IAEA Nuclear Data Section: Progress Report, 2005/06

Summary of Nuclear Data Studies by Staff of the IAEA Nuclear Data Section, 1 October 2005 – 30 September 2006, Editor: O. Schwerer

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1. Staff

The authorized staff level of the Nuclear Data Section remains at a total of 18 professionals and support staff (although a vacancy exists as a consequence of one member of the support staff having transferred to another section). A recruitment exercise is also underway to fill a P5 vacancy in the Nuclear Data Development Unit (hopefully, to be filled in mid-autumn 2006).

2. Data Compilations

2.1 EXFOR and Dictionaries

Over the previous year, NDS staff have distributed 6 CPND TRANS files (D044 - D049), containing 109 new entries (92 compiled at NDS, 14 at ATOMKI, 3 at UkrNDC) and 172 revised entries, and 3 neutron TRANS files (3118 - 3120) containing 41 new entries (38 compiled at NDS, 2 at UkrNDC and 1 in India) and 23 revised entries. The compilations consist of new literature as well as many important old references. Also, two lists of papers (mostly "old" literature) are still being carefully monitored and controlled for completeness of compilation:

1. list for Ion Beam Analysis;

2. list for Reference Input Parameters Library (RIPL).

As of 20 September, 52 TRANS files were received, checked (with feedback to the originating centres) and processed, of which 43 were final versions that were added to the master file. These final transmissions contained 408 neutron entries (177 new, 231 revised), 677 CPND entries (542 new, 135 revised) and 72 photonuclear entries (49 new, 23 revised).

NDS staff have produced and distributed three regular transmissions of the EXFOR/CINDA dictionaries (TRANS 9090-9092) in EXFOR, DANIEL (backup) and archive format. The dictionary revisions introduced in 2004/05 are now routinely in operation, and the introduction of "wild cards" for REACTION SF7 in the quantities dictionary 236 is in preparation. The feedback of Otsuka (JCPRG) on the dictionary transmissions is again much appreciated.

From 4 - 8 September 2006, O. Schwerer conducted a workshop on EXFOR compilation for Indian scientists at B. A.R. C. in Mumbai, India.

2.2 CINDA

CINDA Master file

A new CINDA library (2006/06/20) has been produced since in 2006, containing old CINDA data and data imported automatically from the EXFOR database (2006/01/11) using version 9090 of the Dictionaries. The preliminary data were offered to the NRDC community for revision and corrections. After that exercise, the new CINDA Master File was made available via the NDS compilers' Web site.

Coverage control

Under the CINDA coverage control system, NDS staff scan over 80 journal titles (mainly through the Internet) for the purpose of compilation coverage control. The current status of the compilation activity will be available for EXFOR compilers on the NDS Web site.

Over 1100 journal issues from 1995 to 2006 were added to the database for CINDA coverage control in late 2005/2006. Journal references that should be compiled elsewhere were also dispatched to the relevant centres (Japan, Russia, Hungary and NEADB).

All relevant references absent from EXFOR were sent to the responsible centres for compilation, along with hardcopies of the papers, if necessary.

2.3 Evaluated data libraries, files and programs

Various new evaluated data libraries, files and programs for data checking, processing and graphical presentation were added to the NDS IAEA Web-site and distributed on CD-ROM:

- NuDat-2.1 for interactive searching and plotting of nuclear structure and decay data
- PREPRO 2004. ENDF/B Pre-Processing Codes, November 2004, updated June 2005
- Stopping Power for light ions, compilation by H. Paul (University of Linz)
- EXFOR CINDA Database and Retrieval System, Version 1.91, data updated February 2006 (CD-ROM)
- ENDVER/GUI and EXFOR-CINDA package; Integrated Tools for ENDF-Evaluators, Version 1.4, January 2006

3. Services

Web Services

Further improvements have been implemented in the EXFOR-CINDA-ENDF retrieval systems: plotting of differential cross-sections, simplified data output of plotted data, data uploading The system is also functioning successfully at NNDC, in BARC (India) and IPEN (Brazil). Statistics for the usage of the Web retrieval system are presented in Fig. 1.

CD-ROMs

- "EXFOR/CINDA for Windows" CD was issued once.
- "EXFOR/CINDA for Applications" for Linux and Windows was issued once; also distributed as part of EndVer/GUI-CD and Empire-package.

4. Software

CINDA software

Extensions and changes to the CINDA format agreed upon at the last NRDC meeting were implemented in the CINDA loading tools, Web and CD-ROM retrieval systems, and CINDA editor. An improved algorithm of comparison and import of EXFOR data to CINDA was implemented, discussed and checked together with H. Henriksson (NEA-DB) and N. Otsuka (JCPRG). The concept of CINDA-Projects was further developed.

EXFOR software-tools

The checking program (ZCHEX) was regularly updated. Executables for Windows and Linux with a complete set of dictionaries are maintained on the NDS-compilers' Web-site.

