INTERNATIONAL ATOMIC ENERGY AGENCY

INDC(NDS)-456
Distr.: G, ND

I N D C INTERNATIONAL NUCLEAR DATA COMMITTEE

Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluators

Summary Report of an IAEA Technical Meeting

IAEA Headquarters
10 - 14 November 2003

Prepared by
V.G. Pronyaev, A.L. Nichols and J. Tuli

March 2004

IAEA NUCLEAR DATA SECTION, WAGRAMER STRASSE 5, A-1400 VIENNA

Printed by the IAEA in Austria
March 2004

INDC(NDS)-456
Distr.: G, ND

Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluators

Summary Report of an IAEA Technical Meeting

IAEA Headquarters, Vienna
10 – 14 November 2003

Prepared by
V.G. Pronyaev, A.L. Nichols and J. Tuli

March 2004

Abstract

The IAEA Nuclear Data Section convened the 15th meeting of the Network of Nuclear Structure and Decay Data Evaluators at the IAEA Headquarters, Vienna, 10 – 14 November 2003. This meeting was attended by 23 scientists from 11 Member States concerned with the compilation, evaluation and dissemination of nuclear structure and decay data. A summary of the meeting, recommendations/conclusions, data centre reports and the various proposals considered, modified and agreed by the participants are contained within this document.

ABBREVIATIONS

AGM	IAEA Advisory Group Meeting.
CAJaD, KUR	Centre for Data on the Structure of the Atomic Nucleus and Nuclear Reactions, Kurchatov Institute, Moscow, Russia.
CD-ROM	Compact disk with read-only memory.
CEC	Commission of the European Communities.
CNDC	China Nuclear Data Center, Institute of Atomic Energy (IAE) Beijing.
CPND	Charged-particle nuclear reaction data.
DBMS	Database Management System.
ENSDF	Computer-based Evaluated Nuclear Structure Data File.
Evaluation	Mass-chain evaluation: best data for the structure and decay of all nuclides with the same mass. Horizontal evaluation: best values of one or a few selected nuclear parameters for many nuclides irrespective of their mass.
EXFOR	Computer-based system for the compilation and international exchange of experimental nuclear reaction data.
IAEA	International Atomic Energy Agency.
ICRM	International Committee for Radionuclide Metrology.
INDC	International Nuclear Data Committee.
INEEL	Idaho Nuclear Engineering and Environmental Laboratory, USA.
INIS	International Nuclear Information System operated by the IAEA
IP	Isotopes Project at LBNL.
IRMM	CEC Institute of Reference Materials and Measurements, Geel, Belgium.
JAERI	Japan Atomic Energy Research Institute.
KUW	Kuwait National University.
LBNL	Lawrence Berkeley National Laboratory, USA.
LIYaF	Lenigrad Institut Yadernoy Fiziki: Data Centre of the Petersburg Nuclear Physics Institute of the Russian Academy of Sciences.
NDP	Nuclear Data Project, Oak Ridge National Laboratory.
NDS	Nuclear Data Sheets; journal devoted to ENSDF data.
NDS/IAEA	Nuclear Data Section, IAEA.
NNDC/BNL	National Nuclear Data Center, Brookhaven National Laboratory, USA.
NSDD	Nuclear Structure and Decay Data.
NSR	Nuclear Science References - bibliographic file related to ENSDF.
ORNL	Oak Ridge National Laboratory, USA.
PC	Personal computer.
USDOE	US Department of Energy.
USNDP	US Nuclear Data Program.
TUNL	Triangle Universities Nuclear Laboratory, USA.
XUNDL	Experimental Unevaluated Nuclear Data List.

CONTENTS

Foreword

Nuclear data are essential to the development, implementation and maintenance of all nuclear technologies. The international network of Nuclear Structure and Decay Data (NSDD) Evaluators is sponsored by the IAEA, and consists of evaluation groups and data service centres in several countries. This network has the objective of providing up-to-date nuclear structure and decay data for all known nuclides by evaluating all existing experimental data.

Data resulting from this international evaluation collaboration is included in the Evaluated Nuclear Structure Data File (ENSDF) and published in the journals **Nuclear Physics A** and **Nuclear Data Sheets**. The results represent the recommended "best values" for the various nuclear structure and decay data parameters. Recommended values are made available to users by means of various media, such as the world wide web, CD-ROMs, wall charts of the nuclides, handbooks, nuclear wallet cards and others.

The international NSDD network evolved from the pioneering work in the late 1940s and early 1950s by physicists from the Berkeley Radiation Laboratory and the California Institute of Technology (USA), the Rijksuniversiteit at Utrecht (Netherlands), the Nuclear Data Group (Washington and Oak Ridge, USA) and the Brookhaven National Laboratory (USA). US efforts are coordinated by the Coordinating Committee of the US Nuclear Data Program (USNDP). While the ENSDF master database is maintained by the US National Nuclear Data Center at the Brookhaven National Laboratory, these data are also available from other distribution centres including the IAEA Nuclear Data Section.

Periodic meetings of the network are sponsored by the IAEA Nuclear Data Section, and have the following objectives:

(a) coordinate the work of all centres and groups participating in the compilation, evaluation and dissemination of NSDD;
(b) maintain and improve the standards and rules governing NSDD evaluations;
(c) review the development and common use of the computerized systems and databases maintained specifically for this activity.

NSDD Meetings

Place		Date	Report
1.	Vienna, Austria	29.04. - 03.05.1974	INDC(NDS)-60
2.	Vienna, Austria	03. - 07.05.1976	INDC(NDS)-79
3.	Oak Ridge, USA	14. - 18.11.1977	INDC(NDS)-92
4.	Vienna, Austria	21. - 25.04.1980	INDC(NDS)-115
5.	Zeist, Netherlands	11. - 14.05.1982	INDC(NDS)-133
6.	Karlsruhe, Germany	03. - 06.04.1984	INDC(NDS)-157
7.	Grenoble, France	02. - 05.06.1986	INDC(NDS)-182
8.	Ghent, Belgium	16. - 20.05.1988	INDC(NDS)-206
9.	Kuwait, Kuwait	10. - 14.03.1990	INDC(NDS)-250
10.	Geel, Belgium	09. - 13.11.1992	INDC(NDS)-296
11.	Berkeley, USA	16. - 20.05.1994	INDC(NDS)-307
12.	Budapest, Hungary	14. - 18.10.1996	INDC(NDS)-363
13.	Vienna, Austria	14. - 17.12.1998	INDC(NDS)-399
14.	Vienna, Austria	04. - 07.12.2000	INDC(NDS)-422
15.	Vienna, Austria	10. – 14.11.2003	INDC(NDS)-456

Summary

The 15th meeting on the Co-ordination of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators was held at the IAEA Headquarters, Vienna, from 10 to 14 November 2003. This biennial meeting was initially planned to be held at McMaster University, Hamilton, Canada, 5 to 9 May 2003. Balraj Singh from McMaster University made signifcant contributions towards the preparations for the original meeting, which had to be postponed at short notice due to the SARS scare in and around Toronto at that time. Therefore, the meeting was re-scheduled for IAEA, Vienna; twenty-three participants from eleven countries representing all major data evaluation centres, new evaluation groups and data dissemination centres attended the meeting. The list of participants is given in **Annex 1**.

V.G. Pronyaev (Scientific Secretary) opened the meeting. A.L. Nichols and D. De Frenne were elected to co-chair the meeting. The primary goals of the meeting are given in **Annex 2**, and the approved Agenda is listed in **Annex 3**.

The meeting considered the work undertaken by the ENSDF evaluation and dissemination centres (**Annex 6**) over the previous three years, and their planned activities for the forthcoming two years. A list of all ENSDF evaluation centres and groups is given in **Annex 4**, along with their mass-chain evaluation responsibilities as assigned for 2004 – 2005. Status reports on other activities, and proposals and position papers were also presented (**Annex 7** and **Annex 8**).

Participants discussed a wide range of technical matters, and the recommendations of improvimg the quality of NSDD evaluations. A list of actions was also prepared for implementation during the course of the next two years (see **Annex 5**).

NSDD members prepared many recommendations for the IAEA and the major evaluation centres, which are aimed at improving the technical support towards the network and streamlining the organization of work. These consensus conclusions include: the development and exchange of programming products; revision of the copyright and acknowledgement statements for network products; planning of IAEA and ICTP workshops designed to train new NSDD evaluators; support by the major NSDD centres of the evaluation work by new groups through mentoring; maintenance of the list of horizontal evaluations required by users or covered by on-going activities; and the nuclear data needs of other related disciplines, e.g., astrophysics.

The next Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators will be held in May 2005 at McMaster University, Hamilton, Ontario, Canada.

Recommendations and Conclusions

(1) The NSDD meeting agreed to include the following groups in the list of Network centres:
(a) Argonne National Laboratory, Argonne, USA (contact person: Filip Kondev), and
(b) Australian National University, Canberra, Australia (contact person: Tibor Kibedi).

(2) Other groups will be considered for inclusion in the Network, depending upon the development of their evaluation programmes and involvement in the NSDD evaluation activities.

(3) The network voted to exclude CAJaD from the Network membership due to their low productivity over the previous 5 years; such an exclusion can only be reversed by a clear resumption of productive NSDD evaluation activities. Meeting participants expressed their gratitude to the Russia Nuclear Structure and Reaction Data Centre (CAJaD), Kurchatov Institute, for their contributions to ENSDF evaluations in past years.

(4) The meeting recommended revision of the Copyright statement in the Network Document, proposing that all Network centres include the following or similar statement on their Web front pages:
"One may use or reproduce data and information from this site with an appropriate acknowledgment and reference to the source of data. One may not charge any subsequent fee for these data".
This statement will probably not need any changes in the standard disclaimer.

(5) NSDD participants recommended that Dr. Michael Smith should initially pursue his proposal identified with 'nuclear data for astrophysics' at a national level (i.e., through the USNDP).

(6) The Network strongly endorsed the regular sponsorship of NSDD evaluators' workshops, with a possible schedule for the immediate future of spring 2005 (IAEA smaller workshop) and autumn 2006 (IAEA/ICTP larger workshop).

(7) Evaluation centres within NSDD are encouraged to invite and provide local support and mentoring to new ENSDF evaluators of mass chain evaluations.

(8) The meeting encouraged Network participants to actively exchange developed software between members.

(9) The Network has agreed to replace Hager and Seltzer internal conversion coefficients (ICC) with Band and Raman ICC data, and their related programs will be modified.

(10) NSDD participants agreed that Dr. Jagdish Tuli (ENSDF manager, tuli@bnl.gov) will continue to co-ordinate all work related to the preparation of evaluations for ENSDF, while Dr. Alan Nichols, IAEA Nuclear Data Section (a.nichols@iaea.org) will organize and chair the biennial Network co-ordination meetings, and co-direct IAEA workshops designed to train new nuclear structure and decay data evaluators.

A N N E X E S

Annex 1. List of Participants.

From left to right: Huang Xialong, Dimiter BALABANSKI, Filip KONDEV, Edgardo BROWNE-MORENO, Michael SMITH (sitting), Guillermo MARTI, John WOOD, Jun-ichi KATAKURA, Vladimir PRONYAEV, Feliks CHUKREEV, Jagdish TULI, Ashok Kumar JAIN, Coral BAGLIN, Thomas BURROWS, Alan NICHOLS, Pavel OBLOZINSKY, Denis DE FRENNE, Tibor KIBEDI, HUO Junde, Jean BLACHOT, John CAMERON, Ivan MITROPOLSKY, John KELLEY, David KULP.

AUSTRALIA

Mr. Tibor T. KIBEDI
Department of Nuclear Physics
Research School of Physical Sciences
and Engineering
Australian National University
Garran Road, Canberra, ACT 0200

Phone: +61 2 6125 2093
Mobile: +61 416249650
Fax: +61 2 6125 0748
E-mail: Tibor.Kibedi@anu.edu.au

BELGIUM

Mr. Denis J.A. DE FRENNE
Subatomaire- en Stralingsfysica
(Department Subatomic and
Radiation Physics)
Universiteit Gent
86, Proeftuinstraat, B-9000 Gent

Phone: +32 9 264 6535
Fax: +32 9 264 6697
E-mail: Denis.DeFrenne@rug.ac.be

CANADA

Mr. John A. CAMERON
Department of Physics and Astronomy — **Phone:** +1 905 525 9140 ext. 23345
A.N. Bourns Science Building 241 — **Fax:** +1 905 546 1252
McMaster University — **E-mail:** JAC@physics.mcmaster.ca
1280 Main Street West
Hamilton, Ontario L8S 4M1

CHINA

Mr. HUANG Xiaolong
China Nuclear Data Center — **Phone:** +86 10 6935 7830
China Institute of Atomic Energy (CIAE) — **Fax:** +86 10 6935 7008
P.O. Box 275 (41) — **E-mail:** HuangXl@iris.ciae.ac.cn
Beijing 102413

Mr. HUO Junde
Department of Physics — **Phone:** +86 431 8499701
Jilin University — **Fax:** +86 431 892 1479
119 Jirfang Road — **Fax:** +86 431 894 1554
130023 Changchun — **E-mail:** JDHuo@mail.jlu.edu.cn

FRANCE

Mr. Jean BLACHOT
SPSMS/CEN-Grenoble — **Phone:** +33 4 7675 4507
17, rue des Martyrs — **E-mail:** JBlacho@cea.fr
F-38054 Grenoble Cedex 9 — **E-mail:** Jean.Blachot@wanadoo.fr

INDIA

Mr. Ashok Kumar JAIN
Department of Physics — **Phone:** +91 1332 285753
Indian Institute of Technology — **Fax:** +91 1332 273560
Roorkee – 247 667, Uttaranchal — **E-mail:** ajainfph@iitr.ernet.in

JAPAN

Mr. Jun-ichi KATAKURA
Department of Nuclear Energy System — **Phone:** +81 29 282 5482
Nuclear Data Center — **Fax:** +81 29 282 5766
Japan Atomic Energy Research — **E-mail:** Katakura@ndc.tokai.jaeri.go.jp
Institute (JAERI) — **E-mail:** Katakura@bisha.tokai.jaeri.go.jp
Shirakata Shirane 2-4
Tokai-mura, Naka-gun, Ibaraki-ken 319-1195

RUSSIA

Mr. Feliks E. CHUKREEV
Russia Nuclear Structure and Reaction Data Centre (CAJAD)
"Kurchatov's Institute"
1, Kurchatov's Square
123 182 Moscow
Phone: +7 095 196 1612
Phone: +7 095 196 9968
Fax: +7 095 882 5804
E-mail: Feliks@polyn.kiae.su

Mr. Ivan A. MITROPOLSKY
Petersburg Nuclear Physics Institute
Orlova Roscha, Gatchina
Leningrad district, 188300
Phone: +7 81271 46044
Fax: +7 81271 31347
E-mail: Mitrplsk@pnpi.spb.ru

UNITED STATES OF AMERICA

Ms. Coral M. BAGLIN
Lawrence Berkeley National Laboratory
University of California
1 Cyclotron Road, M/S 88RO192
Berkeley, CA 94720-8101
Phone: +1 408 779 4796
Fax: +1 510 486 5757
E-mail: Baglin@lbl.gov

Mr. Edgardo BROWNE-MORENO
Nuclear Science Division
Lawrence Berkeley National Laboratory
University of California
MS 88RO192
1 Cyclotron Road
Berkeley, CA 94720-8101
Phone: +1 510 486 7647
Fax: +1 510 486 5757
E-mail: EBrowne@lbl.gov

Mr. Thomas W. BURROWS
National Nuclear Data Center
Brookhaven National Laboratory
Building 197D
P.O. Box 5000
Upton, NY 11973-5000
Phone: +1 631 344 5084
Fax: +1 631 344 2806
E-mail: nndctb@bnl.gov
E-mail: Burrows@bnl.gov

Mr. John H. KELLEY
Physics Department
Triangle Universities Nuclear Laboratory and North Carolina State University
Duke University
P.O. Box 90308
Durham, NC 27708-0308
Phone: +1 919 660 2631
Fax: +1 919 660 2634
E-mail: Kelley@tunl.duke.edu

Mr. Filip G. KONDEV
Nuclear Data Program
Nuclear Engineering Division
Argonne National Laboratory
Bld. 362/B117
9700 South Cass Avenue
Argonne, IL 60439
Phone: +1 630 252 4484
Phone: +1 630 252 5242 (Secretary)
Fax: +1 630 252 5287
E-mail: Kondev@anl.gov

Mr. Pavel OBLOŽINSKÝ
National Nuclear Data Center
Brookhaven National Laboratory
Building 197D
P.O. Box 5000
Upton, NY 11973-5000
Phone: +1 631 344 2814
Fax: +1 631 344 2806
E-mail: Oblozinsky@bnl.gov

Mr. Michael S. SMITH
Leader, Nuclear Astrophysics Research Group,
and Leader, Nuclear Data Project
Physics Division
Oak Ridge National Laboratory
Bldg. 6010, MS-6354
P.O. Box 2008
Oak Ridge, TN 37831-6354
Phone: +1 865 576 5037
Fax: +1 865 576 8746
E-mail: MSmith@mail.phy.ornl.gov

Mr. Jagdish K. TULI
National Nuclear Data Center
Brookhaven National Laboratory
Building 197D
P.O. Box 5000
Upton, NY 11973-5000
Phone: +1 631 344 5080
Fax: +1 631 344 2806
E-mail: Tuli@bnl.gov

Mr. John L. WOOD
School of Physics, W507
Georgia Institute of Technology
Atlanta, GA 30332-0430
Phone: +1 404 894 5262
Fax: +1 404 894 9958
E-mail: JW20@prism.gatech.edu

OBSERVERS

ARGENTINA

Mr. Guillermo V. MARTÍ
Dpto. de Física – Lab. TANDAR
Centro Atómico Constituyentes (CAC)
Comisión Nacional de Energía Atómica (CNEA)
Avda. Gral. Paz 1499
Pdo. de Gral. San Martín
(1650) Prov. de Buenos Aires
Phone: +54 11 6772 7073
Fax: +54 11 6772 7121
E-mail: Marti@tandar.cnea.gov.ar

BULGARIA

Mr. Dimiter L. BALABANSKI
Faculty of Physics — **Phone:** +359 2 6256 728
University of Sofia — **Fax:** +359 2 9625 276
J. Bourchier Str. 5 — **E-mail:** Mitak@phys.uni-sofia.bg
BG-1164 Sofia

UNITED STATES OF AMERICA

Mr. W. David KULP
School of Physics, W507 — **Phone:** +1 770 843 8533
Georgia Institute of Technology — **Fax:** +1 404 894 9958
837 State St. — **E-mail:** David@nuclear.physics.gatech.edu
Atlanta, GA 30332-0430

Mr. Richard A. MEYER
RAME', Inc. & Clark University — **Phone:** +1 508 495 1917
129 Maravista Avenue — **Fax:**
Teaticket, MA 02536 — **E-mail:** RAMRAMruth@aol.com
E-mail: RAMruth@ad

IAEA, AUSTRIA

Mr. Vladimir G. PRONYAEV
Scientific Secretary
IAEA Nuclear Data Section — **Phone:** +43 1 2600 21717
Wagramer Strasse 5 — **Fax:** +43 1 26007
A-1400 Vienna — **E-mail:** V.Pronyaev@iaea.org

Mr. Alan L. NICHOLS
Section Head
IAEA Nuclear Data Section — **Phone:** +43 1 2600 21709
Wagramer Strasse 5 — **Fax:** +43 1 26007
A-1400 Vienna — **E-mail:** A.Nichols@iaea.org

Annex 2. Aims of the Meeting.

Co-ordination of the activities of all NSDD centres participating in data evaluations, compilations and dissemination, and to prepare a co-ordinated plan of activity that includes work priorities for the next two years (2004 and 2005).

Review the activities of the database program development; discuss possible changes associated with the NSR, ENSDF and XUNDL databases that might and could provide better user services and wider co-operation between the centres.

Re-distribution of the evaluation load based on current realistic manpower (evaluator FTEs) at various the centres.

Changes of formats and/or procedures in keeping with changing trends in technology and physics.

Preparation of a co-ordinated plan that would assist in the training of future NSDD evaluators at seminars, schools and workshops held by the network centres: find ways of maintaining or raising manpower levels and improving the quality of NSDD evaluations.

Annex 3. Agenda.

Monday, 10 November 2003

08:30-09:00 Registration
09:00-10:30 Introduction

- Welcome remarks (A. Nichols, V. Pronyaev)
- Meeting arrangements (V. Pronyaev)
- Confirmation of meeting chairman (V. Pronyaev)
- Adoption of Agenda (Chairman)
- Meeting goals (Chairman)
- Actions from previous meeting (Chairman)

10:30-11:00 *Coffee Break*

11:00-12:30 Reports by Evaluation Centers
NSDD activities and ENSDF evaluators' reports (all centers)

12:30-14:00 *Lunch*

14:00-15:30 Technical Session
ENSDF format and evaluation policies (J. Tuli)

15:30-16:00 *Coffee Break*

16:00-17:30 Technical Session cont.
In-beam gamma-ray reaction data (J. Cameron)

18:00-19:30 *IAEA Cocktail Reception*

Tuesday, 11 November 2003

09:00-10:30 B. Reports by Evaluation Centers cont.
Horizontal evaluations

- Decay Data Evaluation Project (E. Browne, A. Nichols)
- Electric Monopole Strength (J. Wood)
- Multipole Transition Probabilities (J. Wood, T. Kibedi)
- Nuclear Moments (N. Stone)
- Atomic Mass Tables (J. Blachot)
- Others

Reports on application oriented NSDD activities

- PGAA project (A. Nichols)
- Others

10:30-11:00 *Coffee Break*

11:00-12:30 Data Centre Reports

- Database migration project at NNDC (T. Burrows)

12:30-14:00 *Lunch*

14:00-15:30 Technical Session cont.

ENSDF Evaluations

- Implementation of new ICC calculations by S. Raman et al (T. Burrows, J. Tuli)

15:30-16:00 *Coffee Break*

16:00-17:30 Technical Session cont.

ENSDF Analysis and Utility Programs (T. Burrows)

Wednesday, 12 November 2003

09:00-10:30 Administrative and Technical Items

Long-term policy with respect to NSDD

- Report on the US Nuclear Data Program (P. Oblozinsky)
- Report on the IAEA Nuclear Data Program (A. Nichols)
  - IAEA pilot workshop on NSDD, November 2002
  - ICTP-IAEA workshop on NSDD, November 2003
  - IAEA research contracts in support of new ENSDF evaluators
- Training of new evaluators at McMaster University (report prepared by B. Singh)

10:30-11:00 *Coffee break*

11:00-12:30 Administrative and Technical Items cont.

Revisions to NSDD Network document INDC(NDS)-421 (V. Pronyaev)

Administrative Review

- Activities, priorities and manpower
  - Summary of ENSDF evaluation activity in 2001-2002 (J. Tuli)
  - Revision of NSDD membership
  - Estimated manpower of each centre for future ENSDF evaluation
  - Future evaluations: priorities (J. Tuli)
- Redefinition of responsibilities of current groups
- Preliminary mass assignments to new groups

Needs and plans for horizontal evaluations

Improvements to NSR (and Web access to NSR) as multiplatform database (T. Burrows)

Where we should go and how we get there in today's funding environment? (R.A. Meyer)

12:30-14:00 *Lunch*

14:00-15:30 Technical Session cont.

ENSDF evaluations

- User's Perspective of Data Presented in NDS and ENSDF (J. Cameron)
- Evaluation of Radioactive Decay Data (E. Browne)

15:30-16:00 *Coffee Break*

16:00-17:30 Technical Session cont.

ENSDF evaluations

- General Discussion (Network)

Thursday, 13 November 2003

09:00-10:30 NSDD Administrative and Technical Items cont.

Technical items

- Upgrading of analysis and utility programs (T. Burrows)
- Thermal neutron capture (C. Baglin)
- Integration of horizontal evaluations into ENSDF (J. Tuli)

10:30-11:00 *Coffee Break*

11:00-12:30 NSDD Administrative and Technical Items cont.

