Bersillon (BRC); D. Smith, et al. (ANL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
<td>BNL, ENDF/B-VI, MOD 0, Release 0</td>
</tr>
<tr>
<td>1978 Jan</td>
<td>BRC, ANL, LLNL</td>
<td>C. Philis, O. Bersillon, D. Smith</td>
<td>ENDF/B-V, MAT 6229</td>
</tr>
</tbody>
</table>

### 56Ti ENDF/B-VI Incident Neutron Sublibrary (MAT 2237)

**Evaluation:**

- **Energy Range:** 10<sup>5</sup> eV to 20 MeV
- **Files (MF):** 1, 2, 3, 8, 9
- **Evaluators:** E. Arthur (LANL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
<td>BNL, ENDF/B-VI, MOD 0, Release 0</td>
</tr>
<tr>
<td>1979 May</td>
<td>LANL</td>
<td>E. Arthur</td>
<td>ENDF/B-V, MAT 7220</td>
</tr>
</tbody>
</table>

### natV ENDF/B-VI Incident Neutron Sublibrary (MAT 2300)

**Evaluation:**

- **Energy Range:** 10<sup>5</sup> eV to 20 MeV
- **Files (MF):** 1, 2, 3, 4, 5, 12, 13, 14, 15, 33
- **Evaluators:** A. Smith, D. Smith, P. Guenther, J. Meadows, R. Lawson (ANL); R. Howerton (LLNL); T. Djemil, B. Micklich (UI)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988 Jun</td>
<td>ANL, LLNL, UI</td>
<td>A. Smith, D. Smith, J. Meadows, et al.</td>
<td>ENDF/B-VI, MOD 1, Release 0</td>
</tr>
</tbody>
</table>

### 58Cr ENDF/B-VI Incident Neutron Sublibrary (MAT 2425)

**Evaluation:**

- **Energy Range:** 10<sup>5</sup> eV to 20 MeV
- **Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33
- **Evaluators:** D. M. Hetrick, D. C. Larson, N. M. Larson, C. Y. Fu (ORNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 Jul</td>
<td>ORNL</td>
<td>D. Hetrick, D. Larson, N. Larson, C. Fu</td>
<td>ENDF/B-VI, MAT 2425 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL</td>
<td>D. Hetrick, D. Larson, N. Larson, C. Fu</td>
<td>ENDF/B-VI, MAT 2425 MOD 1, Release 0</td>
</tr>
<tr>
<td>Evaluation:</td>
<td>$^{52}\text{Cr ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 2431)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Range:</td>
<td>$10^5 \text{ eV to 20 MeV}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>ORNL D. Hetrick, D. Larson, N. Larson, C. Fu</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL D. Hetrick, D. Larson, N. Larson, C. Fu</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{53}\text{Cr ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 2434)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5 \text{ eV to 20 MeV}$</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>ORNL D. Hetrick, D. Larson, N. Larson, C. Fu</td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL D. Hetrick, D. Larson, N. Larson, C. Fu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{54}\text{Cr ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 2437)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5 \text{ eV to 20 MeV}$</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>ORNL D. Hetrick, D. Larson, N. Larson, C. Fu</td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL D. Hetrick, D. Larson, N. Larson, C. Fu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{55}\text{Mn ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 2525)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5 \text{ eV to 20 MeV}$</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>K. Shibata (JAERI, ORNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1988 Mar</td>
<td>JAERI, ORNL K. Shibata (Reviewed by D. Muir)</td>
</tr>
<tr>
<td>1983 Apr</td>
<td>ORNL D. Hetrick, D. Larson, N. Larson, C. Fu</td>
</tr>
</tbody>
</table>

A.10
### ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**

#### $^{54}$Fe ENDF/B-VI Incident Neutron Sublibrary (MAT 2625)

- **Energy Range:** $10^5$ eV to 20 MeV
- **Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33
- **Evaluators:** D. M. Hetrick, C. Y. Fu, N. M. Larson (ORNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 Jul</td>
<td>ORNL</td>
<td>MAT 2625 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL</td>
<td>MAT 2625 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

**Evaluation:**

#### $^{56}$Fe ENDF/B-VI Incident Neutron Sublibrary (MAT 2631)

- **Energy Range:** $10^5$ eV to 20 MeV
- **Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33
- **Evaluators:** D. M. Hetrick, C. Y. Fu, N. M. Larson (ORNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 Jul</td>
<td>ORNL</td>
<td>MAT 2631 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Mar</td>
<td>ORNL</td>
<td>MAT 2631 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

**Evaluation:**

#### $^{57}$Fe ENDF/B-VI Incident Neutron Sublibrary (MAT 2634)

- **Energy Range:** $10^5$ eV to 20 MeV
- **Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33
- **Evaluators:** D. M. Hetrick, C. Y. Fu, N. M. Larson (ORNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 Jul</td>
<td>ORNL</td>
<td>MAT 2634 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL</td>
<td>MAT 2634 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

**Evaluation:**

#### $^{58}$Fe ENDF/B-VI Incident Neutron Sublibrary (MAT 2637)

- **Energy Range:** $10^5$ eV to 20 MeV
- **Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33
- **Evaluators:** D. M. Hetrick, C. Y. Fu, N. M. Larson (ORNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 Jul</td>
<td>ORNL</td>
<td>MAT 2637 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL</td>
<td>MAT 2637 MOD 1, Release 0</td>
</tr>
</tbody>
</table>
## ENDF/B-VI Incident Neutron Sublibrary

### Evaluation:

**\( ^{59} \text{Co ENDF/B-VI Incident Neutron Sublibrary} \) (MAT 2725)**

**Energy Range:** \( 10^5 \text{ eV to 20 MeV} \)

**Files:** 1, 2, 3, 4, 5, 12, 13, 14, 15, 33

**Evaluators:** G. DeSaussure, N. M. Larson, J. A. Harvey, N. W. Hill (ORNL), A. B. Smith, D. Smith, P. Gunther, et al. (ANL); R. Howerton (LLNL), M. Sugimoto (JAERI)

**HISTORY**

- **1992 Jun** ORNL  
  G. deSaussure, N. M. Larson, J. A. Harvey, N. W. Hill  
  ENDF/B-VI  
  MAT 2725 MOD 2, Release 1

- **1989 Jul** ANL, LLNL, JAERI  
  A. Smith, D. Smith, et al.  
  (reviewer: P. Young)  
  ENDF/B-VI  
  MAT 2725 MOD 1, Release 0

### Evaluation:

**\( ^{58} \text{Ni ENDF/B-VI Incident Neutron Sublibrary} \) (MAT 2825)**

**Energy Range:** \( 10^5 \text{ eV to 20 MeV} \)

**Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33

**Evaluators:** D. C. Larson, C. M. Perey, D. M. Hetrick, C. Y. Fu (ORNL)

**HISTORY**

- **1991 Jul** ORNL  
  D. C. Larson, C. M. Perey, D. M. Hetrick, C. Y. Fu  
  ENDF/B-VI  
  MAT 2825 MOD 2, Release 1

- **1989 Oct** ORNL  
  D. C. Larson, C. M. Perey, D. M. Hetrick, C. Y. Fu  
  (reviewer: D. L. Smith)  
  ENDF/B-VI  
  MAT 2825 MOD 1, Release 0

### Evaluation:

**\( ^{59} \text{Ni ENDF/B-VI Incident Neutron Sublibrary} \) (MAT 2831)**

**Energy Range:** \( 10^5 \text{ eV to 20 MeV} \)

**Files:** 1, 2, 3

**Evaluators:** F. Mann (HEDL)

**HISTORY**

- **1983 Jan** HEDL  
  F. Mann  
  ENDF/B-VI  
  MAT 2828 MOD 1, Release 0

### Evaluation:

**\( ^{60} \text{Ni ENDF/B-VI Incident Neutron Sublibrary} \) (MAT 2831)**

**Energy Range:** \( 10^5 \text{ eV to 20 MeV} \)

**Files:** 1, 2, 3, 4, 6, 12, 14, 15, 33

**Evaluators:** D. C. Larson, C. M. Perey, D. M. Hetrick, C. Y. Fu (ORNL)

**HISTORY**

- **1991 Jul** ORNL  
  D. Larson, C. Perey, D. Hetrick, C. Fu  
  ENDF/B-VI  
  MAT 2831 MOD 2, Release 1

- **1989 Oct** ORNL  
  D. Larson, C. Perey, D. Hetrick, C. Fu  
  (reviewer: D. Smith)  
  ENDF/B-VI  
  MAT 2831 MOD 1, Release 0

A.12
<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{61}$Ni ENDF/B-VI Incident Neutron Sublibrary (MAT 2834)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>D. M. Hetrick, C. Y. Fu, D. C. Larson (ORNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2834 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Oct</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson (reviewer: D. L. Smith)</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2834 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{62}$Ni ENDF/B-VI Incident Neutron Sublibrary (MAT 2837)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>D. M. Hetrick, C. Y. Fu, D. C. Larson (ORNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2837 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Oct</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson (reviewer: D. Smith)</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2837 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{64}$Ni ENDF/B-VI Incident Neutron Sublibrary (MAT 2843)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>D. M. Hetrick, C. Y. Fu, D. C. Larson (ORNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2843 MOD 2, Release 1</td>
</tr>
<tr>
<td>1989 Oct</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson (reviewer: D. Smith)</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2843 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{63}$Cu ENDF/B-VI Incident Neutron Sublibrary (MAT 2925)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>D. M. Hetrick, C. Y. Fu, D. C. Larson (ORNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1992 Mar</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2925 MOD 3 (No MOD 2), Release 2</td>
</tr>
<tr>
<td>1989 Nov</td>
<td>ORNL D. Hetrick, C. Fu, D. Larson</td>
</tr>
<tr>
<td>ENDFA/B-VI</td>
<td>MAT 2925 MOD 1, Release 0</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{65}$Cu ENDF/B-VI Incident Neutron Sublibrary (MAT 2931)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 6, 12, 14, 15, 33
Evaluators: D. M. Hetrick, C. Y. Fu, D. C. Larson (ORNL)

HISTORY
1992 Mar ORNL D. Hetrick, C. Fu, D. Larson
ENDF/B-VI MAT 2931 MOD 3 (No MOD 2), Release 2
1989 Nov ORNL D. Hetrick, C. Fu, D. Larson
ENDF/B-VI MAT 2931 MOD 1, Release 0

Evaluation: $^{nat}$Ga ENDF/B-VI Incident Neutron Sublibrary (MAT 3231)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 12, 13, 14, 15
Evaluators: R. Howerton (LLNL), P. G. Young (LANL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 3100 MOD 0, Release 0
1980 May LLNL, LANL R. Howerton, P. G. Young
ENDF/B-V MAT 1459

Evaluation: $^{72}$Ge ENDF/B-VI Incident Neutron Sublibrary (MAT 3234)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. E. Schenter and F. Schmittroth (HEDL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 3231 MOD 0, Release 0
1974 Apr HEDL R. E. Schenter, F. Schmittroth
ENDF/B-V MAT 9050
ENDF/B-IV MAT 0048

Evaluation: $^{72}$Ge ENDF/B-VI Incident Neutron Sublibrary (MAT 3234)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. E. Schenter and F. Schmittroth (HEDL)

HISTORY
1993 Feb BNL NNDC (correction to MF=3, MT=53)
ENDF/B-VI MAT 3234 MOD 2, Release 2
1990 Jan BNL NNDC
ENDF/B-VI MAT 3234 MOD 0, Release 0
1974 Apr HEDL R. E. Schenter and F. Schmittroth
ENDF/B-V MAT 9051
ENDF/B-IV MAT 49

A.14
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:** 74Ge ENDF/B-VI Incident Neutron Sublibrary (MAT 3237)
**Energy Range:** $10^5$ eV to 20 MeV
**Files (MF):** 1, 2, 3, 4, 5
**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**
- 1990 Jan BNL NNDC
- 1974 Apr HEDL
  - ENDF/B-VI MOD 0, Release 0
  - ENDF/B-V MAT 9053 (Translated from ENDF/B-IV)
  - ENDF/B-IV MAT 51

**Evaluation:** 76Ge ENDF/B-VI Incident Neutron Sublibrary (MAT 3243)
**Energy Range:** $10^5$ eV to 20 MeV
**Files (MF):** 1, 2, 3, 4, 5
**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**
- 1990 Jan BNL NNDC
- 1974 Apr HEDL
  - ENDF/B-VI MAT 3243 MOD 0, Release 0
  - ENDF/B-V MAT 9056
  - ENDF/B-IV MAT 0054

**Evaluation:** 75As ENDF/B-VI Incident Neutron Sublibrary (MAT 3325)
**Energy Range:** $10^5$ eV to 20 MeV
**Files (MF):** 1, 2, 3, 4, 5
**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**
- 1990 Jan BNL NNDC
- 1974 Apr HEDL
  - ENDF/B-VI MAT 3325 MOD 0, Release 0
  - ENDF/B-V MAT 9071 (Translated from ENDF/B-IV)
  - ENDF/B-IV MAT 0068

**Evaluation:** 74Se ENDF/B-VI Incident Neutron Sublibrary (MAT 3425)
**Energy Range:** $10^5$ eV to 20 MeV
**Files (MF):** 1, 2, 3, 4, 5
**Evaluators:** F. Mann (HEDL)

**HISTORY**
- 1990 Jan BNL NNDC
- 1974 Apr HEDL
  - ENDF/B-VI MAT 3425 MOD 0, Release 0
  - ENDF/B-V MAT 9089

A.15
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: 76Se ENDF/B-VI Incident Neutron Sublibrary (MAT 3431)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL       NNDC
         END/F/B-VI       MAT 3431 MOD 0, Release 0
1974 Apr  HEDL      R. E. Schenter, F. Schmittroth
         END/F/B-V       MAT 9056 (Translated from ENDF/B-IV)
         END/F/B-IV       MAT 0085

Evaluation: 77Se ENDF/B-VI Incident Neutron Sublibrary (MAT 3434)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL       NNDC
         END/F/B-VI       MAT 3434 MOD 0, Release 0
1974 Apr  HEDL      R. E. Schenter, F. Schmittroth
         END/F/B-V       MAT 9092
         END/F/B-IV       MAT 0086

Evaluation: 78Se ENDF/B-VI Incident Neutron Sublibrary (MAT 3437)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL       NNDC
         END/F/B-VI       MAT 3437 MOD 0, Release 0
1974 Apr  HEDL      R. E. Schenter, F. Schmittroth
         END/F/B-V       MAT 9094
         END/F/B-IV       MAT 0088

Evaluation: 80Se ENDF/B-VI Incident Neutron Sublibrary (MAT 3443)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL       NNDC
         END/F/B-VI       MAT 3443 MOD 0, Release 0
1974 Apr  HEDL      R. E. Schenter, F. Schmittroth
         END/F/B-V       MAT 9097
         END/F/B-IV       MAT 0091

A.16
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: 82Se ENDF/B-VI Incident Neutron Sublibrary (MAT 3449)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 3449 MOD 0, Release 0
1974 Apr HEDL R. E. Schenter, F. Schmittroth
ENDF/B-V MAT 9100 (Translated from ENDF/B-IV)
ENDF/B-IV MAT 0094

Evaluation: 79Br ENDF/B-VI Incident Neutron Sublibrary (MAT 3525)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 3525 MOD 0, Release 0
1974 Apr HEDL R. E. Schenter, F. Schmittroth
ENDF/B-V MAT 9113
ENDF/B-IV MAT 0108

Evaluation: 81Br ENDF/B-VI Incident Neutron Sublibrary (MAT 3531)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 3531 MOD 0, Release 0
1974 Apr HEDL R. E. Schenter, F. Schmittroth
ENDF/B-V MAT 9117
ENDF/B-IV MAT 0112

Evaluation: 78Kr ENDF/B-VI Incident Neutron Sublibrary (MAT 3625)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: A. Prince (BNL)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 3625 MOD 0, Release 0
1978 Apr BNL A. Prince
ENDF/B-V MAT 1330
ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{80}$Kr ENDF/B-VI Incident Neutron Sublibrary (MAT 3631)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>A. Prince (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1978 Apr</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{82}$Kr ENDF/B-VI Incident Neutron Sublibrary (MAT 3637)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>A. Prince (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1978 Apr</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{83}$Kr ENDF/B-VI Incident Neutron Sublibrary (MAT 3640)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>A. Prince (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1978 Apr</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{84}$Kr ENDF/B-VI Incident Neutron Sublibrary (MAT 3643)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>A. Prince (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1978 Apr</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**

