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2007/7

Index of Nuclear Data Libraries

available from the IAEA Nuclear Data Section

edited by

O. Schwerer

Abstract: This document lists more than 100 nuclear data libraries together with references that give more detailed information about these libraries. The data libraries include neutron cross-sections, resonance parameters, fission-product yields, nuclear structure and decay data, gamma-rays from radionuclides, data of nuclear reactions induced by charged particles or heavy ions, photonuclear data, photoatomic interaction data, and many others, partly with related data processing computer codes. All data and documentation references are available through WWW or on request from the IAEA Nuclear Data Section, free of charge, on CD-ROM or other computer media.

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Nuclear Data Section
International Atomic Energy Agency
P.O. Box 100
A-1400 Vienna
Austria

e-mail: services@iaeand.iaea.org
fax: (43-1) 26007
telephone: (43-1) 2600-21710
http://www-nds.iaea.org

Note:

The IAEA-NDS-reports should not be considered as formal publications. When a nuclear data library is sent out by the IAEA Nuclear Data Section, it will be accompanied by an IAEA-NDS-report which should give the data user all necessary documentation on contents, format and origin of the data library.

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

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

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

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Citation guideline:

When quoting a computer-based data library in a publication it is recommended

- to give first the print reference in which the author(s) describe(s) the generation of the data,
- to give thereafter the database reference which contains the numerical data, including the version of the database,
- and then to mention the data center or the online service from which the data were received.

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Index of Nuclear Data Libraries
available from the IAEA Nuclear Data Section

Introduction

This document gives a brief summary of available computerized data libraries. Most major data libraries are available online, either for interactive retrieval through WWW or by downloading complete files through the Internet (WWW interface). See the IAEA's "Nuclear Data Services" homepage under **http://www-nds.iaea.org/** Occasionally, references are given also to libraries or data collections available from other sources.

Please contact the IAEA Nuclear Data Section for any additional information you need. Copies of entire data libraries or selective retrievals on CD-ROM or other computer media are available free of charge upon informal request. New or updated data libraries and relevant reports are listed in our ***Nuclear Data Newsletter*** (published biannually), see http://www-nds.iaea.org/newslett.html

An archived previous version of this document is available separately as report IAEA-NDS-307. It contains references to old libraries and data collections which may occasionally still be of interest.

The data libraries listed in this document are sorted as follows:

1. Neutron nuclear data, experimental
2. ENDF format for evaluated nuclear data files
3. ENDF data processing codes
4. Evaluated neutron nuclear data: Comprehensive libraries
5. Evaluated neutron nuclear data: Multigroup libraries

Special purpose neutron nuclear data libraries:

6. Nuclear data standards for nuclear measurements
7. Thermal neutron cross-sections, resonance-parameters and resonance-integrals
8. Thermal neutron scattering law
9. Actinides
10. Fission product yields
11. Neutron induced gamma-rays
12. Neutron activation - general application
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21. Photonuclear data
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23. Charged-particle nuclear reaction data
24. Intermediate energy nuclear data
25. Nuclear data for thermonuclear fusion
26. Nuclear model parameters and codes

31. Nuclear structure and decay data
32. Gamma ray analysis
33. Nuclear constants, Charts of Nuclides
34. Atomic data
35. Bibliographic files

Selected publications:

51. Proceedings of the Trieste Courses and Workshops on nuclear data and reactor physics
52. International Conferences on Nuclear Data for Science and Technology

1. Neutron nuclear data, experimental

EXFOR

Contents: All experimental neutron nuclear data and derived quantities such as resonance-parameters, fission-product yield data, as well as charged-particle induced nuclear reaction data (including some heavy ion data) and photonuclear data. Updated in monthly intervals. Contains 16800 works with 110000 data tables. Computer retrievals available online (WWW). The complete library with retrieval interface is available also on CD-ROM.

CD-ROMs: EXFOR-CINDA Database and Retrieval Systems, version 1.90, data updated as of February 2006. (Check with NDS about latest version.) Two CD-ROMs are available:
• "for Windows" with MS-Access databases
• "for Applications" for Linux and Windows with MySQL databases

Introduction to the EXFOR format for users: IAEA-NDS-206 ("EXFOR Basics Manual"), available in hardcopy or in PDF format from http://www-nds.iaea.org/reports/nds-206.pdf

Dictionaries (for data definition and abbreviations): updated quarterly, available in electronic form from NDS.

Detailed documentation of format and compilation rules: EXFOR Systems Manual, IAEA-NDS-207, Rev. 2004 (available also in PDF format under http://www-nds.iaea.org/reports/nds-207.pdf)

Bibliography and data index: CINDA.Computer retrievals available online (WWW). Also available on CD-ROM. Available also as a book (archival volumes and supplements).

CSISRS: This is identical to EXFOR (name used in the U.S.)

Neutron Scattering Lengths. Tables of experimental data and recommended values, compiled by H. Rauch et al., are available from the web page of the Atominstitut der Österreichischen Universitäten, Vienna, Austria, at http://www.ati.ac.at/~neutropt/scattering/table.html

2. ENDF format for evaluated nuclear data files

The internationally agreed format for data files of evaluated nuclear reaction data is ENDF-6. The earlier versions ENDF-5, ENDF-4 are still in use for some old data files.

ENDF was designed originally for neutron reaction data with allowance for related decay data, fission-product yield data, photo-atomic interaction data and others. ENDF-6 also permits the inclusion of data for nuclear reactions induced by photons and charged particles.

ENDF-6 Format Manual: Published as informal report BNL-NCS-44945-05-Rev (ENDF-102 version June 2005). Latest version edited by M. Herman. Available online from http://www-nds.iaea.org/ndspub/documents/endf/endf102/

Note that ENDF formatted data may be available in different formats: with resonance parameters, or with resonance parameters replaced by point data by means of the code RECENT (or a similar code), see e.g. "POINT2004".

On output from the ENDF database, apart from the original ENDF format, several output formats for easier reading are available (e.g. simple tables or interpreted ENDF).

ENDF-5 Format Manual: Available as document IAEA-NDS-75 Rev. 1. This is a reprint of the report BNL-NCS-50496 (ENDF-102) 2nd Edition Oct. 1979 by R. Kinsey, and updated with the report BNL-NCS-50496 (ENDF-102) 2nd Edition Revised Nov. 1983 by B.A. Magurno.
(Note: The report of Oct. 1979 by R. Kinsey exists as microfiche IAEA-NDS-10/102. The update pages of Nov. 1983 by B.A. Magurno exist as report IAEA-NDS-73.)
A brief introduction and summary of the ENDF format exists as document IAEA-NDS-10 Rev. 2.

ENDF-4 Format Manual: Available as document IAEA-NDS-74. This is a reprint of the report BNL-NCS-50496 (ENDF-102) revised by D. Garber, C. Dunford, S. Pearlstein, Oct. 1975.

3. ENDF data processing codes

The ENDF data processing codes operate on ENDF-4, ENDF-5 and ENDF-6 formatted data files. Available from the IAEA Nuclear Data Section are:

ENDF Utility Codes from NNDC, version 7.02 (2005) for ENDF-6 (and ENDF-5). Included are the data checking codes CHECKER, FIZCON, PSYCHE; the code INTER for calculating cross sections and integrals; and the file maintenance code STANEF. This program package is available online and on CD-ROM for Linux and Windows. Manual also available online.

The 2007 ENDF Pre-Processing Codes by D.E. Cullen ("PRE-PRO 2007", March 2007). Included are the codes ACTIVATE, CONVERT, MERGER, LINEAR, RECENT, SIGMA1, LEGEND, FIXUP, GROUPIE, DICTIN, MIXER, VIRGIN, COMPLOT, EVALPLOT, RELABEL, SIXPAK.
Some of the functions of these codes are: to calculate cross-sections from resonance-parameters; to calculate angular distributions, group averages, mixtures of cross-sections, etc.; to produce graphical plottings and data comparisons. The PREPRO2007 codes completely supersede all earlier versions. Working on all computers for all versions of ENDF formats. Available on CD-ROM or online from http://www-nds.iaea.org/ndspub/endf/prepro/
See document IAEA-NDS-39 Rev. 13.
This is supplemented by the following codes:

- PLOTTAB (a general plotting program) by D.E. Cullen, see documents IAEA-NDS-82 and -83 of June 1987.
- "Red's Natural Editor" (a program designed to edit FORTRAN programs) by D.E. Cullen, see document IAEA-NDS-149.

PLOTC4: plot experimental data with or without related ENDF formatted data. See document IAEA-NDS-79 Rev. 1.

CONV45/CONV56: converting ENDF-4 to ENDF-5 and ENDF-5 to ENDF-format. See document IAEA-NDS-78.

EPICSHOW (Electron Photon Interactive Code - Show Data), 1998 Update, by D.E. Cullen. Interactive graphics code for viewing and interacting with neutron, photon, electron and light charged particle data. Available on CD-ROM. Brief description see IAEA-NDS-194.

ENDVER (ENDF File Verification Support Package). The ENDVER package can be used to convert EXFOR data into computational C4 format, display them and compare graphically with the contents of a specified evaluated data file. The package also contains utilities to retrieve selected materials from a master library in ENDF format, extract cross sections (including differential and double differential data) and output them in two-column PLOTTAB "curves" format. Available on CD-ROM in a package with EXFOR/CINDA.