Technical items

- XUNDL (J. Cameron)
- Nuclear astrophysics project status report, administrative and technical problems of astrophysics data improvment (M. Smith)
- ENSDF evaluation tools (T. Kibedi)
- Quality and completeness of ENSDF (J. Tuli)
- Others

12:30-13:30 *Lunch*

13:30-17:30 ENSDF Customer Services

Dissemination of ENSDF, publications and services (J. Tuli, T. Burrows)

CD-ROM version of ENSDF (V. Pronyaev)

- Should CD-ROM version have full access to the ENSDF data, not partial NuDat?

User-oriented databases: NuDat (J. Tuli)

ENSDF and NSDD network products

- Repackaging and copyright issues (IAEA, NNDC, Network)
- Should web pages for ENSDF or NuDat retrievals state that reference to network product is obligatory when data from ENSDF are used in repackaging?

19:00-21:30 *Joint Dinner*

Friday, 14 November 2003

09:00-10:30 Conclusions and Recommendations
Adoption of recommendations and actions

10:30-11:00 ***Coffee break***

11:00-12:30 Conclusions and Recommendations cont.
NSDD chairman
Next meeting

12:30 ***Adjournment***

14:00-17:00 Software demonstration session

Annex 4. Evaluation Responsibilities and FTEs: A-chains and nuclides.

Nuclear Mass	Responsible Centre (2004-2005)	1999 A-chains, nuclides (FTE)	2000 A-chains, nuclides (FTE)	2001 A-chains, nuclides (FTE)	2002 A-chains, nuclides (FTE)
45-50, 57,58, 60-73 (ex. 62-64), 82, 84-86, 88, 94-97, 99, 136-148, 150, 152, 165	National Nuclear Data Center, Brookhaven National Laboratory, USA	61,142,148 (1.9)	69,139,141,144 (1.55)	68,136,143; 49Mn,50Fe, 94Kr, 99Tc[a)], 137Cs, 137Nd, P-Decays (1.7)	83,138;132In, 133In,134In, 140Xe,140Dy, 142Ho,145Sm (1.7)
213-293 (except 215, 216, 219, 220, 223, 224, 227, 228, 231, 232, 235, 236, 239)	Nuclear Data Project, Oak Ridge National Laboratory, USA	(0.5)	258,262,266 (0.5)	242,250 (0.5)	244 (0.5)
21-31, 59, 81, 83, 90-93, 166-193 (ex 188,190), 210-212, 215, 216, 219, 220, 223, 224, 227, 228, 231, 232, 235, 236, 239	Isotope Project, Lawrence Berkeley National Laboratory, USA	215,219,92Tc,167, 168Tb,168Dy, 179Ta,181Pt, 181Au, 181Hg, 183Au (2.65)	27-39,92,169,223, 231;81Zr,91Kr, 91Sr,91Zr,166W, 183Hg,187Pb, 191Po,265Rf (2.8)	59,93,170,171, 235;179Tl,183Tl,187 Bi (2.0)	179,186,210,239 (2.0)
87, 153-163	Idaho National Engineering and Environmental Laboratory, USA	161Yb,162 (0.35)	161 (0.5)	87 (0.7)	156,159 (0.5)
2-20	Triangle University Nuclear Laboratory, USA		(1.25)		5,6
199-209	Argonne National Laboratory, USA				177 (0.5)

130-135	Nuclear Data Center, Petersburg Nuclear Physics Institute, Academy of Sciences of Russia, Russia	(0.5)	(0.5)	(0.25)	(0.25)
195-198 +51-56, 62, 63	Institute of Atomic Energy + Jilin University People's Republic of China	(0.1) 52 (0.2)	198 (0.2) 62,63 (0.25)	(0.25) 54,55 (0.25)	(0.25) (0.25)
	NTU, Taiwan[b)]	46,57Ni	83		189
101, 104, 107-109, 111, 113-117	CEA, SPN, Bruyeres Le Chatel, France	104,107,110 (0.2)	108,116 (0.3)	117 (0.25)	114 (0.25)
118-129	Nuclear Data Center, Japan Atomic Energy Research Institute, Japan	121 (1.5)	(0.8)	(0.5)	126 (0.5)
74-80	Nuclear Data Center, Physics Department, Kuwait University, Kuwait	(0.3)	(0.1)	(0.2)	75 (0.2)
102, 103, 105, 106, 110, 112	Laboratorium voor Kernfysica, Gent, Belgium	(0.3)	103 (0.3)	(0.1)	(0.1)
1, 31-44, 64, 89, 98, 100, 149, 151, 164, 188, 190, 194	Department of Physics and Astronomy, McMaster University, Canada	43,44,164,165; 58Cu,58Zn,60Zn, 62Ga (0.75)	1,42,130;65Zn, 136Nd,145Gd, 163Lu (0.8)	79,86,188,190;36Ar, 40Ca,41, 58Ni,58Cu, 98Pd[c)],98Cd,108Cd, 128Pr,132Pr,133Sm, 146Gd,154Er,163Lu, 168Hf,184Hg, 190Hg, 198Pb,199Ir, 199Pb,199Fr, 240Pu (1.0)	98;60Ga,60Zn, 71Zn,71Ga,94Pd,94Ag,125Pr, 125Nd,135In, 135Sb,135Sn, 152Dy,163Lu, 164Lu,Sd-Bands, Sf-Decays (1.0)

172	Department of Physics, Australian National University				
Total		14 mass chains, 14 nuclides (9.25)	35 mass chains 13 nuclides (9.6)	18 mass chains 31 nuclides (7.7)	17 mass chains 21 nuclides (8.0)

[a] – jointly with McMaster
[b] – in collaboration with LBNL
[c] – Jointly with Hu (MSU)

Annex 5. List of Actions.

No.	Responsible	Reason	Action
1	J. Tuli, BNL/NNDC	Quality assurance test.	Advise evaluators to run RADLIST, and comment on agreement of Q-value and sum of decay energies and X-ray intensities measured and calculated. Action continues from 1998.
2	J. Tuli, BNL/NNDC	Priority list evaluations has to be updated.	Send yearly priority list for nuclide and mass chain ENSDF evaluations. Add priority list of the NSDD TM and network document. Action continues from 1998.
3	J. Tuli, BNL/NNDC	Format and consistency problems could arise for certain horizontal evaluations.	Co-ordinate horizontal and A-chain evaluators by means of procedures for inserting horizontal evaluations into ENSDF. Action continues from 1998.
4	T.Kibedi, ANU; J. Wood, Georgia Tech	Calculational procedures to characterise E0 transitions should be explained.	Prepare manual that describes how to handle E0 transitions in ENSDF.
5	BNL/NNDC	ENSDF analysis and checking codes need to remain up todate with respect to formats, physics requirements, and the needs of the community.	Update codes for approved format changes. Action continues from 1998.
6	All network participants	Results of significant horizontal evaluations are not always incorporated into ENSDF in a timely manner.	Keep abreast of activities in other areas where horizontal evaluations may be appropriate for incorporation into ENSDF. Action continues from 1996.
7	All network participants	Highly-relevant information and data from some conferences, meetings and laboratory reports are not always available to NSR compilers in NNDC.	Assist the NNDC in obtaining conference proceedings, meeting and laboratory reports for NSR. One copy of unpublished conference reports containing significant NSDD contribution should be sent to D. Winchell. Revised action continues from 1998.
8	IAEA/NDS	Characteristics and parameters of NSDD network have to be regularly updated.	Update NSDD network document regularly as INDC(NDS) report - publish electronically according to the latest changes as defined at the network meeting.

9	BNL/NNDC	Publish versions of ENSDF are required	Continue a journal "publication" for the mass chain evaluations. Action continues from 1998
10	IAEA/NDS	Co-ordinate network activities in the lengthy period between NSDD meetings.	Nominate a chairman and deputy chairman for next NSDD meeting at the current NSDD meeting. Action continues from 1998.
11	Network	Misprints and errors found in NSR and ENSDF.	Report all errors detected in NSR and ENSDF to NNDC as soon as they are found. Action continues from 1998.
12	ENSDF evaluators	Accelerate the review process.	Each ENSDF evaluator should be willing to do 2 mass-chains equivalent reviews per FTE-year. Reviewing process for one mass chain should not be longer than 3 months. Revised action continues from 1998.
13	BNL/NNDC	Researchers are not familiar with ENSDF format.	Promote the concept that researchers should supply data to the network in complete, tabular form. Action continues from 1998.
14	N. Stone, University of Oxford; D. De Frenne, DSRP; J. Blachot, CEA SPN.	Decrease of NSDD manpower in Europe.	Publish in NUPECC new, 2004 an informative article about nuclear data evaluations. Action continues from 1998.
15	Network	Bring NSDD evaluation work to the attention of the nuclear community.	Present network activity at different conferences and meetings. Revised action continues from 1998.
16	T. Kibedi, ANU	Simplify the data input for ENSDF, and the editing of ENSDF files.	Prepare test version of the ENSDF evaluation tool (“editor”) with brief documentation; make available for tests at the IAEA/ICTP workshop (November 2003), and distribute to the network data centres.
17	Network	Avoid duplication of work.	Participants should inform the network about any development of software related to NSDD.
18	J. Tuli, BNL/NNDC	Encourage specific new measurements.	Indicate in the abstract of an evaluation any critical problems in the data compared with the previous evaluation, gaps in the data, and discrepancies that could be resolved by new measurements. Revised action continues from 1998.
19	Data centre managers	Attract young scientists to data evaluations.	Encourage evaluators to participate in research/evaluation of nuclear structure data. Action continues from 1998.

20	NSDD network	Improve NSR.	Send comments and suggestions on NSR improvements (indexing) to D. Winchell. Continuing action from 1998.
21	BNL/NNDC	Increase the accuracy of Auger electron and continuum beta-spectra.	Improve ENSDF codes to provide more detailed presentations of Auger-electron and continuum beta spectra.
22	All network evaluators	Check validity of the rules.	Inform NNDC when experimental results appear to contradict the rules.
23	All network evaluators	Improve quality of evaluations.	Solicit potential non-network evaluation reserves, and send names to ENSDF manager (NNDC).
24	All network evaluators	Rule for the lowest energy of the state with isospin $T_>$.	Consider rule presented by F. Chukreev, and include them in "Introductary Material" if appropriate.
25	IAEA/NDS; BNL/NNDC	Improve communications with users.	Include "chat site" in the agenda of next NSDD meeting. Prepare paper on feasibility of a "chat site" (A&Q, problems and solutions, etc.).
26	BNL/NNDC	Improve NSDD retrieval systems.	Open new relational database versions of ENSDF and NuDat to the network participants for tests and comments.
27	T. Burrows, BNL/NNDC; T. Kibedi, ANU	Improve evaluated Internal Conversion Coefficients.	Prepare BRICC data for network usage.
28	All network evaluators	Test BRICC tables.	Any noticeable differences with BRICC values should be reported to the ENSDF manager.
29	IAEA/NDS	Improve low-energy ICCs.	Translate into English: Grechukhin and Soldatov paper on theoretical calculations of low-energy ICCs, and distribute to network participants.
30	McMaster University; BNL/NNDC; LBNL; and other evaluation centres	Support new ENSDF evaluators.	Invite and provide local support and mentoring to new ENSDF evaluators of mass chain evaluations.
31	All network centres	Improve data service.	Keep a record of requests by customers that can not be satisfied.
32	ENSDF manager	Network should be made aware of needs of NSDD users.	List of horizontal evaluation needs and on-going evaluation activities should be maintained through the NSDD network.
33	All network centres	Maintain up todate information on the Network.	Review, modify and correct the contents of INDC(NDS)-421.

Annex 6. Status Reports of Evaluation Centres.

1 Nuclear Structure and Decay Data Evaluations and Related Activities of the Idaho Group

2 TUNL Nuclear Data Evaluation Project
J.H. Kelley[1,2], J.L Godwin[1,3], J. Purcell[1,4], G. Sheu[1,3], D.R. Tilley[1,2], H.R. Weller[1,3]
[1]TUNL,Durham, NC, USA,
[2]Dept. of Physics, North Carolina State University, Raleigh, NC, USA,
[3]Dept. of Physics, Duke University, Durham, NC, USA,
[4]Dept. of Physics and Astronomy, Georgia State University, Atlanta, Georgia, USA.

3 France Group - Status Report
Jean Blachot, SPN, Bruyeres-le-Chatel, France.

4 Belgian Group Status Report
D. De Frenne, E. Jacobs, University Gent, Belgium.

5 Status report of Japanese Activities for Nuclear Structure and Decay Data Evaluation
J. Katakura, Nuclear Data Center, JAERI, Japan.

6 Isotopes Project
C.M. Baglin('03), E.B. Norman('01, '02) (Project Leaders), LBNL, USA.

7 Isotopes Project (handouts)
C.M. Baglin, S. Basunia, E. Browne, R. Firestone, LBNL, USA.

8 Relational Nuclear Spectroscopy Databases in Internet
I.N. Boboshin, V.V. Varlamov, S.Yu. Komarov, N.N. Peskov, S.B. Semin, M.E. Stepanov, V.V. Chesnokov, MSU SINP Centre for Photonuclear Experiments Data, MSU, Russia.

9 Nuclear Structure and Decay Data Evaluations of the Georgia Tech Group

10 Report to IAEA Advisory Group Meeting on Nuclear Structure and Decay Data Network
F.E. Chukreev, Russian Nuclear Structure and Decay Data Centre, Kurchatov Institute, Russia.

11 National Nuclear Data Center Activity Report
NNDC, Brookhaven National Laboratory, USA.

12 Status of ENSDF Analysis and Utility Codes
NNDC, Brookhaven National Laboratory, USA.

13 Status Report of the Nuclear Data Project at McMaster University (December 1, 2000 – October 15, 2003)
B. Singh, McMaster University, Canada.

14 XUNDL Status Report
B. Singh[1], D.F. Winchell[2], T.W. Burrows[2]
[1]McMaster University, Canad, [2]NNDC, Brookhaven National Laboratory, USA.

15 Oak Ridge National Laboratory Nuclear Data Project: Nuclear Structure and Decay Data Evaluation Activity Report

16 Report of the Recently ENSDF Activities in CNDC
Huang Xialong, Zhou Chunmei and Wu Zhendong
CNDC, China Institute of Atomic Energy, Beijing, China

17 Status Report of the Nuclear Structure and Decay Data Evaluation for Mass Chain at Jilin University
Huo Junde, Jilin University, Changchun, China

18 IAEA Nuclear Data Section: Status Report, May 2003
A.L. Nichols, V.G. Pronyaev, Nuclear Data Section, IAEA, Austria.

19 Activities of Data Center of Petersburg Nuclear Physics Institute 2001 - 2003

Nuclear Structure and Decay Data Evaluations and Related Activities of the Idaho Group

for report to the meeting of the

International Nuclear Data Network
November 10-14, 2003 at IAEA, Vienna

I. Mass-chain Evaluations

Within the Nuclear Structure and Decay Data Evaluation Network, the group working at the Idaho National Engineering and Environmental Laboratory has the responsibility for the twelve mass chains 87 and 153-163. The participants in this work are R. G. Helmer and C. W. Reich. Since the last Network meeting in December 2000, complete evaluations for A=87, 156, 158, and 159 have been finished, with those for A=87, 156 and 159 having been published.

The current status of our mass chains is as follows:

Mass	Date of most recent publication	
87	3/2002	
153	2/1998	
154	10/1998	
155	4/1994	in progress
156	8/2003	
157	6/1996	in progress
158	3/1996	submitted
159	7/2003	
160	8/1996	
161	8/2000	
162	7/1999	
163	1/2000	

As part of this program, we have reviewed the mass-chain evaluations for A=60, 82, 87, 156, and 159.

II. Decay Data Evaluation Project, DDEP, and IAEA Coordinate Research Program

R. G. Helmer is a participant in the Decay Data Evaluation Project, DDEP, an international group that is carrying out evaluations of decay data for a set of nuclides that are important for several applications. This group includes non-ENSDF evaluators from France, Germany, Russia, Spain, and the United Kingdom, along with ENSDF evaluators E. Browne and R. G. Helmer. During the last two years, several evaluations have been submitted, edited, and finalized.

R. G. Helmer is a member of a current Coordinated Research Program, CRP, of the International Atomic Energy Agency, IAEA, which is preparing a set of decay data evaluations to be included in an update of their report entitled "X-ray and Gamma-ray Standards for Detector Calibration" (IAEA-TECDOC-619 (1991)). Since April 2002, he has provided evaluated data for the decay of 15 nuclides (^{22}Na, ^{24}Na, ^{40}K, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{60}Co, ^{64}Cu, ^{65}Zn, ^{95}Nb, ^{110m}Ag, ^{113}Sn, ^{137}Cs, ^{153}Sm, and ^{226}Ra).

REPORT

To IAEA Advisory Group Meeting on

NUCLEAR STRUCTURE AND DECAY DATA EVALUATORS' NETWORK

TUNL NUCLEAR DATA EVALUATION PROJECT

May 2003

J.H. Kelley[1,2], J.L. Godwin[1,3], J. Purcell[1,4], G. Sheu[1,3], D.R. Tilley[1,2], H.R. Weller[1,3]

[1] Triangle Universities Nuclear Laboratory, Durham, NC, 27708-0308

[2] Department of Physics, North Carolina State University, Raleigh, North Carolina, 27695-8202

[3] Department of Physics, Duke University, Durham, North Carolina, 27708-0305

[4] Department of Physics and Astronomy, Georgia State University, Atlanta, Georgia, 30303

I. Status of A = 3–20 data evaluation

TUNL is responsible for data evaluations in the mass range A=3-20. Since the last NSDD/IAEA meeting in 2000, preliminary reviews of the A = 6 and 7 nuclides were completed [in collaboration with G.M. Hale of Los Alamos National Laboratory and H.M. Hoffman of UniversitŁt Erlangen-Nrnberg], and the final reviews for the masses A = 5,6,7 were published in ”Energy Levels of Light Nuclei, A=5,6,7”, Nuclear Physics A708 (2003) 3. Preliminary reviews of A = 8 and 9, and more recently A = 10, were completed and mailed out for comment. We intend to publish reviews of A = 8, 9, 10 in Nuclear Physics A by the end of 2003, and A = 11 and 12 in 2004.

II. ENSDF

Since 2000 the A = 14 and 15 ENSDF files have been updated to include data from the past reviews of Fay Ajzenberg-Selove. ENSDF files for A = 5,6,7 (based on the 2002 TUNL publication) were completed and submitted. ENSDF files which reflect information from the ”Energy Levels of Light Nuclei, A = 8,9,10” review will be submitted shortly after publication in Nuclear Physics A.

Nuclear Mass	Publication/Status	Comments
$A = 5$,6,7	Nucl. Phys. A708 (2002) 3 [a]	TUNL [b]
$A = 8$	Prelim. review – Feb. 2002	TUNL
$A = 9$	Prelim. review – May 2001	TUNL
$A = 10$	Prelim. review – early 2003 [c]	TUNL

[a] Amongst the 10 Most Downloaded Papers from Nuclear Physics A between April and September 2002.
[b] With G.M. Hale (LANL) and H.M. Hoffman (Erlangen-Nrnberg).
[c] With D.J. Millener (BNL).

III. World Wide Web Services

TUNL continues to develop new WWW services for the nuclear science and applications communities. Since 2000, our website has grown and expanded to include: a new website design that was implemented in 2002; PDF and HTML documents (all include direct links to the NSR) for all of TUNL and Fay Ajzenberg-Selove's (FAS) A = 5-20 reviews published from 1979-present [the PDF's include hyperlinks for references and tables, and the HTML includes hyperlinks for references, tables, reactions, reaction discussions, Energy Level Diagrams and much more]. Our efforts in conjunction with Elsevier have made available general PDF documents for FAS A = 5-20 reviews for the years 1966-1991. Energy Level Diagrams are provided in GIF, PDF and EPS/PS formats for the publication years 1978-present. General tables that correspond to our (TUNL's) most recent reviews are available on our website for masses A = 5-10. Update Lists for A = 5-16 nuclides are also available. Both the General tables and the Update Lists are in HTML format and contain direct links to the NSR. A Palm Pilot Physics Page is available that contains links to Palm applications and databases of interest to the Nuclear Physics community.

IV. Related Activities

TUNL continuously scans the literature and maintains a substantial reference database. We also make extensive use of the Nuclear Science References services at NNDC, resources of the Triangle Area Libraries, Monthly Updates from NNDC, and Physics Abstracts.

Supported by the U.S. Department of Energy Director of Energy Research, Office of High Energy and Nuclear Physics, Contract Nos. DEFG02-97-ER41042 (North Carolina State University); DEFG02-97-ER41033 (Duke University).

France Group Status Report

Jean Blachot
Service de Physique Nucleaire
CEA, B.P. 12
F-91680 Bruyères-le-Chatel, France

We have since the beginning of the network the responsibility for 11 Mass chains. All the work now is done as a consultant for the laboratory of Bruyères le Chatel CEA France

1. Status of publications in NDS:

101 NDS 83, 1 (1998)
104 NDS 64, 1 (1991),evaluated and put in ENSDF (Feb 2000)
107 NDS 89, 213 (2000)
108 NDS 91, 135 (2000)
109 NDS 86, 505 (1999)
111 NDS 100, 179 (2003)
113 NDS 83, 647 (1998)
114 NDS 97, 593 (2002)
115 NDS 86, 151 (1999)
116 NDS 92, 455 (2001)
117 NDS 95, 679 (2002)

2. Status of XUNDL.

-Many files of XUNDL have been used for the evaluation in ENSDF.
101 (1) , 104 (1) , 107 (4) , 108 (7) , 109 (2) , 111 (10) , 114 (7) ,
116 (11) , 117 (10)
The following files are available to update ENSDF

101

101**Tc**;176YB(28SI,FG);1999Ho10
101**Ru**;96ZR(9BE,4NG);2002Ya13
101**Rh**;70ZN(36S,P4NG);2001Ti08
101**Ag**;70GE(35CL,2N2PG);1992Cr02,2001Ga49
101**In**;50CR(58NI,PA2NG);2002Li45

104

104**Mo**;248CM SF DECAY;1996Gu04,2002Sm10
176YB(28SI,XG);2000De33
104**Cd**;58NI(50CR,4PG);1999De22
58NI(50CR,4PG);2001Mu19
50CR(58NI,4PG);2002Ro19

107

107**Ru**;176YB(23NA,FG);2000Fo10
252CF SF DECAY;2002Zh02
107**Rh**;176YB(28SI,FG);1999Ve12
107**Sn**;107SB EC DECAY (4.0S);2002Re14
107**Sb**;58NI(58NI,2HEPG);2000La27

108
108**Rh**;176YB(28SI,XG);2002Po11
64NI(48CA,4NG);2002Go03
108**IN**; EC DECAY;2002Ga35
76GE(37CL,5NG);2001Ch71
109
109**Rh**;176YB(28SI,FG);1999Ve12,2002Ve08
109**Cd**;96ZR(18O,5NG);2000Ch04
100MO(13C,4NG);2001Ha09
106CD(A,NG);1999Da05
109**SB**; EC DECAY;2002Re14
109TE EC DECAY (4.6S);2002Re28
109**Te**;58NI(58NI,A2PNG);2000Bo29
109**I**;54FE(58NI,P2NG);1999Yu02
113
113**Rh**;113RU B- DECAY (0.5S);2002Ku18
113RU B- DECAY (0.9 S);2002Ku18
208PB(18O,FG);2002Ve08
113**Pd**;208PB(18O,FG);1999Kr17
238U(12C,FG);1999Ho25
252CF SF DECAY;2000Zh04
113**Cd**;176YB(28SI,FG);2000Bu06
173YB(24MG,FG);2000Fo10
113**Sn**;100MO(18O,5NG);1998Se14
100MO(18O,5NG);1998Ch39
113**Sb**;103RH(16O,A2NG);1998Mo22
113**Te**;54FE(63CU,N3PG);1998Se05
113**I**;58NI(58NI,3PG);2001St16
113**Xe**;58NI(58NI,2PNG);2000Sc23
115
115**Pd**;208PB(18O,FG);1999Kr17
238U(12C,FG);1999Ho25
252CF SF DECAY;2000Zh04
115**Ag**;252CF SFDECAY;2002Hw06
115**Cd**;176YB(28SI,FG);2000Bu06
173YB(24MG,FG);2000Fo10
115**Sn**;113CD(A,2NG);1999Lo04
115**Xe**;60NI(58NI,2PNG);2000Pa33
117
117**Ag**;252CF SFDECAY;2002Hw06

Belgian Group Status Report

D. De Frenne, E. Jacobs

University Ghent

Department Subatomic and Radiation Physics

86, proeftuinstraat

B9000 Gent

Belgium

During the last two years we started the reevaluation of mass chain A=105. Due to a drastic reorganization of our duties in the laboratory, E. Jacobs will retire next year, the workload with respect to especially fundamental research became that high that we could not finish that mass chain evaluation up to now. However we still hope to finish the evaluation of A=105 before the end of 2003. Whether new evaluations will be started up in 2004 is not yet clear and strongly depends on a number of circumstances related to a.o. our research program and lecture duties. However the evaluation activity will not be continued in Belgium after my retirement (D. De Frenne) the latest in 2006 but might be stopped earlier.