<table>
<thead>
<tr>
<th><strong>Kr ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 3646)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
</tbody>
</table>

**Evaluation:**

<table>
<thead>
<tr>
<th><strong>Kr ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 3649)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>1978 Apr</td>
</tr>
<tr>
<td>1978 Apr</td>
</tr>
<tr>
<td>1978 Apr</td>
</tr>
</tbody>
</table>

**Evaluation:**

<table>
<thead>
<tr>
<th><strong>Rb ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 3725)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>1979 Oct</td>
</tr>
<tr>
<td>1979 Oct</td>
</tr>
</tbody>
</table>

**Evaluation:**

<table>
<thead>
<tr>
<th><strong>Rb ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 3728)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Range:</strong></td>
</tr>
<tr>
<td><strong>Files (MF):</strong></td>
</tr>
<tr>
<td><strong>Evaluators:</strong></td>
</tr>
<tr>
<td><strong>HISTORY</strong></td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
</tbody>
</table>
### ENDF/B-VI Incident Neutron Sublibrary

#### 87Rb ENDF/B-VI Incident Neutron Sublibrary (MAT 3731)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** A. Prince (BNL), BRC

**HISTORY**  
<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 3731 MOD 0, Release 0</td>
</tr>
<tr>
<td>1979 Oct</td>
<td>BNL,BRC</td>
<td>A. Prince</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1341</td>
</tr>
</tbody>
</table>

#### 84Sr ENDF/B-VI Incident Neutron Sublibrary (MAT 3825)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** F. Mann (HEDL)

**HISTORY**  
<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 3825 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL</td>
<td>F. Mann</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9179</td>
</tr>
</tbody>
</table>

#### 86Sr ENDF/B-VI Incident Neutron Sublibrary (MAT 3831)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**  
<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 3831 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R. E. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9182 (Translated from ENDF/B-IV)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 0172</td>
</tr>
</tbody>
</table>

#### 87Sr ENDF/B-VI Incident Neutron Sublibrary (MAT 3834)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**  
<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 3834 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R. E. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9183 (Translated from ENDF/B-IV)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 0173</td>
</tr>
</tbody>
</table>

A.20
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{88}$Sr ENDF/B-VI Incident Neutron Sublibrary (MAT 3837)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL       NNDC
          ENDF/B-VI  MAT 3837 MOD 0, Release 0
1974 Apr  HEDL      R. E. Schenter, F. Schmittroth
          ENDF/B-V   MAT 9185 (Translated from ENDF/B-IV)
          ENDF/B-IV  MAT 0175

Evaluation: $^{89}$Sr ENDF/B-VI Incident Neutron Sublibrary (MAT 3840)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL       NNDC
          ENDF/B-VI  MAT 3840 MOD 0, Release 0
1974 Apr  HEDL      R. E. Schenter, F. Schmittroth
          ENDF/B-V   MAT 9186
          ENDF/B-IV  MAT 0176

Evaluation: $^{90}$Sr ENDF/B-VI Incident Neutron Sublibrary (MAT 3843)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL       NNDC
          ENDF/B-VI  MAT 3843 MOD 0, Release 0
1974 Apr  HEDL      R. E. Schenter, F. Schmittroth
          ENDF/B-V   MAT 9187
          ENDF/B-IV  MAT 0177

Evaluation: $^{99}$Y ENDF/B-VI Incident Neutron Sublibrary (MAT 3925)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 12, 13, 14, 15, 33
Evaluators: R. Howerton (LLNL); A. B. Smith, D. L. Smith, P. Rousset, R. D. Lawson (ANL)

HISTORY
1996 Oct  BNL, LANL  P. Young, V. McLane
          ENDF/B-VI  MAT 3925 MOD 2, Release 4
1990 Jan  BNL       NNDC
          ENDF/B-VI  MAT 3925 MOD 0, Release 0
1986 Jan  ANL, LLNL  R. Howerton, A. Smith, D. Smith, P. Rousset, R. Lawson
          ENDF/B-V   MAT 9202  (Reviewers: R. Schenter, P. Young)

A.21
ENDF/B-VI Incident Neutron Sublibrary

| Evaluation: | ⁹⁰Y ENDF/B-VI Incident Neutron Sublibrary (MAT 3928) |
| Energy Range: | $10^{-5}$ eV to 20 MeV |
| Files (MF): | 1, 2, 3, 4, 5 |
| Evaluators: | R. E. Schenter, F. Schmittroth (HEDL) |

| HISTORY |
| 1990 Jan | BNL | NNDC |
| 1974 Apr | HEDL | R. E. Schenter, F. Schmittroth |

| Evaluation: | ⁹¹Y ENDF/B-VI Incident Neutron Sublibrary (MAT 3931) |
| Energy Range: | $10^{-5}$ eV to 20 MeV |
| Files (MF): | 1, 2, 3, 4, 5 |
| Evaluators: | R. E. Schenter, F. Schmittroth (HEDL) |

| HISTORY |
| 1990 Jan | BNL | NNDC |
| 1974 Apr | HEDL | R. E. Schenter, F. Schmittroth |

| Evaluation: | natZr ENDF/B-VI Incident Neutron Sublibrary (MAT 4000) |
| Energy Range: | $10^{-5}$ eV to 20 MeV |
| Files: | 1, 2, 3, 4, 5 |
| Evaluators: | M. Drake, D. Sragis, T. Maung (SAI), P. Rose (BNL) |

| HISTORY |
| 1991 Aug | BNL | NNDC |
| 1990 Jan | BNL | NNDC |
| 1976 Apr | SAI | M. Drake, D. Sragis, T. Maung, P. Rose |

| Evaluation: | ⁹⁰Zr ENDF/B-VI Incident Neutron Sublibrary (MAT 4025) |
| Energy Range: | $10^{-5}$ eV to 20 MeV |
| Files (MF): | 1, 2, 3, 4, 5, 8,9 |
| Evaluators: | M. Drake, D. Sragis, T. Maung (SAI), P. Rose (BNL) |

| HISTORY |
| 1990 Jan | BNL | NNDC |
| 1981 | SAI | M. Drake, D. Sragis, T. Maung, P. Rose |
| 1976 Apr | SAI | M. Drake, D. Sragis, T. Maung |

A.22
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**  
$^{91}$Zr ENDF/B-VI Incident Neutron Sublibrary (MAT 4028)

**Energy Range:**  
$10^5$ eV to 20 MeV

**Files (MF):**  
1, 2, 3, 4, 5

**Evaluators:**  
M. Drake, D. Sragis, T. Maung (SAI), P. Rose (BNL)

**HISTORY**

1990 Jan  
BNL  
ENDF/B-VI  
MAT 4028 MOD 0, Release 0  
NNDC

1976 Apr  
SAI  
ENDF/B-V  
MAT 1386  
M. Drake, D. Sargis, T. Maung, P. Rose

**Evaluation:**  
$^{92}$Zr ENDF/B-VI Incident Neutron Sublibrary (MAT 4031)

**Energy Range:**  
$10^5$ eV to 20 MeV

**Files (MF):**  
1, 2, 3, 4, 5, 8, 9

**Evaluators:**  
M. Drake, D. Sragis, T. Maung (SAI), P. Rose (BNL)

**HISTORY**

1990 Jan  
BNL  
ENDF/B-VI  
MAT 4031 MOD 0, Release 0  
NNDC

1976 Apr  
SAI  
ENDF/B-V  
MAT 1387  
M. Drake, D. Sargis, T. Maung, P. Rose

**Evaluation:**  
$^{93}$Zr ENDF/B-VI Incident Neutron Sublibrary (MAT 4034)

**Energy Range:**  
$10^5$ eV to 20 MeV

**Files (MF):**  
1, 2, 3, 4, 5

**Evaluators:**  
R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**

1990 Jan  
BNL  
ENDF/B-VI  
MAT 4031 MOD 0, Release 0  
NNDC

1974 Apr  
HEDL  
ENDF/B-V  
MAT 9232  
R. E. Schenter, F. Schmittroth

1974 Apr  
ENDF/B-IV  
MAT 0219

**Evaluation:**  
$^{94}$Zr ENDF/B-VI Incident Neutron Sublibrary (MAT 4037)

**Energy Range:**  
$10^5$ eV to 20 MeV

**Files (MF):**  
1, 2, 3, 4, 5, 8, 9

**Evaluators:**  
M. Drake, D. Sragis, T. Maung (SAI), P. Rose (BNL)

**HISTORY**

1990 Jan  
BNL  
ENDF/B-VI  
MAT 4037 MOD 0, Release 0  
NNDC

1976 Apr  
SAI  
ENDF/B-V  
MAT 1388  
M. Drake, D. Sargis, T. Maung, P. Rose
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{95}$Zr ENDF/B-VI Incident Neutron Sublibrary (MAT 4040)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL  NNDC
    ENDF/B-VI  MAT 4040 MOD 0, Release 0
1974 Apr  HEDL  R. E. Schenter, F. Schmittroth
    ENDF/B-V  MAT 9234
    ENDF/B-IV  MAT 0221

Evaluation: $^{96}$Zr ENDF/B-VI Incident Neutron Sublibrary (MAT 4043)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: M. Drake, D. Sragis, T. Maung (SAI), P. Rose (BNL)

HISTORY
1990 Jan  BNL  NNDC
    ENDF/B-VI  MAT 4043 MOD 0, Release 0
1974 Apr  SAI  M. Drake, D. Sragis, T. Maung, P. Rose
    ENDF/B-V  MAT 1389

Evaluation: $^{93}$Nb ENDF/B-VI Incident Neutron Sublibrary (MAT 4125)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 15, 33, 40
Evaluators: A. B. Smith, D. L. Smith, L. P. Gerardo (ANL); R. J. Howerton (LLNL)

HISTORY
1991 Aug  BNL  NNDC
    ENDF/B-VI  MAT 4125 MOD 2, Release 1
1990 Mar  ANL,LLNL  A. Smith, D. Smith, L. Gerardo, R. Howerton
    ENDF/B-VI  MAT 4125 MOD 1, Release 0

Evaluation: $^{94}$Nb ENDF/B-VI Incident Neutron Sublibrary (MAT 4128)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan  BNL  NNDC
    ENDF/B-VI  MAT 4128 MOD 0, Release 0
1974 Apr  HEDL  R. E. Schenter, F. Schmittroth
    ENDF/B-V  MAT 9251
    ENDF/B-IV  MAT 238
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**  
**95Nb ENDf/B-VI Incident Neutron Sublibrary** (MAT 4131)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**  
1990 Jan BNL NNDC  
1974 Apr HEDL,ANC R. E. Schenter, F. Schmittroth  
ENDF/B-V MAT 9253  
ENDF/B-IV MAT 240

**Evaluation:**  
**99Mo ENDf/B-VI Incident Neutron Sublibrary** (MAT 4200)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 12, 13, 14, 15  
**Evaluators:** R. Howerton (LLNL); R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**  
1990 Jan BNL NNDC  
1979 Feb HEDL,INEL R. Howerton, R.E. Schenter, F. Schmittroth  
ENDF/B-V MAT 1321

**Evaluation:**  
**92Mo ENDf/B-VI Incident Neutron Sublibrary** (MAT 4225)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 8, 9  
**Evaluators:** R. E. Schenter, D. L. Johnson, F. Mann, F. Schmittroth (HEDL); H. Gruppelaar (RCN)

**HISTORY**  
1990 Jan BNL NNDC  
ENDF/B-V MAT 9278

**Evaluation:**  
**94Mo ENDf/B-VI Incident Neutron Sublibrary** (MAT 4231)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

**HISTORY**  
1990 Jan BNL NNDC  
ENDF/B-V MAT 9281

A.25
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{95}$Mo ENDF/B-VI Incident Neutron Sublibrary (MAT 4234)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 4234 MOD 0, Release 0
ENDF/B-V MAT 9282

Evaluation: $^{96}$Mo ENDF/B-VI Incident Neutron Sublibrary (MAT 4237)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 4237 MOD 0, Release 0
ENDF/B-V MAT 9283

Evaluation: $^{97}$Mo ENDF/B-VI Incident Neutron Sublibrary (MAT 4240)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 4240 MOD 0, Release 0
ENDF/B-V MAT 9284

Evaluation: $^{98}$Mo ENDF/B-VI Incident Neutron Sublibrary (MAT 4243)
Material: 4243 MOD 0 (January 1990)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, D. Johnson, F. Mann, F. Schmittroth (HEDL); H. Gruppelaar (RCN)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 4243 MOD 0, Release 0
ENDF/B-V MAT 9285

A.26
### ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{99}$Mo ENDF/B-VI Incident Neutron Sublibrary (MAT 4246)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL); C. Reich (INEL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 4246 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL, INEL</td>
</tr>
<tr>
<td></td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 9286</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{100}$Mo ENDF/B-VI Incident Neutron Sublibrary (MAT 4249)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, D. Johnson, F. Mann, F. Schmittroth (HEDL); H. Gruppelaar (RCN)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 4249 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL, RCN</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 9287</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{99}$Tc ENDF/B-VI Incident Neutron Sublibrary (MAT 4325)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, D. Johnson, F. Mann, F. Schmittroth (HEDL); H. Gruppelaar (RCN); Z. Livolsi (BAW)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 4325 MOD 0, Release 0</td>
</tr>
<tr>
<td>1978 Nov</td>
<td>HEDL, BAW, RCN</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 1308</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{96}$Ru ENDF/B-VI Incident Neutron Sublibrary (MAT 4425)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>F. Mann (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 4425 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL</td>
</tr>
<tr>
<td></td>
<td>F. Mann</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 9325</td>
</tr>
</tbody>
</table>
### ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>98Ru ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 4431)</td>
</tr>
<tr>
<td>Energy Range:</td>
</tr>
<tr>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
</tr>
<tr>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
</tr>
<tr>
<td>F. Mann (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>BNL</td>
</tr>
<tr>
<td>NNDC</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>MAT 4431 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
</tr>
<tr>
<td>HEDL</td>
</tr>
<tr>
<td>F. Mann</td>
</tr>
<tr>
<td>ENDF/B-V</td>
</tr>
<tr>
<td>MAT 9327</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>99Ru ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 4434)</td>
</tr>
<tr>
<td>Energy Range:</td>
</tr>
<tr>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
</tr>
<tr>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
</tr>
<tr>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>BNL</td>
</tr>
<tr>
<td>NNDC</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>MAT 4434 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
</tr>
<tr>
<td>HEDL</td>
</tr>
<tr>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td>ENDF/B-V</td>
</tr>
<tr>
<td>MAT 9328</td>
</tr>
<tr>
<td>ENDF/B-IV</td>
</tr>
<tr>
<td>MAT 308</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>100Ru ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 4437)</td>
</tr>
<tr>
<td>Energy Range:</td>
</tr>
<tr>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
</tr>
<tr>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
</tr>
<tr>
<td>R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar (RCN)</td>
</tr>
<tr>
<td>HISTORY</td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>BNL</td>
</tr>
<tr>
<td>NNDC</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>MAT 4437 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
</tr>
<tr>
<td>HEDL, RCN</td>
</tr>
<tr>
<td>ENDF/B-V</td>
</tr>
<tr>
<td>MAT 9329</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>101Ru ENDF/B-VI Incident Neutron Sublibrary</strong> (MAT 4440)</td>
</tr>
<tr>
<td>Energy Range:</td>
</tr>
<tr>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
</tr>
<tr>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
</tr>
<tr>
<td>R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. L. Johnson, G. Neely (HEDL); H. Grupelaar (RCN)</td>
</tr>
<tr>
<td>HISTORY</td>
</tr>
<tr>
<td>1991 Oct</td>
</tr>
<tr>
<td>ORNL</td>
</tr>
<tr>
<td>R. Q. Wright</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>MAT 4440 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Jan</td>
</tr>
<tr>
<td>BNL</td>
</tr>
<tr>
<td>NNDC</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>MAT 4440 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
</tr>
<tr>
<td>HEDL, RCN</td>
</tr>
<tr>
<td>ENDF/B-V</td>
</tr>
<tr>
<td>MAT 9330</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{103}$Ru ENDF/B-VI Incident Neutron Sublibrary (MAT 4443)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. L. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Oct</td>
<td>ORNL R. Q. Wright</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL ENDF/B-VI MAT 4443 MOD 2, Release 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{103}$Ru ENDF/B-VI Incident Neutron Sublibrary (MAT 4446)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL NNDC</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL ENDF/B-VI MAT 4446 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL, RCN R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td>ENDF/B-V</td>
<td>MAT 9332</td>
</tr>
<tr>
<td>ENDF/B-IV</td>
<td>MAT 312</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{104}$Ru ENDF/B-VI Incident Neutron Sublibrary (MAT 4449)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL NNDC</td>
</tr>
<tr>
<td>ENDF/B-V</td>
<td>MAT 9333</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{105}$Ru ENDF/B-VI Incident Neutron Sublibrary (MAT 4452)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL NNDC</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL, ANC R. Schenter, F. Schmittroth, C. Reich</td>
</tr>
<tr>
<td>ENDF/B-V</td>
<td>MAT 9334</td>
</tr>
<tr>
<td>ENDF/B-IV</td>
<td>MAT 314</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{106}$Ru ENDF/B-VI Incident Neutron Sublibrary (MAT 4455)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan BNL
ENDF/B-VI
NNDC
1974 Apr HEDL, ANC
R. Schenter, F. Schmittroth, C. Reich
ENDF/B-V
MAT 9335
ENDF/B-IV
MAT 315