WINENDF, CD-ROM (Update July 2005), available on CD-ROM, contains the comprehensive evaluated data Libraries ENDF/B-VI Release 8, JENDL-3.3, JEFF-3.1, BROND-2 and CENDL-2 as well as a retrieval and merger system for MS Windows, Manuals and Documentation in PostScript, and the Utilities and Preprocessing Codes. Check with NDS about a version with ENDF/B-VII.

SIGACE – a package for generating high-temperature ACE files (ENDF-formatted multigroup cross sections), is available online from http://www-nds.iaea.org/fendl21/downloads/

ZVVIEW – software for interactive plotting of nuclear data, particularly suitable for comparison of evaluated and/or experimental data, is available online from http://www-nds.iaea.org/ndspub/zvview/

Not available from IAEA:

NJOY: A system for processing ENDF formatted data files.
See the report by R.E. MacFarlane "The NJOY nuclear data processing system, version 91", LA-12740-M (1994). For a summary see document IAEA-NDS-119. This code package must be requested from the

Radiation Shielding Information Computational Centre (RSICC)
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN, USA-37831-6171
pdc@ornl.gov
http://www-rsicc.ornl.gov/

4. Evaluated neutron nuclear data: Comprehensive libraries

Web access through "ENDF" database. Comprehensive databases ENDF/B-VII, JENDL-3.3, JEFF-3.1, BROND-2 and CENDL-2 as well as special purpose libraries and pointwise files. Provides also access to archival copies of old libraries. Also plotting option including comparison with experimental data from EXFOR.
See http://www-nds.iaea.org/exfor/endf00.htm

BROND-2.2: USSR evaluated neutron data library, issued in 1992 in ENDF-6 format and updated in 1993. The library is available as basic data with resonance-parameters, and/or as point data where resonance-parameters have been converted to cross-sections. Available online and on the WINENDF CD-ROM.
Summary documentation see IAEA-NDS-90 Rev. 8.

CENDL-2.1, Chinese evaluated neutron data library issued in 1991, updated and supplemented in 1993 and 1995 with some minor revisions in 1997, in ENDF-6 format.
Summary documentation see IAEA-NDS-61, Rev. 4.

ENDF/B-VII, the US evaluated nuclear data file, released in December 2006 in ENDF-6 format. Documentation: M.B. Chadwick et al., Nuclear Data Sheets 107, issue 12 (December 2006), pp. 2931-3060. Contains evaluated neutron data for 393 materials. Other sublibraries contain other data types (photonuclear, charged-particle data, decay data, and others), see the relevant chapters.

ENDF/B-VI, the US evaluated nuclear data file released in 1990 in ENDF-6 format, with revisions released in 1991, 1993, 1995, 1997, 1998, 1999, 2000, and a final Release 8 with corrections up to September 2001. The library is available as basic data with resonance-parameters, and/or as point data where resonance-parameters have been converted to cross-sections. Available online and on the WINENDF CD-ROM.
Summary documentation including information on a variety of specialized sublibraries, see IAEA-NDS-100 Rev. 11.

POINT2007, by D.E.Cullen. A temperature dependent version of the ENDF/B-VII.0 library. Point-wise cross sections, given for 8 temperatures between 0 and 2100 Kelvin, in steps of 300 Kelvin, are available online. The previous version POINT2004 with ENDF-B/VI Release 8 data is still available also.

JEFF-3.1, the Joint Evaluated Fission and Fusion File, issued by the OECD NEA Data Bank resulting from a collaboration of NEA countries. Available online and on the WINENDF CD-ROM. Documentation: A. Koning et al. (eds.), JEFF Report 21, OECD-NEA, 2006. The report is available from the NEA Data Bank or online from
http://www.nea.fr/html/dbdata/nds_jefreports/jeffreport-21/index.html

JENDL-3.3, the Japanese evaluated nuclear data library, update of 2002, in ENDF-6 format. The library is available as basic data with resonance-parameters, and/or as point data where resonance-parameters have been converted to cross-sections. Available online and on the WINENDF CD-ROM. Summary documentation see IAEA-NDS-110 Version 3 Rev.3 (October 2002). See also: K.Shibata, T.Kawano et al., Journal of Nuclear Science and Technology, Vol. 39, No. 11, pp 1125 – 1136 November 2002

WINENDF, CD-ROM (Update July 2005), available on CD-ROM, contains the comprehensive evaluated data Libraries ENDF/B-VI Release 8, JENDL-3.3, JEFF-3.1, BROND-2 and CENDL-2 as well as a retrieval and merger system for MS Windows, Manuals and Documentation in PostScript, and the Utilities and Preprocessing Codes. Check with NDS about a version with ENDF/B-VII.

FENDL/E. Evaluated nuclear data library for neutron reactions photon production, and photo-atomic interactions for coupled neutron-photon transport calculations in fusion (and other)

applications. Version 2.1 of December 2004. 71 materials from 1-H-1 to 83-Bi-209. Available (online or on CD-ROM) in 3 representations:

a) original ENDF-6 format with resonance parameters
b) FENDL/MG-2.1: processed into multigroup data in GENDF and MATXS format
c) FENDL/MC-2.1: processed into the ACE format needed for input to the Monte Carlo code MCNP4A

Documentation: D. López Aldama and A. Trkov, INDC(NDS)-467 (December 2004)

FOND-2.2. Evaluated Neutron Data Library (1999), Russian library of evaluated neutron data files for generating sets of constants in the ABBN constants system, by V.N. Koscheev, M.N. Nikolaev, A.M. Tsiboulia, G.V. Savoskina. Available on CD-ROM or online at http://www-nds.iaea.org/reports/nds-199r1.pdf with hyperlinks to data files for 679 materials in ENDF-6 format. Data were selected from various Russian and foreign libraries.

5. Evaluated neutron nuclear data: Multigroup libraries

In general, multigroup nuclear data libraries for reactor calculations should be requested from the NEA Data Bank, Le Seine Saint-Germain, 12 blvd des Iles, F-92130 Issy-les-Moulineaux, France.

The IAEA Nuclear Data Section has presently only the following:

FENDL/MG-2.1 and FENDL/MC-2.1, the processed cross-section libraries for neutron-photon transport calculations. Evaluated neutron reaction data and photon-atom interaction cross sections for materials contained in the general purpose Fusion Evaluated Nuclear Data Library (FENDL/E-2.0) have been processed with the NJOY code system into VITAMIN-J multigroup structure, for use in discrete-ordinates transport codes, and into continuous energy ACE format, for use in the Monte Carlo transport code MCNP. Available online and on CD-ROM.

Summary documentation: D. López Aldama and A. Trkov, INDC(NDS)-467 (December 2004)

FENDL2/A-MCNP, FENDL2/A-VITJ_E and FENDL2/A-VITJ_FLAT. The FENDL-2 neutron activation cross-section data files, processed into the following three formats: continuous energy format as used by the Monte Carlo neutron/photon transport code MCNP4A; VITAMIN-J 175 multigroup format weighted with the VITAMIN-E weighting spectrum as used by the transmutation codes REAC*2/3 and FOUR ACES; VITAMIN-J 175 multigroup ENDF-6 format, with a flat weighting spectrum. The data are available from the IAEA Nuclear Data Section online or on CD-ROM.

Summary documentation: IAEA-NDS-174 (March 1997) by A.B. Pashchenko and H.Wienke. Note: These files were not updated for the FENDL 2.1 version.

WIMSD-IAEA. Multigroup data library for the WIMS-D code, resulting from an IAEA project. Contains 69-group and 172-group cross sections for 170 materials which were extensively validated, and various auxiliary files. Available online from http://www-nds.iaea.org/wimsd/

6. Nuclear data standards for nuclear measurements

ENDF/B-VII Standards of 2006. Evaluated data in ENDF-6 format for H-1(n,n) integral and differential (up to 20 MeV), He-3(n,p) (up to 20 MeV), Li-6(n,t) (up to 2 MeV), B-10(n,α) (up to 1 MeV), C(n,n) integral and differential (up to 150 MeV), Au-197(n,γ) (up to 2 MeV), U-235(n,f) (up to 200 MeV), U-238(n,f) (up to 200 MeV). He-3(n,p) and C(n,n) data are taken from ENDF/B-VI.8, the others are new evaluations based on an IAEA project. The cross sections are also taken over in the neutron sublibrary of ENDF/B-VII except for U-235(n,f) where a slight difference occurs to satisfy thermal data testing. This version is now a separate ENDF/B sublibrary. Available online.

IAEA Standards (2006). Result of an IAEA project, see http://www-nds.iaea.org/standards/ . Data were taken over to the ENDF/B-VII standards, see above. Available online through the ENDF database.

ENDF/B-VI Standards of 1987

Evaluated data in ENDF-6 format for H-1(n,n) integral and differential, He-3(n,p), Li-6(n,t), B-10(n,a), C(n,n) integral and differential, Au-197(n,q), U-235(n,f). A second file contains cross-section uncertainties and recommended values for the 2200 m/s neutron cross-sections of U-233, 235, Pu-239, 241, and nu-bar of Cf-252. Summary documentation: IAEA-NDS-88, Rev. 3.

"X and Gamma-Ray Standards" – Decay data standards for detector calibration and other applications, December 2005. Recommended decay data, high-energy gamma-ray standards and angular correlation coefficients. Result of an IAEA project, superseding the 1991 "XG Standards". Available online from http://www-nds.iaea.org/xgamma_standards/

Cf-252 neutron spectrum. Evaluation of the californium-252 spontaneous fission neutron spectrum, by W. Mannhart, PTB Braunschweig, FRG, 1986/87.
Summary documentation: IAEA-NDS-98. Available online in a free format from http://www-nds.iaea.org/ndspub/libraries2/cf252/cf252.dat or from the ENDF/B-VII decay data library.