Status Report of Japanese Activities for Nuclear Structure and Decay Data Evaluation

J. Katakura
Nuclear Data Center
Japan Atomic Energy Research Institute

1 Members

The present members of Japanese group for the evaluation of Nuclear Structure and Decay Data are following: H. Iimura, J. Katakura, M. Kanbe, S. Ohya, M. Oshima and Y. Tendow. Most of them are part time evaluators. K. Kitao, T. Tamura and A. Hashizume are not official members of Japanese group now, but they can help us by participating some parts of the evaluation work. It is difficult to recruit new members in the present situation.

JAERI Nuclear Data Center has a visiting scientist from China by nuclear researchers exchange program. He helps our evaluation work.

2 Mass-chain evaluation

The mass chain evaluation Japanese group has the responsibility is for A=118-129. The last publication of the mass chain and the status are listed in Table 1.

Table 1: Status of Mass Chain Evaluation

Mass	Last NDS publications	Evaluators	Status
118	NDS 75, 99 (1995)	Kitao	Evaluating (kanbe)
119	NDS 89, 345 (2000)	Ohya, Kitao	
120	NDS 96, 241 (2002)	Kitao	
121	NDS 90, 107 (2000)	Tamura	
122	NDS 71, 461 (1994)	Tamura	Evaluating (Tamura)
123	NDS 70, 531 (1993)	Ohya, Tamura	Evaluating (Ohya)
124	NDS 80, 895 (1997)	Iimura, Katakura, Tamura, Kitao	Preparing to start evaluation
125	NDS 86, 955 (1999)	Katakura	
126	NDS 97, 765 (2002)	Katakura, Kitao	
127	NDS 77, 1 (1996)	Kitao, Oshima	Evaluating (Hashizume)
128	NDS 94, 227 (2001)	Kitao, Kanbe	
129	NDS 77, 631 (1996)	Tendow	Evaluating (Tendow)

The NDS publications after the previous meeting are A=119, 120, 121, 126 and 128. Other evaluations are being continued. The evaluations of A=118, 122, 123, 127 and 129 are planned to be finished in this year.

3 Other related activities on nuclear structure and decay data evaluation

3.1 Revision of the Chart of the Nuclides

The Chart of the Nuclides are regularly published almost very 4 years from 1977. The 7th edition was published in 2000 [1] and is available from Nuclear Data Center, JAERI. The chart is characterized by inclusion of estimated values for unmeasured beta-decay partial half-life of the nuclides far from beta stability line. Those values are based on "Gross theory of beta decay" by Waseda University group. The estimated partial half-lives of alpha-decay are also given for heavy elements. The number of experimentally identified nuclides are 2821 until the year of 2000. The number of the experimentally identified nuclides included in the chart is shown in Fig. 1 as a function of year.

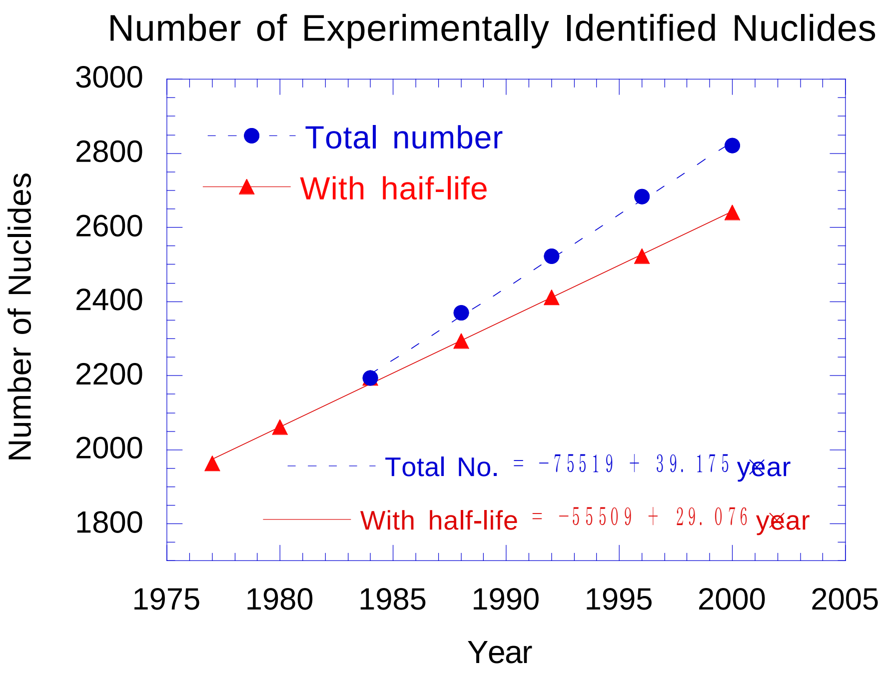


Figure 1: Number of nuclides contained in JAERI's Chart of the Nuclides.

As seen in this figure, about 40 nuclides are identified per year after 1984. Before the year the experimentally identified nuclides had also measured half-life. But after the year the half-life is not always measured. The number of nuclides with measured half-life steadily increases at the rate of about 30 per year from 1977, the year when the first version of JAERI's Chart of the Nuclides was published. The chart is also seen on our web site *http://wwwndc.tokai.jaeri.go.jp/CN01/index.html*. The web chart is revised every year.

The data collection for the 8th edition has been continued after the publication of the 7th edition. The 8th edition is scheduled to be published in 2004 fiscal year.

3.2 Compilation of JENDL FP Decay Data File 2000

As a special purpose file of JENDL (Japanese Evaluated Nuclear Data Library), JENDL FP Decay Data File 2000 was compiled [2]. This file has the ENDF format as other JENDL files do. The file contains decay data such as half-life, decay mode, branching ratio, average decay energy, beta- and gamma-ray energy values and their intensities, and so on. The estimated average decay energy values of gamma- and beta-rays and their spectra are included in the file. About the half of the nuclides included in the file has the estimated average decay energy values and spectra. The usefulness of these estimated data for reactor decay heat and spectrum has been confirmed by comparing measured data. Characteristic of the data is given in Table 2.

Table 2: Characteristics of JENDL FP Decay Data File 2000

No. of Nuclides		Data Type, Comments
1087		Unstable nuclides or states
	197	First isomeric states
	8	Second isomeric states
1087		Average gamma decay energy values
	506	Measured (From ENSDF)
	581	Theoretically estimated
1087		Average beta decay energy values
	544	Measured
	543	Theoretically estimated
1053		Gamma ray spectra
	496	Measured spectrum only
	431	Theoretically estimated spectrum only
	126	Measured + Estimated
899		Beta ray spectra
	374	Measured spectrum only
	432	Theoretically estimated spectrum only
	93	Measured + Estimated

Examples of decay heat and spectrum comparisons with measured data are shown in Figs. 2 and 3. Figure 2 shows decay heat comparison of ^{239}Pu fission by thermal neutrons. The vertical axis indicates the energy lease rate multiplied by the time after fission. The left hand side is a beta-ray component and the right hand side a gamma-ray component. The measurements were performed at ORNL [3] and Lowell, University of Massachusets [4]. The calculations using JENDL FP Decay Data File 2000 show good agreement with the measured data.

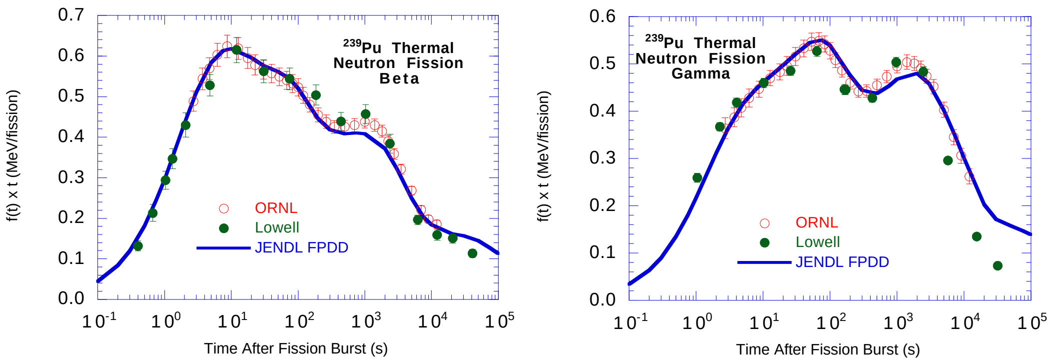


Figure 2: Decay heat of ^{239}Pu fission by thermal neutrons.

Figure 3 shows spectrum comparison of ^{239}Pu fission. The measurements were performed at ORNL [3]. The spectra in the figure were measured during 1 s at 1.7 s after 1 s irradiation by thermal neutrons. The left hand side shows beta-ray spectrum and the right hand side gamma-ray spectrum. In these figures the calculated spectra using the ENSDF file are also shown. For the beta-ray spectrum, the calculation using the ENSDF file underestimates the low energy part of the spectrum. For the gamma-ray spectrum, the calculation using the ENSDF file underestimates the medium energy part of the spectrum. The calculations using JENDL FP Decay Data File 2000 can reproduce well the measured data.

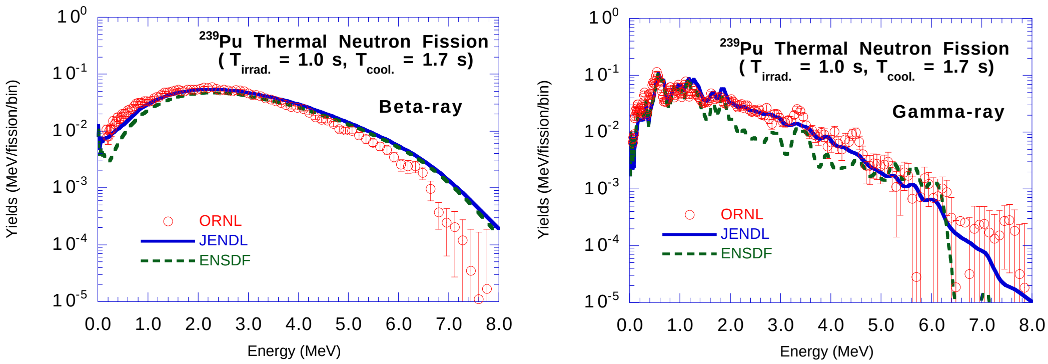


Figure 3: Spectrum at 2.7 s after ^{239}Pu burst fission by thermal neutrons

Decay and photon libraries for ORIGEN2 code [5], which is widely used for estimating the nuclide inventory in a nuclear reactor, were compiled [6] using the data of JENDL FP Decay Data File 2000.

References

[1] T. Horiguchi, T. Tachibana, H. Koura and J. Katakura, "Chart of the Nuclides 2000", Japanese Nuclear Data Committee and Nuclear Data Center, Japan Atomic Energy Research Institute (2000).

[2] J. Katakura, T. Yoshida, K. Oyamatsu and T. Tachibana, "JENDL FP Decay Data File 2000", JAERI 1343 (2001).

[3] J. K. Dickens et al., "Fission Product Energy Release for Time Following Thermal Neutron Fission of ^{239}Pu between 2 and 14,000 seconds," ORNL/NUREG-14 (1978).

[4] H. V. Nguyen et al., "Decay Heat Measurements Following Neutron Fission of ^{235}U and ^{239}Pu," Proc. of Int. Conf. on Nuclear Data for Science and Technol., May 19-24, 1997, Trieste, p.835 (1997).

[5] A. G. Croff, "ORIGEN2 - A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code," ORNL-5621 (1980).

[6] J. Katakura and H. Yanagisawa, "Photon and Decay Data Libraries for ORIGEN2 Code Based on JENDL FP Decay Data File 2000", JAERI-Data/Code 2002-021 (2002).

Isotopes Project

LAWRENCE BERKELEY NATIONAL LABORATORY

C.M. Baglin ('03), E.B. Norman ('01, '02) (Project Leaders)

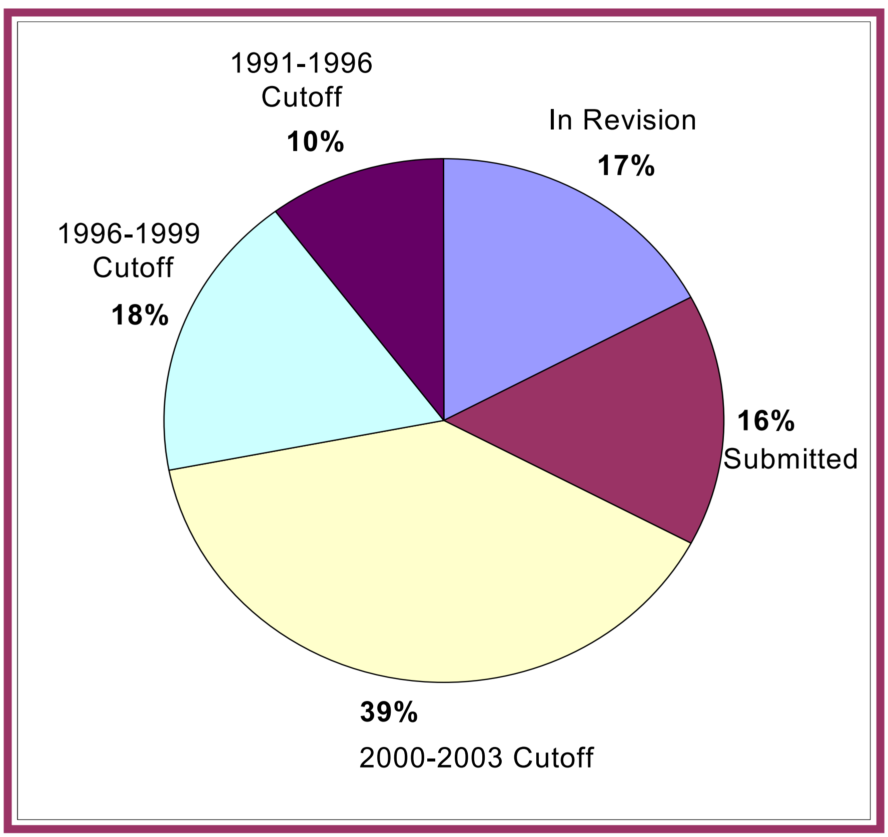
Report prepared for the November 2003 IAEA Advisory Group Meeting in Vienna on Coordination of the International Network of Nuclear Structure and Decay Data Evaluators. This report covers the period from December 2000 through September 2003.

A. NUCLEAR STRUCTURE AND DECAY EVALUATION

Mass Chain Responsibility:

Permanent: A = 21-30, 59, 81, 83, 90-93, 166-193 (except 188, 190), 210-212, 215, 219, 223, 227, 231.
Temporary: A=235, 239.

The literature cutoff dates for the ~550 permanently-assigned nuclides are summarized below. (Both temporarily-assigned chains have been evaluated and were published in Spring 2003.)



PERSONNEL

The group's data evaluation effort has ranged from 2.6 to 2.0 FTE during the period covered by this report. The evaluation personnel are C. Baglin, S. Basunia, E. Browne, R. Firestone and a visitor from Taiwan, Professor Shiu-Chin (Alice) Wu, who spent her leave during 2001 through 2003 with the Isotopes Project evaluating A=189 and A=180.

International collaborations continued with Gabor Molnár (Hungary) and Zhou Chunmei (China) (preparation of evaluated (n,γ) data), and with French, German, British, US, Spanish, Brazilian and Russian scientists participating in the radioactive Decay Data Evaluation Project (DDEP). Recent, short-term visitors to the Isotopes Project include V. Vanin (Brazil, collaboration on A=193), Z. Révay and L. Szentmiklosi (Hungary, (n,γ) data), T. Kibédi (Australia, collaboration on A=172).

EVALUATION ACCOMPLISHMENTS

- Mass Chains

  Submitted: A=21, 59, 168, 170, 171, 179, 186, 180, 189, 210, 211, 239.
  Published: A=59, 83, 92, 170, 171, 186, 189, 210, 215, 219, 223, 227, 231, 235, 239.
  Reviewed: A= 141, 144, 177, 190, 198, 244, 250, 254, 258, 262.

- Complete Nuclide Evaluations

  The nuclide evaluations (listed below) were undertaken because of their 'priority' status (those marked with *), the existence of significant, newly-published information which could be expeditiously included in ENSDF (thus improving the timeliness of the file), the need to revise α-decay parent or daughter information (for internal consistency of the file), or the absence of a published evaluation for the nuclide.

  - Published in Nuclear Data Sheets:
    ^{183}Tl*.
  - Unpublished; reviewed and added to ENSDF:
    ^{59}Zn, ^{92}Sr, ^{93}Kr, ^{93}Br, ^{93}Rh, ^{93}Pd, ^{173}Au, ^{173}Hg, ^{179}Tl, ^{183}Pb, ^{184}Au*, ^{184}Pb ^{187}Bi.

  * Priority nuclide

- Decay Data Evaluation Project (DDEP) Participation
  - Evaluation of DDEP Radionuclides:
  ^{66}Ga, ^{152}Eu, ^{227}Th.

  - Reviews of DDEP Evaluations:
  ^{11}C, ^{18}F, ^{33}P, ^{64}Cu, ^{66}Ga, ^{85}Kr, ^{123m}Te, ^{131}I, ^{131m}Xe, ^{140}La, ^{140}Ba, ^{208}Tl, ^{212}Po, ^{212}Bi, ^{212}Pb, ^{216}Po, ^{220}Rn, ^{224}Ra, ^{228}Th.

  - Coordination of Program

- Evaluated Gamma-ray Activation File (EGAF)

Evaluation of thermal neutron capture gamma-ray data for 262 isotopes has been completed as part of an IAEA-sponsored Coordinated Research Project begun in November 1999 to develop a Database of Prompt Gamma-rays from Slow Neutron Capture for Elemental Analysis. A new database, the Evaluated Gamma-ray Activation File (EGAF), has been produced containing

≈35,000 prompt and decay gamma-ray energies and thermal neutron cross sections for isotopes of all stable elements from hydrogen to uranium. These adopted data are derived from isotopic capture gamma-ray energy and intensity data in ENSDF, which were updated from the current literature, and combined with elemental energy and absolute cross section measurements from the Budapest Reactor. In addition, total radiative neutron capture cross sections have been deduced for most isotopes from the intensity balance through the level scheme. Also, new precise neutron separation energies have been determined by least-squares fits of the primary gamma-ray energies to the level schemes. These data will be published as an IAEA TECDOC with CD-ROM (in press) and in the *Handbook of Prompt Gamma-ray Activation Analysis* (Kluwer). The EGAF database will be disseminated by the IAEA on the WWW in tabular and ENSDF formats. An IAEA-PGAA Database Viewer has also been provided for interactive searching of the database. The ENSDF format version of EGAF will be sent to the NNDC following its official release by the IAEA. EGAF neutron separation energy data have also been provided to the Atomic Mass Data Center (ORSAY) for inclusion in the next mass evaluation.

In conjunction with this evaluation effort, Isotopes Project personnel collaborated in measurements of radiative thermal neutron cross-sections, performed using the cold neutron beam at the Budapest Reactor. The cross sections for two isotopes important for applications, ^{6}Li and ^{12}C, were found to differ by several standard deviations from previously accepted values, the first precise measurement of the ^{11}B cross section (11.5(3) mb) has been accomplished, and measurements of the tellurium isotopic cross sections have been submitted for publication.

B. NUCLEAR DATA DISSEMINATION

PERSONNEL

Isotopes Project personnel involved in data dissemination are as follows:
R. Firestone 0.30 to 0.25 FTE.

DISSEMINATION RESPONSIBILITY, STATUS

- **IAEA-PGAA Database Viewer**

As part of the IAEA CRP for the *Development of a Database for Prompt Gamma-ray Neutron Activation Analysis* we have developed a PGAA Database Viewer. The viewer supports the retrieval of thermal neutron capture gamma-ray data by element or isotope. The database may also be searched by A, Z, energy, cross section, or k_0 value. Histograms of gamma-ray energies and cross sections for elements or isotopes are also provided. The PGAA Database Viewer will be disseminated from the IAEA website in 2004.

- **LBNL Nuclear Data Server**

The Isotopes Project developed and supports Isotope Explorer 2 (C++, Windows), Isotope Explorer 3 (Java, HTML), and the WWW Table of Radioactive Isotopes. The group also supports WWW dissemination home pages for Neutron Capture, Spontaneous Fission, Radioactive Decay, Nuclear Structure, Atomic Masses, Education, Nuclear Structure Systematics and other topics. The home page for Nuclear Astrophysics data is no longer updated, and support for this effort is now the responsibility of R. Hoffman, T. Rauscher, A. Heger, and S. Woosley at LLNL who maintain a *Reaction Rates for Stellar Nucleosynthesis* home page at http://www-pat.llnl.gov/Research/RRSN/.

The demand for these services has increased substantially each year. In 2002, the Isotopes Project served over 154,735 distinct hosts who downloaded nearly 338 GB of data, up dramatically from 117,755 distinct hosts who downloaded 84 Gb in 2001. A comparison of 2001 through September 2003 usage is given in Figure 1. ENSDF file usage (.ENS file extensions) has risen dramatically from 272,739 in 2001 to 4,187,095 in the first nine months of 2003. Most ENSDF usage is by Isotope Explorer 2 users who download ENSDF data directly from our server without accessing any WebPages. About 3500-4000 people download Isotope Explorer 2 software annually.

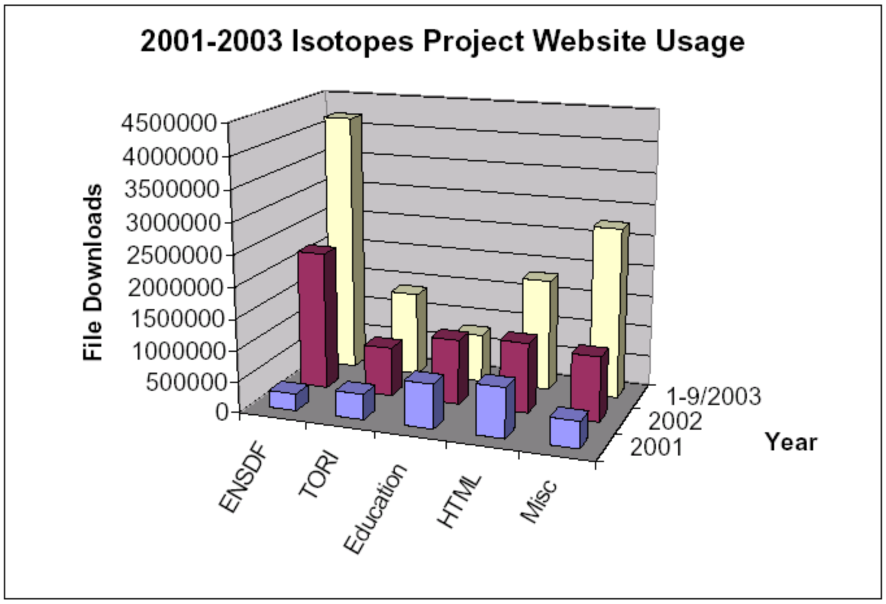


Figure 1. Distribution of Isotopes Project server data retrievals in 2001-9/2003. This information was compiled using Analog 5.22 log file analyzer software. The statistics for usage of NSR, PS, PDF, TXT, Java applets and other data files are combined under the miscellaneous column.

C. PUBLICATIONS and INVITED TALKS

Mass Chain or Nuclide Evaluation Publications

Nuclear Data Sheets for A=46, S.-C. Wu, Nuclear Data Sheets **91**, 1 (2000).