EXFOR-ENDF advanced plotting software-tools

Programs for automatic extension of EXFOR-ENDF conversion dictionaries were developed. Program X4TOC4 was extended. Web wrapping software for the EndVer package and effective support in the database structures were designed and implemented.

5. Nuclear Data Development

Although nuclear data developments are outside the immediate operations of the NRDC, we give a brief summary below.

Co-ordinated Research Projects (CRPs):

- Update of X-Ray and Gamma-Ray Decay Data Standards for Detector Calibration and Other Applications: completed, all materials with IAEA Publishing Section
- Fission Product Yield Data Required for the Transmutation of Minor Actinide Nuclear Waste: completed, all materials with IAEA Publishing Section
- *Improvement of the Standard Cross Sections:* completed, document to be submitted to IAEA Publishing Section
- Nuclear Data for the Production of Therapeutic Radioisotopes: on-going
- Data for the Th-U-fuel cycle: completed, database and document preparation in progress
- Reference Input Parameter Library for Non-Energy Applications: (RIPL-III): on-going
- Development of a Reference Database for Ion Beam Analysis: on-going
- Updated Decay Data Library for Actinides: on-going
- Reference Base for Neutron Activation Analysis: on-going

Data development projects:

• Thermal scattering law library – H in H₂O, D in D₂O, H in ZrH(x) and other metal hydrides (Ti, Y, Ce), and graphite

- Resonance parameters for ⁵⁸Fe and all Cd isotopes re-analysis and evaluation (in collaboration with IRMM)
- Applications library for ADS JEFF-3.1 data library selected as source for pilot library ACE format for Monte-Carlo particle transport calculations, and MATXS format for deterministic transport calculations
- Updates to WIMS-D library package (following release of JEFF-3.1 library)
- Nuclear model parameter sets for RIPL-II
- Update of the handbook and database "Nuclear Data for Safeguards" (on-going)
- Beta decay and decay heat CM in collaboration with WPEC (Sub-group 25) on Total Absorption Gamma-ray Spectroscopy (TAGS) and improvements to decay data files for decay heat calculations

6. Publications

IAEA nuclear data for applications: cross section standards and the reference input parameter library (RIPL)

R. Capote Noy, A.L. Nichols and V.G. Pronyaev, presented at Enlargement Workshop on Neutron Measurements, Evaluations and Applications, NEMEA-2, Bucharest, Romania, 20-23 October 2004, EUR 22136 EN (2005), pp. 7-16, Ed.: A.J.M. Plompen, Luxembourg, ISBN 92-894-8618-X.

Neutron activation cross section measurements from threshold to 20 MeV for the validation of nuclear models and their parameters

A.J.M. Plompen, D.L. Smith, R. Capote et al., A report by the Working Party on International Evaluation Co-operation of the NEA Nuclear Science Committee (WPEC-19), NEA/WPEC-19, OECD, Paris, 2005, ISBN 92-64-01070.

IAEA Co-ordinated Research Project on fission product yield data for minor actinides up to 150 MeV

M. Lammer and A.L. Nichols, presented at 3rd International Workshop on Nuclear Fission and Fission-product Spectroscopy, Fission 2005, 11-14 May 2005, Cadarache, France; also published in AIP Conf. Proc. – 3rd Int. Workshop on Nuclear Fission and Fission-product Spectroscopy, Eds.: H. Goutte, H. Faust, G. Fioni and D. Goutte, Vol. 798 (2005) pp. 285-293, AIP, Melville, New York, ISBN 0-7354-0288-4, ISSN 0094-243X.

Simulation of an end-of cycle trip transient with the LOADF code package

M. Božič and A. Trkov, Int. Conf. Nuclear Energy for New Europe 2005, Bled, Slovenia, 5-8 September 2005.

Neutron capture reaction rates for stellar nucleosynthesis

A. Mengoni, published in Proc. 20th Int. Conf. on Capture Gamma-ray Spectroscopy and Related Topics, University of Notre Dame, Indiana, USA, 4-9 September 2005.

Is a global coupled-channel dispersive optical model potential for actinides feasible? R. Capote, E.Sh. Soukhovitski, J.M. Quesada and S. Chiba, *Phys. Rev.* **C72** (2005) 064610.

Isospin dependent dispersive coupled channel optical model potential for actinides

R. Capote, E.Sh. Soukhovitski, J.M. Quesada and S. Chiba, presented at Workshop on the

Future of Theory and Experimental Based Nuclear Data Evaluation, 26-28 September 2005, CEA-DIF Bruyeres-le-Châtel, France, to be published by NEA.