7. Thermal neutron cross-sections, resonance-parameters, resonance integrals

ENDF-formatted libraries: In general, values of thermal neutron cross-sections and resonance integrals from the data libraries BROND-2.2, CENDL-2, ENDF/B-VII, ENDF/B-VI, JEFF-3.1, JENDL-3.3 must be computed, for example with the ENDF preprocessing codes PREPRO. Thermal cross sections can be directly retrieved from pointwise files where available. Also, some of the basic files give the most important thermal cross sections and resonance integrals for some important materials in the introductory section in free text.

NuDat 2.2 (Selected evaluated nuclear data) contains thermal cross sections and resonance integrals (module "Nuclear Wallet Cards"). Available online under http://www-nds.iaea.org/nudat2/

Atlas of Neutron Resonances – Resonance Parameters and Thermal Cross sections, Z=1-100, by S.F. Mughabghab, published by Elsevier (March 2006). This book is the fifth edition of what was previously known as BNL-325, Neutron Cross Sections, Volume 1, Resonance Parameters. The fourth edition was published by Academic Press in two parts in 1981 and 1984. Contains individual and average resonance parametes as well as thermal cross sections and an introduction to the underlying physics. **Not available from IAEA.**

PGAA-IAEA (2003) contains total and partial thermal neutron capture cross sections. See Chapter 11.

JEFF Report 21 (2006): Table 9 of this report lists the following quantities, derived with the code INTER from the JEFF-3.1 library:

- 0.0253 eV cross-sections
- thermal Maxwellian average cross-sections
- resonance-integrals
- fission spectrum average cross-sections
- 14.0 MeV cross-sections.

The report is available from the NEA Data Bank or online from
http://www.nea.fr/html/dbdata/nds_jefreports/jeffreport-21/index.html

8. Thermal neutron scattering law

INDL/TSL. IAEA Nuclear Data Library / Thermal Scattering Law (2005). Thermal scattering law data for 11 moderator materials at various temperatures. Available online under http://www-nds.iaea.org/indltsl/ or on CD-ROM. Documentation for H(H2O), D(D2O), H(Zr H): M. Mattes and J. Keinert, report INDC(NDS)-470 (April 2005). For graphite: M. Mattes and J. Keinert, report INDC(NDS)-475 (July 2005).

ENDF/B-VII Thermal Scattering Law Data. Contains 20 materials, with several updates and extensions from the ENDF/B-VI version, some taken from INDL/TSL. Available online.

JEFF-3.1 Thermal Scattering Law Data. 9 materials, 4 of them taken from INDL/TSL. Available online and on CD-ROM.

9. Actinides

Evaluated neutron reaction data for actinide nuclides are included in the major ENDF formatted data libraries (see Chapter 4):

- **BROND-2.2**
- **CENDL-2**
- **ENDF/B-VII**
- **JEFf-3.1**
- **JENDL-3.3**

Evaluated Nuclear Data for the Th – U Cycle. Result of an IAEA project (completed 2006). Contains evaluations in ENDF-6 format (basic ENDF, ACE and MATXS formats) for Th-232, Pa-231,233, and U-232,233,234,236. Available online from http://www-nds.iaea.org/Th-U/

Minsk Actinides Library by V. Maslov et al., Minsk, Belarus. Evaluated neutron reaction data for 17 materials between Th-232 and Cm-246 in ENDF-6 format. Latest revisions from 2005. Available on CD-Rom and online from http://www-nds.iaea.org/minskact/ Summary documentation: IAEA-NDS-164, Rev. 6 (March 2004).

Theoretical Evaluation of Neutron and Proton Induced Fission Cross Sections for Pb - Pu Targets in Energy Range 20 - 200 MeV, by S. Yavshits, report IAEA-NDS-153 (February 2002). 9 proton induced and 12 neutron induced fission cross sections for nuclei from Pb-204 to Pu-239 have been evaluated in the Multi-Configuration Fission approach. Report and data available on CD-ROM or online at http://www-nds.iaea.org/reports/nds-153.pdf

WIND and WIND-2: Neutron nuclear data library for isotopes of U, Np, Pu up to 100 MeV, with one file of proton reaction data for U-238 and a file for Pu-239 up to 2 GeV. By A.Ju. Konobejev et al., Obninsk, Russia. Summary documentation: IAEA-NDS-143 (1995).

10. Fission product yields

For experimental fission-product yield data see EXFOR; this includes most of the data compiled earlier in separate files by Crouch and Meek/Rider.

There are three major files for evaluated fission-product yield data for a large number of "fissioning systems", i.e. actinides fissioning by thermal neutrons, fast neutrons, 14 MeV neutrons, or spontaneous fission.

Compilation and evaluation of fission yield nuclear data. Handbook IAEA-TECDOC-1168 (December 2000). Final report of a Co-ordinated Research Project 1991-1996. The appendices contain voluminous tables and also a computer program YCALC for calculating fission yields and are enclosed as a CD-ROM. Limited number of copies available cost-free to scientists from developing countries upon request. See also
http://www-nds.iaea.org/reports-new/tecdocs/iaea-tecdoc-1168.pdf

ENDF/B-VII fission-product yield data: Taken over unchanged from ENDF-B-VI. Separate ENDF/B-6 sublibrary which was released in September 1991 and updated in June 1993 and May 1995. It has two parts: one part for neutron induced fission, another part for spontaneous fission. Available online or on computer media.
Summary: see document IAEA-NDS-106 Rev. 3.

JEFF-3.1/FPY, the JEFF-3.1 fission-product yield data library by the NEA Data Bank, in ENDF-6 format. Data for neutron-induced and spontaneous fission. This file is a modification of UKFY3, the UK fission-product yield data library by M. James and R. Mills, which in turn is a development of UKFY2.

JENDL-3.3/FPY, the JENDL fission-product yield data library, has been compiled by T. Nakagawa in ENDF-6 format. Same as JENDL-3.2/FPY. The evaluated data have been taken over from JNDC-FP2, a special format data library (see below) documented in the reports JAERI-M-89-204 (1989) and JAERI-1320 (1990). Available online or on computer media.

For some fissioning systems that are not included in above data libraries the following file may be used which has been obtained from a theoretical thermodynamical model:

ASIYAD, fission-product yield library by A.F. Grashin reported at the 1988 Mito Nuclear Data Conference, and converted to ENDF-6 format by the Russian Nuclear Data Center, Obninsk. Available online from
http://www-nds.iaea.org/ndspub/libraries2/asiyad/asiyad.dat
Summary see document: IAEA-NDS-133.

For a review of **delayed neutron data**, see *Progress in Nuclear Energy, vol. 41 (2002).* This volume is dedicated to a review of the delayed neutron data situation and related activities resulting from the NEA/WPEC subgroup 6.

Other fission-product data:

Evaluated neutron cross sections of fission products are included in the general purpose files of the major evaluated libraries ENDF/B-VII, JEFF-3.1, JENDL-3.3, and BROND-2. See Chapter 4.

Fission product decay data are included in the decay data sublibraries of ENDF/B-VII and JEFF-3.1.

11. Neutron induced gamma-rays

PGAA-IAEA: Database for Prompt-Gamma Ray Neutron Activation Analysis. Result of and IAEA project (completed 2003). The resulting database provides a variety of tables for all natural elements (from H to U) including the following data: isotopic composition, thermal radiative cross section (total and partial), Westcott g-factors, energy of the gamma rays (prompt and delayed), decay mode, half life and branching ratios. Available online under http://www-nds.iaea.org/pgaa/ and on CD-ROM. With database viewer and data in Excel, pdf/PS, and text format. Full documentation available from http://www-nds.iaea.org/pgaa/tecdoc.pdf

Thermal Neutron Capture Gamma Rays (CapGam), an online database by J.K. Tuli, is available from http://www-nds.iaea.org/oldwallet/tnc/capgam.shtml Energies and intensities can be retrieved by target or by gamma energy. Based on ENSDF and a compilation by M.A. Lone.

Thermal Neutron Capture Data for A=1-25. Report INDC(CPR)-051 (July 2000) by Zhou Chunmei. New evaluation of level properties, prompt gamma rays and decay scheme properties, done for the PGAA-IAEA project. Available online at http://www-nds.iaea.org/reports/indc-cpr-051.pdf

Thermal Neutron Capture Data Update and Revision for Some Nuclides with A > 190. Report INDC(CPR)-055 (June 2001) by Zhou Chunmei. Done for the PGAA-IAEA project. Available online at http://www-nds.iaea.org/reports/indc-cpr-055.pdf

Atlas of energy-angular distributions of photons produced in neutron interactions. Report Yad. Konst. 1993(2) by A.I. Blokhin et al.
Contents: Brief introduction in Russian. Index to available experimental data. Bibliography. 255 figures of double differential cross-sections for 52 elements. 100 figures of gamma production cross-sections.

12. Neutron activation – general

This chapter includes evaluated data files for neutron activation cross-sections for general use.
See also the following chapter for application in dosimetry, and chapter 7 for thermal neutron activation cross-sections.