Nuclear Data Sheets for A=92, Coral M. Baglin, Nuclear Data Sheets **91**, 423 (2000).

Nuclear Data Sheets for A=83, S.-C. Wu, Nuclear Data Sheets **92**, 893 (2001).

Nuclear Data Sheets for A=215, 219, 223, 227, 231, E. Browne, Nuclear Data Sheets **93**, 763 (2001).

Nuclear Data Sheets for ^{183}Tl, Coral M. Baglin, Nuclear Data Sheets **95**, 49 (2002).

Nuclear Data Sheets for A=59, Coral M. Baglin, Nuclear Data Sheets **95**, 215 (2002).

Nuclear Data Sheets for A=171, Coral M. Baglin, Nuclear Data Sheets **96**, 399-610 (2002).

Nuclear Data Sheets for A=170, Coral M. Baglin, Nuclear Data Sheets **96**, 611-873 (2002).

Nuclear Data Sheets for A=235, 239, E. Browne, Nuclear Data Sheets **98**, 665 (2003).

Nuclear Data Sheets for A=186, Coral M. Baglin, Nuclear Data Sheets **99**, 1 (2003).

Nuclear Data Sheets for A=210, E Browne, Nuclear Data Sheets **99**, 649 (2003).

Nuclear Data Sheets for A=189, S.-C. Wu and H. Niu, Nuclear Data Sheets **100**, 1 (2003).

Other Nuclear Data Related Publications

A new gamma-ray spectrum catalog for PGAA, Zs. Révay, G.L. Molnár, T. Belgya, Zs. Kasztovszky, and R.B. Firestone, Journal of Radioanalytical and Nuclear Chemistry 244, 379-382 (2000).

Thermal-Neutron Capture Data for A=26-35, C. Zhou and R.B. Firestone, INDC(CPR)-054 (2001).

A New Gamma-Ray Spectrum Catalog and Library for PGAA, Zs. Révay, G.L. Molnár, T. Belgya, Zs. Kasztovsky, R.B. Firestone, J. Radioanal. Nucl. Chem. **248**, 395 (2001).

Development of a Database for Prompt Gamma-ray Neutron Activation Analysis, R.B. Firestone, INDC(NDS)-424, June 2001.

Report on the Activities of the Decay Data Evaluation Project, Edgardo Browne, Marie-Martine Bé, T. Desmond MacMahon and Richard G. Helmer, October 3, 2001, CEA Report, CEA-R-5990, 2001.

From Data Evaluation to Research, E. Browne, American Nuclear Society 2001 Winter Meeting, Reno, Nevada, November 2001, Transactions **85**, 232 (2001).

New Capture Gamma-Ray Library and Atlas of Spectra for All Elements, R. B. Firestone, Zs. Révay, and G. L. Molnár, Proceedings of the Eleventh International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics, Pruhonice near Prague, Czech Republic, September 2 - 6, 2002, World Scientific, in press.

Table of Superdeformed Nuclear Bands and Fission Isomers, B. Singh, R. Zywina, R.B. Firestone, Nuclear Data Sheets **97**, 241 (2002).

Thermal Neutron Capture for A=36-44, Z. Chunmei and R.B. Firestone, IAEA Report INDC(CPR)-057 (2003).

Development of a Database for Prompt Gamma-ray Neutron Activation Analysis, R.B. Firestone *et al,* INDC(NDS)-443, March 2003.

Development of a Database for Prompt Gamma-ray Neutron Activation Analysis, H.D. Choi, R.B. Firestone, R.M. Lindstrom, G.L. Molnár, A.V.R. Reddy, V.H. Tan, C.M. Zhou, R. Paviotti-Corcuera, and A. Trkov, Proceedings of the International Conference on Nuclear Data for Science and Technology, 7-12 October 2001, Tsukuba, Ibaraki, Japan. Journal of Nuclear Science and Technology, Supplement 2, 1372-1375 (2002).

New Catalog of Neutron Capture Gamma Rays for Prompt Gamma Activation Analysis, G.L. Molnár, Zs. Révay, T. Belgya, R.B. Firestone, Proceedings of the International Conference on Nuclear Data for Science and Technology, 7-12 October 2001, Tsukuba, Ibaraki, Japan. Journal of Nuclear Science And Technology, Supplement 2, 1338-1343 (2002).

Other Nuclear Science Publications Involving Isotopes Project Personnel

New Determination of the Ba-Mo Yield Matrix for ^{252}Cf, S.-C. Wu, R. Donangelo, J.O. Rasmussen, A.V. Daniel, J.K. Hwang, A.V. Ramayya, J.H. Hamilton, Phys. Rev. C **62**, 041601 (2000).

Terrestrial Evidence of a Nuclear Catastrophe in Paleoindian Times, R.B. Firestone and W. Topping, The Mammoth Trumpet 16, 9 (2001).

Determination of the Half-life of ^{37}Ar by Mass Spectrometry, P.R. Renne and E.B. Norman, Phys. Rev. C **63**, 047302 (2001).

Search for the Decay of the 3.5 eV Level in ^{229}Th, E. Browne, E.B. Norman, R.D. Canaan, D.C. Glasgow, J.M. Keller, J.P. Young, Phys. Rev. C **64**, 014311 (2001).

Influence of Physical and Chemical Environments on the Decay Rates of ^{7}Be and ^{40}K, E.B. Norman, G. A. Rech, E. Browne, R.-M. Larimer, M. R. Dragowsky, Y. D. Chan, M. C. P. Isaac, R. J. McDonald and A. R. Smith, Phys. Letters **519B**, 15 (2001).

Q_{EC} Value and Internal Bremsstrahlung Spectra of ^{179}Ta, M. M. Hindi, B. O. Faircloth, R. L. Kozub, K. R. Czerwinski, R.-M. Larimer, E.B. Norman, B. Sur, and I. Zlimen, Phys. Rev. C **63,** 065502 (2001).

Half-life of the 6.3-keV Isomer in ^{121}Sn, G.A. Rech, E. Browne, I.D. Goldman, F.J. Schima, and E.B. Norman, Phys. Rev. C **65**, 057302 (2002).

^{66}Ga: a Standard for High-Energy Calibration of Ge Detectors, C.M. Baglin, E. Browne, E.B. Norman, G.L. Molnár, T. Belgya, Zs. Révay, F. Szelecsényi, Nuclear Inst. and Methods in Physics Research **A 481**, 365-377 (2002).

Neutron-Induced Prompt Gamma Activation Analysis (PGAA) of Metals and Non-metals in Ocean Floor Geothermal Vent-Generated Samples, D.L. Perry, R.B. Firestone, G. Molnár, Zs. Révay, Zs. Kasztovszky, R.C. Gatti, and P. Wilde, Journal of Anal. At. Spectrom. **17**, 32 (2002).

Prompt Gamma Activation Analysis: An Old Technique Made New, J. English, R. Firestone, D. Perry, K-N. Leung, J. Reijonen, G. Garabedian, B. Bandong, G. Molnár, and Zs. Révay, Accelerator Radiation Safety Newsletter 11 (2002).

Response to the Comments by J.R. Southon and R.E. Taylor on Terrestrial Evidence of a Nuclear Catastrophe in Paleoindian Times, R.B. Firestone, Mammoth Trumpet 17, 14 (2002).

Searching for X(5) behavior in nuclei , R. M. Clark, M. Cromaz, M. A. Deleplanque, M. Descovich, R. M. Diamond, P. Fallon, R. B. Firestone, I. Y. Lee, A. O. Macchiavelli, H. Mahmud, E. Rodriguez-Vieitez, F. S. Stephens, and D. Ward , Phys. Rev. C 68, 037301 (2003)

Invited Talks

Did a Supernova in Paleo-Indian Times Reset the Radiocarbon Clock?, R.B. Firestone, UC Berkeley seminar series "YnK Conservation: Time, the Overlooked Dimension", March 2, 2001.

Application of Prompt Gamma-ray Activation Analysis (PGAA) With a Portable Neutron Source, R.B. Firestone, August 28, 2001, Lawrence Livermore National Laboratory.

Prehistoric Supernovae, R.B. Firestone, Nuclear Physics Forum, October 25, 2001, University of California, Berkeley.

Cosmic Consequences for Radiocarbon Dating, R.B. Firestone, Archaeological Research Faculty Lecture, Archeometry Network 2001-02 Series, October 29, 2001, University of California, Berkeley.

New Capture Gamma-Ray Library and Atlas of Spectra for All Elements. R. B. Firestone, Zs. Révay, and G. L. Molnár, Eleventh International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics, Pruhonice near Prague, Czech Republic, September 2 - 6, 2002.

Analysis of Unknown Materials With prompt Gamma-Ray Activation Analysis, R.B. Firestone and J. English, Russian-American WSSX Workshop on High Explosives Aging, July 25, 2002, Monterey.

Overview of Nuclear Data, R.B. Firestone, Lecture given at the Workshop on Nuclear Data for Science and Technology: Materials Analysis, Abdus Salam International Centre for Theoretical Physics, Trieste, 19-30 May 2003.

Other Talks/Posters

^{66}Ga and ^{229}Th: Two puzzles in nuclear data, Eric B. Norman, Am. Chem. Soc. National Meeting, 1-5 April 2001, San Diego CA, Paper NUCL 90.

Nuclear Data for Basic and Applied Research in the 21st Century, USNDP and Nuclear Structure and Decay Data Network (presented by E.B. Norman), International Nuclear Physics Conference 2001, Berkeley, LBNL-48247, 632 (2001).

A New Prompt Gamma-Ray Database for Cold and Thermal Neutron Capture, R.B. Firestone, G. Molnár, Zs. Révay and Zs. Kasztovsky, International Nuclear Physics Conference 2001, Berkeley, LBNL-48247, 438 (2001).

Search for the Decay of the 3.5 eV ^{229}Th^{m}, E. Browne, E.B. Norman, R.D. Canaan, D.C. Glasgow, J.M. Keller, J.P. Young, International Nuclear Physics Conference 2001, Berkeley, LBNL-48247, 552 (2001).

^{102}Rh^{m}: Could it be a cosmic-ray chronometer?, P. Perso, N. Added, …, E.B. Norman, et al., International Nuclear Physics Conference 2001, Berkeley, LBNL-48247, 66 (2001).

^{66}Ga Emission Probabilities for Ge Detector Calibration, C.M. Baglin, E. Browne, E.B. Norman, G.L. Molnár, T. Belgya, Zs. Révay, F. Szelecsényi, International Nuclear Physics Conference 2001, Berkeley, LBNL-48247, 434 (2001).

Terrestrial Evidence for a Nuclear Catastrophe in Paleo-Indian Times, R.B. Firestone and W. Topping, International Nuclear Physics Conference 2001, Berkeley, LBNL-48247, 483 (2001).

Compact Neutron Generators for Environmental Recovery Applications, K.N. Leung, R.B. Firestone, T.P. Lou, J. Reijonen, and J. Vujic, Proc. International Conf. on Environmental Recovery of Yugoslavia, ENRY2001, 27-30 September 2001, Belgrade.

Development of a Database for Prompt Gamma-ray Neutron Activation Analysis, H.D. Choi, R.B. Firestone, R.M. Lindstrom, G.L. Molnár, A.V.R. Reddy, V.H. Tan, C.M. Zhou, R. Paviotti-Corcuera, and A. Trkov, Proc. International Conf. on Nuclear Data for Science and Technology, 7-12 October 2001, Tsukuba, Ibaraki, Japan.

New Catalog of Neutron Capture Gamma Rays for Prompt Gamma Activation Analysis, G.L. Molnár, Zs. Révay, T. Belgya, R.B. Firestone, Proc. International Conf. on Nuclear Data for Science and Technology, 7-12 October 2001, Tsukuba, Ibaraki, Japan.

Prompt Gamma Activation Analysis (PGAA) and Short-Lived Neutron Activation Analysis (NAA) Applied to the Characterization of Legacy Materials, Gerald A. English, Richard B. Firestone, Dale L. Perry, Jani P. Reijonen, Bernhard A. Ludewigt, Ka-Ngo Leung, Glenn F. Garabedian and Bryan B. Bandong, Gabor L. Molnár and Zsolt Révay, Sixth international conference on Methods and Applications of Radioanalytical Chemistry, MARC VI Kailua-Kona, Hawaii, April 7-11 2003 (to be published in J. Nucl. Radioanal. Chem.).

The Characterization of Legacy Radioactive Materials by Gamma Spectroscopy and Prompt Gamma Activation Analysis (PGAA), G.A. English, D.L. Perry, J. Reijonen, B. Ludewigt, K-N. Leung, R.B. Firestone, G. Garabedian, G. Molnár, and Zs. Révay, Proceedings of the 5th International Topical Meeting on Industrial Radiation and Radioisotope Measurement Applications (IRRMA-V), Bologna, Italy, 9-14 June 2002 (to be published in Nucl. Instrum. Meth. B).

The Use of Prompt Gamma Activation Analysis (PGAA) for the Analysis and Characterization of Materials: Photochromic materials, D.L. Perry, G.A. English, R.B. Firestone, K-N. Leung, G. Garabedian, G.L. Molnár and Zs. Révay, Proceedings of the 5th International Topical Meeting on Industrial Radiation and Radioisotope Measurement Applications (IRRMA-V), Bologna, Italy, 9-14 June 2002 (to be published in Nucl. Instrum. Meth. B).

PGAA/NAA Analysis with the Lawrence Berkeley National Laboratory (LBNL) D+D Neutron Generator, R.B. Firestone, G.A. English , D.L. Perry, J.P. Reijonen, F. M. Gicquel, S. Basunia, K.N. Leung, G.F. Garabedian, B.B. Bandong, G.L. Molnár, L. Szentmiklosi and Zs. Révay, Proceedings of the American Nuclear Society Embedded Topical Meeting on Accelerator Applications in a Nuclear Renaissance (AccApp'03), June 1-5 2003, San Diego CA (to be published).

Compact Neutron Generator Development at LBNL, J. Reijonen, G. English, R. Firestone, F. Giquel, M. King, K-N. Leung and M. Sun, Proceedings of the American Nuclear Society Embedded Topical Meeting on Accelerator Applications in a Nuclear Renaissance (AccApp'03), June 1-5 2003, San Diego CA (to be published).

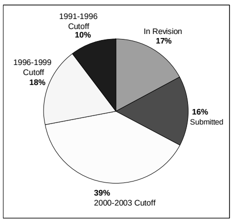
Isotopes Project

NUCLEAR SCIENCE DIVISION
LBNL

C. Baglin, S. Basunia, E. Browne, R. Firestone

Mass Chain Responsibility (~550 nuclides):
Permanent: A=21-30, 59, 81, 83, 90-93, 166-187, 189, 191-193, 210-212, 215, 219, 223, 227.
Temporary: 235, 239.

Evaluation Status



Manpower:

Evaluation: 2.6-2.0 FTE (staff)

0.3 FTE (guest)

Dissemination: 0.30-0.25 FTE

Accomplishments Since Dec. '00

Mass Chain and Nuclide Evaluation

• Submitted:
A=21, 59, 168, 170, 171, 179, 180, 186, 189, 210, 211, 239, ^{59}Zn, ^{92}Sr, ^{93}Kr, ^{93}Br, ^{93}Rh, ^{93}Pd, ^{173}Au, ^{173}Hg, ^{179}Tl, ^{183}Pb, ^{183}Tl, ^{184}Au, ^{184}Pb, ^{187}Bi
(150 nuclides)

• Published:
A=59, 83, 92, 170, 171, 186, 189, 210, 215, 219, 223, 227, 231, 235, 239 ^{183}Tl (154 nuclides)

• Reviewed: 10 mass chains (A=141, 144, 177, 190, 198, 244, 250, 254, 258, 262).

DDEP Activity

• Coordinated international collaboration.
• Evaluated 3 radionuclide decays.
• Reviewed 19 radionuclide evaluations.

Web Page Maintenance and Software Support

• Maintained approximately 12 web pages.
• Supported *Isotope Explorer 2* and *3*, *WWW Table of Radioactive Isotopes*.
• Served 155,000 distinct hosts who downloaded ~338 Gb data in 2002.

Accomplishments - continued

IAEA Coordinated Research Project:

"Development of Database for Prompt Gamma-ray Neutron Activation Analysis"

Led by: R. Firestone, Isotopes Project, LBNL

Participants: China, Hungary, India, Korea, US, Vietnam

Mission: To improve accuracy, completeness and availability of thermal (n,γ) data needed for prompt-gamma neutron activation analysis.

Status:

•Commenced November 1999, final meeting March 2003.

•Produced "EGAF" (Evaluated Gamma-ray Activation File) database of 35,000 evaluated prompt and decay gamma-ray cross-sections for thermal neutron capture on any stable element from H to U.

•Prepared TECDOC publication with CD-ROM (in press).

•Created web site (in press) and developed software for searching database on CD-ROM and on the web.

• Energies and cross sections adopted by the CRP will also be published in *Handbook of Prompt Gamma-ray Activation Analysis* (Kluwer).

Manpower Issues Addressed

Isotopes Project:

• **Postdoctoral Position (2-year, structure and decay data evaluation/research):** filled in April 2003 by Shamsu Basunia.

• **Current Isotopes Project Levels of Effort:**
  • Evaluation: 2.18 FTE (staff) + 0.3 FTE (guest).
  • Dissemination: 0.25 FTE.
  • Management, coordination, research: 1.0

International:

• **Provided Lecturer** for Structure and Decay Data Evaluator training workshop in Vienna (Nov., 2002).

• **Assisted** three participants in that workshop with subsequent proposal writing and/or ongoing evaluation activities.

The MSU SINP Centre for Photonuclear Experiments Data
(Centr Dannykh Fotoyadernykh Eksperimentov - CDFE)
Relational Nuclear Spectroscopy Databases in Internet

I.N.Boboshin, V.V.Varlamov, S.Yu.Komarov, N.N.Peskov, S.B.Semin, M.E.Stepanov, V.V.Chesnokov

Status Report
to the IAEA 15th Meeting of the Nuclear Structure and Decay Data (NSDD) Network
(5 - 9 May 2003, Ontario, Canada)

Among several data processing activities the Moscow State University Skobeltsym Institute of Nuclear Physics CDFE there is production of relational nuclear database using the MySQL Data Base Management System (Linux). In addition to that for nuclear reaction data (EXFOR) the CDFE has produced several powerful scientific tools that could be interesting and useful for Nuclear Structure and Decay Data (NSDD) Network.

Some of them put upon the CDFE Web-site (http://depni.sinp.msu.ru/cdfe) are presented shortly.

1. The relational nuclear spectroscopy database NESSY ("New ENSDF Search System") /1/ has been developed before /2/ for using on PC and compatible computers. This is a very powerful tool for scientific research which use the nuclear spectroscopy information because it has an evident advantages in comparison of other software for database operation with the ENSDF mentioned above:

- configuration on both search conditions and output information is not limited;
    - automating formation of tables containing the search parameters can be included in the common query configuration:
    - Query_1 (ENSDF) $\Rightarrow$ Result_1,
    - Query_2 (Result_1) $\Rightarrow$ Result_2,
    - and so on;
- requests are posed by means of both values and the relations between them;
- performing arithmetic and other operations over searched values is possible.

This gives to all people who have Web-browser the possibilities for:

- solve all the tasks that can be solved on existing search systems on ENSDF in the world and additionally a number tasks that can be solved on the NESSY only;
- receive the rapid access to any data from the ENSDF;
- do the search job with simplicity and clearness because NESSY's user interface is very friendly: CUI (Common User Interface) standard is keeping out.

2. The relational database "Low ($\hbar\omega \leq 3$ keV) Energy Isomer Transition Internal Conversion Probabilities" was produced in cooperation with CAJaD (Dr. F.E.Chukreev) using the data /3/; conversion of some low-energy transitions of ΛL = E1 - E4, M1 - M3 multipolarities ($E_1I_1 \rightarrow E_2I_2$ ($\hbar\omega = E_1 - E_2 \leq 3$ keV; I_1,I_2 - nucleus initial and final states spins, correspondingly) on the external electronic shells ($4p_{3/2}$ - $7d_{5/2}$) in the nuclei ^{90}Nb, ^{99}Tc, ^{103}Rh, ^{110}Ag, ^{140,142}Pr, ^{153,159}Gd, ^{160}Tb, ^{165}Tm, ^{171}Lu, ^{183}W, ^{188}Re, ^{193}Pt, ^{201}Hg, ^{205}Pb, ^{236}Pa, ^{250}Bk were investigated for the case of an isolated atom; the probabilities of the conversion transitions were calculated in framework of the Hartri-Fock-Slater method with the electron wave functions, obtained by integrating numerically the Dirac equations in the atomic field; the calculations were carried out for the normal configuration of the valence bans of the above listed atoms; the search is possible for Z, A, ΛL and shell (N, L, J).

3. The relational database "Nucleus Ground State Parameters" was developed using several well known sources /4, 5/ and new CDFE data /6/ for first isobar analogue state energies includes the following data:

- nucleus Z and A numbers;
- $T_{1/2}$ or Γ or Abundance /4, 5/;
- spin-parity J^{π} /2/;
- atomic mass M (with correspondent uncertainty) /5/;
- mass excess M-A (with correspondent uncertainty) /5/;
- nucleus binding energy (with correspondent uncertainty) /5/;
- nucleus ground state isospin (N-Z) value;
- first isobar analogue $T_{>}$-state energy /6/;
- nucleus dipole and quadrupole moments /7/.

4. "Calculator for Nuclear Reaction Threshold and Energy Values" was produced using the nucleus mass data from other CDFE relational data base "Nuclear Ground State Parameters" (all needed mass data from /4); using the Calculator one can easily obtain both threshold and energy values for any reaction with definite incident particle (γ-quantum, neutron, charged particle, …) and any combinations of outgoing particles for all nuclei contained in atomic nuclei mass table /4/.

References

1. I.N.Boboshin, V.V.Varlamov. The International Evaluated Nuclear Structure Data File (ENSDF) in Fundamental and Applied Photonuclear Research. INDC(CCP)- 297/GE, IAEA NDS, Vienna, Austria, 1989, pp. 1 - 8.
2. I.N.Boboshin, V.V.Varlamov. The New ENSDF Search System NESSY: IBM/PC Nuclear Spectroscopy Data Base. Nucl.Instr. and Meth., A369 (1996) 113.
3. D.P.Grechukhin, A.A.Soldatov. Conversion of low energy nuclear transitions ($\hbar\omega \leq 3$ keV) on external electronic shells of an isolated atom. Voprosy atomnoj nauki i tekhniki. Seriya: Yadernye Konstanty, 1 (1987) 55.
4. G.Audi, A.H.Wapstra. The 1995 Update to the Atomic Mass Evaluation. Nucl.Phys., A595 (1995) 409.
5. J.K.Tuli. Nuclear Wallet Cards (Sixth Edition), U.S.A. Brookhaven National Laboratory National Nuclear Data Center, January 2000.
6. I.N.Boboshin, B.S.Ishkhanov, V.V.Varlamov. Energy of the First $T_{>}$–Isospin Nuclear State New Formula. International Conference on Nuclear Data for Science and Technology. Embracing the Future at the Beginning of the 21st Century (October 7 - 12, 2001). Tsukuba, Japan, Abstracts, Japan Atomic Energy Research Institute, 2001, p. 2-P-2.
7. N.Stone. Table of New Nuclear Moments. 1997 Preprint (A revision of the Table of Nuclear Moments by P.Raghavan (Atomic Data Nuclear Data Tables 42, 189 (1989))).

Nuclear Structure and Decay Data Evaluations of the Georgia Tech Group U.S. Nuclear Data Program Meeting May 1-2, 2003

The program of horizontal systematics at Georgia Tech is most succinctly described as “mining the ENSDF Library for global nuclear structure features”. The Georgia Tech Nuclear Data Search Engine (GTNDSE) is a perl script which has been developed to assist in extracting data from a database of ENSDF-formatted A-chain data files for requested nuclear data.

In the first phase of testing GTNDSE, we undertook to extract all B(E2) values for all doubly-even nuclei from the database. The program delivered ∼3100 measured B(E2)’s and an additional ∼500 entries which included comments and calculated B(E2) limits. Two tab-delimited text files were output: one file which contained the measured B(E2) data and one which listed other records which contained the string “B(E2)”for line-by-line inspection of the database for comparison.