Evaluation: $^{103}$Rh ENDF/B-VI Incident Neutron Sublibrary (MAT 4525)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, D. L. Johnson, F. Mann, F. Schmittroth (HEDL); H. Gruppelaar (RCN); Z. Livolsi (BAW)

HISTORY
1990 Jan BNL
ENDF/B-VI
NNDC
1978 Nov HEDL, BAW, RCN
ENDF/B-V
MAT 1310

Evaluation: $^{105}$Rh ENDF/B-VI Incident Neutron Sublibrary (MAT 4531)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan BNL
ENDF/B-VI
NNDC
1974 Apr HEDL, ANC
R. Schenter, F. Schmittroth, C. Reich
ENDF/B-V
MAT 9355
ENDF/B-IV
MAT 334

Evaluation: $^{102}$Pd ENDF/B-VI Incident Neutron Sublibrary (MAT 4625)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: F. Mann (HEDL)

HISTORY
1990 Jan BNL
ENDF/B-VI
NNDC
1980 Feb HEDL
F. Mann
ENDF/B-V
MAT 9379

A.30
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{104}$Pd ENDF/B-VI Incident Neutron Sublibrary (MAT 4631)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar (RCN)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 4631 MOD 0, Release 0
ENDF/B-V MAT 9381

Evaluation: $^{105}$Pd ENDF/B-VI Incident Neutron Sublibrary (MAT 4634)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. Schenter, F. Schmittroth, F. Mann (HEDL); H. Grupelaar, et al. (RCN)

HISTORY
ENDF/B-VI MAT 4634 MOD 1, Release 0

Evaluation: $^{106}$Pd ENDF/B-VI Incident Neutron Sublibrary (MAT 4637)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth, F. Mann, D. L. Johnson, G. Neely (HEDL); H. Grupelaar (RCN)

HISTORY
1990 Jan BNL NNDC
ENDF/B-VI MAT 4637 MOD 0, Release 0
ENDF/B-V MAT 9383

Evaluation: $^{107}$Pd ENDF/B-VI Incident Neutron Sublibrary (MAT 4640)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. Schenter, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar (RCN)

HISTORY
ENDF/B-VI MAT 4640 MOD 1, Release 0

A.31
ENDF/B-VI Incident Neutron Sublibrary

| Evaluation: | $^{108}$pd ENDF/B-VI Incident Neutron Sublibrary (MAT 4643) |
| Energy Range: | $10^5$ eV to 20 MeV |
| Files (MF): | 1, 2, 3, 4, 5 |
| Evaluators: | R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar, et al. (RCN) |
| HISTORY | |
| 1990 Jan | BNL | NNDC |
| 1980 Feb | ENDF/B-VI | MAT 4643 MOD 0, Release 0 |
| 1980 Feb | ENDF/B-V | MAT 9386 |

| Evaluation: | $^{110}$Pd ENDF/B-VI Incident Neutron Sublibrary (MAT 4649) |
| Energy Range: | $10^5$ eV to 20 MeV |
| Files (MF): | 1, 2, 3, 4, 5 |
| Evaluators: | R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar, et al. (RCN) |
| HISTORY | |
| 1990 Jan | BNL | NNDC |
| 1980 Feb | ENDF/B-VI | MAT 4649 MOD 0, Release 0 |
| 1980 Feb | ENDF/B-V | MAT 9389 |

| Evaluation: | $^{107}$Ag ENDF/B-VI Incident Neutron Sublibrary (MAT 4725) |
| Energy Range: | $10^5$ eV to 20 MeV |
| Files (MF): | 1, 2, 3, 4, 5 |
| Evaluators: | A. Prince (BNL), R. Schenter (HEDL) |
| HISTORY | |
| 1990 Jan | BNL | NNDC |
| 1993 Jun | ENDF/B-VI | MAT 4725 MOD 0, Release 0 |
| 1993 Jun | BNL, HEDL | A. Prince, R. Schenter |
| 1993 Jun | ENDF/B-V | MAT 1407 |

| Evaluation: | $^{109}$Ag ENDF/B-VI Incident Neutron Sublibrary (MAT 4731) |
| Energy Range: | $10^5$ eV to 20 MeV |
| Files (MF): | 1, 2, 3, 4, 5, 8, 9 |
| Evaluators: | A. Prince (BNL), R. Schenter (HEDL) |
| HISTORY | |
| 1990 Jan | BNL | NNDC |
| 1993 Jun | ENDF/B-VI | MAT 4731 MOD 0, Release 0 |
| 1993 Jun | BNL, HEDL | A. Prince, R. Schenter |
| 1993 Jun | ENDF/B-V | MAT 1409 |
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{111}$Ag ENDF/B-VI Incident Neutron Sublibrary (MAT 4737)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Jan
BNL
ENDF/B-VI
NNDC
MAT 4737 MOD 0, Release 0

1974 Apr
HEDL, ANC
ENDF/B-V
R. Schenter, F. Schmittroth, C. Reich
MAT 9415

Evaluation: $^{106}$Cd ENDF/B-VI Incident Neutron Sublibrary (MAT 4825)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: J. McCabe, A. B. Smith, J. W. Meadows (ANL); R. Q. Wright (ORNL)

HISTORY
1996 Aug
ORNL, NNDC
ENDF/B-VI
R. Q. Wright, V. McLane
MAT 4825 MOD 4, Release 4

1994 Aug
ANL
ENDF/B-VI
J. McCabe, A. Smith, J. Meadows (reviewer: P. Young)
MAT 4825 MOD 3, Release 3 (mislabeled MOD 1)

1991 Dec
ORNL
ENDF/B-VI
R. Q. Wright
MAT 4825 MOD 2, Release 2

1990 Jan
BNL
ENDF/B-VI
NNDC
MAT 4825 MOD 0, Release 0

1980 Feb
HEDL
ENDF/B-V
F. Mann
MAT 9440

A.33
<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{108}$Cd ENDF/B-VI Incident Neutron Sublibrary (MAT 4831)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>J. McCabe, A. B. Smith, J. W. Meadows (UAZ,ANL); R. Q. Wright (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Evaluator(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Aug</td>
<td>ORNL,NNDC</td>
<td>R.Q. Wright, V. McLane</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4825 MOD 4, Release 4</td>
</tr>
<tr>
<td>1994 Aug</td>
<td>ANL</td>
<td>J. McCabe, A. Smith, J. Meadows (reviewer: P. Young)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4831 MOD 3, Release 3 (mislabeled MOD 1)</td>
</tr>
<tr>
<td>1991 Oct</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4831 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4831 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R.E. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9442</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{110}$Cd ENDF/B-VI Incident Neutron Sublibrary (MAT 4837)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>J. McCabe, A. B. Smith, J. W. Meadows (UAZ,ANL); R. Q. Wright (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Evaluator(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Aug</td>
<td>ORNL,NNDC</td>
<td>R.Q. Wright, V. McLane</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4825 MOD 4, Release 4</td>
</tr>
<tr>
<td>1994 Aug</td>
<td>ANL</td>
<td>J. McCabe, A. Smith, J. Meadows (reviewer: P. Young)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4837 MOD 3, Release 3 (mislabeled MOD 1)</td>
</tr>
<tr>
<td>1991 Oct</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4837 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4837 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R.E. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9444</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{111}$Cd ENDF/B-VI Incident Neutron Sublibrary (MAT 4840)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>J. McCabe, A. B. Smith, J. W. Meadows (UAZ,ANL); R. Q. Wright (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Evaluator(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994 Aug</td>
<td>ANL</td>
<td>J. McCabe, A. Smith, J. Meadows (reviewer: P. Young)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4840 MOD 1, Release 3</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 4840 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R.E. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9445</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:** $^{125}$Cd ENDF/B-VI Incident Neutron Sublibrary (MAT 4843)
**Energy Range:** $10^5$ eV to 20 MeV
**Files:** 1, 2, 3, 4, 5
**Evaluators:** J. McCabe, A. B. Smith, J. W. Meadows (UAZ,ANL); R. Q. Wright (ORNL)

**HISTORY**
1996 Aug ORNL,NNDC R.Q. Wright, V. McLane
ENDF/B-VI MAT 4825 MOD 4, Release 4
1994 Aug ANL J. McCabe, A. Smith, J. Meadows (reviewer: P. Young)
ENDF/B-VI MAT 4843 MOD 3, Release 3 (mislabeled MOD 1)
1991 Oct ORNL R. Q. Wright
ENDF/B-VI MAT 4843 MOD 2, Release 2
1990 Jan BNL NNDC
ENDF/B-VI MAT 4831 MOD 0, Release 0
1974 Apr HEDL R.E. Schenter, F. Schmittroth
ENDF/B-V MAT 9447

**Evaluation:** $^{135}$Cd ENDF/B-VI Incident Neutron Sublibrary (MAT 4846)
**Energy Range:** $10^5$ eV to 20 MeV
**Files:** 1, 2, 3, 4, 5
**Evaluators:** J. McCabe, A. B. Smith, J. W. Meadows (UAZ,ANL); R. Q. Wright (ORNL)

**HISTORY**
1994 Aug ANL J. McCabe, A. Smith, J. Meadows (reviewer: P. Young)
ENDF/B-VI MAT 4846 MOD 1, Release 3
1990 Jan BNL NNDC
ENDF/B-VI MAT 4831 MOD 0, Release 0
1978 Nov BNL,HEDL S. Pearlstein, F. Mann, R. Schenter
ENDF/B-V MAT 1318

**Evaluation:** $^{145}$Cd ENDF/B-VI Incident Neutron Sublibrary (MAT 4849)
**Energy Range:** $10^5$ eV to 20 MeV
**Files:** 1, 2, 3, 4, 5
**Evaluators:** J. McCabe, A. B. Smith, J. W. Meadows (UAZ,ANL); R. Q. Wright (ORNL)

**HISTORY**
1996 Aug ORNL,NNDC R.Q. Wright, V. McLane
ENDF/B-VI MAT 4825 MOD 4, Release 4
1994 Aug ANL J. McCabe, A. Smith, J. Meadows (reviewer: P. Young)
ENDF/B-VI MAT 4849 MOD 3, Release 3 (mislabeled MOD 1)
1991 Dec ORNL R. Q. Wright
ENDF/B-VI MAT 4849 MOD 2, Release 2
1990 Jan BNL NNDC
ENDF/B-VI MAT 4831 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9450

A.35
**ENDF/B-VI Incident Neutron Sublibrary**

**Evaluation:***

<table>
<thead>
<tr>
<th>Isotope</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 4853)</th>
<th>Energy Range:</th>
<th>10^{-5} eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 4853 MOD 0, Release 0</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>NNDC</td>
<td>ENDF/B-VI</td>
<td>MAT 4853 MOD 0, Release 0</td>
</tr>
<tr>
<td>1994 Apr</td>
<td>HEDL, ANC</td>
<td>ENDF/B-V</td>
<td>MAT 9452</td>
</tr>
<tr>
<td>1994 Apr</td>
<td>R. Schenter, F. Schmittroth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990 Jan</td>
<td>ENDF/B-IV</td>
<td>MAT 425</td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation:***

<table>
<thead>
<tr>
<th>Isotope</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 4855)</th>
<th>Energy Range:</th>
<th>10^{-5} eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluators:</td>
<td>J. McCabe, A. B. Smith, J. W. Meadows (UAZ, ANL); R. Q. Wright (ORNL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Aug</td>
<td>ORNL, NNDC</td>
<td>ENDF/B-VI</td>
<td>MAT 4825 MOD 4, Release 4</td>
</tr>
<tr>
<td>1994 Aug</td>
<td>ANL</td>
<td>ENDF/B-VI</td>
<td>MAT 4855 MOD 3, Release 3 (mislabeled MOD 1)</td>
</tr>
<tr>
<td>1991 Dec</td>
<td>ORNL</td>
<td>ENDF/B-VI</td>
<td>MAT 4855 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 4855 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>ENDF/B-V</td>
<td>MAT 9453</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>R. Schenter, F. Schmittroth</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation:***

<table>
<thead>
<tr>
<th>Isotope</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 4900)</th>
<th>Energy Range:</th>
<th>10^{-5} eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5, 12, 13, 14, 15, 33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluators:</td>
<td>A. B. Smith, D. L. Smith, P. Guenther (ANL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>ANL</td>
<td>ENDF/B- VI</td>
<td>MAT 4900 MOD 1, Release 0</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>A. B. Smith, D. L. Smith, P. Guenther</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation:***

<table>
<thead>
<tr>
<th>Isotope</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 4925)</th>
<th>Energy Range:</th>
<th>10^{-5} eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Jan</td>
<td>BNL</td>
<td>ENDF/B- VI</td>
<td>MAT 4925 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>ENDF/B- V</td>
<td>MAT 9473</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>ENDF/B-IV</td>
<td>MAT 445</td>
<td></td>
</tr>
</tbody>
</table>

---

A.36
### ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>Energy Range: $10^5$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 8, 9, 10, 33, 40</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL); D. L. Smith, S. Chiba (ANL)</td>
</tr>
</tbody>
</table>

#### HISTORY

- **1990 Mar**
  - HEDL, ANL
  - R. Schenter, F. Schmittroth, D. L. Smith, S. Chiba
  - ENDF/B-VI
  - MAT 4900 MOD 1, Release 0

### Evaluation: $^{115}$In ENDF/B-VI Incident Neutron Sublibrary (MAT 4900)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>Energy Range: $10^5$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>F. M. Mann (HEDL)</td>
</tr>
</tbody>
</table>

#### HISTORY

- **1991 Aug**
  - BNL
  - NNDC
  - ENDF/B-VI
  - MAT 5025 MOD 2, Release 1
- **1990 Feb**
  - BNL
  - NNDC
  - ENDF/B-VI
  - MAT 5025 MOD 0, Release 0
- **1980 Feb**
  - HEDL
  - F. Mann
  - ENDF/B-V
  - MAT 5913

### Evaluation: $^{112}$Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5025)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>Energy Range: $10^5$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>F. M. Mann (HEDL)</td>
</tr>
</tbody>
</table>

#### HISTORY

- **1991 Aug**
  - BNL
  - NNDC
  - ENDF/B-VI
  - MAT 5031 MOD 2, Release 1
- **1990 Feb**
  - BNL
  - NNDC
  - ENDF/B-VI
  - MAT 5031 MOD 0, Release 0
- **1980 Feb**
  - HEDL
  - F. Mann
  - ENDF/B-V
  - MAT 5916

### Evaluation: $^{114}$Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5031)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>Energy Range: $10^5$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>F. M. Mann (HEDL)</td>
</tr>
</tbody>
</table>

#### HISTORY

- **1991 Aug**
  - BNL
  - NNDC
  - ENDF/B-VI
  - MAT 5031 MOD 2, Release 1
- **1990 Feb**
  - BNL
  - NNDC
  - ENDF/B-VI
  - MAT 5031 MOD 0, Release 0
- **1980 Feb**
  - HEDL
  - F. Mann
  - ENDF/B-V
  - MAT 5916

### Evaluation: $^{115}$Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5034)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>Energy Range: $10^5$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
</tbody>
</table>

#### HISTORY

- **1990 Feb**
  - BNL
  - NNDC
  - ENDF/B-VI
  - MAT 5034 MOD 0, Release 0
- **1974 Apr**
  - HEDL
  - R. Schenter, F. Schmittroth
  - ENDF/B-V
  - MAT 5917
  - ENDF/B-IV
  - MAT 482
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{116}$Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5037)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5037 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9518
ENDF/B-IV MAT 483