Neutron capture cross section measurements for nuclear astrophysics at CERN n-TOF

U. Annondanno, R. Capote, A. Mengoni et al., (the n-TOF Collaboration), Nucl. Phys. A758 (2005) 501-504.

Measurement of the 151 Sm(n, γ) cross section at n_TOF

S. Marrone, R. Capote, A. Mengoni, et al., (the n-TOF Collaboration), Nucl. Phys. A758 (2005) 533-536.

Measurement of the Zr-90,91,92,94,96(n,γ) cross sections at n_TOF

G. Tagliente, R. Capote, A. Mengoni et al., (the n-TOF Collaboration), Nucl. Phys. A758 (2005) 573-576.

Stellar neutron capture rates of C-14

R. Reifarth, A. Mengoni et al., Nucl. Phys. A758 (2005) 787-790.

Nuclear data requirements for decay heat calculations

A.L. Nichols, pp. 65-69 in Lecture Notes, Vol. 20, Workshop on Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety, 25 February – 28 March 2002, The Abdus Salam International Centre for Theoretical Physics, Eds.: M. Herman, N. Paver, ICTP Publ., Trieste, Italy, 2005.

Higher Landau levels contribution to the energy of interacting electrons in a quantum dot

A. Gonzalez, J.D. Serna, R. Capote and G. Avendaño, Physica E30 (2005) 134-137.

Laser-generated nanosecond pulsed neutron sources: scaling from VULCAN to tabletop

T. Žagar, J. Galy, J. Magill and M. Kellett, New J. Phys. 7 (2005) 2-13.

Nuclear reaction and structure web services of the National Nuclear Data Center

B. Pritychenko, A.A. Sonzogni, D.F. Winchell, V.V. Zerkin, R. Arcilla, T.W Burrows, C.L. Dunford, M.W. Herman, V. McLane, P. Obložinský, Y. Sunborn and J.K. Tuli, *Nucl. Instrum. Meth. Phys. Res.* A. **33** (2006) 390-399.

Monte Carlo correction factors for a Farmer 0.6 cm³ ion chamber dose measurement in the build up of the 6 MV clinical beam

J. Pena, F. Sanchez-Doblado, R. Capote, J.A. Terrón and F. Gómez, to be published on-line by IOP, March 2006.

New measurements of neutron capture resonances of ²⁰⁹Bi

C. Domingo-Pardo, R. Capote, A. Mengoni, et. al., for publication in Phys. Rev. C.

Uncertainty estimation in IMRT absolute dosimetry verification

F. Sánchez-Doblado, G.H. Hartmann, J. Pena, R. Capote et al., (to be submitted to Int. J. Radiation Oncology, Biology and Physics).

Fission of light actinides: ²³²Th(n,f) and ²³¹Pa(n,f) reactions

M. Sin, R. Capote, A. Ventura, M. Herman and P. Obložinský (submitted to Phys. Rev. C).

Atomic and nuclear data services of the International Atomic Energy Agency

S. Dunaeva, A.L. Nichols, O. Schwerer, presented to 56th International Conference "Nucleus-2006", 4-8 September 2006, Sarov, Russia *(to be published in proceedings)*

International Atomic Energy Agency: Dedicated nuclear databases

A.L. Nichols, invited paper presented at a plenary session on 'Advances in Nuclear Data Libraries', PHYSOR-2006, ANS Topical Meeting on Advances in Nuclear Analysis and Simulation, 10-14 September 2006, Vancouver, British Columbia, Canada.

7. Workshops 2006 (since 2005 NRDC Meeting)

- Workshop on Nuclear Structure and Decay Data: Theory and Evaluation, 20 February -3 March 2006, ICTP Trieste, Italy.
- Workshop on Atomic and Molecular Data for Fusion Energy Research, 28 August 8 September 2006, ICTP Trieste, Italy.

8. Visits and Inter-centre Cooperation

- V. Zerkin (IAEA/NDS) to BNL/NNDC, 14 November 2 December 2005: Develop ENDF, EXFOR and CINDA Web-Retrieval and Management Systems.
- Mark A. Kellett (IAEA/NDS) to BNL/NNDC: 5 9 December 2005, NSR Keyword Abstract Compilation Discussions
- S. Dunaeva (IAEA/NDS) to CJD and CAJAD: 28 30 December 2005, EXFOR compilation
- G. Pikulina and S. Taova (Sarov) to NDS, 22 26 May 2006: Development of EXFOR-Editor.
- D. Winchell (BNL/NNDC) to NDS, 12 16 June 2006: NSR Keyword Abstract Collaboration Discussions
- O. Schwerer (IAEA/NDS) to CNDC, 11 12 September 2006: EXFOR compilation at CNDC
- G. Pikulina and S. Taova (Sarov) to NDS, 20 29 September 2006: Development and deployment of EXFOR-Editor.

Geographical Distribution (%)



Fig.1. Statistics of Web accesses and retrievals from IAEA-NDS, IPEN (Brazil) and BARC (India)