Version 1 of GTNDSE was limited by the available queries (extraction of B(EL) and B(ML) values or tabulation of adopted levels and gamma rays associated with a nuclide or with a beta decay parent) and by the fixed output format. Modifications to the code allow the user to select what data will be extracted from the database and to choose the format for the output.

The modified code will be tested by extracting B(M1) systematics and by searching for K-isomers. While the B(M1) compilation does not require any changes to the present GTNDSE code, it will serve to check that no data is lost by any changes. The K-isomer search will require a high level of flexibility for both the type of data queried and the output format in order to analyze the output.

Plans for the future include adapting GTNDSE to a common gateway interface (CGI) format in preparation for disseminating the code via the web. The current text interface requires familiarity with the code (i.e., it lacks a user-friendly interface) and the present text output requires additional effort to reorganize the data in a spreadsheet for further analysis. Documentation will include instructions for using GTNDSE and tabulations of the data extracted in testing the code.

REPORT

To IAEA Advisory Group Meeting on

NUCLEAR STRUCTURE AND DECAY DATA NETWORK

Russian Nuclear Structure and Reaction Data Center

November 2003

F.E.Chukreev

1. ENSDF Activity

Some objective and subjective reasons to force decrease our activity for new ENSDF mass chains. After our meeting-2000 only mass chain A=238 were completed in collaboration with M.J. Martin (ORNL). The mass chain has been published in NDS, 97,129 (2002).

Now we finished A=240. But some political and technical problems must be decided during to our Meeting.

2. Young Evaluators Problem.

According to my agreement with Moscow State University, one or two students will be learned for ENSDF activity. Probably, the students will be saved for CAJAD. I would like to remark, that the attract depends from financial support of domestic and international organizations.

3. Related Activity

The relational database ***"Low (ħω ≤ 3 KeV) Energy Isomer Transition Internal Conversion Probabilities"*** was produced in cooperation with CDFE (Moscow State University).

The database includes data from paper of D.P.Grechukhin, A.A.Soldatov. "Conversion of low energy nuclear transitions hω<=3 keV> on external electronic shells of an isolated atom." Voprosy atomnoj nauki i tekhniki. Seriya: Yadernye Konstanty, 1 (1987) 55

The probabilities of the conversion transitions were calculated in framework of the Hartree-Fock-Slater method with the electron wave functions, obtained by integrating numerically the Dirac equations in the atomic field. The calculations were carried out for the normal configuration of the valence bands of neutral atoms.

The database includes the results of calculations for transitions of 7 multipolarities (E1 - E4, M1 - M3) for 31 atomic shells (4p3/2 - 7d5/2) in 18 nuclei (90-Nb, 99-Tc, 103-Rh, 110-Ag, 140-,142Pr, 153-,159-Gd, 160-Tb, 165-Tm, 171-Lu, 173-W, 188-Re, 193-Pt, 201-Hg, 205-Pb, 236-Pa, 250-Bk).

The database will be added by similar data for isomeric state of 235-U.

During to previous Meeting I promised to disseminate the code system to analyze internal conversion experimental data. Sorry, but serious trouble on my computer forced me to prepare the codes again. I am ready to show the codes and disseminate its during to our Meeting in suitable time.

4.Dissimination ENSDF Data.

We recommend our users to use WEB site of CDFE (Moscow State University) for simple requests (see http://depni.npi.msu.su/cdfe/index.html). The decision was conditioned by very good defense of the site against virus attacks. But the site can not to satisfy all requests of our users. Time by time, we had the requests, which force use ENSDF as auxiliary data source only. For example, we had request about some details regarding to 31-year isomer of Hf-178. Similar problems request from our Center large volume of handwork.

National Nuclear Data Center Activity Report

October 1, 2003

This report reviews the evaluation of nuclear structure, decay data and related activities of the National Nuclear Data Center (NNDC) for the period October 2000 to October 2003. The name of the person with lead responsibility for each of the sections is underlined.

I. New Evaluations for ENSDF:

(T.W. Burrows, A.S. Sonzogni, J.K. Tuli)
Evaluations submitted for updating ENSDF:
In 2000: 69, 139, 141, 142, 144, 148
In 2001: ^{49}Mn, ^{50}Fe, ^{50}Co, 68, ^{94}Kr, ^{99}Tc, 143, p-emitters, 136
In 2002: 82, $^{132\text{-}134}$In, 138, ^{140}Xe, ^{140}Dy, ^{142}Ho, ^{145}Sm
In 2003: 60, ^{70}Ni, ^{78}Y, ^{78}Sr, ^{80}Y, ^{129}Ag, 134

II. Database Maintenance:
1. The Evaluated Nuclear Structure Data File (ENSDF):
(M.T. Blennau, P. Dixon, J.K. Tuli)

The ENSDF is continuously updated on the basis of new evaluations submitted; details of processing these are given in Section III.1. The current status of mass- chains for A > 20 is shown in Fig. 1. The ENSDF is distributed twice a year, generally in February and August. It is distributed in two forms, as a complete file as well as an update file in which only those data sets that have been modified since the last distribution are included. Users may also update their local databases easily by using the Web ENSDF access. Superdeformed bands and high-spin evaluations submitted by network evaluators have also been added to the ENSDF and are available to users via the online system and Web access. The evaluations of A≤20 published by the TUNL group in *Nuclear Physics A* were added to the ENSDF. Nuclear Wallet Cards and NuDat databases are also updated periodically to include additions to the ENSDF. NuDat is distributed along with ENSDF.

2. The Nuclear Science References (NSR):
(A. Sonzogni, J. Tallarine, J. Totans, D.F. Winchell)

Compilation of nuclear science articles has continued, with keywords being assigned when appropriate. All articles from *Physical Review C*, *Nuclear Physics A*, and *The European Physical Journal A* are assigned keynumbers and entered into the database. About 70 other journals are regularly scanned. Secondary source entries prepared by groups at RIKEN Data Center, Japan and Gatchina, Russia were received and merged into the database. One support staff member retired in 2002 and was replaced. Development of a relational version of NSR has continued. The relational database was ported to Sybase software on Linux. Beginning in early 2003, the hardcopy author keyword preparation package distributed by *Physical Review C* was discontinued and replaced by a Web page. During the summer of 2003, all administrative functions for NSR, including monthly distributions, were moved to the Linux/Sybase platform.

3. The Experimental Unevaluated Nuclear Data List (XUNDL):
(T. Burrows, B. Singh, D. F. Winchell)

The NNDC continues to maintain the XUNDL database. B.Singh (M^{c}Master University) provides regular updates consisting of compiled data from recent papers. The database currently contains over 1100 datasets for 795 nuclides. Additions and modifications to XUNDL are distributed to LBNL and ORNL on a regular basis.

III. Data Dissemination:
(T.W. Burrows, C.L. Dunford, R.R. Kinsey, V. McLane, D.F. Winchell)

The data available from the NNDC are disseminated in hard copy, magnetic media, CD-ROM, and through online access via Telnet, the Web, and anonymous FTP.

1. **Processing New Evaluations (Hard copy, Telnet, Web):**

New evaluations submitted to the NNDC are checked by the format and physics checking codes and errors are corrected. A hard copy of the evaluation is sent for review and for final checking by the editor. Academic Press publishes the final corrected evaluations in the Nuclear Data Sheets as its eleven issues per year. The twelfth issue is devoted to Recent References, which includes the yearly updates to the NSR. Academic Press is continuing to make available the contents of each NDS issue on the Web as Adobe Portable Document Format (PDF) files. Starting with *Nuclear Data Sheets* **98** (2), the NNDC is providing the PDF directly to Academic Press.

2. **Nuclear Wallet Cards (Hard copy, FTP, Web):**

The 2000 Edition of the Nuclear Wallet Cards was published with a literature cut-off date of July 31, 1999. The contents of the Wallet Cards have been available on the Web and FTP sites since September 1, 1995 and the Wallet Cards Module of NuDat is updated every six months coinciding with the ENSDF distribution. The US Department of Energy headquarters (Nuclear Materials Management and Safeguards System) has accepted the 2000 Edition of the Nuclear Wallet Cards as standard for half-life for all DOE inventory reporting.

3. **Online Data Services (FTP, Telnet, Web):**

The total number of retrievals in 2002 was 278,646 compared to 257,552 in 2001 and 225,902 in 2000 for an average yearly increase of 12%. NSR and NuDat are the two most popular systems with each contributing about 24 to 25% of the total retrievals in 2002. The Web continues to be the most popular method of accessing the NNDC systems with 94% of the retrievals in 2002 compared to 90% and 86% in 2001 and 2000, respectively.

Improvements and additions to the Online Services since the last NSDD meeting include the following:

a. FTP or Web:
    i. Proceedings of the "CSEWG Symposium: A CSEWG Retrospective" added. [Web]
    ii. History of the Origin of the Chemical Elements and Their Discoverers (N. E. Holden) added. [Web]
    iii. Table of Magnetic Dipole Rotational Bands (A. Jain, A. K. JAIN, and B. Singh) added. [Web]
    iv. Proton Radioactivity Resources added. [Web]
    v. Q-value Calculator added: Decay Q-values, reaction Q-values and threshold energies, and atomic masses, binding energies, *etc*. [Web]
    vi. Table of Superdeformed Nuclear Bands and Fission Isomers (B. Singh, R. Zywina, and R. B. Firestone) added. [Web]
    vii. Table of Nuclear Moments (N. Stone) updated. [Web]
    viii. Nuclear Reaction Model Codes site added. Current contents include: ABAREX, EMPIRE-II, and PRECO-2000. [FTP, Web]
    ix. EXFOR Basics manual added. [FTP, Web]
    x. ENDF Utility Codes reorganized and Linux and MS Windows versions added to distribution. [FTP, Web]
    xi. Linux versions added to ENSDF Analysis and Utility Codes distribution. [FTP, Web]
    xii. ENDF 102 and 201 manuals updated. [FTP, Web]
    xiii. ENSDF manual updated [FTP, Web]
    xiv. HTML tabular representation of ENSDF data improved. [Web]
    xv. Contributions to the ENSDF Evaluators' Training Workshop (April 2001) added to the ENSDF Evaluators' Corner. [Web]
    xvi. HTML forms and CGI-scripts for CINDA, ENDF, MIRD, and NuDat upgraded. [Web]
    xvii. Digital Object Identifier (DOI) information added for APS and Elsevier journals. NSR site using Sybase and Java Server Pages added (replaced site using MS SQL Server and Active Server Pages). [Web]
    xviii. CSISRS/EXFOR system improved to use ZVVIEW as a "helper" application. [Web]

b. Telnet: This service is in maintenance mode. In 2002, the Codes, Documents, and Libraries were removed from the Telnet service. CGI scripts were recently added to the Web allowing users access to files they had placed in the Telnet open area.

The NSR Link Manager described in the 1998 Center report to the NSDD is currently being used on pages at the NNDC, the Oak Ridge RadWare site, TUNL, the IAEA Nuclear Data Section and its Brazilian mirror, and others. The ENSDF Link Manager was not used in 2002, or in 2003 as of October 1, 2003.

The NNDC continues to host the USNDP site and is now hosting the CSEWG and NSDD sites. Since the 2000 NSDD meeting, Tom Burrows has visited the IAEA Nuclear Data Section once to consult on dissemination of nuclear data.

4. **Current Activities and Future Plans:**

The major effort is in converting the databases resident on the NNDC OpenVMS machine to Sybase relational databases on Linux or UNIX platforms and developing interfaces to the new databases using jsp (Java Server Pages) or Java servlets. These interfaces will have all the capabilities of the current Telnet and Web interfaces.

After the database conversions are completed and tested, the remaining portions of the NNDC Web site will be transferred. The NNDC will attempt to do this move in a manner that will be transparent to the users.

IV. User Services & Network Support:
(T.W. Burrows, M.T. Blennau, V. McLane, J. Totans)

The ENSDF analysis and checking codes continue to be maintained and improved; recent improvements made in them and their current status is given in a separate report accompanying this contribution. The NNDC provides many services to the international Nuclear Structure and Decay Data (NSDD) network evaluators and others on a routine basis. At present they are:

i. Monthly NSR updates are sent to evaluation centers for the A-chains assigned to them.
ii. Complete NSR and ENSDF retrievals are sent at the start of an evaluation to those who cannot access online the NSR or the ENSDF from the NNDC, or the NDS, IAEA; others do their own retrievals.
iii. Copies of hard-to-get references are sent to evaluators (with help from the NDP for older references).
iv. ENSDF updates are sent twice a year.
v. NSR updates are sent every month.
vi. The ENSDF analysis and utility codes are maintained; and corrections and updates are sent periodically
vii. Special retrievals are made from the NSR and the ENSDF. Requests for these specialized retrievals are satisfied on a case-by-case basis. Users are encouraged to take advantage of the full potential of the NNDC online system; only if their needs cannot be met by the system then their requests are processed in-house.
viii. ENSDF, NSR, and NuDat updates are sent to the IAEA Nuclear Data Section, the NEA Databank, the Obninsk Data Center, RFNC, Sarov and Slavutych, Ukraine on a regular basis.

V. Evaluation Workshop at Vienna.

J.K. Tuli and T.W. Burrows helped conduct an evaluators' workshop sponsored by the

IAEA in Vienna in November 2002. Ten scientists from eight countries attended the workshop.

VI. Publicity for Network Activities & User Outreach:

The following is a list of items done to publicize the network activities, and its products and services: Information on the products and services available from the NNDC and other members of the U.S. Nuclear Data Program (USNDP) is given on their Web homepages with cross-links amongst them.

Evaluation Processing Status
21-OCT-03

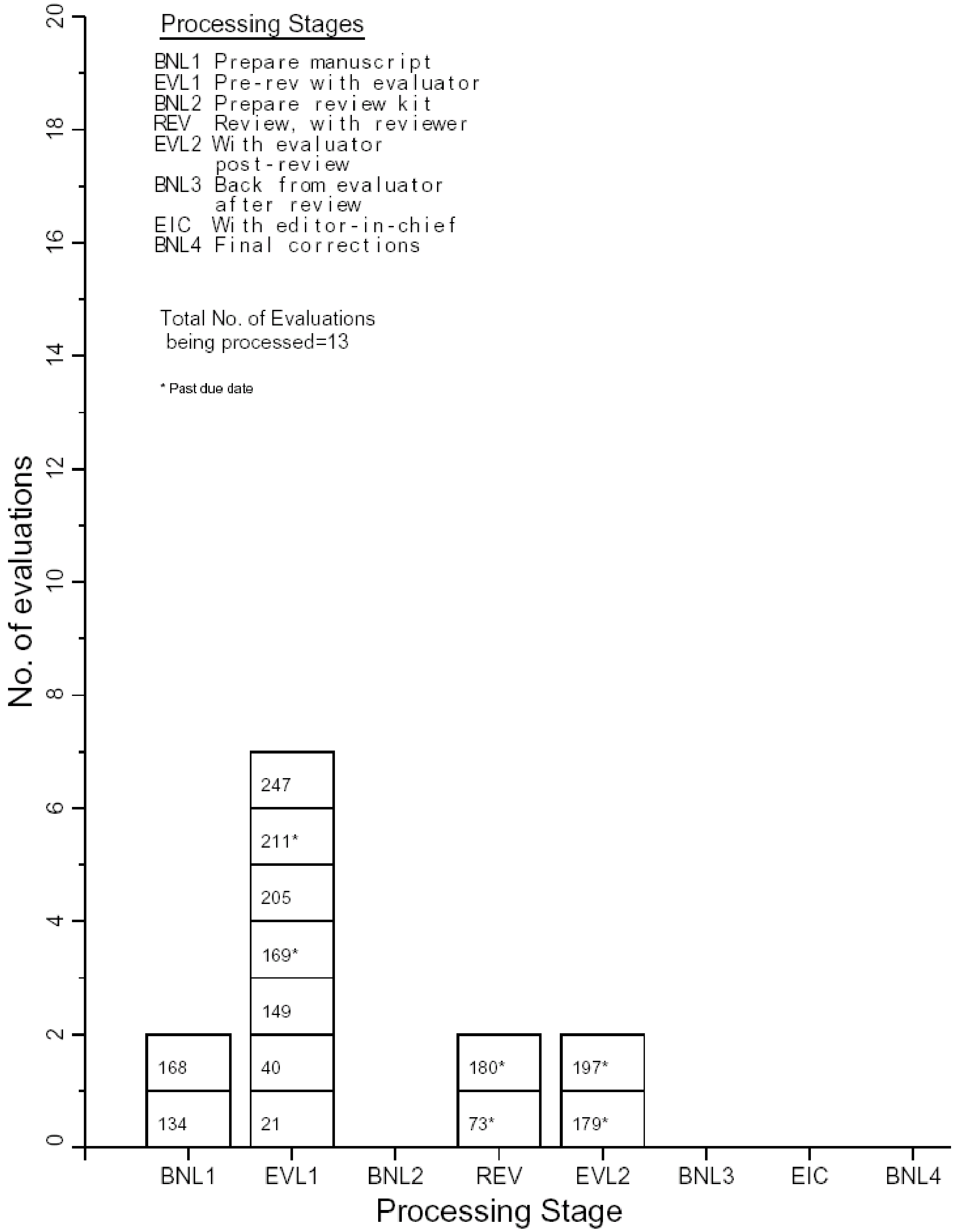


Figure 1

Status of ENSDF Analysis and Utility Codes

(October 24, 2000 to September 30, 2003)

Report Prepared for the 2003 Meeting of the IAEA-sponsored Nuclear Structure and Decay Data (NSDD) Network

---

Previous Status Reports

Nov. 10, 1998: Status report for the 1998 meeting of the IAEA-sponsored Nuclear Structure and Decay Data (NSDD) Network.
April 21, 1999: Status report for the 1999 USNDP Coordination Meeting
April 14, 2000: Status report for the 2000 USNDP Coordination Meeting
Oct. 24, 2000: Status report for the 2000 meeting of the IAEA-sponsored Nuclear Structure and Decay Data (NSDD) Network.
March 21, 2001: Status report for the 2001 USNDP Coordination Meeting
March 15, 2002: Status report for the 2002 USNDP Coordination Meeting
Sept. 30, 2003: Status report for the 2003 USNDP Annual Meeting

---

Current Status

A. With the exception of RadList all ANSI, Open-VMS, Linux, and MS Windows versions are current with those maintained in-house at the NNDC.
B. Linux versions of all the analysis and utility codes were added with the exception of RadList.
C. Code Revisions (See the relevant "Read Me's" for additional details):

COMTRANS
1. Modified to make more stable if multiple runs are made and other problems corrected.
2. Converted to FORTRAN 95 and Linux version added.
3. ISAM dictionary replaced by direct access dictionary

ENSDAT
1. Converted to FORTRAN 95.
2. ISAM dictionary replaced by direct access dictionary
3. ENSWIN version discontinued and replaced by option in ENSDAT which will invoke a PostScript viewer such as GhostView.

FMTCHK
1. Implemented check on new formalism of J, J1, *etc.* for JPI of level record.
2. Fixed erroneous report for IB+IE .NE. TI when uncetainties non-numeric
3. Added warning on missing RI if absolute normalization, EG<=400 keV, and no CC but TI given on G record.
4. Changed from <E> to <W> "TI field missing".
5. Allow non-unique forbidden UN for B and E records.
6. Corrected error on checking for duplicate DSID's when first DSID was shorter than second.
7. Added check for trailing "," if reference list was not closed by ")".
8. Added more checks on the N record for possible mistypes.
9. Corrected erroneous warning on A/B/E intensities when uncertainty was very small.
10. Corrected error in checking op code when followed by a "(".
11. Added check to see if value for "FL=" consistent with E(level)-Egamma.
12. Allow "E AP " for reaction DSID.

13. Add check for blank field preceding "$" on COMMENT record.
14. Added check for SUMOF or DELTA on Comment record not followed by " ".
15. Added various consistency checks between fields and continuation records for BETA and EC records.
16. Flag where first "{" occurs when unbalanced.
17. Added checks for possible duplicate "S E" records.
18. Added check for capture fractions to be <=1.
19. Allow "J GE" and "J LE" in J field.
20. Added checks for possible junk before first parentheses or square bracket and after last parentheses or square bracket in J field.
21. Added check for "/2" without preceding numeric character in J field.
22. IB and EAV check for BETA records not being initialized - Corrected.
23. For EL-EG message, changed to non-numeric format if E(level) had a "+X,...".

GTOL Corrected output overflows when adding new Comment record for DEG, *etc*.

HSICC
1. Added terminal warning if "2 G" record to be replaced has quantities not output by HSICC.
2. Missing leading blank on non-numerical DCC when placed on "S G" records - Fixed.

HSMRG
1. Increased tables to 2000 gammas.
2. Added check on "S G" records for quantities not output by HSICC.

PANDORA Increased the allowed decay modes

RULER
1. Fixed problem recognizing asymmetric DT's.
2. Fixed some logic problems in storing +DT and -DT.
3. Fixed Problems with approximate T1/2's when preceded by asymmetric DT's.
4. "2 G" records containing "BM1=",... confused program - Fixed and added note to report to check the record.

In Progress and Future Plans

A.

GAMUT:

The last working VMS version of GAMUT has been converted to MS Windows by Dr. Choi while on sabbatical leave from Seoul National University. Remaining work to be done before release is:

1. Extensive testing
2. Upgrade to current ENSDF formats and standards
3. Porting to Linux and OpenVMS

B.

GTOL:

The limits on levels and gammas stored will be increased to 500 and 2000, respectively.

C.

HSICC:

Work is in progress on converting the HSICC package to use the new Band, *et al.* Table of Internal Conversion Coefficients. The current status of this effort will be reported at the 2003 USNDP Meeting.

D.

LOGFT:

The logic from the LBNL program ft has been incorporated into LOGFT to calculate 3rd and higher order unique forbidden transitions. Extensive testing and comparison with the LBNL programs beta and ft still remains before release.

The program currently assumes that the theoretical values used in calculating the electron-capture fractions have no uncertainties, resulting in an underestimate of the electron-capture fractions uncertainty. This will be corrected using the data of Schönfeld.

E.

RadList:

The current in-house version of RadList is being converted to FORTRAN 95 and will be distributed in Linux, MS Windows, and OpenVMS versions.

Calculation of subshell conversion- and Auger-electron and X-ray intensities will be added and the calculation of continua spectra improved. Logic to properly calculate the beta spectra for 3rd and higher order unique forbidden transitions will be added after the new version of LOGFT is released.

Note: In calender year 2005, maintenance of OpenVMS versions will cease.

Tables

Analysis Codes							
			FORTRAN				
Code	Function	Version No./Date	ANS[a]	DVF[b]	VMS[c]	UNX[d]	Documentation
ALPHAD	Calculates α R_0's, HF's and theoretical $T_{1/2}(\alpha)$'s	1.6 20010207	X	X	X	X	No (See "Read Me" file)
DELTA	Analyzes angular correlation data.	1.01 19930415	X	X	X	X	LUNFD/(NFFR-3048) 1-27
GABS	Calculates absolute ΔIγ's.	9.2 20010207	X	X	X	X	Yes
GTOL	Determines level energies from a least-squares fit to Eγ's & feedings.	6.4a 20010611	X	X	X	X	BNL-NCS-23375/R LUNFD/(NFFR-3049) 1-27
HSICC	Interpolates internal conversion coefficients	11.13f 20011009	X	X	X	X	Nucl. Data **A4**, 1 Nucl. Data Tables **A6**, 235 Nucl. Data Tables **A9**, 119 BNL-NCS-23375/R (1977)
LOGFT	Calculates log *ft*.	7.2a 20010220	X	X	X	X	Nucl. Data Tables **A10**, 206 BNL-NCS-23375/R (1977)
NSDFLIB	Support subprograms for many codes	1.5d 19990628	X				Yes
PANDORA	Physics check of ENSDF data sets. Aids with adopted gammas & XREF.	6.6b 20010827	X	X	X	X	Yes
RadList	Calculates atomic & nuclear radiations. Checks energy balance.	5.5 19881005	X	X	X		BNL-NCS-52142
RULER	Calculates reduced transition probabilities.	1.31a 20020715	X	X	X	X	Yes

a ANSI-standard FORTRAN 77
b Compaq/Digital Visual Fortran (Win9x/ME/NT/2000/XP)
c OpenVMS Fortran
d Linux GNU f77 Fortran

Utility Codes							
Code	Function	Version No./Date	FORTRAN				Documentation
			ANS[a]	DVF[b]	VMS[c]	UNX[d]	
ADDGAM	Adds gammas to adopted data set.	1.4 20010207	X	X	X	X	No (See "Read Me" file)
COMTRANS	Converts the text comments of an ENSDF dataset to a "rich text format"	7.0 20030808		X [e]	X [e]	X [e,f]	No (See "Read Me" file)
ENSDAT	Produces tables and drawings	12.0 20030826		X [e]	X [e]	X [e,f]	No (See "Read Me" file)
FMTCHK	ENSDF format checking	9.0g 20030804	X	X	X	X	No (See "Read Me" file or "Read Me" in HTML)
NSDFLIB	Support subprograms for many codes	1.5d 19990628	X				Yes
TREND	Tabular display of ENSDF data.	8.3 20010207	X	X	X	X	No (See "Read Me" file)

a ANSI-standard FORTRAN 77
b Compaq/Digital Visual Fortran (Win9x/ME/NT/2000/XP)
c OpenVMS Fortran
d Linux GNU f77 Fortran, except as noted
e Only the executables are available
f Lahey Fortran 95

Thomas W. Burrows.
The latest version of this report is maintained at http://www.nndc.bnl.gov/nndcscr/ensdf_pgm/code_status.html.