Evaluation: $^{117}$Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5040)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5040 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9519
ENDF/B-IV MAT 484

Evaluation: $^{118}$Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5043)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5043 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9521
ENDF/B-IV MAT 486

Evaluation: $^{119}$Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5046)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5046 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9522
ENDF/B-IV MAT 487

A.38
ENERGY RANGE:

Files (MF): 1, 2, 3, 8, 9

EVALUATORS:

R. Schenter, F. Schmittroth (HEDL)

HISTORY

- 1990 Feb
  - BNL
  - ENDF/B-VI
  - MAT 5049 MOD 0, Release 0

- 1974 Oct
  - HEDL
  - ENDF/B-V
  - MAT 9524
  - ENDF/B-IV
  - MAT 489

- 1990 Jan
  - BNL
  - ENDF/B-VI
  - MAT 5055 MOD 0, Release 0

- 1974 Oct
  - HEDL
  - ENDF/B-V
  - MAT 9527
  - ENDF/B-IV
  - MAT 492

- 1990 Feb
  - BNL
  - ENDF/B-VI
  - MAT 5061 MOD 0, Release 0

- 1974 Oct
  - HEDL
  - ENDF/B-V
  - MAT 9530
  - ENDF/B-IV
  - MAT 495

A.39
### ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:** 125Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5064)  
**Energy Range:** 10^{-5} eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Schenter, F. Schmittroth (HEDL)  

**HISTORY**  
- 1990 Feb: BNL, NNDC  
  - ENDF/B-VI MAT 5064 MOD 0, Release 0  
- 1974 Apr: HEDL  
  - ENDF/B-V MAT 9531  
  - ENDF/B-IV MAT 496

**Evaluation:** 126Sn ENDF/B-VI Incident Neutron Sublibrary (MAT 5067)  
**Energy Range:** 10^{-5} eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Schenter, F. Schmittroth (HEDL)  

**HISTORY**  
- 1990 Feb: BNL, NNDC  
  - ENDF/B-VI MAT 5067 MOD 0, Release 0  
- 1974 Apr: HEDL  
  - ENDF/B-V MAT 9533  
  - ENDF/B-IV MAT 498

**Evaluation:** 129Sb ENDF/B-VI Incident Neutron Sublibrary (MAT 5125)  
**Energy Range:** 10^{-5} eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar, et al. (RCN)  

**HISTORY**  
- 1990 Feb: BNL, NNDC  
  - ENDF/B-VI MAT 5125 MOD 0, Release 0  
- 1980 Feb: HEDL,RCN  
  - ENDF/B-V MAT 9548

**Evaluation:** 135Sb ENDF/B-VI Incident Neutron Sublibrary (MAT 5131)  
**Energy Range:** 10^{-5} eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar, et al. (RCN)  

**HISTORY**  
- 1990 Feb: BNL, NNDC  
  - ENDF/B-VI MAT 5131 MOD 0, Release 0  
- 1980 Feb: HEDL,RCN  
  - ENDF/B-V MAT 9551
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: \(^{124}\text{Sb}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 5134)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Agency</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5134 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9552</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 515</td>
</tr>
</tbody>
</table>

Evaluation: \(^{125}\text{Sb}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 5137)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Agency</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5137 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9555 (Translated from ENDF/B-IV)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 518</td>
</tr>
</tbody>
</table>

Evaluation: \(^{126}\text{Sb}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 5140)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Agency</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5140 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9556 (Translated from ENDF/B-IV)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 519</td>
</tr>
</tbody>
</table>

Evaluation: \(^{126}\text{Te}\) ENDF/B-VI Incident Neutron Sublibrary (MAT 5225)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: F. Mann (HEDL)

HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Agency</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5225 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL</td>
<td>F. Mann</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9576</td>
</tr>
</tbody>
</table>

A.41
### ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{122}$Te ENDF/B-VI Incident Neutron Sublibrary (MAT 5231)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5231 MOD 0 (Translated from ENDF/B-V)</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9579</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 538</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{123}$Te ENDF/B-VI Incident Neutron Sublibrary (MAT 5224)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5234 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9580</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 539</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{124}$Te ENDF/B-VI Incident Neutron Sublibrary (MAT 5237)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5237 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9582</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 541</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{125}$Te ENDF/B-VI Incident Neutron Sublibrary (MAT 5240)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 5240 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9583</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 542</td>
</tr>
<tr>
<td>Evaluation:</td>
<td>$^{126}\text{Te}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 5243)</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
<td></td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
<td></td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
<td></td>
</tr>
<tr>
<td>HISTORY</td>
<td>1990 Feb BNL NNDC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI MAT 5243 MOD 0, Release 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1974 Oct HEDL R. Schenter, F. Schmittroth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V MAT 9585</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV MAT 544</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{127m}\text{Te}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 5247)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td>1990 Feb BNL NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI MAT 5247 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>1974 Oct HEDL R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V MAT 9587</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV MAT 546</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{128}\text{Te}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 5249)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td>1990 Feb BNL NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI MAT 5249 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>1974 Oct HEDL R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V MAT 9588</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV MAT 547</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{129m}\text{Te}$ ENDF/B-VI Incident Neutron Sublibrary (MAT 5253)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td>1990 Feb BNL NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI MAT 5253 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>1974 Oct HEDL R. Schenter, F. Schmittroth, C. Reich</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V MAT 9590</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV MAT 549</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{130}$Te ENDF/B-VI Incident Neutron Sublibrary (MAT 5255)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)
HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5255 MOD 0, Release 0
1974 Oct HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9591
ENDF/B-IV MAT 550

Evaluation: $^{127}$I ENDF/B-VI Incident Neutron Sublibrary (MAT 5325)
Energy Range: $10^{-5}$ eV to 30 MeV
Files: 1, 2, 3, 4, 6, 8, 9, 12, 14, 15
Evaluators: P. G. Young, R. E. MacFarlane (LANL)
HISTORY
1991 Mar LANL P. Young, R. MacFarlane
ENDF/B-VI MAT 5325 MOD 1, Release 2

Evaluation: $^{129}$I ENDF/B-VI Incident Neutron Sublibrary (MAT 5331)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Grupelaar, et al. (RCN)
HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5331 MOD 0, Release 0
ENDF/B-V MAT 9608

Evaluation: $^{130}$I ENDF/B-VI Incident Neutron Sublibrary (MAT 5334)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)
HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5334 MOD 0, Release 0
1974 Oct HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9609
ENDF/B-IV MAT 568

A.44
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**  
**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Schenter, F. Schmittroth (HEDL)

**HISTORY**  
1990 Feb  
BNL  
ENDF/B-VI  
MAT 5337 MOD 0, Release 0  

1974 Oct  
HEDL  
ENDF/B-V  
MAT 9611  
ENDF/B-IV  
MAT 570

**Evaluation:**  
**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Schenter, F. Schmittroth (HEDL)

**HISTORY**  
1990 Feb  
BNL  
ENDF/B-VI  
MAT 5349 MOD 0, Release 0  

1974 Oct  
HEDL  
ENDF/B-V  
MAT 9618  
ENDF/B-IV  
MAT 576

**Evaluation:**  
**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** M. R. Bhat, S. F. Mughabghab (BNL)

**HISTORY**  
1990 Feb  
BNL  
ENDF/B-VI  
MAT 5425 MOD 0, Release 0  

1978 Mar  
BNL  
ENDF/B-V  
MAT 1335

**Evaluation:**  
**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** M. R. Bhat, S. F. Mughabghab (BNL)

**HISTORY**  
1990 Feb  
BNL  
ENDF/B-VI  
MAT 5431 MOD 0, Release 0  

1978 Mar  
BNL  
ENDF/B-V  
MAT 1339
### ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**  
\(^{125}\text{Xe ENDF/B-VI Incident Neutron Sublibrary (MAT 5437)}\)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>10^5 eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>M. R. Bhat, S. F. Mughabghab (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**  
- 1990 Feb: BNL – ENDF/B-VI – MAT 5437 MOD 0, Release 0
- 1978 Mar: BNL – ENDF/B-V – MAT 1348

**Evaluation:**  
\(^{125}\text{Xe ENDF/B-VI Incident Neutron Sublibrary (MAT 5440)}\)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>10^5 eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>M. R. Bhat, S. F. Mughabghab (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**  
- 1990 Feb: BNL – ENDF/B-VI – MAT 5440 MOD 0, Release 0
- 1978 Mar: BNL – ENDF/B-V – MAT 1349

**Evaluation:**  
\(^{130}\text{Xe ENDF/B-VI Incident Neutron Sublibrary (MAT 5443)}\)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>10^5 eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>M. R. Bhat, S. F. Mughabghab (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**  
- 1990 Feb: BNL – ENDF/B-VI – MAT 5443 MOD 0, Release 0
- 1978 Mar: BNL – ENDF/B-V – MAT 1350

**Evaluation:**  
\(^{131}\text{Xe ENDF/B-VI Incident Neutron Sublibrary (MAT 5446)}\)

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>10^5 eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>M. R. Bhat, S. F. Mughabghab (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**  
- 1990 Feb: BNL – ENDF/B-VI – MAT 5446 MOD 0, Release 0
- 1978 Mar: BNL – ENDF/B-V – MAT 1351
### ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>(^{132}\text{Xe ENDF/B-VI Incident Neutron Sublibrary}) (MAT 5449)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>(10^{-5}) eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>M. R. Bhat, S. F. Mughabghab (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td>1978 Mar</td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 5449 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>M. R. Bhat, S. F. Mughabghab</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 1352</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>(^{133}\text{Xe ENDF/B-VI Incident Neutron Sublibrary}) (MAT 5452)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>(10^{-5}) eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 5452 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 9643</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
</tr>
<tr>
<td></td>
<td>MAT 595</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>(^{134}\text{Xe ENDF/B-VI Incident Neutron Sublibrary}) (MAT 5455)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>(10^{-5}) eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>M. R. Bhat, S. F. Mughabghab (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td>1978 Mar</td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 5455 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>M. R. Bhat, S. F. Mughabghab</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 1354</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>(^{135}\text{Xe ENDF/B-VI Incident Neutron Sublibrary}) (MAT 5458)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>(10^{-5}) eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>B. Leonard, K. Stewart (BAW); R. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>NNDC</td>
</tr>
<tr>
<td>1980 Oct</td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>MAT 5458 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>MAT 1294 (extended from 1 keV to 20 MeV)</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{136}$Xe ENDF/B-VI Incident Neutron Sublibrary (MAT 5461)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: M. R. Bhat, S. F. Mughabghab (BNL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5461 MOD 0, Release 0
1978 Mar BNL M. R. Bhat, S. F. Mughabghab
ENDF/B-V MAT 1356

Evaluation: $^{133}$Cs ENDF/B-VI Incident Neutron Sublibrary (MAT 5525)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, R. Johnson, F. Mann, F. Schmittroth (HEDL); M. R. Bhat, A. Prince (BNL); H. Gruppelaar (RCN)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5525 MOD 0, Release 0
ENDF/B-V MAT 1355

Evaluation: $^{134}$Cs ENDF/B-VI Incident Neutron Sublibrary (MAT 5528)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. Schenter, F. Schmittroth (HEDL)

HISTORY
1988 Dec ORNL R. Q. Wright
ENDF/B-VI MAT 5528 MOD 1, Release 0
1974 Aprc HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9663
ENDF/B-IV MAT 614

Evaluation: $^{135}$Cs ENDF/B-VI Incident Neutron Sublibrary (MAT 5531)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5531 MOD 0, Release 0
1974 Aprc HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9665
ENDF/B-IV MAT 616

A.48
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: \(^{136}\text{Cs ENDJF/B-VI Incident Neutron Sublibrary}\) (MAT 5534)
Energy Range: \(10^{-5}\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5534 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9667
ENDF/B-IV MAT 618

Evaluation: \(^{137}\text{Cs ENDJF/B-VI Incident Neutron Sublibrary}\) (MAT 5537)
Energy Range: \(10^{-5}\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC
ENDF/B-VI MAT 5537 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9669
ENDF/B-IV MAT 619

Evaluation: \(^{138}\text{Ba ENDJF/B-VI Incident Neutron Sublibrary}\) (MAT 5637)
Energy Range: \(10^{-5}\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. Schenter, F. Schmittroth (HEDL)

HISTORY
1988 Dec ORNL R. Q. Wright
ENDF/B-VI MAT 5637 MOD 1, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9684
ENDF/B-IV MAT 634

Evaluation: \(^{138}\text{Ba ENDJF/B-VI Incident Neutron Sublibrary}\) (MAT 5640)
Energy Range: \(10^{-5}\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. Schenter, F. Schmittroth (HEDL)

HISTORY
1988 Dec ORNL R. Q. Wright
ENDF/B-VI MAT 5640 MOD 1, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9685
ENDF/B-IV MAT 635

A.49
### Evaluation: $^{136}$Ba ENDF/B-VI Incident Neutron Sublibrary (MAT 5643)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Q. Wright (ORNL); R. Schenter, F. Schmittroth (HEDL)

<table>
<thead>
<tr>
<th>HISTORY</th>
</tr>
</thead>
</table>
| 1988 Dec | ORNL | R. Q. Wright  
|          | ENDF/B-VI | MAT 5643 MOD 1, Release 0  
| 1974 Apr | HEDL | R. Schenter, F. Schmittroth  
|          | ENDF/B-V | MAT 9687  
|          | ENDF/B-IV | MAT 637

### Evaluation: $^{137}$Ba ENDF/B-VI Incident Neutron Sublibrary (MAT 5646)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** R. Q. Wright (ORNL); R. Schenter, F. Schmittroth (HEDL)

<table>
<thead>
<tr>
<th>HISTORY</th>
</tr>
</thead>
</table>
| 1988 Dec | ORNL | R. Q. Wright  
|          | ENDF/B-VI | MAT 5646 MOD 1, Release 0  
| 1974 Apr | HEDL | R. Schenter, F. Schmittroth  
|          | ENDF/B-V | MAT 9689  
|          | ENDF/B-IV | MAT 639

### Evaluation: $^{138}$Ba ENDF/B-VI Incident Neutron Sublibrary (MAT 5649)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5, 12, 13, 14, 15  
**Evaluators:** R. Q. Wright (ORNL); R. Howerton (LLNL)

<table>
<thead>
<tr>
<th>HISTORY</th>
</tr>
</thead>
</table>
| 1994 Dec | ORNL | R. Q. Wright (reviewed by Evaluation Committee)  
|          | ENDF/B-VI | MAT 5649 MOD 2, Release 3  
| 1990 Feb | BNL | NNDC  
|          | ENDF/B-VI | MAT 5649 MOD 0, Release 0  
| 1978 Aug | LLNL | R. Howerton  
|          | ENDF/B-V | MAT 1353 (converted from ENDL format)

A.50
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{140}$Ba ENDF/B-VI Incident Neutron Sublibrary (MAT 5655)

Energy Range: $10^{-5}$ eV to 20 MeV

Files: 1, 2, 3, 4, 5

Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY:
- 1995 May
  - BNL
  - ENDF/B-VI
  - NNDC
  - MAT 5655 MOD 0, Release 3

- 1990 Feb
  - BNL
  - ENDF/B-VI
  - NNDC

- 1974 Apr
  - HEDL
  - ENDF/B-V
  - MAT 9693
  - ENDF/B-IV
  - MAT 643

Evaluation: $^{139}$La ENDF/B-VI Incident Neutron Sublibrary (MAT 5728)

Energy Range: $10^{-5}$ eV to 20 MeV

Files: 1, 2, 3, 4, 5, 8, 9

Evaluators: R. E. Schenter, F. Schmittroth, F. Mann, D. L. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

HISTORY:
- 1991 Jul
  - BNL
  - ENDF/B-VI
  - NNDC
  - MAT 5728 MOD 2, Release 1

- 1990 Feb
  - BNL
  - ENDF/B-VI
  - NNDC

- 1980 Feb
  - HEDL, RCN
  - ENDF/B-V
  - MAT 9707, 7579

Evaluation: $^{140}$La ENDF/B-VI Incident Neutron Sublibrary (MAT 5731)

Energy Range: $10^{-5}$ eV to 20 MeV

Files (MF): 1, 2, 3, 4, 5

Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY:
- 1990 Feb
  - BNL
  - ENDF/B-VI
  - NNDC
  - MAT 5731 MOD 0, Release 0