RNAL- Reference Neutron Activation Library (2000). Result of an IAEA project. Evaluated data for 255 important neutron-induced reactions leading to radioactive products, selected from various libraries and reformatted to ENDF-6 format. The full library, individual reactions and comparison plots with experimental data from EXFOR are available online under http://www-nds.iaea.org/ndspub/rnal/www/ or on CD-ROM.

JEFF-3.1 Activation File. Neutron cross-section data, consisting of 12617 excitation functions for 774 materials from H-1 to Fm-257, up to 20 MeV. Data are based on the European Activation File EAF-2003, converted to ENDF-6 format. Same as JEFF-3.0 Activation File. Available online. Documentation: J.Ch. Sublet et al., IAEA-NDS-211 (2004).

EAF-2007 (European Activation File) Neutron-induced cross section library. Part of the JEFF project. Not available from IAEA, for enquiries contact the NEA Data Bank, http://www.nea.fr/html/dbdata/ . Contains 65 565 excitation functions for 816 targets from H-1 to Fm-257 up to 60 MeV. Summary documentation: R.A. Forrest, J. Kopecky, C.-Ch. Sublet, report UKAEA-FUS-535(March 2007), http://www.fusion.org.uk/techdocs/ukaea-fus-535.pdf

Atlas of neutron capture cross sections. J. Kopecky et al.
Report INDC(NDS)-362 (1997), 370 pages. Plots of neutron capture cross sections in the energy range 10^{-5} eV - 20 MeV as evaluated and compiled in recent activation libraries, compared with available experimental values at thermal energy, 30 keV and 14.5 MeV, for 739 targets from H and Cm. Report available cost-free. Data can be downloaded from http://www-nds.iaea.org/ngatlas2/ in tabular and graphical form.

FENDL/A-2.0, Comprehensive neutron cross section library for 13006 neutron activation reactions with 739 target nuclides from H to Cm in the incident energy range up to 20 MeV. The data are in ENDF format with some modifications. Compared to the previous version FENDL/A-1.1, many nuclides and reactions were added or revised. The evaluations were selected from major activation libraries including EAF-4.1, ADL-3, JENDL/A-3.2 and others. Available online and on CD-ROM.
Summary documentation: IAEA-NDS-173. Not updated for FENDL-2.1 version, use of JEFF-3.1/Activation is recommended.

LLCRP. Excitation functions of 16 long-lived activation reactions of importance in fusion reactor technology. Result of an IAEA project. Available in slightly modified ENDF-5 format on computer media. Summary documentation: INDC(NDS)-344 (1997). Available online from http://www-nds.iaea.org/ndspub/irdl/llcrp/data_file.crp

ADL-3, Russian Activation Data Library, evaluated neutron activation cross-sections of 20049 excitation functions. Documentation: O.T. Grudzevich, A.V. Zeleneckij, A.V. Ignatyuk, A.B. Pashchenko, Catalogue of ADL-3 library, in: Yadernye Konstanty, issue 1993 (3-4). Copies available costfree. (180 pages of index, self-explanatory, with an introduction in Russian, abstract in English.) Data library available online from http://www-nds.iaea.org/ndspub/libraries2/adl3t/adl3t_mat.dat
Summary documentation: IAEA-NDS-137.

13. Neutron activation - for Dosimetry

IRDF-2002, the International Reactor Dosimetry File, version of 2002. Result of an IAEA project, supersedes IRDF-90. Data were selected from various sources after extensive intercomparisons. Contains damage cross sections, standard spectra, decay data, dosimetry cross sections in several formats (pointwise, groupwise, and metrology format), and codes for damage parameter and spectral adjustment calculations. Available online from http://www-nds.iaea.org/irdf2002/ or on CD-ROM. Documentation: INDC(NDS)-448, available online from http://www-nds.iaea.org/reports-new/indc-reports/indc-nds/indc-nds-0448.pdf

NMF-90, Neutron Metrology File, an integrated database for performing neutron spectrum adjustment calculations.
Documented in the reports IAEA-NDS-171 and INDC(NDS)-347 by N.P. Kocherov. It contains the IRDF-90 database, together with 4 different adjustment codes, 6 data sets for reactor benchmark neutron fields, and utility codes for processing and plotting the input and output data. Available on computer media or online from
http://www-nds.iaea.org/ndspub/libraries/nmf/

Neutron Excitation Function Guide for Reactor Dosimetry, by O. Gritzay, M. Vlasov, L. Chervonna, V. Zerkin, N. Klimova, G. Kolota (January 2002). Intercomparison of 81 dosimetry reactions for 56 nuclides. Available on CD-ROM or online at
http://www-nds.iaea.or.at/reports/indc-ukr-005.pdf

RRDF-98. Russian Reactor Dosimetry File. Cross sections and uncertainties for 22 reactions used for neutron flux dosimetry by foil activation. By K.I. Zolotarev, A.V.Ignatyuk, V.N. Manokhin, and A.B. Pashchenko. Summary documentation: IAEA-NDS-193 (March 1999). Data and documentation available online from http://www-nds.iaea.org/reports/nds-193.htm. The complete library can be downloaded from http://www-nds.iaea.org/ndspub/libraries2/rrdf98/rrdf98_new.dat

Other dosimetry reaction files may be included in the "General purpose evaluated neutron nuclear data".

14. Miscellaneous specialized neutron data libraries

ADS-Lib: Application Library for Accelerator-Driven Systems (2005). Result of an IAEA project. Evaluated data files in ENDF-6 format, in ACE format for use with MCNP, and group cross sections in MATXS format for various temperatures. Basic data are from the JEFF-3.1 library. With auxiliary files and programs. Available online from http://www-nds.iaea.org/ads/ or on CD-ROM. Documentation: D. Lopez Aldama and A. Trkov, INDC(NDS)-0474 (August 2005).

INGDB-90: The international neutron nuclear database for geophysics applications. It contains neutron cross-section data selected from ENDF/B-VI and JENDL-3 in pointwise and 640 group format, spectrum data of selected neutron sources, and the cross-section data processing codes LINEAR and GROUPIE.
Assembled by N.P. Kocherov and P.K. McLaughlin.
Summary see document IAEA-NDS-127.
The full information see N.P. Kocherov, IAEA Technical Report 357: Handbook on Nuclear Data for Borehole Logging and Mineral Analysis (1993).

SGNucDat (New version of 2007). This replaces the handbook and database from 1997.
A: Actinide nuclear data (decay data, selected neutron cross-section data, fission-neutron data);
B: fission-product nuclear data (decay data and selected neutron cross-section data);
C: fission-product yield data. Available online at
http://www-nds.iaea.org/sgnucdat/

Atlas of neutron capture cross sections. J. Kopecky et al.
Report INDC(NDS)-362 (1997), 370 pages. Plots of neutron capture cross sections in the energy range 10^{-5} eV - 20 MeV as evaluated and compiled in recent activation libraries, compared with available experimental values at thermal energy, 30 keV and 14.5 MeV, for 739 targets from H and Cm. Report available cost-free. Data can be downloaded from http://www-nds.iaea.org/ngatlas2/ in tabular and graphical form. Also available on CD.

Californium-252 spectrum averaged neutron cross-sections, W. Mannhart - See Handbook on Nuclear Activation Data, IAEA Technical Report Series No. 273, Vienna 1987, p. 413-440.

Neutron scattering lengths: see chapter 1, experimental neutron data.

21. Photonuclear data

IAEA Photonuclear Data Library (March 2000), contains recommended evaluated photonuclear cross section data for 164 isotopes for incident photon energies mostly up to 140 MeV. Handbook available as IAEA-TECDOC-1178. Data available online and on CD-ROM.

ENDF/B-VII Photonuclear sublibrary. New ENDF/B sublibrary largely based on the IAEA Photonuclear Data Library. Available online.

EXFOR, see documentation above under item 1. The EXFOR file contains photo-neutron data and selected other photonuclear data. Selective retrievals available online, complete library on CD-ROM.

GDR - Giant dipole resonance-parameters for gamma-rays. Included in RIPL-2 which is available on CD-ROM or online from http://www-nds.iaea.org/RIPL-2/

22. Photo-atomic interaction data

EPDL-97 The Evaluated Photon Data Library, 1997 version (EPDL97), is designed for use in photon transport calculations at Lawrence Livermore National Laboratory. This library includes photon interaction data for all elements with atomic number between Z= 1 (hydrogen) and 100 (fermium), including: photoionization, photoexcitation, coherent and incoherent scattering, and pair and tripletproduction cross sections. For use in applications data is provided for all elements over the energy range 1 eV to 100 GeV. EPDL97 completely supersedes the earlier 1989 version of EPDL(89) (see IAEA-NDS-158, Summary documentation to the EPDL) and it is highly recommended that users only use the most recent version of this library. The Evaluated Atomic Data Library (**EADL**), Evaluated Electron Data Library (**EEDL**) an Evaluated Excitation Data Library (**EXDL**) are included to allow consistent coupled photon-electron transport calculations. The data package is available from the IAEA Nuclear Data Section on CD-ROM (12 files, 74.2 MB) and online. Summary documentation: IAEA-NDS-196 (August 1998).

ENDF/B-VII Photo-atomic sublibrary. Taken over from ENDF/B-VI. This is essentially identical to EPDL mentioned above. The main differences are: This library is in ENDF-6 format (EPDL has its own format). The energy range is from 10 eV to 100 MeV (EPDL goes up to 100 GeV). Available online or on computer media. For a summary description see the document IAEA-NDS-58 Rev. 3.