Status Report of the Nuclear Data Project at McMaster University
(December 1, 2000 – October 15, 2003)

(Report prepared by B. Singh, October 15, 2003 for NSDD-2003)

Status of mass chains in ENSDF for which McMaster group has permanent responsibility:

A=31-40 (by P. Endt), Nucl. Phys. A521, 1 (1990); update A630, 1 (1998). (*)

A=41, NDS 94, 429-603 (2001).

A=42, NDS 92, 1-145 (2001).

A=43, NDS 92, 783-891 (2001).

A=44, NDS 88, 299-546 (1999).

A=64, NDS 78, 395-546 (1996).

A=89, NDS 85, 1-179 (1998)

A=98, NDS 98, 335-514 (2003).

A=100, NDS 81, 1-181 (1997).

A=149, NDS 73, 351-556 (1994). (*)

A=151, NDS 80, 263-565 (1997).

A=164, NDS 93, 243-445 (2001)

A=188, NDS 95, 387-541 (2002).

A=190, NDS, (In Press, 2003)

A=194, NDS 79, 277-446 (1996) (*)

(*): A=40 and 149 have been submitted; A=39 and 194 are currently being evaluated.

Mass-chain/Nuclide Evaluations published/submitted since December 2000:

A=149, B. Singh, NDS (Submitted September 2003).

A=40, J.A. Cameron and B. Singh, NDS (Submitted August 2003).

A=73, B. Singh, NDS (Submitted March 2003).

A=190, B. Singh, NDS 99, 275-481 (2003).

A=98, B. Singh and Z. Hu, NDS 98, 335-514 (2003).

Table of Superdeformed Nuclear Bands and Fission Isomers:
B. Singh, R. Zywina and R.B. Firestone, NDS 97, 241-592 (2002)

A=79, B. Singh , NDS 96, 1-176 (2002)

A=188, B. Singh, NDS 95, 387-541 (2002).

^{152}Dy, B. Singh, NDS 95, 995-1036 (2002)

^{199}Pb, B. Singh and G. Reed, NDS 94, 397-427 (2001)

A=41, J.A. Cameron and B. Singh, NDS 94, 429-546 (2001).

A=86, B. Singh, NDS 94, 1-130 (2001).

^{99}Tc, J.K. Tuli, G. Reed and B. Singh, NDS 93, 1-32 (2001)

A=130, B. Singh, NDS 93, 33-242 (2001).

^{143}Tb, B. Singh, NDS 92, 429-442 (2001)

^{143}Dy, B. Singh, NDS 92, 443-454 (2001)

A=62, Huo Junde and B. Singh, NDS 91, 317-422 (2001).

A=42, B. Singh and J.A. Cameron, NDS 92, 1-146 (2001)

A=164, B. Singh, NDS 93, 243-445 (2001).

A=43, J.A. Cameron and B. Singh, NDS 92, 783-891 (2001)
.

.
Nuclide updates (Dec. 1, 2000-October 15, 2003) by B. Singh**:**

The following 22 nuclides were evaluated and included in ENSDF:

^{58}Cu, ^{60}Zn, ^{60}Ga, ^{94}Ag, ^{94}Pd, ^{125}Nd, ^{125,126,132}Pr, ^{133}Sm, ^{135}In, ^{135}Sn, ^{135}Sb, ^{136}Nd, ^{137}Sn, ^{143}Ho, ^{145,149}Gd, ^{163}Lu, ^{168}Hf, ^{199}Ir, ^{199}Fr.

Superdeformed structures (Dec. 1, 2000-Oct. 15, 2003)**:** by B. Singh,

Complete updates of all SD band data published between Dec. 2000-Oct. 2003 for the following 38 nuclides were included in ENSDF on a timely basis.

^{36}Ar, ^{40}Ca, ^{58}Ni, ^{59}Cu, ^{68}Ge, $^{80-83}$Sr, $^{82-84}$Y, ^{83,84}Zr, ^{88}Mo, ^{89,91}Tc, ^{108}Cd, ^{133}Nd, ^{143}Eu, ^{146}Gd, ^{152}Dy, ^{154}Er, ^{161,162,165,167}Lu, ^{170,174}Hf, ^{191,192,194}Hg, $^{192,193,196-198}$Pb, ^{240}Pu.

As of October 15, 2003, the ENSDF database is current on the coverage of all published and known SD structures in nuclei.

In addition the 1996 edition of the Table of Superdeformed Nuclear Bands and Fission Isomers was updated to include all data published since 1996. New computer codes were written to generate tables, band drawings, moment of inertia plots, etc., since the programs used to generate the 1996 edition were no longer available. Since complete structure data are provided for the nuclides included in this Table, normal-deformed data for a large number of nuclides were also updated for newer publications since the last NDS evaluations. The 2002 update of this table appeared in print in October 2002 issue of NDS, as well as available on website. A 2003 electronic update of SD Band structures has been completed and will soon be made available on McMaster/BNL websites.

Review work (Dec. 1, 2000-Oct. 15, 2003) by B. Singh:

A=126, A=189, A=198 (partial).

Revision of rules for JPI, bands and multipolarity assignments:

Initiated by the McMaster group at the 1998 NSDD meeting, the group actively participated during 1999-2001 in the discussion and formulation of revised rules for band and spin-parity assignments. A document detailing revisions and updating of the previous rules finally appeared in print in the January 2001 issue of NDS.

Compilation of data from recent publications (for XUNDL):

Initiated by the McMaster group in January 1999, the XUNDL project has been continuing. Details of this project can be found in the XUNDL report.

From Dec. 1, 2000 to Oct. 15, 2003, about 515 compiled new datasets and about 65 updated datasets from about 450 recent (mainly 2000-onwards) publications have been prepared at McMaster and included in XUNDL database. A few datasets prepared at other data centers were reviewed and edited at McMaster, prior to their inclusion in XUNDL.

A new code to translate tabular TEXT files to ENSDF format has been written and tested. This code has many additional features than the one used for compilation procedures until the middle of 2002. Currently, the new code is routinely used for compilation of datasets for XUNDL.

There is evidence that the compiled datasets in XUNDL database are being used by mass-chain evaluators, which possibly speeds up the evaluations.

Work in progress (as of October 15, 2003)

A=39, 80, 194. (Full mass-chain updates).

A=74: Full mass-chain update in collaboration with the data group in Kuwait. All nuclides, except ^{74}Se and ^{74}As, have been submitted To BNL for inclusion in ENSDF.

Superdeformed Bands: Continuous update of SD band data for all nuclides from current publication.

Compilation of recent data for XUNDL: Continued work on compilation of, primarily, high-spin data in ENSDF format from current publications. Selected low-spin (current) papers will also be compiled.

Collaborative work as a part of training of new ENSDF evaluators:

A=132: Work is in progress in collaboration with the new team of evaluators (Yuri Khazov, Alexandr Rodionov, Sergei Sakharov and Ivan Mitropolsky) at Petersburg Nuclear Physics Institute in Gatchina, Russia. The data files and comments are regularly exchanged through e-mail between the two centers. Ten nuclides of this mass chain have already been completed. We hope to submit this A chain to BNL before the end of this year.

A=165: Work has recently started in collaboration with the new team of evaluators (Ashok Jain and S.S. Malik) at the Department of Physics, Indian Institute of Technology, Roorkee, India. The work on this A chain is expected to proceed more actively after Drs. Jain and Malik have attended IAEA's Trieste workshop in November 2003. We have also extended invitation to one of the scientists to visit McMaster for 2-3 weeks (local expenses to be covered by McMaster data group) after some work on A=165 has been accomplished.

Other (data related) activities since the NSDD-2000 meeting:

Magnetic-dipole rotational (MR) bands:

Proposed and guided by the McMaster group, compilation of magnetic-dipole rotational structures is continuing in collaboration with a Nuclear Theory research group at IIT, Roorkee, India. The first compilation of such structures, covering all published data up to 1999, was published by Amita, A.K. Jain and B. Singh in Atomic Data and Nuclear Data Tables 74, 283-331 (2000). A two-year update covering all data published up to 2001 was placed on NNDC website. An update of this work covering all published data on such structures up to October 2003 is near completion and it is expected to be submitted to the Atomic Data and Nuclear Data Tables by the end of this year.

3-quasiparticle structures in deformed region:

The use of large gamma-ray detector arrays during the past few years has revealed a large number of new 3-quasiparticle structures and high-spin bands. The above mentioned theory group in India have done calculations using Tilted-Axis-Cranking (TAC) model in the deformed region to explain properties of such structures. As a collaborative effort between McMaster data group and the theory group in Roorkee, India, a compilation of all the known 3-quasiparticle structures in the deformed region has been prepared. It is expected to be submitted to the Atomic Data and Nuclear Data Tables early in 2004.

Network co-ordination:

McMaster was to host the US-NDP meeting from May 1-2, 2003 and IAEA-NSDD meeting from May 5-9, 2003. All the necessary arrangements, administrative matters, and website for NSDD-2003 were handled by the data group at McMaster. Unfortunately, both meetings got cancelled just one week prior to the scheduled dates due to SARS situation in Toronto area. The website for the November meeting of NSDD-2003 is still being maintained by McMaster for posting updated reports and other revisions.

Financial Support: One FTE for evaluation + partial support for summer undergraduate students (NSERC, Canada + DOE, USA)

Personnel: Jim C. Waddington (Professor, Head of the Project),
John A. Cameron (Emeritus Professor),
Balraj Singh (Research Scientist Nuclear Data Evaluator),
Roy Zywina and Michelle Lee (Undergraduate Students).

XUNDL Status Report (Dec. 1, 2000- Oct. 15, 2003)

B. Singh (McMaster), D.F. Winchell (BNL), T.W. Burrows (BNL)
(October 15, 2003 for NSDD-2003)

XUNDL database:

Provides prompt internet access to recently published or completed (fully analyzed but not published) primarily high-spin level-scheme data that are not yet available in ENSDF database. (The database is not limited to high-spin papers, currently many low-spin papers are also being compiled.)

Convenient access to different viewers (LBNL's Isotope explorer, Oak Ridge's RADWARE, BNL's on-line retrieval) and, to the published article on journal webpage (if the user has valid internet access to the journal). Database is indexed by mass number, nuclide and reference keynumber.

The entry of datasets in XUNDL database is co-ordinated by B. Singh at McMaster, while the database is organized and managed by David Winchell and Tom Burrows at NNDC, BNL.

STATUS:

Since January 1999, about 1100 datasets have been added to XUNDL, mostly from papers published in 1995-2003. About 515 datasets were added since the 2000 NSDD meeting.

(Almost all the high-spin papers published from1998-2003; and about 50% of the high-spin papers published from 1995-97 are included.
2003: 101; 2002: 141; 2001: 134; 2000: 141; 1999: 115;
1998: 124; 1997: 60; 1996: 66; 1995: 50; 1994-1990: 48.)

About 90% of the datasets were compiled at McMaster, using semi-automated translation procedures. About 10% datasets were received by McMaster group from other data centers (mainly from Berkeley and Grenoble). These datasets were reviewed and edited at McMaster, prior to inclusion in XUNDL.

Presently XUNDL has about 1100 datasets from about 980 papers covering data for about 800 nuclides from ^{21}Ne to ^{254}No, amongst 204 A-chains (A=21 to 254).
(~95% content is high-spin level schemes.)

We are almost up-to-date (as of October 15, 2003) with the coverage of high-spin papers for XUNDL. Only about eight papers remain to be included, which are being worked on at present.

A lot of actual compilation work is done by undergraduate summer students (Jordan Chenkin: May 1999-April 2000; George Reed: May 2000-August 2001; Roy Zywina: June 2001-present; Michelle Lee: February 2002-present). The students are trained in basic nuclear physics, ENSDF formats, semi-automatic translation codes, consistency checking codes such as FMTCHK and GTOL, calculation codes such as HSICC and LOGFT for decay datasets. The students' work is checked thoroughly by data evaluator before submitting a dataset to BNL. Generally, one or two undergraduate students work full time during the summer months (May to August) and part-time (few hours/month) during the study semesters.

We frequently communicate with the authors of original papers to resolve data-related errors and inconsistencies, and to request additional details of data, which are often lacking in publications due to space limitations or other reasons. The response from the original authors is generally prompt. A compilation of about 100 e-mail communications containing additional information or clarification and data received from the original authors (between 1999-2003) has been sent to BNL (for archival purposes) as a composite computer file as well as in print version. These private communications have not been assigned NSR keynumbers. The A-chain evaluators or other users can request copies of these communications and request BNL to assign keynumbers, if deemed necessary.

Data errors found in original published level schemes, based on level-scheme checking codes, are routinely communicated to the original authors for corrections or comments. Most common type of data errors found in the publications are: 1. Quoted gamma-ray

energies do not match the level-energy differences. 2. Spins and parities quoted in tables different from those in figures.
3. Angular distribution/correlation coefficients inconsistent with assigned multipolarities.

When we run out of current papers to compile, we compile high-spin papers for A-chains which are quite outdated in ENSDF. During the last two years we have compiled high-spin data for about 5 mass chains, which were more than 10 years old in ENSDF. Since January 2002, we have started to compile low-spin papers also which have significant new data. The codes HSICC and LOGFT are utilized for decay datasets in this category.

As we understand, the compiled datasets in XUNDL are being used by mass-chain evaluators, which probably speeds up the evaluation process for ENSDF. The current retrieval rate, as monitored by NNDC, is about 400/month from the NNDC website alone. There are probably other retrievals made through RADWARE and LBNL websites.

Semi-automated Procedures to Translate Tabular data in journals into ENSDF format:

- **Step 1: Create tabular text file of data from tables in journal web pages using a commercial software FINEREADER . Communicate with original authors if data tables or details are not given in the published papers**.

- **Step 2: Edit the tabular text file created in step 1, using a text editor**.

  Use **TXT2ENS** (PC) code written at McMaster to convert tabular text files in step 2 to ENSDF format.

- **Step 3: Check the ENSDF formatted dataset for level-scheme consistency and possible data-related problems in publications. This involves**

use of FMTCHK and GTOL codes. For decay datasets use HSICC and LOGFT codes, as needed. Commercial software TEXTPAD is used to edit ENSDF-formatted files.

Communicate with original authors if there are data related-problems or inconsistencies in a paper.

- **Step 4: Check the final ENSDF formatted dataset for correct transcription of data from papers. LBNL's viewer 'Isotope Explorer' is used to verify that the level scheme and the band assignments, correctly, match the publication.**

Oak Ridge National Laboratory
Nuclear Data Project
Nuclear Structure and Decay Data
Evaluation Activity Report

October 2000 - October 2003

Activities at the Nuclear Data Project (NDP) at Oak Ridge National Laboratory (ORNL) include: the evaluation of nuclear structure and decay data information needed for nuclear structure and nuclear astrophysics studies; the compilation, evaluation, and dissemination of nuclear reaction information relevant for nuclear astrophysics studies; the development of a computational infrastructure to facilitate the incorporation of nuclear data into astrophysical models; and the development and maintenance of computational tools expanding the utility of the ENSDF and XUNDL nuclear structure databases.

This report focuses on the nuclear structure and decay data evaluation activities of the ORNL Nuclear Data Project since the IAEA Advisory Group meeting in 2000 of the International Network of Nuclear Structure and Decay Data Evaluators. Future plans for nuclear structure and decay data evaluations are also included, as well as a very brief description of some of our related nuclear data efforts.

Nuclear Structure and Decay Evaluations of Mass Chains - Y. A. Akovali

The ORNL NDP has responsibility for the evaluation of 46 A-chains, all above mass 200. In the last three years, eight A-chains have been completed and published, and one additional A-chain has been completed and submitted for review. Additionally, two A-chains have been reviewed and one evaluation is in progress.

Published evaluations:

Evaluations of nuclear structure data pertaining to all nuclei with mass numbers 254, 258, 262, 266, 242, and 238 were completed, and adopted data, levels, spin, parity and configuration assignments are presented in the following publications:

A=254, 258, 262 and 266: Y. A. Akovali, Nucl. Data Sheets 94, 131 (2001)
A=242: Y. A. Akovali, Nucl. Data Sheets 96, 177 (2002)
A=238: F. E. Chukreev, V. E. Makarenko, M. J. Martin, Nucl. Data Sheets 97, 129 (2002)
A= 244: Y. A. Akovali, Nucl. Data Sheets 98, 1009 (2003)
A= 217: Y. A. Akovali, Nucl. Data Sheets 100, 141 (2003)

Submitted evaluation:
A=247: Y. A. Akovali; evaluations are completed and submitted. These evaluations have not been reviewed.

Evaluations in progress:
A=243: Evaluations of A=243 nuclei have been started. It is estimated that they will be finalized in Spring 2004.

Reviewed evaluations:
A=235, 239: these two A-chain evaluations were reviewed.

Plans for future evaluations:
Evaluations of nuclear structure and decay data for A=241 and 237 nuclei are planned to be started after the evaluations of A=243 nuclei are submitted for publication. A=241 and A=237 evaluations are expected to be completed in 2004.

Nuclear Structure Evaluations Relevant for Astrophysics – M. S. Smith, J. C. Blackmon, Z. Ma, N. Shu

Some important nuclear reactions that occur in stars can be directly measured in the laboratory. For others, an indirect technique is utilized whereby stellar thermonuclear reaction rates are determined from laboratory measurements and theoretical estimates of the masses, lifetimes, and excited state properties (spin, parity, total and partial decay widths, energy, spectroscopic factors) of the interacting nuclei. For the latter studies, an evaluation of the available, relevant structure information on the interacting nuclei is very important. The ORNL NDP is currently involved in evaluating the relevant properties of a number of nuclei involved in reactions occurring in stellar explosions. Each of these projects is closely coupled to recent or planned measurements at ORNL's Holifield Radioactive Ion Beam Facility.

^{19}Ne levels for the ^{18}F(p,□)^{15}O and ^{18}F(p,□)^{19}Ne Reactions: N. Shu et al.
The properties of 19 levels in the ^{19}Ne nucleus above the ^{18}F + p threshold are being evaluated to determine new ^{18}F + p reaction rates in nova explosions and X-ray bursts. One Ph.D. Thesis [N. Shu, Chinese Institute of Atomic Energy] and one paper [N. Shu et al., Chin. Phys. Lett. **20** (2003) 1470] have been written, and a longer paper is in preparation for Phys. Rev. C.

^{18}Ne levels for the ^{14}O(□,p)^{17}F Reaction: J.C. Blackmon et al.
The properties of six levels in the ^{18}Ne nucleus above the ^{14}O + □ and ^{17}F + p thresholds are being evaluated to determine a new reaction rate in nova explosions and X-ray bursts. One short paper has been published [J.C. Blackmon et al., Nucl. Phys. **A718** (2003) 127] and a longer paper of our results is in preparation.

^{31}S levels for the $^{30}P(p,\gamma)^{31}S$ Reaction: Z. Ma et al.

The properties of ten levels in the ^{31}S nucleus above the ^{30}P + p threshold are being evaluated to determine a new reaction rate in nova explosions.

$^{34,35}Ar$ levels for the $^{33,34}Cl(p,\gamma)^{34,35}Ar$ Reactions: Z. Ma et al.

The properties of eight levels in the ^{34}Ar nucleus above the ^{33}Cl + p threshold, and seven levels in the ^{35}Ar nucleus above the ^{34}Cl + p threshold, are being evaluated to determine new reaction rates in nova explosions and X-ray bursts.

Related Nuclear Data Activities –
M. S. Smith, K. Chae, E. Lingerfelt, R. A. Meyer, D. Radford, J. P. Scott

A suite of programs is being developed to facilitate the incorporation of nuclear physics information into astrophysical models. This computational infrastructure will take nuclear structure and reaction information – the products of evaluation activities - as input and, with a point-and-click interface, generate thermonuclear reaction rates in formats readily inserted into libraries used by astrophysics modelers. It will be accessible through the **www.nucastrodata.org** site which links together the datasets relevant for nuclear astrophysics studies.

An FTP site **radware.phy.ornl.gov** and a suite of programs have been developed to facilitate nuclear structure data analyses and evaluations. This effort provides a modern and efficient user access – via the RADWARE program - to the ENSDF and XUNDL data libraries. Users can rapidly combine their own measured gamma-ray energies with those in the libraries to generate dynamic level schemes with publication-quality output options. The semi-automatic conversion of journal articles and other data sources into ENSDF-format databases is also featured on this site, as well as a utility to search the databases for coincident gamma rays. These programs and the databases are continuously developed and maintained.

Finally, the **Mentoring in Nuclear Information Technology (MINIT) Program** has been developed and proposed as a mechanism to rebuild and revitalize the evaluation capabilities of the US Nuclear Data Program. The goal is to reverse the current shrinking and aging manpower pool involved in nuclear data evaluations. MINIT may also have features that may provide useful to other international evaluation centers as they address their manpower issues.

Report of the Recently ENSDF Activities in CNDC

Huang Xiaolong Zhou Chunmei Wu Zhendong
China Nuclear Data Center China Institute of Atomic Energy
P.O.Box 275 (41), Beijing 102413, China

1. ENSDF Members

The present ENSDF members of China Nuclear Data Center(CNDC) for the evaluation of Nuclear Structure and Decay Data(NSDD) are: Huang Xiaolong, Wu Zhendong and Zhou Chunmei. All of them are part-time evaluators. Now Prof. Zhou Chunmei is retired and he can participate some parts of the evaluations.

2. ENSDF Activities

The nuclear structure and decay data evaluation in China Nuclear Data Center has permanent responsibility for evaluating and updating NSDD for A=51,195-198; temporary for A= 61 and 170. The status is as follows:

Updated-A	Status	Evaluators
51	NDS,81,183(1997)	Zhou Chunmei
	NDS,62,229(1994)	Zhou Chunmei
	NDS,48,111(1986)	Zhou Chunmei, Zhou Enchen, et al.
195	NDS,86,645(1999)	Zhou Chunmei
	NDS,71,367(1994)	Zhou Chunmei
	NDS,57,1(1989)	Zhou Chunmei
196	Being updated	Wu Zhendong, Zhou Chunmei
	NDS,83,145(1998)	Zhou Chunmei, Wang Gongqing, et al.
	NDS,76,1(1995)	Wang Gongqing ,et al.
197	Submit	Huang Xiaolong, Zhou Chunmei
	NDS,76,399(1995)	Zhou Chunmei
	NDS,62,433(1991)	Zhou Chunmei
198	NDS,95,59 (2002)	Zhou Chunmei
	NDS,74,259(1995)	Zhou Chunmei
	NDS,60,527(1990)	Zhou Chunmei
61	NDS,67,271(1992)	Zhou Chunmei
170	NDS,50,351(1987)	Zhou Chunmei

3. Other Related Activities- WWW Chart of The Nuclides

The cooperation in the field of chart of the nuclides between China and Russia has been starting since 1995. Up to now we have compiled and recommended lots of nuclear data. On the basis of these researches, we prepared WWW chart of the nuclides.