- 1974 Apr
  - HEDL
  - ENDF/B-V
  - MAT 9708
  - ENDF/B-IV
  - MAT 643

A.51
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{140}\text{Ce ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 5837)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb
BNL
ENDF/B-VI
MAT 5837 MOD 0, Release 0
1974 Apr
HEDL
R. Schenter, F. Schmittroth
ENDF/B-V
MAT 9724
ENDF/B-IV
MAT 674

Evaluation: $^{141}\text{Ce ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 5840)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb
BNL
ENDF/B-VI
MAT 5840 MOD 0, Release 0
1974 Apr
HEDL
R. Schenter, F. Schmittroth
ENDF/B-V
MAT 9725
ENDF/B-IV
MAT 675

Evaluation: $^{142}\text{Ce ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 5843)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb
BNL
ENDF/B-VI
MAT 5843 MOD 0, Release 0
1974 Apr
HEDL
R. Schenter, F. Schmittroth
ENDF/B-V
MAT 9726
ENDF/B-IV
MAT 676

Evaluation: $^{143}\text{Ce ENDF/B-VI Incident Neutron Sublibrary}$ (MAT 5846)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb
BNL
ENDF/B-VI
MAT 5846 MOD 0, Release 0
1974 Apr
HEDL
R. Schenter, F. Schmittroth
ENDF/B-V
MAT 9727
ENDF/B-IV
MAT 677

A.52
### ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:** 144Ce ENDF/B-VI Incident Neutron Sublibrary (MAT 5849)

**Energy Range:** 10^5 eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. Schenter, F. Schmittroth (HEDL)

<table>
<thead>
<tr>
<th>HISTORY</th>
<th>1990 Feb</th>
<th>BNL</th>
<th>NNDC</th>
<th>ENDF/B-VI</th>
<th>MAT 5849 MOD 0, Release 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
<td>ENDF/B-V</td>
<td>MAT 9728</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 678</td>
</tr>
</tbody>
</table>

**Evaluation:** 141Pr ENDF/B-VI Incident Neutron Sublibrary (MAT 5925)

**Energy Range:** 10^4 eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. Schenter, F. Schmittroth, F. Mann, D. L. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

<table>
<thead>
<tr>
<th>HISTORY</th>
<th>1990 Feb</th>
<th>BNL</th>
<th>NNDC</th>
<th>ENDF/B-VI</th>
<th>MAT 5925 MOD 0, Release 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1980 Feb</td>
<td>HEDL,RCN,BNL</td>
<td>R. Schenter, H. Gruppelaar, A. Prince, et al.</td>
<td>ENDF/B-V</td>
<td>MAT 9742</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 692</td>
</tr>
</tbody>
</table>

**Evaluation:** 142Pr ENDF/B-VI Incident Neutron Sublibrary (MAT 5928)

**Energy Range:** 10^5 eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. Schenter, F. Schmittroth (HEDL)

<table>
<thead>
<tr>
<th>HISTORY</th>
<th>1990 Feb</th>
<th>BNL</th>
<th>NNDC</th>
<th>ENDF/B-VI</th>
<th>MAT 5928 MOD 0, Release 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
<td>ENDF/B-V</td>
<td>MAT 9743</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 693</td>
</tr>
</tbody>
</table>

**Evaluation:** 143Pr ENDF/B-VI Incident Neutron Sublibrary (MAT 5931)

**Energy Range:** 10^4 eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. Schenter, F. Schmittroth (HEDL)

<table>
<thead>
<tr>
<th>HISTORY</th>
<th>1990 Feb</th>
<th>BNL</th>
<th>NNDC</th>
<th>ENDF/B-VI</th>
<th>MAT 5931 MOD 0, Release 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
<td>ENDF/B-V</td>
<td>MAT 9745</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 695</td>
</tr>
</tbody>
</table>
### Evaluation: \(^{142}\text{Nd END}F/B-\text{VI Incident Neutron Sublibrary}\) (MAT 6025)

**Energy Range:** \(10^{-5} \text{ eV to 20 MeV}\)

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Schenter, F. Schmittroth (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td>1974</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9763</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 713</td>
</tr>
</tbody>
</table>

### Evaluation: \(^{143}\text{Nd END}F/B-\text{VI Incident Neutron Sublibrary}\) (MAT 6028)

**Energy Range:** \(10^{-5} \text{ eV to 20 MeV}\)

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. L. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td>1990</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 6028 MOD 0, Release 0</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9764</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 714</td>
</tr>
</tbody>
</table>

### Evaluation: \(^{144}\text{Nd END}F/B-\text{VI Incident Neutron Sublibrary}\) (MAT 6031)

**Energy Range:** \(10^{-5} \text{ eV to 20 MeV}\)

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Schenter, F. Schmittroth (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 6031 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9765</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: \(^{145}\text{Nd ENDF/B-VI Incident Neutron Sublibrary}\) (MAT 6034)
Energy Range: \(10^5\) eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Developer</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992 Jan</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
<td>MAT 6034 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
<td>MAT 6034 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL,RCN,BNL</td>
<td>R. Schenter, H. Gruppelaar, A. Prince, et al.</td>
<td>MAT 9766</td>
</tr>
</tbody>
</table>

Evaluation: \(^{146}\text{Nd ENDF/B-VI Incident Neutron Sublibrary}\) (MAT 6037)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>NNDC</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC</td>
<td>MAT 6037 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL,RCN,BNL</td>
<td>R. Schenter, H. Gruppelaar, A. Prince, et al.</td>
<td>MAT 9767</td>
</tr>
</tbody>
</table>

Evaluation: \(^{147}\text{Nd ENDF/B-VI Incident Neutron Sublibrary}\) (MAT 6040)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. Schenter, F. Schmittroth (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Developer</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 Aug</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
<td>MAT 6040 MOD 2, Release 1</td>
</tr>
<tr>
<td>1988 Dec</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
<td>MAT 6040 MOD 1, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
<td>MAT 9768</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MAT 718</td>
</tr>
</tbody>
</table>

A.55
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: 148Nd ENDF/B-VI Incident Neutron Sublibrary (MAT 6043)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

HISTORY
1990 Feb BNL NNDC
ENDING/B-VI MAT 6043 MOD 0, Release 0
ENDF/B-V MAT 9769
ENDF/B-IV MAT 719

Evaluation: 150Nd ENDF/B-VI Incident Neutron Sublibrary (MAT 6049)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

HISTORY
1990 Feb BNL NNDC
ENDING/B-VI MAT 6049 MOD 0, Release 0
ENDF/B-V MAT 9771
ENDF/B-IV MAT 721

Evaluation: 147Pm ENDF/B-VI Incident Neutron Sublibrary (MAT 6149)
Energy Range: $10^{-5}$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

HISTORY
1991 Aug ORNL R. Q. Wright
ENDING/B-VI MAT 6149 MOD 2, Release 1
1989 Apr ORNL R. Q. Wright
ENDING/B-VI MAT 6149 MOD 1, Release 0
ENDING/B-V MAT 9783
ENDING/B-IV MAT 733
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: **148Pm ENDF/B-VI Incident Neutron Sublibrary** (MAT 6152)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY

- 1990 Feb BNL NNDC (converted from ENDF/B-V)
- 1974 Feb ENDF/B-VI MAT 6152 MOD 0, Release 0
- ENDF/B-V R. Schenter, F. Schmittroth
- ENDF/B-IV MAT 734

Evaluation: **148mPm ENDF/B-VI Incident Neutron Sublibrary** (MAT 6153)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY

- 1990 Feb BNL NNDC (converted from ENDF/B-V)
- 1974 Feb ENDF/B-VI MAT 6153 MOD 0, Release 0
- ENDF/B-V R. Schenter, F. Schmittroth
- ENDF/B-IV MAT 735

Evaluation: **149Pm ENDF/B-VI Incident Neutron Sublibrary** (MAT 6155)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY

- 1990 Feb BNL NNDC (converted from ENDF/B-V)
- 1974 Feb ENDF/B-VI MAT 6155 MOD 0, Release 0
- ENDF/B-V R. Schenter, F. Schmittroth
- ENDF/B-IV MAT 736

Evaluation: **151Pm ENDF/B-VI Incident Neutron Sublibrary** (MAT 6161)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY

- 1990 Feb BNL NNDC (converted from ENDF/B-V)
- 1974 Feb ENDF/B-VI MAT 6161 MOD 0, Release 0
- ENDF/B-V R. Schenter, F. Schmittroth
- ENDF/B-IV MAT 738

A.57
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: 144Sm Incident Neutron Library, Release 3 (MAT 6225)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); F. M. Mann (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994 Oct</td>
<td>ORNL</td>
<td>R. Q. Wright (reviewed by the Evaluation Committee)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6225 MOD 2, Release 3</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V format)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6225 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL</td>
<td>F. M. Mann</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9083</td>
</tr>
</tbody>
</table>

Evaluation: 147Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6234)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989 Apr</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6234 MOD 1, Release 0</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9806</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 753</td>
</tr>
</tbody>
</table>

Evaluation: 148Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6237)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6237 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Apr</td>
<td>HEDL</td>
<td>R. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9807</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 754</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{149}$Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6240)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, D. Johnson, F. Mann, F. Schmittroth (HEDL); H. Gruppelaar (RCN); B. Leonard, K. Stewart (BNW)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)

Evaluation: $^{150}$Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6243)
Energy Range: $10^{-5}$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1992 Jul ORNL R. Q. Wright
1990 Feb BNL NNDC (converted from ENDF/B-V)
1974 Apr HEDL R. E. Schenter and F. Schmittroth

Evaluation: $^{151}$Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6246)
Energy Range: $10^{-5}$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

HISTORY
1991 Aug ORNL R. Q. Wright
1989 Mar ORNL R. Q. Wright
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{152}$Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6249)
Energy Range: $10^{-5}$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

HISTORY
1992 Oct ORNL R. Q. Wright (reviewed by F. Mann, P. Young)
ENDF/B-VI MAT 6249 MOD 2, Release 2
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 6249 MOD 0, Release 0
ENDF/B-V MAT 9811
ENDF/B-IV MAT 758

Evaluation: $^{153}$Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6252)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 6252 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9812
ENDF/B-IV MAT 759

Evaluation: $^{154}$Sm ENDF/B-VI Incident Neutron Sublibrary (MAT 6255)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 6255 MOD 0, Release 0
1974 Apr HEDL R. Schenter, F. Schmittroth
ENDF/B-V MAT 9813
ENDF/B-IV MAT 760

Evaluation: $^{151}$Eu ENDF/B-VI Incident Neutron Sublibrary (MAT 6325)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 12, 13, 14, 15
Evaluators: P. G. Young, E. D. Arthur (LANL)

HISTORY
1986 Apr LANL P. G. Young, E. D. Arthur
ENDF/B-VI MAT 6325 MOD 1, Release 0
<table>
<thead>
<tr>
<th>Evaluation</th>
<th>152Eu ENDF/B-VI Incident Neutron Sublibrary (MAT 6328)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>10^5 eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Q. Wright (ORNL), H. Takahashi (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1988 Dec ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
<td>MAT 6328 MOD 1, Release 0</td>
</tr>
<tr>
<td>1973 Dec BNL</td>
<td>H. Takahashi</td>
</tr>
<tr>
<td>ENDF/B-V</td>
<td>MAT 1292</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>155Eu ENDF/B-VI Incident Neutron Sublibrary (MAT 6331)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>10^5 eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5, 12, 13, 14, 15</td>
</tr>
<tr>
<td>Evaluators</td>
<td>P. G. Young, E. D. Arthur (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1986 Apr LANL</td>
<td>P. G. Young, E. D. Arthur (Reviewer: R. Schenter)</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
<td>MAT 6331 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>154Eu ENDF/B-VI Incident Neutron Sublibrary (MAT 6334)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>10^5 eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Q. Wright (ORNL), H. Takahashi (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1989 May ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
<td>MAT 6334 MOD 1, Release 0</td>
</tr>
<tr>
<td>1973 Dec BNL</td>
<td>H. Takahashi</td>
</tr>
<tr>
<td>ENDF/B-V</td>
<td>MAT 1293</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>155Eu ENDF/B-VI Incident Neutron Sublibrary (MAT 6337)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>10^5 eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Q. Wright (ORNL); R. Schenter (HEDL); A. Prince (BNL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Aug ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
<td>MAT 6337 MOD 2, Release 1</td>
</tr>
<tr>
<td>1988 Dec ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td>ENDF/B-VI</td>
<td>MAT 6337 MOD 1, Release 0</td>
</tr>
<tr>
<td>1979 Dec HEDL,BNL</td>
<td>R. Schenter, A. Prince</td>
</tr>
<tr>
<td>ENDF/B-V</td>
<td>MAT 9832</td>
</tr>
<tr>
<td>ENDF/B-IV</td>
<td>MAT 774</td>
</tr>
</tbody>
</table>

A.61
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: \(^{156}\text{Eu ENDF/B-VI Incident Neutron Sublibrary}\) (MAT 6340)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
   ENDF/B-VI MAT 6340 MOD 0, Release 0
1974 Feb HEDL R. Schenter, F. Schmittroth
   ENDF/B-V MAT 9833
   ENDF/B-IV MAT 779

Evaluation: \(^{157}\text{Eu ENDF/B-VI Incident Neutron Sublibrary}\) (MAT 6343)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
   ENDF/B-VI MAT 6343 MOD 0, Release 0
1974 Oct HEDL R. Schenter, F. Schmittroth
   ENDF/B-V MAT 9834
   ENDF/B-IV MAT 780

Evaluation: \(^{152}\text{Gd ENDF/B-VI Incident Neutron Sublibrary}\) (MAT 6425)
Energy Range: \(10^5\) eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL), Fission Product Nuclear Data Group (JNDC)

HISTORY
1994 Dec ORNL, JNDC R. Q. Wright, JNDC FP Nuclear Data Group
   (Reviewer: P. Young)
   ENDF/B-VI MAT 6425 MOD 1, Release 4
1990 Feb BNL NNDC (converted from ENDF/B-V)
   ENDF/B-VI MAT 6425 MOD 0, Release 0
1977 Jan BNL B. A. Magurno
   ENDF/B-V MAT 1362
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{154}$Gd ENDF/B-VI Incident Neutron Sublibrary (MAT 6431)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL), Fission Product Nuclear Data Group (JNDC)

HISTORY
1994 Dec ORNL,JNDC R. Q. Wright, JNDC FP Nuclear Data Group
(Reviewer: P. Young)
ENDF/B-VI MAT 6425 MOD 1, Release 4
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 6431 MOD 0, Release 0
1977 Jan BNL B. A. Magurno
ENDF/B-V MAT 1364

Evaluation: $^{155}$Gd ENDF/B-VI Incident Neutron Sublibrary (MAT 6434)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: B. A. Magurno (BNL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 6434 MOD 0, Release 0
1977 Jan BNL B. A. Magurno
ENDF/B-V MAT 1365

Evaluation: $^{156}$Gd ENDF/B-VI Incident Neutron Sublibrary (MAT 6437)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: B. A. Magurno (BNL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 6437 MOD 0, Release 0
1977 Jan BNL B. A. Magurno
ENDF/B-V MAT 1366

Evaluation: $^{157}$Gd ENDF/B-VI Incident Neutron Sublibrary (MAT 6440)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: B. A. Magurno (BNL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 6440 MOD 0, Release 0
1977 Jan BNL B. A. Magurno
ENDF/B-V MAT 1367
**ENDF/B-VI Incident Neutron Sublibrary**

**Evaluation:** ¹⁵⁸Gd ENDF/B-VI Incident Neutron Sublibrary (MAT 6443)

**Energy Range:** $10^5$ eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** B. A. Magurno (BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6443 MOD 0, Release 0</td>
</tr>
<tr>
<td>1977 Jan</td>
<td>BNL</td>
<td>B. A. Magurno</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1368</td>
</tr>
</tbody>
</table>

**Evaluation:** ¹⁶⁰Gd ENDF/B-VI Incident Neutron Sublibrary (MAT 6449)

**Energy Range:** $10^5$ eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** B. A. Magurno (BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6449 MOD 0, Release 0</td>
</tr>
<tr>
<td>1977 Jan</td>
<td>BNL</td>
<td>B. A. Magurno</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1370</td>
</tr>
</tbody>
</table>