JEF-2/Photo, the JEF-2 photo-atomic interaction data library containing pair production cross-sections, photoelectric cross-sections, coherent scattering cross-sections, atomic form factors, and other data for all elements from Z=1 to 100. It is based on the Livermore EPDL file and on the ENDF/B-6 Photo-Atomic data file. Compared to ENDF/B-6, the photo-electric cross-section data have been updated in 1990. - 260 000 records. Summary documentation: IAEA-NDS-58 Rev. 4. - Available online and on computer media.

XCOM: Photon cross section database, available online from NIST (US), see http://www.physics.nist.gov/PhysRefData/Xcom/Text/XCOM.html

23. Charged-particle nuclear reaction data

See also Chapters 24 (Intermediate energy nuclear data) and 25 (Nuclear data for thermonuclear fusion)

EXFOR, compilation of experimental and evaluated nuclear reaction data induced by charged particles and heavy ions. Retrievals online, complete database available on CD-ROM. Less complete than the neutron-induced reaction data in EXFOR. Special emphasis on: Integral cross-sections and thick target yields; Neutron source reactions; and miscellaneous other data, e.g. differential data, data for biomedical applications, and charged-particle induced fission data. See Chapter 1 for more information on EXFOR.

Charged-particle cross section database for medical radioisotope production (March 2000), developed under an IAEA Co-ordinated Research Project, contains recommended evaluated cross sections for 48 reactions induced by light charged particles with incident energies up to several tens of MeV (maximum 100MeV). Available online (WWW) and on CD-ROM, and as IAEA-TECDOC-1211.

NRDF, the Nuclear Reaction Data File of the Japan Charged-Particle Nuclear Reaction Data Group at the Hokkaido University, contains mainly differential charged-particle and heavy-ion induced reaction data measured in Japan. Some of this database has been converted and included in EXFOR, more conversions are under preparation. Available online from http://www.jcprg.org/nrdf/

FENDL/C-2.0: See Chapter 25.

EAF-2007 (European Activation File) Deuteron- and proton-induced cross section libraries. Part of the JEFF project. Not available from IAEA, for enquiries contact the NEA Data Bank, http://www.nea.fr/html/dbdata/ . Contains 66 864 deuteron-induced reactions and 67 925 proton-induced reactions up to 60 MeV. Summary documentation: R.A. Forrest, report UKAEA-FUS-536(March 2007), http://www.fusion.org.uk/techdocs/ukaea-fus-536.pdf

Charged-particle induced neutron source reactions, see Chapter 25 on "Nuclear data for thermonuclear fusion".

IBANDL – Ion Beam Analysis Nuclear Data Library. IAEA experimental cross section database for ion beam analysis, containing mainly differential cross sections for scattering and nuclear reactions and ratio to Rutherford scattering, available in r33 tabular format and as graphs. Available online and on CD-ROM.

SigmaCalc. Evaluated cross sections for ion beam analysis. Evaluations by A. Gurbich (Obninsk, Russia). Software tool calculating on the fly differential cross sections for tabular and graphical output. See http://www-nds.iaea.org/sigmacalc/

ENDF/B-VII charged-particle sublibraries (2006). The proton sublibrary contains 47 materials between H-1 and Pb-208, mostly up to 150 MeV, including several updates and new evaluations. The deuteron, triton and He-3 sublibraries contain 5, 3 and 2 materials, respectively (H, He, and Li isotopes). Available online and on CD-ROM. Documentation: M.B. Chadwick et al., Nuclear Data Sheets 107, issue 12 (December 2006), pp. 2931-3060.

ENDF/B-VI High Energy Data File (1990): contains proton (and neutron) reaction data up to 1 GeV for 6-C-12, 26-Fe-56, 82-Ph-208, 93-Bi-209. See IAEA-NDS-113 Rev. 2. Available online.

JEFF-3.1 Proton special purpose library. Cross sections for isotopes of Ca, Sc, Ti, Fe, Ge, Pb and Bi (altogether 26 materials) up to 200 MeV, primarily based on theoretical analysis with the nuclear model code TALYS. Available online.

DROSG-2000 (Monoenergetic neutron source reactions): see Chapter 25

TLAPrfl: Package for Calculation of Depth Profile for Thin Layer Activation, by G. Wallace. The package is available online together with summary documentation IAEA-NDS-192 (September 1999) under
http://www-nds.iaea.org/reports/nds-192.pdf

Stopping Power for Light Ions. Compilation by H. Paul (Univ. Linz, Austria) with tables, graphs and programs. Available online from
http://www-nds.iaea.org/stoppinggraphs/

Stopping power data: ESTAR, PSTAR, ASTAR, a PC package for calculating stopping powers and ranges of electrons, protons and helium ions in various materials, by M.J. Berger, NIST, Washington. Available on computer media. Documentation see IAEA-NDS-144. For protons and alpha particles this work has been described in ICRU-report-49 which also contains tabulated data. Latest version available online from NIST (USA) under http://www.physics.nist.gov/PhysRefData/Star/Text/contents.html

24. Intermediate energy nuclear data

a. Reactions induced by neutrons

ENDF/B-VII General Purpose File (see Chapter 4) contains about 40 (out of 393) materials with data given up to 150 MeV.

JEFF-3.1 General Purpose File (see Chapter 4): for some materials, data are given up to 150 or 200 MeV.

MENDL-2, the Russian cross-section data library for transmutation and activation of materials irradiated by neutrons with energies up to 100 MeV. Yu.N. Shubin et al., report INDC(CCP)-385. - Available on computer media from the IAEA Nuclear Data Section or online: Download individual materials (http://www-nds.iaea.org/ndspub/mendl2/) or whole library under http://www-nds.iaea.org/ndspub/mendl2/mendl2_all.dat (76 MB).
Summary documentation: IAEA-NDS-136 (1995).

WIND and WIND-2: Neutron nuclear data library for isotopes of U, Np, Pu up to 100 MeV, with one file of proton reaction data for U-238 and a file for Pu-239 up to 2 GeV. By A.Ju. Konobejev et al., Obninsk, Russia.
Download WIND1 under
http://www-nds.iaea.org/ndspub/libraries2/wind/wind_1_new.dat and WIND2 under
http://www-nds.iaea.org/ndspub/libraries2/wind/wind_2_new.dat
Summary documentation: IAEA-NDS-143 Rev. 1.

BISERM v.2: Nuclear Data Library for Evaluation of Radiation Effects in Materials Induced by Neutrons of Intermediate Energies. By Yu.A. Korovin et al., Obninsk, Russia. The library contains neutron displacement cross sections as well as hydrogen and helium production cross sections for 259 stable nuclei from Al-27 to Bi-209 at neutron energies up to 1 GeV. The data are in slightly modified ENDF-6 format. Available online from
http://www-nds.iaea.org/ndspub/libraries2/biserm/biserm.dat
Summary documentation: IAEA-NDS-203 (March 1997).

b. Reactions induced by neutrons and charged particles

Theoretical Evaluation of Neutron and Proton Induced Fission Cross Sections for Pb - Pu Targets in Energy Range 20 - 200 MeV, by S. Yavshits, report IAEA-NDS-153 (February 2002). 9 proton induced and 12 neutron induced fission cross sections for nuclei from Pb-204 to Pu-239 have been evaluated in the Multi-Configuration Fission approach. Report and data available on CD-ROM or online at http://www-nds.iaea.org/reports/nds-153.pdf

ENDF/B-VI High Energy Data File (1990/1993): contains four sets of neutron and proton reaction data up to 1 GeV for 26-Fe-56 (1990) and 6-C-12, 82-Pb-208, 93-Bi-209 (1993). See IAEA-NDS-113 Rev. 1. Available online.

EXFOR: Includes experimental data for reactions induced by intermediate-energy neutrons and charged particles, though the compilation does not claim completeness. See Chapter 1.

c. Charged-particle induced reactions

ENDF/B-VII proton sublibrary (2006) contains 47 materials between H-1 and Pb-208, mostly up to 150 MeV, including several updates and new evaluations. Available online and on CD-ROM. Documentation: M.B. Chadwick et al., Nuclear Data Sheets 107, issue 12 (December 2006), pp. 2931-3060.

PADF-2007 – Proton Activation Data File, by A.Yu. Konobeyev, C.H.M. Broeders, U. Fischer, L. Mercatali, I. Schmuck and S.P. Simakov, Karlsruhe (Germany). Contains 418 575 excitation functions of nuclear reactions for 2355 target nuclei from Mg to Ra at proton energies up to 150 MeV in ENDF-6 format. Will be available online from about September 2007 under http://www-nds.iaea.org/padf/

JEFF-3.1 Proton special purpose library. Cross sections for isotopes of Ca, Sc, Ti, Fe, Ge, Pb and Bi (altogether 26 materials) up to 200 MeV, primarily based on theoretical analysis with the nuclear model code TALYS. Available online.

WIND: The WIND library for neutron reaction data (see above), includes one file of proton reaction data for U-238.

MENDL-2P. Proton reaction data library for nuclear activation by Yu.N. Shubin et al., Obninsk, Russia. This library includes calculated proton cross-sections in ENDF-6 format for 505 nuclei (Z=13-84) for energies up to 200 MeV. The total number of reactions is 87196. Available on CD-ROM or online: Download individual materials http://www-nds.iaea.org/ndspub/mendl2p/ or the whole library from http://www-nds.iaea.org/ndspub/mendl2p/mendl2p_new.dat (133 MB).
Summary documentation: IAEA-NDS-204.