By viewing WWW chart of the nuclides, one can retrieve the fundamental data of nuclide such as atomic mass, abundance, spin and parity; the decay mode, branching ratio, half-life and Q-value of radioactive nuclide, energy and intensity of strong γ-ray, etc. The URL of WWW chart of the nuclides is: http://rsh.nst.pku.edu.cn/nuclide.

Status Report of the Nuclear Structure and Decay Data Evaluation for Mass Chain at Jilin University

Junde Huo
Physics School, Jilin University
Changchun 130023, China

1. Mass Chain Evaluation

(1) We have evaluated A-mass chain as follows:

A=52	NDS,	90, 1, 2000	
A=53	NDS,	87, 517, 1999	
A=54	NDS,	68, 687, 1993,	ENSDF has been updated to date Jun. 2001
A=55	NDS,	64, 723, 1991,	ENSDF has been updated to date Jun. 2001
A=56	NDS,	86, 315, 1999	
A=62	NDS,	91, 317, 2000	(Joint with B. Singh)
A=63	NDS,	92, 147, 2000	
A=174	NDS,	87, 15, 2000	(Joint with E. Browne)
A=176	NDS,	84, 337, 2000	(Joint with E. Browne)

(2) JLU is responsible for data evaluation in mass chain range A=52 – 56, 62, and 63.

A=55 is being evaluated now.

2. High-Spin Data Evaluation

We are evaluating high-spin data and composed of Nuclear Superdeformation Data Table in association with Profs. X-L. Han and C-L. Wu, Physics Department, Chung Yuan Christian University, Taiwan.

IAEA Nuclear Data Section: Status Report, May 2003

A.L. Nichols, V.G. Pronyaev

Nuclear Data Section, IAEA,
Vienna, Austria

A brief summary is given below of the dissemination of Nuclear Structure and Decay Data (NSDD) by the IAEA Nuclear Data Section (NDS) for the period from October 2000 to April 2003.

1. On-line NSDD user service

NDS mirrors the Telnet/NDIS and Web services developed by the National Nuclear Data Center, BNL, for on-line data retrievals of regularly updated data from NSR and ENSDF. Statistics for Web retrievals are shown in the table, while a geographical distribution of such retrievals from the nuclear structure and nuclear reaction databases is shown in the figure (10% of which represents retrievals from the Brazilian server - Latin America mirror of the NDS server).

	NSR	Nuclear Wallet Cards	ENSDF	NUDAT	MIRD	All
Web Accesses, Oct 1998-Sept 2000	-	6700	30	5800	1100	13630
Web Accesses, Oct 2000-April 2003	1400	14200	2500	13000	6900	38000

NDS is also participating in the migration of the various international nuclear databases to a multi-platform environment; our area of responsibility involves the nuclear reaction databases (CINDA, EXFOR and ENDF). Experience has been accumulated in the use of Web, local network and CD-ROM for retrievals based on platform-independent Java/RDB technology.

2. Off-line NSDD user service

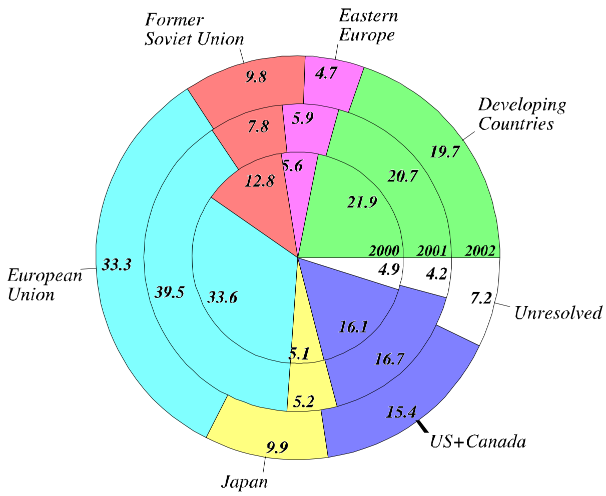
Over the previous two years, NDS has continued the distribution of the Nuclide Wall Charts (i.e., Knolls, Karlsruhe, JAERI), Nuclear Wallet Cards (Sixth edition) by J. Tuli, and PC NUDAT on CD-ROM by R. Kinsey with an updated database.

3. NSDD development programmes and projects

Development programmes and projects identified clearly with the NSDD include the IAEA and ICTP Workshops for NSDD evaluators, provision of individual IAEA Research Contracts in support of ENSDF evaluations, and a Co-ordinated Research Programme for "Update of X- and Gamma-ray Decay Data Standards for Detector Calibration and Other Applications" (latter is close to completion). These work packages are described in other reports to this meeting.

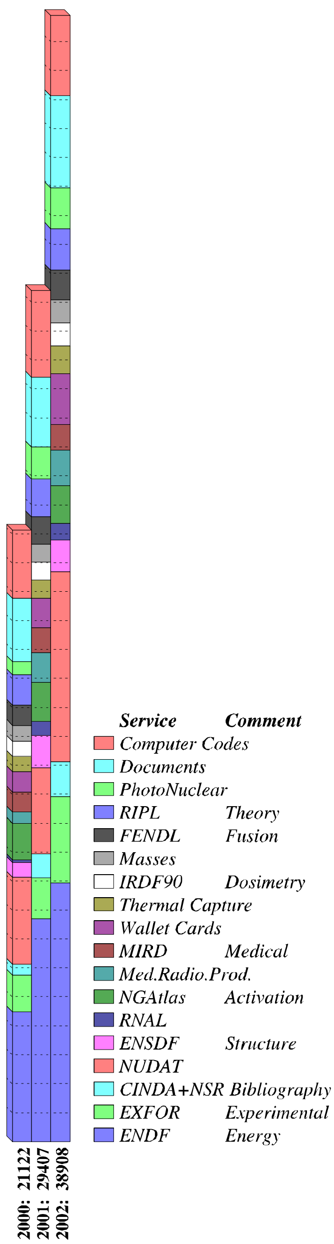
IAEA+IPEN Nuclear Data Services: Web Statistics

Geographical Distribution (%)



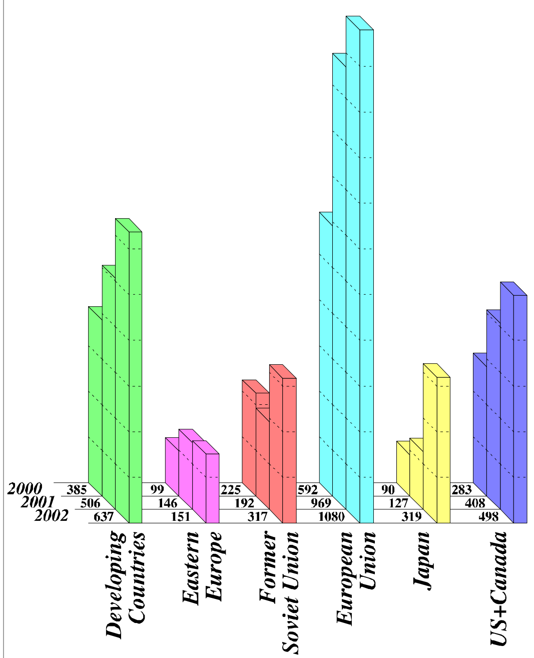
Total per Year

(Number of accesses+retrievals)



Average per Month

(Number of accesses+retrievals)



IAEA, Vienna, 7 January 2003

ACTIVITIES OF DATA CENTER
OF PETERSBURG NUCLEAR PHYSICS INSTITUTE
2001-2003

(November 6, 2003)

General

Our Data Center has 4 physicists, 1 mathematician, 3 programmers and 1 post-graduated student. The group is provided with the necessary facilities and is an integral part of the Institute.

Contribution to NSR Database

Data Center continues to scan and document Russian publications in nuclear physics in the NSR format. These include the programs and theses reports presented at the Annual Conferences in Russia on Nuclear Spectroscopy and Structure of Atomic Nuclei, preprints of Joint Institute for Nuclear Research (JINR, Dubna) and Petersburg Nuclear Physics Institute (PNPI, Gatchina). This activity can be extended, if the Center receives publications from other Russian institutes.

Evaluation for the ENSDF

Dr. S. Sakharov reviewed the evaluation of A=242. It was published in 2002.

Our Data Center has responsibility for nuclei with mass numbers from 130 to 135. Together with Dr. B. Singh (McMaster University, Canada) we have practically completed the evaluations of A=132 chain. We have started to work on A=131 and A=133 chains. We plan to finish the A=131 evaluations in the first half of the next year and the A=133 by the end of the year 2004. At the same time we shall try to work on A=135 chain.

The evaluation of A=130 was published in 2001 (B. Singh), and A=134 is in pre-review (A. Sonzogni).

Systematics and horizontal evaluations

We constructed the database of rotational bands in odd-A nuclei on the basis of ENSDF. The energies of rotational states were described with the ‘variable moment of inertia’ model. The results are published as Atlas of rotational bands in 2003 (in Russian). We are trying to systematize decay properties of rotational states in the database, starting first with their lifetimes.

Now we have two new databases of rotational bands in odd-odd and even- even nuclei.

We constructed the database of monopole (0+) states of even-even nuclei extracted from ENSDF. It is very useful for study of these interesting nuclear states. Model descriptions of the monopole states and their systematics are in progress.

Useful codes

In the evaluation process, a code designed for the level scheme construction based on the Ritz combination principle can be used. The code calculates all sums and differences of level energies and transition energies, and estimates probabilities of their chance coincidences.

At the Data Center the code of modeling neutron irradiation of the samples (I. Kondurov) was constructed. The code takes into account the processes of neutron capture and beta-decay. Recently the code was improved and extended to the nuclear fission process.

Finally we have a code comparable to GTOL, which calculates ‘chi-square’ fit for the total level scheme, in addition to usual functions of the GTOL code. These parameters are essential for the evaluation.

Ivan MITROPOLSKY
Head of the Data Center
of Petersburg Nuclear Physics Institute

Annex 6. Status Reports: Projects and Other Activities.

1. Progress Report: IAEA Nuclear Data Section – Horizontal Evaluations, 2001/02
A.L. Nichols, Nuclear Data Section, IAEA, Austria.

2. Decay Data Horizontal Evaluations and Related Activities of the Radionuclide Data Center
(2000 – 2003 Progress Report)
V.P. Chechev, Radionuclide Data Center, Khlopin Radium Institute, Russia.

3. NUBASE
G. Audi[a], O. Bersillon[b], J. Blachot[b], A.H. Wapstra[c]
[a]CSNSM, Orsay Campus, France
[b]SPN, CEA, Bryueres-le-Chatel, France
[c]NIKHEF, Amsterdam, The Netherlands.

4. Contrinution to JEF3
O. Bersillon, J. Blachot, SPN, CEA, Bryueres-le-Chatel, France.

5. Table of Nuclear Magnetic Dipole and Electric Quadrupole Moments
N.J. Stone, Oxford University, UK.

6. Decay Data Evaluation Project
Edgardo Browne, LBNL, Berkley, USA.

7. Nuclear Structure and Decay Data Evaluations of the Georgia Tech Group.

8. GTNDSE: the GA Tech nuclear Data Search Engine
W.D. Kulp, J.L. Wood, Georgia Institute of Technology, USA.

9. Implementation of Band-Raman Internal Conversion Coefficients (BRICC)
Thomas W. Burrows, NNDC, BNL, USA.

10. Dissemination of ENSDF, Publications, and Services
Thomas W. Burrows, NNDC, BNL, USA.

11. Status of ENSDF Analysis and Utility Codes
Thomas W. Burrows, NNDC, BNL, USA.

12. ENSDF Analysis and Utility Codes Overview
Thomas W. Burrows, NNDC, BNL, USA.

13. NNDC Database Migration Project
Thomas W. Burrows, Charles L. Dunford, NNDC, BNL, USA.

14. NSR Modifications
NNDC, BNL, USA.

15. IAEA Coordinated Research Project: “Development of Database for Prompt Gamma-ray Neutron activation Analysis”
R. Firestone, Isotopes Project, LBNL, USA.

Progress Report: IAEA Nuclear Data Section – Horizontal Evaluations, 2001/02

A.L. Nichols,
IAEA Nuclear Data Section,
Department of Nuclear Sciences and Applications,
PO Box 100,
Wagramerstrasse 5,
A-1400 Vienna,
Austria.

Work Programme

Evaluations completed in 2001/02 for DDEP and IAEA Co-ordinated Research Project on Update of X-ray and Gamma-ray Decay Data Standards for Detector Calibration and Other Applications: ^{56}Mn, ^{203}Hg, ^{228}Th decay chain, and ^{234m}Pa. Data files are in preparation.

^{56}Mn

A consistent decay scheme has been constructed from the gamma-ray measurements of 1967Au01, 1968Sh07, 1973Ar15, 1974Ti01 and 1974Ho25. Beta-particle emission probabilities were calculated from the recommended gamma-ray emission probabilities and the theoretical internal conversion coefficients of 1976Ba63 (latter estimated by interpolation of data). Log *ft* systematics was applied to the beta-particle transition to the ground state of ^{56}Fe ($\Delta J = 3$, $\Delta\pi$ = no), with a lower limit for log *ft* of 13.9 (1998Si17), to give a beta-particle emission probability of < 0.0005 (set to zero).

^{56}Mn possesses suitable decay characteristics for use as a calibrant over the gamma-ray energy range 840 to 2550 keV.

^{203}Hg

The simple decay scheme is dominated by beta decay to the first excited state of ^{203}Tl, followed by a single gamma transition to the ground state. Multipolarity and internal conversion coefficients of 279.1952 keV gamma ray: comprehensive assessment of 1985HaZA provides accurate estimates for α_{tot} of 0.2271(12) and α_K of 0.1640(10), and a multipolarity of close to 25%M1 + 75%E2. Beta-particle emission probabilities were calculated from the limits set on the beta transition to the ground state by 1955Ma40 and 1956Wo09. Beta-decay branch to $½^+$ ground state of ^{203}Tl has a recommended value of 0.0001(1) from these studies. Hence, the beta-particle emission probability was defined as 0.9999(1) for the transition to the first excited state of ^{203}Tl ($5/2^- \rightarrow 3/2^+$).

The single well-characterised gamma ray at 279.1952(10) keV and the 46.6-day half-life of ^{203}Hg make this radionuclide of some value as a standard in the calibration of γ-ray detectors.

^{228}Th Decay Chain

^{228}Th decay chain is important in quantifying the environmental impact of the decay of naturally-occurring ^{232}Th. Specific radionuclides in this decay chain are noteworthy because of their decay characteristics (^{224}Ra alpha decay to ^{220}Rn; ^{212}Bi and ^{208}Tl gamma-ray emissions). ^{208}Tl in particular emits high-energy gamma rays that represent a well-defined spectroscopic signature for this decay chain.

^{228}Th

A reasonably well-defined decay scheme was derived from the alpha-particle studies of 1970Ba20, 1976BaZZ, 1969Pe17, and 1993Ba72, and the gamma-ray measurements of 1977Ku15, 1982Sa36 and 1984Ge07. An alpha-particle emission probability of 0.732(2) was derived for the alpha decay directly to the ground state of ^{224}Ra, based on the various alpha-particle studies. This value and the gamma-ray data were used in conjunction with the theoretical internal conversion coefficients to determine a normalisation factor of 0.0117(5) for the relative emission probabilities of the gamma rays.

Cluster decay has also been observed, and reviewed by 1995Ar33 and 1997Tr17. O-20 emissions were detected, with an estimated branching fraction of 1.1(2)E-13. However, this decay mode has not been included in the decay-data summary section.

^{224}Ra

The decay scheme was constructed from the alpha-particle studies of 1962Wa28, 1969Pe17, 1971So15 and 1984Bo15, and the gamma-ray measurements of 1969Pe17, 1972DaZA, 1977Ku15, 1982Sa36, 1983Sc13, 1983Va22, 1984Bo15, 1984Ge07 and 1992Li05. Alpha-particle emission probabilities to the first excited states of ^{220}Rn have been directly measured by 1969Pe17, 1971So15, 1984Bo15 and 1993Ba72, and these data were used to calculate the alpha-particle emission probability directly to the ground state of ^{220}Rn. A weighted mean value of 95.00(4) was determined for P_α(5685.50 keV), and matched with a value of 5.01(4) for P_α(5448.81 keV). Assuming that the measured gamma-ray emission probabilities are absolute (as quoted in the various references) and P_γ(240.986 keV) is 4.12(4), NF = 1.000, P_α(5685.50 keV) of 94.72(7) was calculated taking into account the low-intensity gamma-ray transition probabilities populating the 240.986 keV nuclear level:

P_α(5448.81 keV) =

$$P_\gamma(240.986\ \text{keV})(1 + \alpha_{tot}(240.986\ \text{keV})) - [\ \Sigma\ P_{\gamma i}\ (1 + \alpha_i)\ \text{populating nuclear level}]$$

$$= [4.12(4) \times 1.280(8)] - 0.0125(18) = 5.26(7)$$

and P_α(5685.50 keV) = 94.72(7). If gamma-ray emission probabilities are judged to be not strictly absolute and P_α(5685.50 keV) of 95.00(4) is adopted as the weighted mean of the alpha-particle measurements, NF = 0.947(8) and P_γ(240.986 keV) is 3.90(3). Thus, a discrepancy exists between measurements of the absolute emission probability of the 240.986 keV gamma ray and measurements of the direct alpha-particle emission probability to the ground state of ^{220}Rn.

Although this problem cannot be resolved on the basis of the known measurements, the gamma-ray data were judged to be more reliable. Therefore, the recommended alpha-particle emission probabilities were determined from the gamma-ray data and theoretical internal conversion coefficients, rather than available alpha-particle measurements. These calculations resulted in an absolute emission probability of 5.26(7) for the 5448.81 keV alpha particle (compared with a weighted mean value of 5.01(4) from the alpha-particle measurements), and 94.72(7) for the 5685.50 keV alpha particle. Further spectroscopic measurements are required to resolve the discrepancies between the alpha-particle and gamma-ray data.

Cluster decay has been observed by 1985Pr01 and 1991Ho15, and reviewed by 1995Ar33 and 1997Tr17. ^{14}C emissions were detected with a branching fraction of 5(1)E-11. However, this decay mode has not been included in the decay-data summary section.

^{220}Rn

A simple decay scheme has been derived from the gamma-ray studies of 1972DaZA, 1977Ku15, and 1984Ge07. The single 549.76 keV gamma ray had a weighted mean emission probability of 0.114(16)%, and this value and theoretical internal conversion coefficients were used to calculate the absolute emission probabilities of the 5748.46 and 6288.22 keV alpha particles to the 549.76 keV and ground states of ^{216}Po, respectively.

^{216}Po

A simple decay scheme was derived from the gamma-ray studies of 1977Ku15, with an absolute emission probability of 0.0019(3)% for the single 804.9 keV gamma ray. This value and theoretical internal conversion coefficients were used to calculate the alpha-particle emission probabilities.

^{212}Po

^{212}Po is an extremely short-lived radionuclide populated via the beta decay of ^{212}Bi and the alpha decay of ^{216}Rn. Alpha decay of ^{212}Po occurs directly to the ground state of ^{208}Pb.

^{212}Bi

^{212}Bi undergoes beta decay to ^{212}Po (BF = 0.6407(7)), and alpha decay to ^{208}Tl (BF = 0.3593(7)). The alpha branching fraction was calculated as the weighted mean of the measurements of 1960Sc07, 1962Be09, 1962Fl03 and 1965Wa09, with the uncertainty increased to include the most precise value of 0.3600(3). A consistent decay scheme has been constructed from a combination of alpha-particle studies by 1951Ry17(two main emissions modified), 1960Wa14, and 1962Be09, and the gamma-ray measurements of 1960Sc07, 1962Be09, 1962Fl03, 1967Be19, 1968Yt02, 1972DaZA, 1978Av01, 1982Sa36, 1983Sc13, 1983Va22 and 1984Ge07.

The main alpha-particle emission probabilities emitted directly by ^{212}Bi were calculated from the evaluated gamma-ray emission probabilities and theoretical internal conversion coefficients, combined with an alpha branching fraction of 0.3593(7). These data are in excellent agreement with the measured emission probabilities of the two main alpha transitions (1951Ry17, 1960Wa14 and 1962Be09), but deviate considerable for the low-intensity transitions that are poorly resolved. Under such circumstances, the low-intensity alpha-particle data of 60Wa14 were adopted when appropriate, while others were derived from the gamma-ray studies.

Long-range alpha-particle emissions from the $\beta^-\alpha$ decay mode have been observed at energies greater than 9 MeV by 1951Ry17, 1962Be09 and 1965Le08. Total α emissions from $\beta^-\alpha$ decay have an estimated mean value of 219 relative to 10^6 for the emission probability of the 8785.18 keV alpha particle of ^{212}Po, with an uncertainty of 15 to cover the range of measured data. Therefore, a mean value of 0.00014 was estimated for the $\beta^-\alpha$ branching fraction, combined with an uncertainty of approximately 7% (BF($\beta^-\alpha$) = 0.00014(1)). Absolute alpha-particle emission probabilities for this small branch were calculated from the mean values and BF($\beta^-\alpha$).

^{212}Pb

The decay scheme has been constructed from the gamma-ray measurements of 1960Ro16, 1961Gi02, 1972DaZA, 1978Av01, 1982Sa36, 1983Sc13, 1983Va22 and 1984Ge07. Only five distinct gamma-ray emissions were identified with ^{212}Pb decay in these various studies.

^{208}Tl

A consistent decay scheme has been derived, assuming no direct beta decay to the 2614.55 keV and ground states of ^{208}Pb (based on spin-parity considerations). This decay scheme is primarily based on the gamma-ray measurements of 1960Em01, 1960Sc07, 1961Si11, 1969Au10, 1969Pa02, 1969La23, 1972Ja25, 1972DaZA, 1975Ko02, 1977Ge12, 1978Av01, 1982Sa36, 1983Sc13, 1983Va22, 1984Ge07 and 1993El08.

^{234m}Pa

Studies to quantify the two branching fractions are sparse (IT and β^-): recommended values are based on the measurements of BF_{IT} by 1938Fe02, 1960Fo15, 1963Bj02 and 1973Go40: BF_{IT} of 0.0016(2) was adopted as the weighted mean of five measurements, with the uncertainty set marginally above the smallest uncertainty of the values used to calculate the average. BF_β of 0.9984(2) was simply calculated from the adopted value for BF_{IT}.

A complex decay scheme has been constructed from the gamma-ray measurements of 1963Bj02, 1967Wa09, 1971GuZQ, 1975Ar23, 1982Mo30, 1986Mo09, 1990Sc09, 1992Si17, 1993Su37 and 2000Ni13. Over 120 gamma transitions are identified with the beta decay of ^{234m}Pa, and a minimum of two gamma transitions are associated with the small IT decay mode. All of the gamma-ray emission probabilities have been expressed in terms of the 1001.025 keV gamma-ray emission, and an absolute value for this parameter (normalisation factor) has been calculated from the studies of 1971GuZQ, 1986Mo09, 1990Sc09, 1992Ja17, 1992Li05, 1992Si17 and 1999An40. The beta-particle emission probabilities were calculated from the recommended gamma-ray emission probabilities and the theoretical internal conversion coefficients of 1978Ro22. Direct beta decay to specific nuclear levels of ^{234}U were assigned values of zero on the basis of spin and parity considerations, effectively ruling out the existence of beta transitions above first forbidden non-unique. Thus, there was assumed to be no direct beta decay to the 1457.59, 1126.68, 1085.30, 989.45, 926.74, 851.7, 849.30, 143.351 and 43.498 keV nuclear levels. Limitations were placed on the emission probabilities of these beta transitions, as defined in the systematic study of 1998Si17; such an approach was adopted for 2nd and 3rd forbidden transitions.

Concluding Remarks

Various commitments limit the author to a restricted number of decay-data evaluations per year, with efforts focused towards specific radionuclides of direct interest to the fission and fusion research programmes and radiometric standards. The Decay Data Evaluation Project (DDEP) is suited to this abbreviated approach, and further work is planned to evaluate the decay schemes of the following radionuclides:

^{97m}Tc, ^{106}Rh, ^{109}Pd, ^{126}Sb, ^{127}Sb, ^{127}Te, ^{132}Te, ^{132}I, ^{144}Pr and ^{201}Pb.