**Evaluation:** ¹⁵⁹Tb ENDF/B-VI Incident Neutron Sublibrary (MAT 6525)

**Energy Range:** $10^5$ eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6525 MOD 0, Release 0</td>
</tr>
<tr>
<td>1980 Feb</td>
<td>HEDL</td>
<td>R. E. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9857</td>
</tr>
</tbody>
</table>

**Evaluation:** ¹⁶⁰Tb ENDF/B-VI Incident Neutron Sublibrary (MAT 6528)

**Energy Range:** $10^5$ eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 6528 MOD 0, Release 0</td>
</tr>
<tr>
<td>1974 Oct</td>
<td>HEDL</td>
<td>R. E. Schenter, F. Schmittroth</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 9858</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 804</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:** ¹⁶⁰Dy ENDF/B-VI Incident Neutron Sublibrary (MAT 6637)

**Energy Range:** \(10^{-5}\) eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**
- 1990 Feb: BNL, NNDC (converted from ENDF/B-V)
- 1974 Oct: ENDF/B-VI, HEDL, ENDF/B-V, ENDF/B-IV

**Evaluation:** ¹⁶¹Dy ENDF/B-VI Incident Neutron Sublibrary (MAT 6640)

**Energy Range:** \(10^{-5}\) eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**
- 1990 Feb: BNL, NNDC (converted from ENDF/B-V)
- 1974 Oct: ENDF/B-VI, HEDL, ENDF/B-V, ENDF/B-IV

**Evaluation:** ¹⁶²Dy ENDF/B-VI Incident Neutron Sublibrary (MAT 6643)

**Energy Range:** \(10^{-5}\) eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**
- 1990 Feb: BNL, NNDC (converted from ENDF/B-V)
- 1974 Oct: ENDF/B-VI, HEDL, ENDF/B-V, ENDF/B-IV

**Evaluation:** ¹⁶³Dy ENDF/B-VI Incident Neutron Sublibrary (MAT 6646)

**Energy Range:** \(10^{-5}\) eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. E. Schenter, F. Schmittroth (HEDL)

**HISTORY**
- 1990 Feb: BNL, NNDC (converted from ENDF/B-V)
- 1974 Oct: ENDF/B-VI, HEDL, ENDF/B-V, ENDF/B-IV

A.65
**ENDF/B-VI Incident Neutron Sublibrary**

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{164}$Dy ENDF/B-VI Incident Neutron Sublibrary (MAT 6649)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>B. R. Leonard, Jr., K. B. Stewart (BNW)</td>
</tr>
<tr>
<td>HISTORY</td>
<td>1990 Feb BNL NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>1967 Jun BNW B. R. Leonard, K. Stewart</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{168}$Ho ENDF/B-VI Incident Neutron Sublibrary (MAT 6725)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5, 12, 13, 14, 15</td>
</tr>
<tr>
<td>Evaluators</td>
<td>P. G. Young, E. D. Arthur (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td>1988 Apr LANL P. G. Young, E. D. Arthur</td>
</tr>
<tr>
<td></td>
<td>1988 Dec ORNL R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>1974 Oct HEDL R. E. Schenter, F. Schmittroth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{166}$Er ENDF/B-VI Incident Neutron Sublibrary (MAT 6837)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td>1988 Dec ORNL R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>1974 Oct HEDL R. E. Schenter, F. Schmittroth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{167}$Er ENDF/B-VI Incident Neutron Sublibrary (MAT 6840)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Evaluators</td>
<td>R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth (HEDL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td>1989 Mar ORNL R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>1974 Oct HEDL R. E. Schenter, F. Schmittroth</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: ¹⁷⁵Lu ENDF/B-VI Incident Neutron Sublibrary (MAT 7125)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: B. R. Leonard, Jr., K. B. Stewart (BNW)

HISTORY
- 1990 Feb: NNDC
- 1967 Jun: BNW

Evaluation: ¹⁷⁶Lu ENDF/B-VI Incident Neutron Sublibrary (MAT 7128)
Energy Range: $10^{-5}$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: B. R. Leonard, Jr., K. B. Stewart (BNW)

HISTORY
- 1990 Feb: NNDC
- 1967 Jun: BNW

Evaluation: ¹⁷⁴Hf ENDF/B-VI Incident Neutron Sublibrary (MAT 7225)
Energy Range: $10^{-5}$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

HISTORY
- 1992 Apr: ORNL
- 1990 Feb: BNW
- 1976 Apr: SAI

Evaluation: natHf ENDF/B-VI Incident Neutron Sublibrary (MAT 7200)
Energy Range: $10^{-5}$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: M. K. Drake, D. A. Sargis, T. Maung (SAI)

HISTORY
- 1990 Feb: BNW
- 1976 Apr: SAI

A.67
### \(^{176}\)Hf ENDF/B-VI Incident Neutron Sublibrary (MAT 7231)

**Energy Range:** \(10^5\) eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5  
**Evaluators:** R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

**HISTORY**
- 1990 Feb: BNL, ENDF/B-VI, NNDC (converted from ENDF/B-V)  
- 1976 Apr: SAI, ENDF/B-V, MAT 1376

### \(^{177}\)Hf ENDF/B-VI Incident Neutron Sublibrary (MAT 7234)

**Energy Range:** \(10^5\) eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5  
**Evaluators:** R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

**HISTORY**
- 1991 Sep: ORNL, R. Q. Wright  
- 1990 Feb: BNL, ENDF/B-VI, NNDC (converted from ENDF/B-V)  
- 1976 Apr: SAI, ENDF/B-V, MAT 1377

### \(^{178}\)Hf ENDF/B-VI Incident Neutron Sublibrary (MAT 7237)

**Energy Range:** \(10^5\) eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5  
**Evaluators:** R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

**HISTORY**
- 1991 Sep: ORNL, R. Q. Wright  
- 1990 Feb: BNL, ENDF/B-VI, NNDC (converted from ENDF/B-V)  
- 1976 Apr: SAI, ENDF/B-V, MAT 1378
### Evaluation:

**179Hf ENDF/B-VI Incident Neutron Sublibrary (MAT 7240)**

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992 Jul</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 7240 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 7240 MOD 0, Release 0</td>
</tr>
<tr>
<td>1976 Apr</td>
<td>SAI</td>
<td>M. Drake, D. Sargis, T. Maung</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1383</td>
</tr>
</tbody>
</table>

### Evaluation:

**180Hf ENDF/B-VI Incident Neutron Sublibrary (MAT 7243)**

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 Sep</td>
<td>ORNL</td>
<td>R. Q. Wright</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 7243 MOD 2, Release 2</td>
</tr>
<tr>
<td>1991 Aug</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 7243 MOD 2 Revision 1</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 7243 MOD 0, Release 0</td>
</tr>
<tr>
<td>1976 Apr</td>
<td>SAI</td>
<td>M. Drake, D. Sargis, T. Maung</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1384</td>
</tr>
</tbody>
</table>

### Evaluation:

**181Ta ENDF/B-VI Incident Neutron Sublibrary (MAT 7328)**

**Energy Range:** $10^{-5}$ eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15

**Evaluators:** R. J. Howerton, S. T. Perkins, R. C. Haight, M. H. MacGregor (LLNL)

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 7328 MOD 0, Release 0</td>
</tr>
<tr>
<td>1972 Jan</td>
<td>LLNL</td>
<td>R. Howerton, S. Perkins, R. Haight, M. MacGregor</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1285</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
<td>MAT 1285</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{182}$Ta ENDF/B-VI Incident Neutron Sublibrary (MAT 7331)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>J. Otter, C. Dunford, E. Ottewitte (AI)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1971 Apr</td>
<td>AI</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-IV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{99}$W ENDF/B-VI Incident Neutron Sublibrary (MAT 7400)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5, 12, 13, 14, 15</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>E. D. Arthur, P. G. Young, R. Boicourt (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1991 Jul</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1982 Mar</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{182}$W ENDF/B-VI Incident Neutron Sublibrary (MAT 7431)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5, 12, 13, 14, 15</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>E. Arthur, P. Young (LANL); A. Smith (ANL); C. Philis (BRC)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1980 Dec</td>
<td>LANL,ANL,BRC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>$^{183}$W ENDF/B-VI Incident Neutron Sublibrary (MAT 7434)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^{-5}$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5, 12, 13, 14, 15</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>E. Arthur, P. Young (LANL); A. Smith (ANL); C. Philis (BRC)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1980 Dec</td>
<td>LANL,ANL,BRC</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: $^{184}$W ENDF/B-VI Incident Neutron Sublibrary (MAT 7437)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 12, 13, 14, 15
Evaluators: E. Arthur, P. Young (LANL); A. Smith (ANL); C. Philis (BRC)

HISTORY
1990 Feb BNL ENDF/B-VI NNDC (converted from ENDF/B-V)
1980 Dec LANL, ANL, BRC ENDF/B-V E. Arthur, P. Young, A. Smith, C. Philis

Evaluation: $^{186}$W ENDF/B-VI Incident Neutron Sublibrary (MAT 7443)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 12, 13, 14, 15
Evaluators: E. Arthur, P. Young (LANL); A. Smith (ANL); C. Philis (BRC)

HISTORY
1990 Feb BNL ENDF/B-VI NNDC (converted from ENDF/B-V)
1980 Dec LANL, ANL, BRC ENDF/B-V E. Arthur, P. Young, A. Smith, C. Philis

Evaluation: $^{185}$Re ENDF/B-VI Incident Neutron Sublibrary (MAT 7525)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 33
Evaluators: L. W. Weston (ORNL); P. G. Young (LANL)

HISTORY
1990 Mar ORNL, LANL ENDF/B-VI L. W. Weston, P. G. Young

Evaluation: $^{185}$Re ENDF/B-VI Incident Neutron Sublibrary (MAT 7531)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 33
Evaluators: L. W. Weston (ORNL); P. G. Young (LANL)

HISTORY
1990 Mar ORNL, LANL ENDF/B-VI L. W. Weston, P. G. Young

Evaluation: $^{191}$Ir ENDF/B-VI Incident Neutron Sublibrary (MAT 7725)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 12, 14, 15
Evaluators: R. Q. Wright, R. R. Spencer (ORNL)

HISTORY
1995 Mar ORNL ENDF/B-VI R. Q. Wright, R. R. Spencer (Reviewer: C. Lubitz)

A.71
<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 7731)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5, 12, 14, 15</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. Q. Wright, R. R. Spencer (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

  ENDF/B-VI, MAT 7731 MOD 1, Release 4

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 7925)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 30 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>P. G. Young, E. D. Arthur (LANL)</td>
</tr>
</tbody>
</table>

**HISTORY**

- 1991 Jul: LANL, P. G. Young  
  ENDF/B-VI, MAT 7925 MOD 2, Release 1
- 1984 Jan: LANL, P. G. Young, E. D. Arthur (Reviewer: W. Poenitz)  
  ENDF/B-VI, MAT 7925 MOD 1, Release 0

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 8231)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>C. Y. Fu, N. M. Larson, D. C. Larson (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

  ENDF/B-VI, MAT 8231 MOD 1, Release 0

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 8234)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>C. Y. Fu, N. M. Larson, D. C. Larson (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

  ENDF/B-VI, MAT 8234 MOD 2, Release 1
  ENDF/B-VI, MAT 8234 MOD 1, Release 0

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>ENDF/B-VI Incident Neutron Sublibrary (MAT 8237)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range:</td>
<td>$10^5$ eV to 20 MeV</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 6, 12, 14, 15, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>C. Y. Fu, D. C. Larson (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

  ENDF/B-VI, MAT 8237 MOD 1, Release 0

A.72
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: \[^{209}\text{Bi}\] ENDF/B-VI Incident Neutron Sublibrary (MAT 8325)
Energy Range: \(10^5\) eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 13, 14, 15, 33
Evaluators: A. B. Smith, D. Smith, P. T. Gunther (ANL); R. Howerton (LLNL); M. Sugimoto (JAERI)

HISTORY
1995 May NNDC V. McLane (minor comment correction)

Evaluation: \[^{229}\text{Th}\] ENDF/B-VI Incident Neutron Sublibrary (MAT 9034)
Energy Range: \(10^5\) eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: F. Mann (HEDL)

HISTORY
1990 Feb NNDC BNL (converted to ENDF/B-VI)
1977 Nov HEDL F. Mann

Evaluation: \[^{232}\text{Th}\] ENDF/B-VI Incident Neutron Sublibrary (MAT 9040)
Energy Range: \(10^5\) eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 14, 15, 31, 33
Evaluators: M. R. Bhat (BNL); J. W. P. Poenitz, A. B. Smith, et al. (ANL); R. Howerton (LLNL); B. R. Leonard, et al. (BNL); G. deSaussure, et al. (ORNL)

HISTORY
1990 Feb NNDC BNL (converted to ENDF/B-VI)

Evaluation: \[^{231}\text{Pa}\] ENDF/B-VI Incident Neutron Sublibrary (MAT 9131)
Energy Range: \(10^5\) eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: F. Mann (HEDL)

HISTORY
1990 Feb NNDC BNL (converted to ENDF/B-VI)
1977 Nov HEDL F. Mann

A.73
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: ²³³Pa ENDF/B-VI Incident Neutron Sublibrary (MAT 9137)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: D. Mathews (GGA), R. Kinsey (BNL), P. C. Young (BAPL)

HISTORY
1990 Feb  NNDC  BNL (converted to ENDF/B-VI)
       ENDF/B-VI  MAT 9137 MOD 0, Release 0
1978 May  GGA,BNL,BAPL  D. Mathews, R. Kinsey, P. C. Young
       ENDF/B-V  MAT 1391

Evaluation: ²³²U ENDF/B-VI Incident Neutron Sublibrary (MAT 9219)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: F. Mann (HEDL)

HISTORY
1990 Feb  NNDC  BNL (converted to ENDF/B-VI)
       ENDF/B-VI  MAT 9219 MOD 0, Release 0
1977 Nov  HEDL  F. Mann
       ENDF/B-V  MAT 8232

Evaluation: ²³⁴U ENDF/B-VI Incident Neutron Sublibrary (MAT 9225)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8
Evaluators: M. Divadeenam (BNL); M. K. Drake, P. F. Nichols (GGA); F. Mann, R. E. Schenter (HEDL)

HISTORY
1990 Feb  NNDC  BNL (converted to ENDF/B-VI)
       ENDF/B-VI  MAT 9225 MOD 0, Release 0
       ENDF/B-V  MAT 1394

Evaluation: ²³³U ENDF/B-VI Incident Neutron Sublibrary (MAT 9222)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 14, 15
Evaluators: L. Stewart, et al. (LANL); L. Weston, et al. (ORNL); F. Mann (HEDL); N. Steen (BAPL); B. Leonard (BNW); R. Kinsey (BNL)

HISTORY
1990 Feb  NNDC  BNL (converted to ENDF/B-VI)
       ENDF/B-VI  MAT 9222 MOD 0, Release 0
       ENDF/B-V  MAT 1397

¹ Mistakingly coded as LANL in ENDFB-VI file.