Carlson compilation. Proton-nucleus total reaction cross-sections and total cross-sections up to 1 GeV. Tables of all directly measured data. By R.F. Carlson, Univ. of Redlands, California. Published in Atomic Data and Nucl. Data Tables 63 (1996) p. 93-116. Not available as a computer file. Most of the data have recently been included in EXFOR.

25. Nuclear data for thermonuclear fusion

FENDL-2.1 Fusion evaluated Nuclear Data Library (December 2004). With several sublibraries. See also Chapter 4 (FENDL/E), Chapter 12 (FENDL/A for activation), Chapter 31 (FENDL/D for decay data).

ENDF/B-VII charged-particle sublibraries, December 2006 version, contains cross sections for incident protons, deuterons, tritons, and He-3 particles, including fusion reactions between d,t, and He3 particles. Available online and on CD-ROM.

FENDL/C-2.0, (March 1997). Integrated cross section evaluations and processed data for the fusion reactions H-2 (d,n)He-3, H-2(d,p)H-3, He-3(d,p)He-4, H-3(t,2n)He-4, and H-3(d,n)He-4, in ENDF-6 format. The data for the first four reactions are extracted from ENDF/B-6 (unchanged from previous version FENDL/C-1.0), while the data for the H-3(d,n)H-4 reaction were replaced with an improved evaluation by G.M. Hale and M. Drosg. Available online from http://www-nds.iaea.org/fendl/fen-fusion.htm or on CD-ROM.
Summary documentation: IAEA-NDS-177.

JEFF Report 21 (2006): Table 9 of this report lists the following quantities, derived with the code INTER from the JEFF-3.1 library:

- 0.0253 eV cross-sections
- thermal Maxwellian average cross-sections
- resonance-integrals
- fission spectrum average cross-sections
- 14.0 MeV cross-sections.

The report is available from the NEA Data Bank or online from
http://www.nea.fr/html/dbdata/nds_jefreports/jeffreport-21/index.html

SaBa: Library of Evaluated and Experimental Data on Charged Particles for Fusion Applications, contains data for 52 reactions with a set of data processing procedures. See Report IAEA-NDS-191 by A.G. Zvenigorodskij et al. (December 1999). See http://www-nds.iaea.org/reports/data/saba/ for downloading the data and http://www-nds.iaea.org/reports/nds-191.pdf for the documentation.

DROSG-2000. Monoenergetic neutron source reactions, by M. Drosg, University of Vienna. The database, previously known as DROSG-87 and DROSG-96, was extended significantly and contains now 59 reactions and various new features. The package contains the basic data and several FORTRAN programs for calculation of neutron yields, and white source properties. A detailed documentation is included. Version 2.21 (May 2005) of the database with programs (in compressed form) is available online from http://www-nds.iaea.org/drosg2000.html

26. Nuclear model parameters and codes

EMPIRE-II, Modular System of Codes for Nuclear Reaction Calculations (co-ordinated by M. Herman, NNDC). EMPIRE-II is a system of FORTRAN codes linked through a number of bash scripts that with a few key strokes and mouse clicks performs comprehensive calculations of nuclear reactions using combination of the most important reaction mechanisms. Available on CD-ROM or online at http://www-nds.iaea.org/empire/

Requests for **other nuclear model codes** should be addressed to the **NEA Data Bank**, Le Seine Saint-Germain, 12 blvd des Iles, F-92130 Issy-les-Moulineaux, France, see http://www.nea.fr/html/dbprog/

RIPL-2 Reference Input Parameter Library (April 2003). Contains input parameters for theoretical calculations of nuclear reactions involving light particles such as n, p, d, t, 3-He, 4-He, and gammas at incident energies up to about 100 MeV. The library contains nuclear masses, deformations, matter densities, discrete levels and decay schemes, spacings of neutron resonances, optical model potentials, level density parameters, Giant Resonance parameters, gamma-ray strength-functions, and fission barriers. It also includes extensive database of level densities, gamma-ray strength-functions and fission barriers calculated with microscopic approaches. Several computer codes are provided in order to facilitate use of the library. Some files of RIPL-1 were not included and may still be of some interest, therefore RIPL-1 remains available also. Available online under http://www-nds.iaea.org/RIPL-2/ or on CD-ROM.

RIPL - Reference Input Parameter Library (RIPL-1) for theoretical calculations of nuclear reactions. Contains: Atomic Masses and Deformations; Discrete Level Schemes; Average Neutron Resonance Parameters; Optical Model Parameters; Level Densities (Total, Fission, Partial); Gamma-Ray Strength Functions; Continuum Angular Distributions. Incident and outgoing particles can be n, p, d, t, 3-He, 4-He, and gamma with energies up to about 100 MeV. Developed as a project co-ordinated by IAEA. Available online and on CD-ROM. A detailed description is given in IAEA-TECDOC-1034 (1998).

Table of Nuclear Root Mean Square Charge Radii (June 1999) by I. Angeli.. The tables and a brief summary of the data evaluation are given in IAEA-NDS-163 (also available online under http://www-nds.iaea.org/reports/nds-163.pdf), the full report in INDC(HUN)-033 (September 1999).

Nuclear Charge Radii, see also: journal "Atomic Data and Nuclear Data Tables" vol. 60 Number 2, July 1995.

31. Nuclear structure and decay data

FENDL/D-2.0. Decay properties (decay type, decay energy, half-life) for 1867 nuclides and isomers, taken from the EAF-4.1 decay library. The data, in ENDF-6 format as well as processed into MNCNP and REAC-compatible formats, are available online and on CD-ROM. Not updated for FENDL-2.1 version.
Summary documentation: IAEA-NDS-178 (March 1997).

ENSDF, evaluated nuclear structure and decay data file, available online. New evaluations are published in the journal "Nuclear Data Sheets". Evaluations are performed within the International Network of Nuclear Structure and Decay Data Evaluators (NSDD) (see http://www-nds.iaea.org/nsdd/), coordinated by the IAEA Nuclear Data Section. The master file is maintained by NNDC (USA).

Also available online: ENSDF analysis and utility programs, see
http://www-nds.iaea.org/www_ensdfpgm/www_ensdfpgm.html

XUNDL – Experimental Unevaluated Nuclear Data List, contains experimental data compiled from over 1500 recent nuclear structure papers. Available online through common interface with ENSDF, see http://www-nds.iaea.org/www_ensdfpgm/www_ensdfpgm.html

NUDAT-2.2. This is a database in which essential data have been extracted from ENSDF in a user friendly form. The database is accessible online. It contains for each nuclide: adopted levels and gamma-ray energies; decay radiations; and half-lives and other properties of ground and metastable states (Nuclear Wallet Cards). In addition, the "Nuclear Wallet Cards" branch of NUDAT includes thermal neutron cross-sections and resonance-integral data.

Isotope Explorer, an alternative viewer for ENSDF data. For this and other relevant information see the LBNL Isotopes Project – Lund University data distribution web page on http://ie.lbl.gov/toi.html#toi

MIRD - Medical Internal Radiation Dose Tables. Tables of nuclear and atomic radiations from nuclear decay and decay scheme are produced online from the Evaluated Nuclear Structure Data File (ENSDF) for the specified nuclide. Output may be either HTML-formatted tables and GIF drawings or pdf –formatd tables and drawings. Available online from
http://www-nds.iaea.org/mird/

Table of Isotopes, 8th edition (1996, 1998, 1999) by R.B. Firestone, Lawrence Berkeley National Laboratory, USA. Handbook with CD-ROM, published by Wiley & Sons. Based on ENSDF, not available from IAEA.

NUBASE-2003. Database for experimentally known nuclear properties, by G. Audi, O. Bersillon, J. Blachot, A.H. Wapstra. Available online from
http://www-nds.iaea.org/amdc/web/nubase_en.html. NUBASE contains mass, isomeric excitation energy, half-life, spin, parity, decay modes and intensities for 3177 nuclides. Published in Nucl.Phys. A729, pp. 3-128 (2003)

"X and Gamma-Ray Standards" – Decay data standards for detector calibration and other applications, December 2005. Recommended decay data, high-energy gamma-ray standards and angular correlation coefficients. Result of an IAEA project, superseding the 1991 "XG Standards". Available online from
http://www-nds.iaea.org/xgamma_standards/

ENDF/B-VII decay data sublibrary (2006). Completely reevaluated and extended since the ENDF/B-VI version. It includes data for 3838 materials (all known nuclei, with only spin and parity given for stable levels), mostly derived from ENSDF and the 2005 edition of the Nuclear Wallet Cards.

JEFF-3.1/RDD, the JEFF-3.1 radioactive decay data library by the NEA Data Bank, in ENDF-6 format, containing decay data for 3852 radionuclides. Completely new library (2006) compared to earlier versions. Documentation: JEFF Report 20 (to be published). Data available online.

UKPADD-6.7 (Activation Product Decay Data for 559 radionuclides) and **UKHEDD-2.5** (Heavy Element and Actinide Decay Data for 125 radionuclides), evaluations by A.L. Nichols (2007), in ENDF-6 format. UKPADD and UKHEDD data are fed into the JEFF decay data library (see above). For obtaining UKPADD-6.7 and UKHEDD-2.5 contact the NEA Data Bank, http://www.nea.fr/html/dbdata/

Documentation:
UKPADD-6.7: Report UKNSF(2007)P212 (=JEF/DOC-1165) by A.L. Nichols and R.J. Perry, February 2007

UKHEDD-2.5: Report UKNSF(2007)P213 (= JEF/DOC-1166) by A.L. Nichols and R.J. Perry, February 2007

"Nuclear Wallet Cards" (April 2005), a booklet by J.K. Tuli, US National Nuclear Data Center, Brookhaven National Laboratory, Upton NY, USA-11973. It lists for all known nuclides and some of their isomers the natural abundance or the half-life and decay mode. Also included are spin and parity assignments and the mass excess. Available online. The data are included also in NUDAT, see above. An appendix lists fundamental physics constants. Limited number of copies available costfree from the IAEA Nuclear Data Section.

Internal conversion coefficients:

Rösel, F., Fries, H.M., Alder, K., Pauli, H.C., 1978. Internal conversion coefficients for all atomic shells. *At. Data Nucl. Data Tables* **21**, 91-514.

Band, I.M., Trzhaskovskaya, M.B., Nestor Jr., C.W., Tikkanen, P.O., Raman, S., 2002. Dirac-Fock internal conversion coefficients. *At. Data Nucl. Data Tables* **81**, 1-334.

Raman, S., Nestor Jr., C.W., Ichihara, A., Trzhaskovskaya, M.B., 2002. How good are the internal conversion coefficients now? *Phys. Rev.* **C66**, 044312.

Kibedi, T., Burrows, T.W., Trzhaskovskaya, M.B., Nestor, Jr., C.W., A New Tool to Interpolate Conversion Coefficients and E0 Electronic Factors, Int. Conf. Nuclear Data for Science and Technology, pp. 268-271 in AIP Conference Proceedings, Volume 769, American Institute of Physics (2006).

R.S. Hager and E.C. Seltzer, *Nucl. Data Tables* **A4** (1968) 1

Decay alphas: Recommended energy and intensity values of alpha particles from radioactive decay. A consistent set of recommended energy and branching values, evaluated by A. Rytz, Bureau International des Poids et Mesures, France. Not available on computer media. See Atomic Data and Nuclear Data Tables 47, 205-239 (1991).

SGNucDat (New version of 2007). This replaces the handbook and database from 1997.
A: Actinide nuclear data (decay data, selected neutron cross-section data, fission-neutron data);
B: fission-product nuclear data (decay data and selected neutron cross-section data);
C: fission-product yield data. Available online at http://www-nds.iaea.org/sgnucdat

Beta and antineutrino decay of radionuclides. A handbook by V.G. Aleksankin, S.V. Rodichev, P.M. Rubcov, P.A. Ruzhanskij, F.E. Chukreev, Moscow, Energoatomizdat 1989. 100 pages text in Russian, 700 pages of energies and intensities of beta and antineutrino radiations plus other decay parameters for all radionuclides. Neither the book nor the data file are available from IAEA.

Spontaneous fission data: Yields and spectra of fission neutrons and fission products, see EXFOR.

Nuclear quantities such as nuclear temperatures, level density parameters, spin cut-off factors, see EXFOR (Chapter 1) and RIPL (Chapter 26).

Fission product decay data See above under "Fission products - evaluated neutron reactions, yields and decay data".

32. Gamma ray analysis

The following packages contain software with gamma data included which were taken from collections from about 1995 and before but may nevertheless still be of some use.

IDGAM, A PC code and database to identify isotopes in a radioactive sample by their gamma rays. Diskette by R. Paviotti Corcuera, M. de Moraes Cunha, K.A. Jayanti, Sao José dos Campos, Brazil. It uses the database "Strong gammas" by T. Narita et al. (1993) with about 6000 gamma lines. Documentation: IAEA-NDS-135

NUCHART. A PC package which displays nuclear decay data from ENSDF/NUDAT, including a search routine for assigning gamma-ray energies to radionuclides. NUCHART for Windows, version 1.2 of Feb. 1995, by V. Osorio and H. Peraza, IAEA Physics Section. Documentation: IAEA-NDS-161.

GANAAS. A PC software for gamma spectrum analysis, activity calculations and neutron activation analysis, by the IAEA Physics Section. A set of four HD diskettes and a software handbook IAEA/CMS-3. The package uses the thermal neutron cross-section data by E. Gryntakis et al. (Handbook of Nuclear Activation Data, IAEA Technical Report 273, 1987, p. 199) and fast neutron cross-sections by R. Pepelnik (unpublished).

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33. Nuclear constants, Charts of Nuclides

AMDC (Atomic Mass Data Center) – Mirror site of George Audi's website containing the Atomic Mass Evaluation, NUBASE and other related data. See http://www-nds.iaea.org/amdc/web/amdcw_en.html

Karlsruher Nuklidkarte (Karlsruhe chart of Nuclides), 7th ed. 2006,
The Karlsruhe Chart of the Nuclides is available as both a 44 page brochure with 20 page fold-out nuclide chart and as a wallchart (1.00 m x 1.40 m). To be ordered from: Marktdienst Haberbeck GmbH, Industriestraße 17, D-32791 Lage (Germany) E-mail: marktdienste@haberbeck.de

Chart of the Nuclides Book, issued by Knolls Atomic Power Laboratory (16th edition, revised to 2002). A limited number of copies is available from IAEA cost-free for scientists and teachars in developing countries.

Chart of the Nuclides 2000, Japanese Nuclear Data Committee and Nuclear Data Centre, JAERI, 2000.

Karlsruher Nuklidkarte (Karlsruhe chart of Nuclides), 6th ed. 1995, by G. Pfennig, H. Klewe-Nebenius, W. Seelmann-Eggebert. A: wall chart,
B: desk copy with a fold-out chart and introductory text in German, English, Spanish and French.
A limited number of copies is available from IAEA costfree for scientists in developing countries.

Chart of Nuclides 1996 issued by JNDC and JAERI-NDC, compiled by T. Horiguchi et al. Desk chart showing decay modes and half-lives. Supplemented by five tables (periodic table of elements; fundamental constants; (-ray energy and intensity standards; "-particle energies and intensities; isotopic abundances and thermal neutron cross sections).
For a WWW version (containing additional data) see
http://cracker.tokai.jaeri.go.jp/CN96/index.html.

NUDAT-2.2 - Nuclear levels, decay radiations, half-lives and other properties extracted from ENSDF (see chapter 31), plus thermal neutron cross-sections and resonance integrals (see chapter 7). Accessible online.

NUBASE-2003. Database for experimentally known nuclear properties, by G. Audi, O. Bersillon, J. Blachot, A.H. Wapstra. Available online from
http://www-nds.iaea.org/amdc/web/nubase_en.html .NUBASE contains mass, isomeric excitation energy, half-life, spin, parity, decay modes and intensities for 3177 nuclides. Published in Nucl.Phys. A729, pp. 3-128 (2003)

Atomic Masses 2003. The 2003 atomic mass evaluation by G. Audi and A.H. Wapstra. Available online from http://www-nds.iaea.org/amdc/web/masseval.html .Published in Nucl.Phys. A729, pp. 129-336 (2003) (evaluation method) and Nucl.Phys. A729, pp. 337-676 (2003) (Tables, graphs and references).

34. Atomic Data

Atomic and molecular data for nuclear fusion and other applications (not the topic of the present index) are available from the web site of the Atomic and Molecular Data Unit of the IAEA Nuclear Data Section, see http://www-amdis.iaea.org/ Available are databases and computer programs on atomic and molecular collision and radiative processes, atomic and molecular structure characteristics, particle-solid surface interaction processes and physico-chemical and thermo-mechanical material properties for use in fusion energy research and other plasma science and technology applications.

EADL, the evaluated Atomic Data Library of the Lawrence Livermore National Laboratory, USA. Available on CD-ROM together with EPDL-97, see Chapter 22.

ENDF/B-VII Atomic relaxation and electro-atomic sublibraries. Taken over from ENDF/B-VI. Elemental data for 100 materials (Z=1 through 100) from 10 eV to 100 GeV. Same data as EADL, EEDL, EXDL. Available online.

Atomic and molecular data for radiotherapy and radiation research. IAEA-TECDOC-799 (1995), 750 pages, N. Kocherov (ed.). Final report of Coordinated Research Project. Contents: Particle therapy in cancer management; heavy ion therapy. Ionization by fast charged particles. Electron collision cross-sections. Low energy electron interaction with condensed matter. Photoabsorption, photoionization, photodissociation cross-sections. Collision processes between ions and molecules. Stopping powers, ranges, and straggling. Yields of ionization and excitation in irradiate matter. Track structure quantities. ESTAR, PSTAR, ASTAR; computer programs for calculating stopping powers and ranges for electrons, protons, and helium ions - Limited number of copies available costfree upon request, or online from http://www-nds.iaea.org/reports-new/tecdocs/iaea-tecdoc-0799.pdf

35. Bibliographic files

CINDA, bibliography and database index for experimental and evaluated nuclear reaction data. Originally containing only neutron data, recently extended to include also charged-particle-induced reactions and photonuclear data. It includes an index to EXFOR data and to the more important evaluated neutron reaction data libraries. Handbook and online database. Complete database available on CD-ROM.
CINDA book: CINDA Archive 2006 (1935 – 2006), The Comprehensive Index of Nuclear Reaction Data, published 2007 in 7 volumes by the OECD NEA. Limited number of copies for scientists in developing countries available from NDS.