A.74
**ENDF/B-VI Incident Neutron Sublibrary**

### Evaluation: 235U ENDF/B-VI Incident Neutron Sublibrary (MAT 9228)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 31  
**Evaluators:** L. Weston (ORNL), P. G. Young (LANL), W. Poenitz (ANL), C. Lubitz (KAPL)

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>NNDC</th>
<th>MAT 9228 MOD 5, Release 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Nov</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td></td>
</tr>
<tr>
<td>1993 Nov</td>
<td>KAPL</td>
<td>ENDF/B-VI</td>
<td>C. R. Lubitz (Reviewers: A. Carlson, C. Duston, M. Moore)</td>
</tr>
<tr>
<td>1993 Feb</td>
<td>ORNL</td>
<td>ENDF/B-VI</td>
<td>L. Weston</td>
</tr>
<tr>
<td>1991 Jun</td>
<td>ORNL, LANL, ANL+</td>
<td>ENDF/B-VI</td>
<td>L. Weston, P. Young, W. Poenitz</td>
</tr>
<tr>
<td>1989 Apr</td>
<td>ORNL, LANL, ANL+</td>
<td>ENDF/B-VI</td>
<td>L. Weston, P. Young, W. Poenitz</td>
</tr>
</tbody>
</table>

### Evaluation: 236U ENDF/B-VI Incident Neutron Sublibrary (MAT 9231)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 8  
**Evaluators:** F. Mann, R. Schenter (HEDL); M. Divadeenum (BNL)

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>NNDC</th>
<th>MAT 9231 MOD 1, Release 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989 Oct</td>
<td>HEDL</td>
<td>ENDF/B-VI</td>
<td>F. Mann, R. Schenter</td>
</tr>
</tbody>
</table>

### Evaluation: 237U ENDF/B-VI Incident Neutron Sublibrary (MAT 9234)

**Energy Range:** $10^{-5}$ eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5, 8, 12, 13, 14, 15  
**Evaluators:** R. Benjamin, F. McCrosson (SRL); R. Howerton (LLNL) (Assembled by R. Kinsey, BNL)

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>NNDC</th>
<th>MAT 9434 MOD 2, Release 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 May</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9434 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
</tbody>
</table>

**A.75**
### ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:** 238U ENDF/B-VI Incident Neutron Sublibrary (MAT 9237)

**Energy Range:** $10^5$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 31, 33

**Evaluators:** L. W. Weston (ORNL); P. G. Young (LANL); W. Poenitz (ANL)

**HISTORY**
- 1993 Jan ORNL L. Weston (Reviewer: R. McKnight)
- 1991 Jul BNL ENDF/B-VI MAT 9237 MOD 3, Release 2
- 1989 Nov ORNL, LANL, ANL ENDF/B-VI MAT 9237 MOD 2, Release 1

---

**Evaluation:** 237Np ENDF/B-VI Incident Neutron Sublibrary (MAT 9346)

**Energy Range:** $10^5$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5, 6, 8, 9, 12, 13, 14, 15

**Evaluators:** P. G. Young, E. D. Arthur (LANL); F. M. Mann (HEDL)

**HISTORY**
- 1991 Jul LANL ENDF/B-VI P. G. Young, E. D. Arthur, F. M. Mann
- 1990 Apr LANL, HEDL ENDF/B-VI P. G. Young, E. D. Arthur, F. M. Mann

---

**Evaluation:** 238Np ENDF/B-VI Incident Neutron Sublibrary (MAT 9349)

**Energy Range:** $10^5$ eV to 20 MeV

**Files:** 1, 2, 3, 4, 5, 8

**Evaluators:** R. W. Benjamin, F. J. McCrosson (SRL)

**HISTORY**
- 1993 May BNL NNDC ENDF/B-VI MAT 9349 MOD 2, Release 2
- 1990 Feb BNL ENDF/B-VI NNDC (converted from ENDF/B-V)
- 1975 Aug SRL ENDF/B-V R. W. Benjamin and F. J. McCrossen

---

**Evaluation:** 239Np ENDF/B-VI Incident Neutron Sublibrary (MAT 9352)

**Energy Range:** $10^5$ eV to 20 MeV

**Files (MF):** 1, 2, 3, 4, 5

**Evaluators:** R. Q. Wright (ORNL); Y. Kanda (Kyushu U.)

**HISTORY**
- 1988 Dec ORNL ENDF/B-VI MAT 9352 MOD 1, Release 0
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: 236Pu ENDF/B-VI Incident Neutron Sublibrary (MAT 9428)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL)

HISTORY
1995 Sep ORNL R. Q. Wright (Reviewer: C. Lubitz)
ENDF/B-VI MAT 9428 MOD 1, Release 4
1990 Feb BNL NNDC (converted from ENDF/B-V)
ENDF/B-VI MAT 9428 MOD 0, Release 0
1978 Apr HEDL,SRL F. Mann, R. Schenter, R. Benjamin, F. McCrosson
ENDF/B-V MAT 8436

Evaluation: 237Pu ENDF/B-VI Incident Neutron Sublibrary (MAT 9431)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 8
Evaluators: F. Mann, R. Schenter (HEDL)

Documentation: NNDC (converted from ENDF/B-V)

HISTORY
1990 Feb BNL MAT 9431 MOD 0, Release 0
ENDF/B-VI
1978 Apr HEDL F. Mann, R. Schenter
ENDF/B-V MAT 8437

Evaluation: 238Pu ENDF/B-VI Incident Neutron Sublibrary (MAT 9434)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 8
Evaluators: F. Mann, R. Schenter (HEDL); H. Alter, C. Dunford (AI)

Documentation: NNDC (converted from ENDF/B-V)

HISTORY
1990 Feb BNL MAT 9434 MOD 1, Release 0
ENDF/B-VI
1978 Apr HEDL,AI F. Mann, R. Schenter, H. Alter, C. Dunford
ENDF/B-V MAT 1338

Evaluation: 239Pu ENDF/B-VI Incident Neutron Sublibrary (MAT 9437)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 6, 12, 13, 14, 15
Evaluators: P. Young (LANL); L. W. Weston, H. Derrien (ORNL); W. Poenitz (ANL); T. Nakagawa

HISTORY
1993 Jan ORNL L. Weston, H. Derrien (reviewer: P. Young)
ENDF/B-VI MAT 9437 MOD 3, Release 2
1989 Apr LANL,ORNL P. Young, L. Weston, W. Poenitz
ENDF/B-V MAT 9437 MOD 1, Release 0

A.77
### ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>$10^{-5}$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5, 8, 12, 13, 14, 15, 31, 32, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>L. W. Weston (ORNL); E. D. Arthur (LANL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 Jun</td>
<td>ORNL</td>
<td>L. Weston</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 9440 MOD 3, Release 2</td>
</tr>
<tr>
<td>1991 Jul</td>
<td>ORNL</td>
<td>L. Weston</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 9440 MOD 2, Release 1</td>
</tr>
<tr>
<td>1986 Aug</td>
<td>ORNL, LANL</td>
<td>L. Weston, E. Arthur</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 9440 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

**Evaluation:**

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>$10^{-5}$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files:</td>
<td>1, 2, 3, 4, 5, 8, 12, 13, 14, 15, 31</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>L. W. Weston, R. Q. Wright, H. Derrien, et al. (ORNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1994 Aug</td>
<td>ORNL</td>
<td>L. Weston (Reviewer: P. Young)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 9443 MOD 3, Release 3</td>
</tr>
<tr>
<td>1991 Jun</td>
<td>ORNL</td>
<td>L. Weston</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 9443 MOD 2, Release 1</td>
</tr>
<tr>
<td>1988 Oct</td>
<td>ORNL</td>
<td>L. Weston</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 9443 MOD 1, Release 0</td>
</tr>
</tbody>
</table>

**Evaluation:**

<table>
<thead>
<tr>
<th>Energy Range:</th>
<th>$10^{-5}$ eV to 20 MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Files (MF):</td>
<td>1, 2, 3, 4, 5, 8, 12, 13, 14, 15, 32, 33</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>F. Mann, R. Schenter (HEDL); D. Madland, P. Young (LANL); R. Benjamin (SRL); R. Howerton (LLNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
<td>MAT 9446 MOD 1, Release 0</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-V</td>
<td>MAT 1342</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**  
243Pu ENDF/B-VI Incident Neutron Sublibrary (MAT 9449)

**Energy Range:**  
$10^{-5}$ eV to 20 MeV

**Files:**  
1, 2, 3, 4, 5, 8, 12, 13, 14, 15

**Evaluators:**  
R. Benjamin, F. McCrosson (SRL); R. Howerton (LLNL) (assembled by R. Kinsey, BNL)

**Documentation:**

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 May</td>
<td>BNL</td>
<td>NNDC</td>
</tr>
<tr>
<td>1993 May</td>
<td>ENDF/B-VI</td>
<td>MAT 9449 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>ENDF/B-VI</td>
<td>MAT 9449 MOD 0, Release 0</td>
</tr>
<tr>
<td>1976 Jul</td>
<td>SRL, LLNL, BNL</td>
<td>R. Benjamin, F. McCrosson, R. Howerton, R. Kinsey</td>
</tr>
<tr>
<td>1976 Jul</td>
<td>ENDF/B-V</td>
<td>MAT 8443</td>
</tr>
</tbody>
</table>

**Evaluation:**  
244Pu ENDF/B-VI Incident Neutron Sublibrary (MAT 9452)

**Energy Range:**  
$10^{-5}$ eV to 20 MeV

**Files (MF):**  
1, 2, 3, 4, 5, 8

**Evaluators:**  
F. Mann, R. Schenter (HEDL); R. Benjamin, F. McCrosson (SRL)

**Documentation:**

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>NNDC (converted from ENDF/B-V)</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>ENDF/B-VI</td>
<td>MAT 9452 MOD 0, Release 0</td>
</tr>
<tr>
<td>1978 Apr</td>
<td>HEDL, SRL</td>
<td>F. Mann, R. Schenter, R. Benjamin, F. McCrosson</td>
</tr>
<tr>
<td>1978 Apr</td>
<td>ENDF/B-V</td>
<td>MAT 8444</td>
</tr>
</tbody>
</table>

**Evaluation:**  
241Am ENDF/B-VI Incident Neutron Sublibrary (MAT 9543)

**Energy Range:**  
$10^{-5}$ eV to 30 MeV

**Files:**  
1, 2, 3, 4, 5, 6, 8, 9, 12, 13, 14, 15, 32, 33

**Evaluators:**  
P. G. Young, D. W. Madland (LANL); Zhou Delin, Yu Baosheng, et al. (CNDC)

**Documentation:**

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994 Aug</td>
<td>LANL</td>
<td>P. Young, D. Madland (reviewer: F. Mann)</td>
</tr>
<tr>
<td>1994 Aug</td>
<td>ENDF/B-VI</td>
<td>MAT 9543 MOD 3, Release 3</td>
</tr>
<tr>
<td>1992 Jun</td>
<td>ENDF/B-VI</td>
<td>MAT 9543 MOD 2, Release 2</td>
</tr>
<tr>
<td>1988 Feb</td>
<td>ENDF/B-VI</td>
<td>MAT 9543 MOD 1, Release 0</td>
</tr>
</tbody>
</table>
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: 242Am ENDF/B-VI Incident Neutron Sublibrary (MAT 9546)
Energy Range: 10^3 eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8
Evaluators: R. W. Benjamin, F. J. McCrossen (SRL)

HISTORY
1991 Aug BNL  NNDC
       ENDF/B-VI   MAT 9546 MOD 2, Release 1
1990 Feb BNL  NNDC (converted from ENDF/B-V)
       ENDF/B-VI   MAT 9546 MOD 1, Release 0
       ENDF/B-V    MAT 8542

Evaluation: 242mAm ENDF/B-VI Incident Neutron Sublibrary (MAT 9547)
Energy Range: 10^5 eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15
Evaluators: F. Mann, R. Schenter (HEDL); R. Benjamin (SRL); R. Howerton (LLNL)

HISTORY
1991 Aug BNL  NNDC
       ENDF/B-VI   MAT 9547 MOD 2, Release 1
1990 Feb BNL  NNDC (converted from ENDF/B-V)
       ENDF/B-VI   MAT 9547 MOD 0, Release 0
1978 Apr HEDL,SRL+  F. Mann, R. Schenter, R. Benjamin, et al.
       ENDF/B-V    MAT 1369

Evaluation: 243Am ENDF/B-VI Incident Neutron Sublibrary (MAT 9549)
Energy Range: 10^5 eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 8
Evaluators: L. W. Weston (ORNL); F. Mann, R. Schenter (HEDL); R. Howerton (LLNL)

HISTORY
1988 Oct ORNL  L. Weston, F. Mann, R. Schenter, R. Howerton
       ENDF/B-VI   MAT 9549 MOD 1, Release 0

Evaluation: 244Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9628)
Energy Range: 10^5 eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 8
Evaluators: F. Mann, R. Schenter (HEDL)

HISTORY
1990 Feb BNL  NNDC (converted from ENDF/B-V)
       ENDF/B-VI   MAT 9628 MOD 0, Release 0
1978 Apr HEDL  F. Mann, R. Schenter
       ENDF/B-V    MAT 8641
ENDF/B-VI Incident Neutron Sublibrary

Evaluation: ²⁴²Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9631)
Energy Range: 10⁻⁵ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: F. Mann, R. Schenter (HEDL); R. Benjamin, F. McCrosson (SRL); R. Howerton (LLNL)

HISTORY
1990 Feb NNDC BNL (converted from ENDF/B-V)
1978 Apr ENDF/B-VI MAT 9631 MOD 1, Release 0

Evaluation: ²⁴³Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9634)
Energy Range: 10⁻⁵ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: F. Mann, R. Schenter (HEDL); R. Benjamin (SRL); R. Howerton (LLNL)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
1978 Apr ENDF/B-VI MAT 9634 MOD 0, Release 0

Evaluation: ²⁴⁴Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9637)
Energy Range: 10⁻⁵ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: F. Mann, R. Schenter (HEDL); R. Benjamin, F. McCrosson (SRL); R. Howerton (LLNL); C. Dunford, H. Alter (AI)

HISTORY
1990 Feb BNL NNDC (converted from ENDF/B-V)
1978 Apr ENDF/B-VI MAT 9637 MOD 0, Release 0

Evaluation: ²⁴⁵Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9640)
Energy Range: 10⁻⁵ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: R. W. Benjamin (SRL); R. J. Howerton (LLNL)

HISTORY
1993 May BNL NNDC
1990 Feb ENDF/B-VI MAT 9640 MOD 2, Release 2
1979 Jan SRL, LLNL ENDF/B-V
                     MAT 1345
## ENDF/B-VI Incident Neutron Sublibrary

### Evaluation: $^{246}$Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9643)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5, 8, 12, 13, 14, 15  
**Evaluators:** R. W. Benjamin, F. McCrosson (SRL); R. J. Howerton (LLNL) (assembled by R. Kinsey, BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Sublibrary</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 May</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9643 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9643 MOD 0, Release 0</td>
</tr>
<tr>
<td>1976 Jul</td>
<td>SRL,LLNL,BNL</td>
<td>ENDF/B-V</td>
<td>MAT 1346</td>
</tr>
</tbody>
</table>

### Evaluation: $^{247}$Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9646)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files:** 1, 2, 3, 4, 5, 8, 12, 13, 14, 15  
**Evaluators:** R. W. Benjamin, F. McCrosson (SRL); R. J. Howerton (LLNL) (assembled by R. Kinsey, BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Sublibrary</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 May</td>
<td>NNDC</td>
<td>ENDF/B-VI</td>
<td>MAT 9646 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9646 MOD 0, Release 0</td>
</tr>
<tr>
<td>1976 Jul</td>
<td>SRL,LLNL,BNL</td>
<td>ENDF/B-V</td>
<td>MAT 8647</td>
</tr>
</tbody>
</table>

### Evaluation: $^{248}$Cm ENDF/B-VI Incident Neutron Sublibrary (MAT 9649)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5, 8, 12, 13, 14, 15  
**Evaluators:** F. Mann, R. Schenter (HEDL); R. Benjamin (SRL); R. Howerton (LLNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Sublibrary</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>NNDC</td>
<td>ENDF/B-VI</td>
<td>MAT 9649 MOD 0, Release 0</td>
</tr>
<tr>
<td>1978 Apr</td>
<td>HEDL,SRL,LLNL</td>
<td>ENDF/B-V</td>
<td>MAT 8648</td>
</tr>
</tbody>
</table>

### Evaluation: $^{249}$Bk ENDF/B-VI Incident Neutron Sublibrary (MAT 9752)

**Energy Range:** $10^5$ eV to 20 MeV  
**Files (MF):** 1, 2, 3, 4, 5  
**Evaluators:** Zhou Delin, et al. (CNDC)

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agency</th>
<th>Sublibrary</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986 Jun</td>
<td>CNDC</td>
<td>ENDF/B-VI</td>
<td>MAT 9752 MOD 1, Release 0</td>
</tr>
</tbody>
</table>
ENF/B-VI Incident Neutron Sublibrary

Evaluation: 249Cf ENF/B-VI Incident Neutron Sublibrary (MAT 9852)
Energy Range: $10^5$ eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: Zhou Delin, Liu Tong, Su Zhongdi, et al. (CNDC)
1989 Apr
   CNDC
   ENF/B-VI
   MAT 9852 MOD 1, Release 0

Evaluation: 250Cf ENF/B-VI Incident Neutron Sublibrary (MAT 9855)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: F. Mann, R. Schenter (HEDL); R. Benjamin (SRL); R. Howerton (LLNL)

HISTORY
   1993 May
       BNL
       ENF/B-VI
       MAT 9855 MOD 2, Release 2
   1990 Feb
       BNL
       ENF/B-VI
       NNDC (converted from ENDF/B-V)
       MAT 9855 MOD 0, Release 0
   1976 Jul
       BNL, SRL, LLNL
       R. Benjamin, F. McCrosson, R. Howerton, R. Kinsey
       ENF/B-V
       MAT 8850

Evaluation: 251Cf ENF/B-VI Incident Neutron Sublibrary (MAT 9858)
Energy Range: $10^5$ eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 12, 13, 14, 15
Evaluators: F. Mann, R. Schenter (HEDL); R. Benjamin (SRL); R. Howerton (LLNL)
(assembled by R. Kinsey, BNL)

HISTORY
   1993 May
       BNL
       ENF/B-VI
       NNDC
       MAT 9858 MOD 2, Release 2
   1990 Feb
       BNL
       ENF/B-VI
       NNDC (converted from ENDF/B-V)
       MAT 9858 MOD 1, Release 0
   1976 Jul
       BNL, SRL, LLNL
       R. Benjamin, F. McCrosson, R. Howerton, R. Kinsey
       ENF/B-V
       MAT 8851

A.83
ENDF/B-VI Incident Neutron Sublibrary

**Evaluation:**

252Cf ENDF/B-VI Incident Neutron Sublibrary (MAT 9861)

**Energy Range:**

10^{-5} eV to 20 MeV

**Files:**

1, 2, 3, 4, 5, 8, 12, 13, 14, 15

**Evaluators:**

F. Mann, R. Schenter (HEDL); R. Benjamin (SRL); R. Howerton (LLNL)
(-assembled by R. Kinsey, BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Lab</th>
<th>Library</th>
<th>Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 May</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9861 MOD 3, Release 2</td>
</tr>
<tr>
<td>1991 Aug</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9861 MOD 2, Release 1</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9861 MOD 0, Release 0</td>
</tr>
</tbody>
</table>

**Evaluation:**

253Cf ENDF/B-VI Incident Neutron Sublibrary (MAT 9864)

**Energy Range:**

10^{-5} eV to 20 MeV

**Files:**

1, 2, 3, 4, 5

**Evaluators:**

F. Mann, R. Schenter (HEDL); R. Benjamin (SRL)
(assembled by R. Kinsey, BNL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Lab</th>
<th>Library</th>
<th>Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 May</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9864 MOD 2, Release 2</td>
</tr>
<tr>
<td>1990 Feb</td>
<td>BNL</td>
<td>ENDF/B-VI</td>
<td>MAT 9864 MOD 0, Release 0</td>
</tr>
<tr>
<td>1975 Dec</td>
<td>SRL, BNL</td>
<td>ENDF/B-V</td>
<td>R. Benjamin, F. McCrosson (assembled by R. Kinsey)</td>
</tr>
</tbody>
</table>

**Evaluation:**

253Es ENDF/B-VI Incident Neutron Sublibrary (MAT 9913)

**Energy Range:**

10^{-5} eV to 20 MeV

**Files (MF):**

1, 2, 3, 4

**Evaluators:**

R. Kinsey (BNL); R. Benjamin, F. McCrosson (SRL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Lab</th>
<th>Library</th>
<th>Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Feb</td>
<td>NNDC</td>
<td>ENDF/B-VI</td>
<td>MAT 9913 MOD 0, Release 0</td>
</tr>
</tbody>
</table>

A.84
**ENDF/B-VI Thermal Neutron Scattering Sublibrary**

**Evaluation:**  
H (H₂O) ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 1)  
Energy Range: 296, 350, 400, 450, 500, 600, 800, 1000 °K  
Files (MF): 1, 7  
Evaluators: R. E. MacFarlane (LANL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
<td>R. E. MacFarlane (Reviewer: M. Lazo)</td>
</tr>
<tr>
<td>1990 May</td>
<td>LANL</td>
<td>R. MacFarlane</td>
</tr>
</tbody>
</table>

**Evaluation:**  
Liquid Para Hydrogen ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 2)  
Energy Range: 20 °K  
Files (MF): 1, 7  
Evaluators: R. E. MacFarlane (LANL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
<td>R. E. MacFarlane (Reviewer: M. Lazo)</td>
</tr>
<tr>
<td>1990 May</td>
<td>LANL</td>
<td>R. MacFarlane</td>
</tr>
</tbody>
</table>

**Evaluation:**  
Liquid Ortho Hydrogen ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 3)  
Energy Range: 20 °K  
Files (MF): 1, 7  
Evaluators: R. E. MacFarlane (LANL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
<td>R. E. MacFarlane (Reviewer: M. Lazo)</td>
</tr>
<tr>
<td>1990 May</td>
<td>LANL</td>
<td>R. MacFarlane</td>
</tr>
</tbody>
</table>

**Evaluation:**  
H (ZrH) ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 7)  
Energy Range: 296, 400, 500, 600, 700, 800, 1000, 1200 °K  
Files (MF): 1, 7  
Evaluators: R. E. MacFarlane (LANL)

**HISTORY**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
<td>R. E. MacFarlane (Reviewer: M. Lazo)</td>
</tr>
<tr>
<td>1990 May</td>
<td>LANL</td>
<td>R. MacFarlane</td>
</tr>
</tbody>
</table>

A.85
ENDF/B-VI Thermal Neutron Scattering Sublibrary

**Evaluation:** D (D$_2$O) ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 11)

**Temperatures:** 296, 350, 400, 450, 500, 600, 800, 1000 °K

**Files (MF):** 1, 7

**Evaluators:** R. E. MacFarlane (LANL)

**HISTORY**

1990 May  
LANL  
RENDF/B-VI  
MAT 11 MOD 0

1969 DEC  
GA  
RENDF/B-III  
MAT 1004

**Evaluation:** Liquid Para Deuterium ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 12)

**Temperatures:** 19 °K

**Files (MF):** 1, 7

**Evaluators:** R. E. MacFarlane (LANL)

**HISTORY**

1993 Apr  
LANL  
RENDF/B-VI  
MAT 12 MOD 1, Release 3

**Evaluation:** Liquid Ortho Deuterium ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 13)

**Temperatures:** 19 °K

**Files (MF):** 1, 7

**Evaluators:** R. E. MacFarlane (LANL)

**HISTORY**

1993 Apr  
LANL  
RENDF/B-VI  
MAT 2 MOD 13, Release 3

**Evaluation:** Be Metal ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 26)

**Temperatures:** 296, 400, 500, 600, 700, 800, 1000, 1200 °K

**Files (MF):** 1, 7

**Evaluators:** R. E. MacFarlane (LANL)

**HISTORY**

1993 Apr  
LANL  
RENDF/B-VI  
MAT 26 MOD 1, Release 3

1990 May  
LANL  
RENDF/B-VI  
MAT 26 MOD 0

1969 DEC  
GA  
RENDF/B-III  
MAT 1064

A.86
<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>BeO ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperatures:</td>
<td>296, 400, 500, 600, 700, 800, 1000, 1200 °K</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 7</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. E. MacFarlane (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1990 May</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-III</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>Graphite ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperatures:</td>
<td>296, 400, 500, 600, 700, 800, 1000, 1200, 1600, 2000 °K</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 7</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. E. MacFarlane (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td>1990 May</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-III</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>Liquid Methane ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperatures:</td>
<td>100 °K</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 7</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. E. MacFarlane (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>Solid Methane ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperatures:</td>
<td>22 °K</td>
</tr>
<tr>
<td>Files (MF):</td>
<td>1, 7</td>
</tr>
<tr>
<td>Evaluators:</td>
<td>R. E. MacFarlane (LANL)</td>
</tr>
<tr>
<td>HISTORY</td>
<td></td>
</tr>
<tr>
<td>1993 Apr</td>
<td>LANL</td>
</tr>
<tr>
<td></td>
<td>ENDF/B-VI</td>
</tr>
</tbody>
</table>
ENDF/B-VI Thermal Neutron Scattering Sublibrary

Evaluation: H (Polyethylene) ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 37)
Temperatures: 296, 350 °K
Files (MF): 1, 7
Evaluators: R. E. MacFarlane (LANL)

HISTORY
1993 Apr LANL R. E. MacFarlane (Reviewer: M. Lazo)
ENDF/B-VI MAT 37 MOD 1, Release 3
1990 May LANL R. MacFarlane
ENDF/B-VI MAT 37 MOD 0
ENDF/B-III MAT 1114

Evaluation: Benzene ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 40)
Temperatures: 296, 350, 400, 450, 500, 600, 800, 1000 °K
Files (MF): 1, 7
Evaluators: R. E. MacFarlane (LANL)

HISTORY
1993 Apr LANL R. E. MacFarlane (Reviewer: M. Lazo)
ENDF/B-VI MAT 40 MOD 1, Release 3
1990 May LANL R. MacFarlane
ENDF/B-VI MAT 40 MOD 0
ENDF/B-III MAT 1095

Evaluation: Zr (ZrH) ENDF/B-VI Thermal Neutron Scattering Sublibrary (MAT 58)
Temperatures: 296, 400, 500, 600, 700, 800, 1000, 1200 °K
Files (MF): 1, 7
Evaluators: R. E. MacFarlane (LANL)

HISTORY
1993 Apr LANL R. E. MacFarlane (Reviewer: M. Lazo)
ENDF/B-VI MAT 58 MOD 1, Release 3
1990 May LANL R. MacFarlane
ENDF/B-VI MAT 58 MOD 0
ENDF/B-III MAT 1096

Evaluation: UO₂ ENDF/B-III Thermal Neutron Scattering Sublibrary (MAT 1167)
Temperatures: 296, 400, 500, 600, 700, 800, 1000, 1200 °K
Files (MF): 1, 7

HISTORY
ENDF/B-III MAT 1167
ENDF/B-VI Incident Proton Sublibrary

Evaluation: ³H Incident Proton Sublibrary (MAT 125)
Energy Range: 0 to 100 MeV
Files (MF): 1, 3, 6
Evaluators: D. Dodder (LANL)
HISTORY 1987 Oct LANL D. Dodder
ENDF/B-VI MAT 125 MOD 1, Release 1

Evaluation: ³He Incident Proton Sublibrary (MAT 225)
Energy Range: 1 keV to 20 MeV
Files (MF): 1, 3, 6
Evaluators: G. Hale (LANL)
HISTORY 1987 Oct LANL G. Hale
ENDF/B-VI MAT 225 MOD 1, Release 1

A.89
ENDF/B-VI Incident Deuteron Sublibrary

Evaluation: \(^2\text{H Incident Deuteron Sublibrary}\) (MAT 128)
Energy Range: 332.5 eV to 30 MeV
Files (MF): 1, 3
Evaluators: R, M. White and D. A. Resler (LLNL)

HISTORY
1991 May
   LLNL R, M. White and D. A. Resler
   ENDF/B-VI MAT 128 MOD 1, Release 1

Evaluation: \(^3\text{H Incident Deuteron Sublibrary}\) (MAT 131)
Energy Range: 285 eV to 30 MeV
Files (MF): 1, 3
Evaluators: R, M. White and D. A. Resler (LLNL)

HISTORY
1991 May
   LLNL R, M. White and D. A. Resler
   ENDF/B-VI MAT 131 MOD 1, Release 1

Evaluation: \(^3\text{He Incident Deuteron Sublibrary}\) (MAT 225)
Energy Range: 118.75 eV to 30 MeV
Files (MF): 1, 3
Evaluators: R, M. White and D. A. Resler (LLNL)

HISTORY
1991 May
   LLNL R, M. White and D. A. Resler
   ENDF/B-VI MAT 225 MOD 1, Release 1
ENDF/B-VI Incident Triton Sublibrary

Evaluation: 3H Incident Deuteron Sublibrary (MAT 131)
Energy Range: 475 eV to 30 MeV
Files (MF): 1, 3
Evaluators: R, M. White and D. A. Resler (LLNL)

HISTORY
1991 May LLNL R, M. White and D. A. Resler
ENDF/B-VI MAT 131 MOD 1, Release 1
Appendix B

History of Materials Issued in ENDF/HE-VI

This section includes all materials issued in all releases of ENDF/HE-VI. The materials are ordered by sublibrary and material. Information on the latest release is given first, and is followed by the history of that material.

<table>
<thead>
<tr>
<th>Sublibrary</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incident Neutron Sublibrary</td>
<td>B.1</td>
</tr>
<tr>
<td>Incident Proton Sublibrary</td>
<td>B.2</td>
</tr>
</tbody>
</table>
ENDF/HE-VI Incident Neutron Sublibrary

Evaluation: $^{12}$C ENDF/HE-VI Incident Neutron Sublibrary (MAT 625)
Energy Range: $10^{-5}$ eV to 10 GeV
Files (MF): 1, 2, 3, 4, 6
Evaluators: S. Pearlstein (BNL)
HISTORY
1992 Sep BNL S. Pearlstein (reviewed by T. Fukahori)
ENDF/HE-VI MAT 625 MOD 1, Release 2

Evaluation: $^{56}$Fe ENDF/HE-VI Incident Neutron Sublibrary (MAT 2631)
Energy Range: $10^{-5}$ eV to 1 GeV
Files (MF): 1, 2, 3, 4, 6
Evaluators: S. Pearlstein (BNL)
HISTORY
1990 Jun BNL S. Pearlstein
ENDF/HE-VI MAT 2631 MOD 1, Release 0

Evaluation: $^{208}$Pb ENDF/HE-VI Incident Neutron Sublibrary (MAT 8237)
Energy Range: $10^{-5}$ eV to 1 GeV
Files (MF): 1, 2, 3, 4, 6
Evaluators: T. Fukahori, S. Pearlstein (BNL)
HISTORY
1990 Jun BNL T. Fukahori, S. Pearlstein
ENDF/HE-VI MAT 8237 MOD 1, Release 2

Evaluation: $^{209}$Bi ENDF/HE-VI Incident Neutron Sublibrary (MAT 8325)
Energy Range: $10^{-5}$ eV to 1 GeV
Files (MF): 1, 2, 3, 4, 6
Evaluators: T. Fukahori, S. Pearlstein (BNL)
HISTORY
1990 Jun BNL T. Fukahori, S. Pearlstein
ENDF/HE-VI MAT 8325 MOD 1, Release 2
<table>
<thead>
<tr>
<th>Evaluation</th>
<th>€12C ENDF/HE-VI Incident Proton Sublibrary (MAT 625)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 10 GeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 6</td>
</tr>
<tr>
<td>Evaluators</td>
<td>S. Pearlstein (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Sublibrary</th>
<th>Release Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Dec</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>MAT 625 MOD 2, Release 4</td>
</tr>
<tr>
<td>1992 Sep</td>
<td>BNL</td>
<td>ENDF/B-HE</td>
<td>S. Pearlstein (reviewed by T. Fukahori)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{56}$Fe ENDF/HE-VI Incident Proton Sublibrary (MAT 2631)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 1 GeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 3, 6</td>
</tr>
<tr>
<td>Evaluators</td>
<td>S. Pearlstein (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Sublibrary</th>
<th>Release Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Dec</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>MAT 625 MOD 2, Release 4</td>
</tr>
<tr>
<td>1990 Jun</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>S. Pearlstein (Reviewed by Y. Nakahara)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{209}$Bi ENDF/HE-VI Incident Proton Sublibrary (MAT 8325)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 1 GeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 6</td>
</tr>
<tr>
<td>Evaluators</td>
<td>T. Fukahori, S. Pearlstein (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Sublibrary</th>
<th>Release Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Dec</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>MAT 625 MOD 2, Release 4</td>
</tr>
<tr>
<td>1990 Jun</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>T. Fukahori, S. Pearlstein</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{208}$Pb ENDF/HE-VI Incident Proton Sublibrary (MAT 8237)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 1 GeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 6</td>
</tr>
<tr>
<td>Evaluators</td>
<td>T. Fukahori, S. Pearlstein (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Sublibrary</th>
<th>Release Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Dec</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>MAT 625 MOD 2, Release 4</td>
</tr>
<tr>
<td>1990 Jun</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>T. Fukahori, S. Pearlstein</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>$^{209}$B ENDF/HE-VI Incident Proton Sublibrary (MAT 8325)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Range</td>
<td>$10^5$ eV to 1 GeV</td>
</tr>
<tr>
<td>Files (MF)</td>
<td>1, 2, 3, 4, 6</td>
</tr>
<tr>
<td>Evaluators</td>
<td>T. Fukahori, S. Pearlstein (BNL)</td>
</tr>
</tbody>
</table>

**HISTORY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Sublibrary</th>
<th>Release Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Dec</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>MAT 625 MOD 2, Release 4</td>
</tr>
<tr>
<td>1990 Jun</td>
<td>BNL</td>
<td>ENDF/HE-VI</td>
<td>T. Fukahori, S. Pearlstein</td>
</tr>
</tbody>
</table>

B.2