NSR (Nuclear Science References), an international database available online. Indexed bibliography of nuclear physics articles published since 1910, maintained at NNDC. See http://www-nds.iaea.org/nsr

Photonuclear Data Index, by the Russian Center for Photonuclear Experiments Data at Moscow State University, is available online from http://cdfe.sinp.msu.ru/services/pnisearch.html.
It is based mainly on two previous bibliographies:

- V.V.Varlamov, V.V.Sapunenko, M.E.Stepanov. Photonuclear Data Index 1976 - 1995. Izdatel'stvo Moskovskogo Universiteta, Moscow, 1996/,
- JAERI /T.Asami, T.Nakagawa. Bibliographic Index to Photonuclear Reaction Data (1955 - 1992). JAERI-M-93-195, INDC(JPN)-167L, JAERI, Japan, 1993/

The report "Photonuclear Data - Abstract Sheets" 1955 - 1982 /E.G.Fuller, H.Gerstenberg, NBSIR 83-2742, USA NBS, 1984/ was used also. The more recent literature was, and is being, added continuously.

AMBDAS: Atomic and Molecular Bibliographic Data Base. AMBDAS contains searchable bibliographic references and is available online at http://www-amdis.iaea.org/AMBDAS/

IAEA-NDS-Documentation Series. See document IAEA-NDS-0 for an index to the IAEA-NDS-documents summarizing format and contents of nuclear data libraries. Available online from http://www-nds.iaea.org/nds-0.html

51. Proceedings of the Trieste Courses and Workshops on Nuclear Data

Starting in 1978, nuclear data related courses were held at the International Centre for Theoretical Physics, Trieste, Italy. The proceedings of the earlier courses (1978-1982) were published as IAEA reports.

The proceedings of the courses between 1986 and 1998 are not available from IAEA. They have been published by the World Scientific Publishing Co., P.O. Box 128, Farrer Road, Singapore 9128. U.S. Office: Suite 1B, 1060 Main Street, River Edge, NJ 07661. U.K. office: 57 Shelton Street, Covent Garden, London WC2H 9HE.

From 2000 through 2002, the proceedings were published within the ICTP lecture notes series. These are available both as hardcopies and electronically from the ICTP web site.

2006
Nuclear Structure and Decay Data: Theory and Evaluation
20 February -3 March 2006
http://www-nds.iaea.org/workshops/ictp2006/

2005/2
Nuclear Structure and Decay Data: Theory and Evaluation
4 – 15 April 2005
Editors: A.L. Nichols, P.K. McLaughlin
INDC(NDS)-0473 (July 2005), see
http://www-nds.iaea.org/reports-new/indc-reports/indc-nds/indc-nds-0473.pdf
and INDC(NDS)-452, see workshop 2003/2
Alternatively, lecture notes for individual lectures can be downloaded from
http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a04185

2005/1
Nuclear Reaction Data for Science and Technology: Activation Analysis
7-18 March 2005
Lecture notes for individual lectures can be downloaded from
http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a04183

2004
Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety.
16 February - 12 March 2004
Lecture notes for individual lectures can be downloaded from
http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a0335

2003/2
Nuclear Structure and Decay Data: Theory and Evaluation
17 – 28 November 2003
Editors: A.L. Nichols, P.K. McLaughlin
INDC(NDS)-452 (November 2004), Parts 1 and 2, see
http://www-nds.iaea.org/reports-new/indc-reports/indc-nds/indc-nds-0452-part1.pdf and
http://www-nds.iaea.org/reports-new/indc-reports/indc-nds/indc-nds-0452-part2.pdf

2003/1
Nuclear Reaction Data for Science and Technology: Materials Analysis
19 – 30 May 2003
Lecture notes for individual lectures can be downloaded from
http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a0268

2002
Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety.
25 February - 28 March 2002
Editors: M. Herman , N. Paver (Partial collection of lectures only)
ICTP Lecture Notes Series, Volume 20 (ISBN 92-95003-30-6) - Aug 2005
http://users.ictp.it/~pub_off/lectures/LNS20.html

2001
Nuclear Reaction Data for Science and Technology: Accelerator Driven Waste Incineration.
10 - 21 September 2001
Editors: M. Herman , N. Paver, and A. Stanculescu
ICTP Lecture Notes Series, Volume 12 (ISBN 92-95003-17-9) - Dec 2002
http://users.ictp.it/~pub_off/lectures/LNS12.html

2000
Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety.
13 March - 24 April 2000
Editors: N. Paver, M. Herman and A. Gandini
ICTP Lecture Notes Series, Volume V -Parts 1 & 2 (ISBN 92-95003-08-X) - Dec 2001
http://www.ictp.trieste.it/~pub_off/lectures/vol5.html

1999
Nuclear Reaction Data for Science and Technology: Medical Applications
20 September - 15 October 1999
Published in Radiochimica Acta vol. 89, issue 4-5 (2001)

1998
Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety.
23 February - 27 March 1998
Editors: P. Oblozinsky, A. Gandini. World Scientific, Singapore.

1996
Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety.
15 April - 17 May 1996.
Editors: A. Gandini, G. Reffo. World Scientific, Singapore.

1994
Nuclear Reactors, Physics, Design and Safety.
11 April - 13 May 1994.
Editors: A. Gandini, S. Ganesan, J.J. Schmidt.
World Scientific, Singapore.

1992
Computation and Analysis of Nuclear Data Relevant to Nuclear Energy and Safety. 10 Feb - 13 March 1992.
Editors: M.K. Mehta, J.J. Schmidt.
World Scientific, Singapore.

1990
Reactor Physics Calculations for applications in nuclear technology.
12 Feb - 16 March 1990.
Editors: D.E. Cullen, R. Muranaka, J.J. Schmidt.
World Scientific, Singapore.

1988
Applied Nuclear Theory and Nuclear Model Calculations for Nuclear Technology Applications. 15 Feb - 19 March 1988.
Editors: M.K. Mehta, J.J. Schmidt.
World Scientific, Singapore.

1986
Applications in Nuclear Data and Reactor Physics.
17 Feb - 21 March 1986.
Editors: D.E. Cullen, R. Muranaka, J.J. Schmidt.
World Scientific, Singapore.

1982
Nuclear theory for applications.
25 Jan - 19 Feb 1982.
Report IAEA-SMR-93.

1980
Nuclear theory for applications.
Jan/Feb 1980.
Report IAEA-SMR-68.

1978
Nuclear theory for applications.
17 Jan - 11 Feb 1978.
Report IAEA-SMR-43.

1975
Nuclear theory in neutron data evaluation.
Consultants' Meeting, Trieste 1975.
Report IAEA-190, 2 vols.

52. International Conferences on "Nuclear Data for Science and Technology"

Proceedings generally NOT available from IAEA

2004 in Santa Fe, New Mexico, USA. AIP conference proceedings, vol. 769, edited by R. C. Haight, M.B. Chadwick, T. Kawano, P. Talou. College Park, Md., American Institute of Physics, 2005

2001 in Tsukuba, Japan. J.Nucl. Science and Technology (Tokyo), Supplement No.2, August 2002

1997 in Trieste, Italy. G. Reffo, A. Ventura, C. Grandi (eds.), two volumes by Italian Physical Society, SIF, Bologna, 1998

1994 in Gatlinburg, Tennessee, U.S.A. J.K. Dickens (ed.), two volumes by American Nuclear Society, 1994.

1991 in Jülich, Germany. S.M. Qaim (ed.), publ. by Springer-Verlag, Germany, 1992.

1988 in Mito, Japan. S. Igarasi (ed.), publ. by Saikon Publishing Co., 1988.

1985 in Santa Fe, N.M., U.S.A., "Nuclear Data for Basic and Applied Science", 1985.

1982 in Antwerp, Belgium. K.H. Böckhoff (ed.), publ. by D. Reidel Publishing Co., 1983.

1979 in Knoxville, Tennessee, U.S.A., "Nuclear Cross-Sections for Technology", J.L. Fowler, C.H. Johnson, C.D. Bowman (eds.), publ. by U.S. Dept. of Commerce as NBS Special Publ. 594, 1980.

1975 in Washington, D.C., U.S.A., "Nuclear Cross-Sections and Technology", R.A. Schrack, C.D. Bowman (eds.), publ. by U.S. Dept. of Commerce as NBS Special Publ. 425, 2 vols., 1975.

1973 in Paris, France, "Applications of Nuclear Data in Science and Technology", published by IAEA as STI/PUB/343, 2 vols., 1973.

1971 in Knoxville, Tennessee, U.S.A., "Neutron Cross-Sections and Technology", J.A. Harvey, R.L. Macklin (eds.), publ. by U.S. Dept. of Commerce as CONF-710301, 2 vols., 1971.

1970 in Helsinki, Finland, "Nuclear Data for Reactors", J.J. Schmidt, V. Konshin (eds.), published by IAEA as STI/PUB/259, 2 vols., 1970.

1968 in Washington, D.C., U.S.A., "Neutron Cross-Sections and Technology", D.T. Goldman (ed.), publ. by U.S. Dept. of Commerce as NBS Special Pub. 299, 2 vols., 1968.

1966 in Paris, France, "Nuclear Data for Reactors", published by IAEA as STI/PUB/140, 2 vols., 1967.

1966 in Washington, D.C., U.S.A., "Neutron Cross-Section Technology", P.B. Henning (ed.), publ. by U.S. Atomic Energy Commission as CONF-660303, 2 vols., 1966.