The precise timings of these evaluations are uncertain.

Decay Data Horizontal Evaluations and Related Activities of the Radionuclide Data Center (2000-2003 Progress Report)

V.P.Chechev,
Radionuclide Data Center,
V.G.Khlopin Radium Institute,
2nd Murinsky pr., 28,
194021 St.Petersburg,
Russia

Decay data evaluations

Decay data evaluations for chosen applied radionuclides are being carried out within the framework of the international Decay Data Evaluation Project (DDEP) cooperation and the IAEA Co-ordinated Research Project on Update of X-ray and Gamma-ray Decay Data Standards for Detector Calibration and Other Applications.

Evaluations and recommendations of full decay-scheme data have been completed for the following 12 radionuclides: ^{99}Mo and ^{99}Tc^{m} (in cooperation with LNHB), ^{57}Co, ^{67}Ga, ^{93}Nb^{m}, ^{111}In, ^{129}I, ^{133}Ba, ^{154}Eu, ^{155}Eu, ^{170}Tm and ^{241}Am.

Measurements of X- and gamma emission probabilities

In 2000-2002 within the framework of the international EUROMET Project [1] 416 measurements of the emission probabilities were made for photons accompanying the decay of ^{237}Np in equilibrium with ^{233}Pa. The measurement results were obtained in cooperation with the French laboratory CEA-DAMRL-BNM-LNHB. The emission probabilities of the main γ-, KX - and LX -rays in decays of ^{237}Np/^{233}Pa have been determined with a relative uncertainty of about 2%.

Dissemination of nuclide data

a) The national Certified Reference Data (CRD) have been worked out for half-lives and alpha-particle energies and emission probabilities for the radionuclides forming parts of the standard spectrometric alpha-particle sources (OSAI): ^{226}Ra with daughter decay products, ^{233}U, ^{238}Pu and ^{239}Pu. The recommended values of CRD have been obtained using the ENSDF-2000 data and an analysis and selection of the new experimental results.

á) The second edition of NUCLIDE GUIDE (Moscow, Atominform, 2002) has been published. It contains a short information on characteristics of the all the known nuclides.

Radionuclide data for astrophysics

Half-lives of 20 radionuclides (^{26}Al, ^{40}K, ^{53}Mn, ^{60}Fe, ^{87}Rb, ^{93}Zr, ^{98}Tc, ^{107}Pd, ^{129}I, ^{135}Cs, ^{146}Sm, ^{176}Lu, ^{182}Hf, ^{187}Re, ^{205}Pb, ^{232}Th, ^{235}U, ^{238}U, ^{234}Pu, ^{247}Cm) used in nuclear geochronology and cosmochronology have been evaluated.

Publications

1. V.P.Chechev, INDC(NDS)-415, IAEA, Vienna, September 2000, p.47, 49-50.
2. V.P.Chechev, INDC(NDS)-422, IAEA, Vienna,February 2001, p.82-85, 91-92.
3. V.P.Chechev, Half-lives of radionuclides used in nuclear geochronology and cosmochronology (evaluated data), Voprosi Atomnoi Nauki i Tekhniki (VANT), 2001, seriya: Yadernie Konstanti, N1, section: The constants and parameters of nuclear structure and nuclear reactions, p.108-118.
4. V.P.Chechev, Certified Reference Data on nuclear characteristics of alpha-emitting radionuclides ^{226}Ra, ^{233}U, ^{238}Pu è ^{239}Pu. // Izmeritel’naya Tekhnika. 2001. N 11. C. 41-43.
5. V.P.Chechev, Measurements of KX-and γ-rays and decay data evaluation for some applied radionuclides at V.G.Khlopin Radium Institute from MITO-1998 to TSUKUBA-2001, J. of Nucl. Sci. Techn., 2002, Suppl. 2, vol.1, p.459-462.
6. A.Luca, S.Sepman, K.Iakovlev, G.Shchukin, M.Etcheverry, J.Morel, Emission Probabilities of the KX-Rays following the Decay of 237Np in Equilibrium with 233Pa, Appl.Radiat.Isot. 56 (2002) 173.
7. T.V.Golashvili, V.P.Chechev, A.A.Lbov et al. Nuclide Guide-2. Edited by V.N.Michajlov. Moscow, Atominform, 2002. –348 pp.
8. Recommended data by the Decay Data Evaluation Project working group. http://www.bnm-lnhb/NucData.htm.

NUBASE

G. Audi a , O. Bersillon b , J. Blachot b , A.H. Wapstra c
a Centre de Spectrom'etrie Nucl'eaire et de Spectrom'etrie de Masse, CSNSM, IN2P3-CNRS,
B“atiment 108, F-91405 Orsay Campus, France
b Service de Physique Nucl'eaire, CEA, B.P. 12, F-91680 Bruy`eres-le-Ch“atel, France
c National Institute of Nuclear Physics and High-Energy Physics, NIKHEF, PO Box 41882,
1009DB Amsterdam, The Netherlands

The first version of the NUBASE evaluation of nuclear and decay properties has been published in **Nucl. Phys. 624, Sept. 29, 1997.**

NUBASE has been set up by G.Audi, O.Bersillon, J.Blachot and A.H.Wapstra. It contains experimentaly known nuclear properties, and some others estimated from extrapolation, for 3010 nuclides in ground-state, 669 in the first and 58 in second isomeric states: mass, isomeric excitation energy, half-life, spin, parity, decay modes and intensities.

All the information are properly referenced; this traceability allows any user to check the recommended data.

An electronic (ascii) file for the NUBASE table, for use with computer programs, is distributed by the AMDC. This file was NOT updated, to allow stable reference data for calculations. Any work that will use that file should make reference to the Nucl. Phys. paper and not to the electronic file.

DISPLAYING NUBASE

Two programs have been written to display the contents of NUBASE in a user friendly environment.

1 - For PC computers, the program NUCLEUS has been further developed and integrates now an "Educational" display. The later has been written in collaboration with the Palais de la decouverte, Paris, for the "Centenial of the Radioactivity" exhibition. NUCLEUS can be downloaded from the AMDC as explained in file nucleus.status (ascii).

2 - Directly from the AMDC Web: jvNubase is a JAVA applet that can be run from any JAVA compatible browser.

Both display programs will be updated regularly to allow the AMDC user to check for the latest available information in NUBASE.

NUCLEUS

NUCLEUS draws a chart of the nuclides and displays various information from incorporated databases. There are also an on-line help and a manual both in french and in english.

NUCLEUS is a DOS program for PC

The present version on AMDC is of February 24, 2003.

To get NUCLEUS in your PC type:

http://csnwww.in2p3.fr/AMDC/nucleus/nucleus.zip
http://csnwww.in2p3.fr/AMDC/nucleus/nucwav.zip
http://csnwww.in2p3.fr/AMDC/nucleus/unzip.exe

NUBASE versus ENSDF

Many of the new ENSDF evaluations, since the publication of NUBASE, have used data of NUBASE.

After each new publication of ENSDF, we update NUBASE for the corresponding mass chain.
The rules in ENSDF and in NUBASE are different , So sometimes the evaluator of NUBASE don't use the Half lives of ENSDF.

141 Excitation energies given as +X or +Y in ENSDF are estimated in NUBASE by systematics.

339 half lives are also derived from systematics in NUBASE

The fact that NUBASE is an horizontal evaluation and the display function of NUCLEUS help to realize these systematics.

CONTRIBUTION TO JEF3

Olivier Bersillon, Jean Blachot
Service de Physique Nucleaire
CEA, B.P. 12
F-91680 Bruyères-le-Chatel, France

A-JEF3 Project

Within the framework of the JEF3 Project (1), we have submitted:

1 A file in ENDF format which contains 3779 (nuclides,states). This file was obtained from NUBASE (version 2000). It contains no information on the spectra data.

2 A file of a selection of 307 fission products

These 2 files were created by the SDF2NDF(2) code.

The Table shows a summary of the PF data for A=93

Z	A I	Ex	T 1/2		Mo	Q-calc		Q-eff		Dif. 2 Q
36	93KR0	0.00	1.286 S	10	B-	8588.8	223.0	8600.0	100.0	-11.2
37	93RB0	0.00	5.84 S	2	B-	11.6	0.4	29.0	1.1	-17.4
37	93RB0	0.00	5.84 S	2	B-	7173.3	250.5	7462.0	9.0	-288.7
38	93SR0	0.00	7.423 M	24	B-	4212.1	78.9	3947.1	12.0	264.9
39	93Y 0	0.00	10.18 H	8	B-	2893.2	36.1	2893.0	10.0	0.2
39	93Y 1	758.72	0.82 S	4	IT	754.7	1.8	758.7	0.0	-4.0
40	93ZR0	0.00	1.53E+6 Y	10	B-	89.4	2.3	91.4	1.6	-2.0
41	93NB1	30.77	16.13 Y	14	IT	28.7	1.0	30.8	0.0	-2.1

B-Final Branching

In NUBRA (Working file of NUBASE), we also maintain an evaluation of the final branching of the isomers states.
This evaluation is done with the help of

-SDF2NDF(2) when the ENSDF data are complete.
The branching to the 2 sates of 115In is shown below.
48115Cd 1 181.0 5 (11/2)- 44.56 0.24 D B-=100$IT LT 0.003
99
B-=99.989 level 0 (SDF2NDF)
B-=0.011 level 1 (SDF2NDF)

-the different spin and parities and the available energy

-If no estimation can be done, the two branchings are given as 50 :50

1 The Jef3 Project. The Joint Evaluated File (JEF) project was started in 1982 as a collaborative project between the NEA Data Bank Member countries.
2 SDF2NDF . A new version of RADLIST code written by O. Bersillon

Report on horizontal evaluation December 2000 - March 2003

TABLE OF NUCLEAR MAGNETIC DIPOLE AND ELECTRIC QUADRUPOLE MOMENTS

Present status

The Table is now current to the end of 2002 and the great majority of entries have NSR keyword references The latest version can be obtained directly from me, although it has not been posted on the NNDC website. This restriction on open access is connected with forthcoming publication of the Table in the journal Atomic and Nuclear Data Tables.

Changes during the period

The period since December 2000 has seen the addition of approximately 500 new measurements and incorporation of the previous compilation of Raghavan (Atomic and Nuclear Data Tables 42 189 1989) to form a comprehensive record of all measured moments. Close to complete Keyword references have been incorporated into the Table and I wish to acknowledge the extensive assistance of NNDC staff in providing these references.

Present plans for the evaluation

Currently the prime objective, in addition to keeping the Table up-to-date, is to survey all measurements and give recommended values. To this end a set of interrelated standard values for several 'reference' moments per element having consistent treatment of details such as diamagnetic correction and hyperfine anomaly [where appropriate] is being compiled. This compilation will be completed during the next 12 months. It will be followed by assessing each tabulated moment in relation to the reference standards to give recommended values.

An undertaking

Although the latest list is not currently available at NNDC, I undertake to give detailed recommendations to any data compiler based on the latest measurements upon request.

N.J.Stone
Oxford and Oak Ridge
March 2003

Decay Data Evaluation Project (DDEP)

Edgardo Browne

Lawrence Berkeley National Laboratory

Berkeley, California

May 2003

Contents

1. Objectives

Applied research in general, and detector calibrations in particular, require accurate nuclear data. In the power reactor industry, which often deals with large amounts of radioactive material, a poorly known γ-ray emission probability may result in serious miscalculations. Also, for detector calibration, the effect of inaccurate standards may be propagated to the outcome of actual measurements in both applied and basic research. For example, until recently the efficiency calibration of Ge γ-ray detectors for energies above ~3.5 MeV was accomplished with capture γ rays from (n,γ) or (p,γ) reactions. This is not a simple procedure and it requires the use of a nuclear reactor or accelerator, a neutron generator, or a neutron source. Thus, it was tempting for researchers to rely instead on gamma-ray emission probabilities for ^{66}Ga decay. Recent measurements by Baglin et al. [1] and Raman et al. [2] have provided the first reliable set of intensities (1-3% accuracy) for γ-ray energies up to 4.8 MeV from the decay of ^{66}Ga, thus making this radionuclide useful for Ge-detector calibration.

Accurate half-life values are needed for detector calibration purposes; they are used for adjusting γ-ray intensities from standards to times subsequent to the date of calibration. They are also important in astrophysics as may be illustrated with ^{44}Ti (60 years). This radionuclide was produced in substantial amounts during the explosion of supernova Cassiopeia A. The explosion was detected on earth 300 years ago, but the γ rays from the decay of the ejected ^{44}Ti were measured in 1994. Thus there was a need for an accurate half-life value for ^{44}Ti to enable the extrapolation of the measured 1994 γ-ray flux in order to determine the mass of ^{44}Ti ejected in the explosion 300 years before. Both ^{66}Ga and ^{44}Ti are on the DDEP list of radionuclides to be evaluated.

Most nuclear properties given in DDEP evaluations may also be found in the Evaluated Nuclear Structure Data File (ENSDF). DDEP evaluations, however, often present original measured results in greater detail and follow prescribe procedures to produce recommended values. Also, DDEP evaluations include atomic properties associated with radioactive decay (X rays, atomic conversion and Auger electrons). Such data are particularly useful for applied research.

DDEP evaluations are published in laboratory reports, and recently have become available on the World Wide Web. In addition, the DDEP collaboration is working toward making their evaluated nuclear data more accessible to ENSDF evaluators, and toward integrating their data evaluation efforts with the International Atomic Energy Agency Coordinated Research Programme (IAEA-CRP). This topic is discussed in section 8 of this report.

2. Members of the DDEP Collaboration

Below is a list of research centers and scientists who have participated in this collaboration. Those marked with an asterisk have produced DDEP evaluations. The others have contributed with the review of data evaluations, with the development of computer software for data analysis, or have attended meetings of the DDEP and shown interest in participating in this collaboration.

Dr. Marie-Martine Bé*
Dr. Vanessa Chiste*
Dr. B. Duchemin*
CEA/LNHB
91191 Gif-sur-Yvette, CEDEX
France
Te: 33-1-69-08-46-41
Fax: 33-1-69-08-26-19
E-mail: mmbe@cea.fr

Dr. Edgardo Browne*
Lawrence Berkeley National Laboratory
MS 88RO192
Berkeley, California 94720-8101
USA
Te: 1-(510) 486-7647
Fax: 1-(510) 486-5757
E-mail: ebrowne@lbl.gov

Dr. Valery P. Chechev*
Radionuclide Data Center
V.G. Khlopin Radium Institute
28, 2nd Murinsky pr.
St. Petersburg
Russia
Te: 007 (812) 2473706
Fax: 007 (812) 2478095
E-mail: chechev@atom.nw.ru

Dr. Richard G. Helmer*
Dr. Charles Reich
Idaho National Engineering and
Environmental Laboratory
P.O. Box 1625 MS 2114
Idaho Falls, Idaho 83415
USA
Te: 1-(208) 526-4157
Fax: 1-(208) 526-9267
E-mail: HelmerR@pcif.net

Dr. Filip Kondev*
Nuclear Applications and Nuclear Data
Program
Technology Development Division
Argonne National Laboratory
9700 South Cass Ave.
Argonne, ILL 60439
Te: 1-(630) 252-4484
Fax: 1-(630) 252-5287
E-mail: kondev@anl.gov

Dr. Jose M. Los Arcos
Ionizing Radiations Metrology Unit
CIEMAT
Avenida Complutense 22
E-28040 Madrid
Spain
Te: 91 34 3466288
Fax: 91 34 3466442
E-mail: jm.losarcos@ciemat.es

Dr. Shiu-Chin Wu*
Physics Department
Tsing Hua University
Taiwan
E-mail: scwu@phys.nthu.edu.tw

Dr. Amalia Williart Torres
Dr. Maria Shaw
UNED
Fisica Nuclear
Facultad de Ciencias, Rm. 239
E-28040 Madrid,
Spain
Te: 91 398 7184
Fax: 91 398 6697
E-mail: awilliart@ccia.uned.es
E-mail: mshaw@ccia.uned.es

Dr. T. Desmond MacMahon
Department of Nuclear Science and
Technology
HMS Sultan
Gosport, Hampshire P012 3BY
United Kingdom
Te: 44-239254-6046
Fax: 44-239254-6018
E-mail: mbsy52@dial.pipex.com

Dr. Alan L. Nichols*
IAEA Nuclear Data Section
Department of Nuclear Sciences and
Applications
P.O. Box 100, Wagramerstrasse 5
A-1400 Vienna, Austria
Te: 43-1-2600-21709
Fax: 43-1-26007
E-mail: a.nichols@iaea.org

Dr. Rainer Dersch
Dr. Herbert Janssen
Dr. E. Schönfeld*
Physikalisch-Technische Bundesanstalt
Bundesallee 100
38116 Braunschweig
Germany
Te: 49-0531-592-6110
Fax: 49-0531-592-6015
E-mail: rainer.dersch@ptb.de

Dr. Jagdish K. Tuli
National Nuclear Data Center
Brookhaven National Laboratory
Bldg. 197D
Upton, New York 11973-5000
USA
Te: 1-(631) 344-5080
Fax: 1-(631) 344-2806
E-mail: Tuli@bnl.gov

Dr. Simon Woods
Radioactivity Metrology Group
Centre for Ionising Radiation Metrology
National Physical Laboratory
Queens Road
Teddington
Middlesex, TW11 0LW
UK
Te: +44 20 8943 6424
Fax: +44 20 8943 6161
E-mail: simon.woods@npl.co.uk

Dr. Vito Vanin*
Dr. Rui M. Castro*
Instituto de Fisica
University of Sao Paulo
Caixa Postal 66318
05315-970 Sao Paulo, SP
Brazil
Te: 55-11-3091-6853
Fax: 55-11-3091-6832
E-mail: Vanin@if.usp.b

3. Formation of the DDEP Collaboration

During the last four decades, several research groups have undertaken the compilation and evaluation of nuclear decay data to provide best values needed in these fields. By 1991 it was clear that coordinating the efforts of these groups would help resolve the following two problems: First, the reduction in the funding of data evaluation efforts, which obviously dictated a more efficient use of human resources. Second, several published evaluations presented different recommended values, which was disconcerting. The same year Richard G. Helmer initiated a discussion with members of the radiation standards laboratories in Germany and France (i.e., Physikalisch-Technische Bundesanstalt, in Braunschweig, and what has become Laboratoire National Henri Becquerel, in Saclay) concerning the feasibility of a cooperative program for the evaluation of nuclear decay data used in applied research that would coordinate the national efforts. Within a couple of years, France and Germany had reached an agreement. In 1994 the evaluators from the United States of America received approval to participate in this effort, and soon evaluators from Russia and the United Kingdom joined them. The first meeting of the new Decay Data Evaluation Project (DDEP) was held in Paris in 1995.

4. Nuclear and Atomic Properties in DDEP Evaluations

Most radiation properties evaluated by the DDEP collaboration are relevant to applied research, such as

- Radionuclide half-life
- Nuclear radiations (α, $\beta^{\pm}$, γ) energies, emission and transition probabilities, and equilibrium emission probabilities.
- Energies and emission probabilities of atomic radiations such as X rays, conversion and Auger electrons, and electron-positron pairs emitted in nuclear disintegrations.

Other properties reported, but usually not evaluated, are:

- Q-values (from Audi et al. [3])
- Theoretical internal conversion (Rösel et al. [4]) and pair creation (Schlüter et al. [14]) coefficients.
- γ-ray multipolarities and mixing ratios (from ENSDF)
- Level schemes: levels spin, parity, and half-life (from ENSDF)
- Auger electron energies (from Schönfeld and Rodloff [5]) and X-ray energies and relative emission probabilities (from Schönfeld and Rodloff [6])
- Atomic data such as K-fluorescence yields (ω_k), mean L-shell fluorescence yields (ω_L), and total number of L vacancies created by a K→ L transfer (η_{KL}) (from Schönfeld and Janssen [7]).
- Log ft's for $\beta^{\pm}$ decay and α-decay hindrance factors (from ENSDF, or calculated with computer programs used for ENSDF evaluations.)

5. Evaluation Procedures and Computer Programs

The following procedures and computer programs were developed for DDEP evaluations.

- ***EMISSION***, E. Schönfeld and H. Janssen. This computer program is used to deduce emission probabilities for X-rays and Auger-electrons. It applies formulas given by Schönfeld and Janssen [8].
- ***EC-CAPTURE***, E. Schönfeld, F. Chu, and E. Browne. This is an interactive computer program to calculate electron-capture probabilities (for allowed and first-forbidden unique transitions) to the K, L, M, N, and O atomic shells. *EC-Capture* applies formulas given by Schönfeld [9].
- ***Limitation of Relative Statistical Weight***, W.L. Zijp [10]; M.U. Rajput and T.D. MacMahon [11]. This is a procedure for averaging discrepant data, since the use of the conventional weighted average method for this kind of data may be questionable. Most conventional procedures that have been developed to overcome this difficulty are based on the assumption that the experimental precision given by authors has been overestimated. Therefore, they increase all (or some) uncertainties in order to reduce χ^2/ν thus making consistent the set of data.

  The *Limitation of Relative Statistical Weight* procedure uses a different approach. It is a straightforward method that avoids unnecessary and extensive manipulation of the experimental data. The procedure is based on the premise that "at least two measured values must contribute significantly to any proper evaluation." Although it may increase some uncertainty, it is not necessarily aimed at reducing χ^2/ν for the set of data. The computer program *LWEIGHT* (T.D. MacMahon and E. Browne) applies this procedure to discrepant data.

6. List of Radionuclides for DDEP Evaluation

A list of 259 radionuclides to be evaluated by the DDEP collaboration is given in Table 1 and was extracted from the following sources:

- Existing lists supplied by the Laboratoire National Henri Bequerel (LNHB), AEA Technology, European Collaboration in Measurement Standards (EUROMET), National Institute of Standards and Technology (NIST), and Idaho National Energy and Environmental Laboratory (INEEL).
- Russian books presented at the IAEA-Specialists Meeting on the Development of an International Nuclear Decay Data and Cross-Section Database, Vienna, November 1994, and proceedings of the conference on "Industrial Applications of Radioisotopes and Radiation Technology," Grenoble, France, September 28 – October 2, 1981.
- Reports such as "Radionuclides for Reactor Decommissioning," INDC(NDS)-269 (1993); and PTB-Ra-16/4, Braunschweig, July 1993.

Table 1. Radionuclides to be evaluated by the DDEP collaboration

Radionuclide	Half-life	Radionuclide	Half-life	Radionuclide	Half-life	Radionuclide	Half-life
3H	12.33 y	89Kr	3.1 m	115Cd	2.2 d	140La	1.6 d
7Be	53 d	81Rb	4.25 h	115mCd	44 d	141La	3.9 h
11C	2.4 m	83Rb	86 d	111In	2.8 d	139Ce	137 d
14C	5.73 Ky	84Rb	32.8 d	113mIn	1.6 h	141Ce	32 d
13N	10.0 m	86Rb	18 d	114mIn	49.5 d	143Ce	1.3 d
15O	2.0 m	88Rb	17 m	115mIn	4.4 h	144Ce	284 d
18F	109.8 m	89Rb	15 m	113Sn	115 d	143Pr	13.57 d
22Na	2.6 y	82Sr	25.6 d	117mSn	13 d	144Pr	17 m
24Na	14 h	85Sr	64 d	123Sn	129 d	147Nd	10 d
26Al	720 Ky	89Sr	50.5 d	125Sn	9.6 d	147Pm	2.6 y
32P	14.3 d	90Sr	29 y	122Sb	2.7 d	151Pm	28.40 h
33P	25.3 d	91Sr	9.5 h	124Sb	60 d	151Sm	90 y
35S	87.5 d	92Sr	2.7 h	125Sb	2.7 y	153Sm	1.9 d
36Cl	300 Ky	88Y	106 d	126Sb	12 d	152mEu	9.3 h
38Cl	37 m	90Y	64.1 h	127Sb	3.8 d	152Eu	13 y
41Ar	1.8 h	90mY	3.1 h	121Te	16.8 d	154Eu	8.8 y
42Ar	32.9 y	91mY	49 m	121mTe	154 d	155Eu	4.9 y
40K	1.2 Gy	91Y	58 d	123mTe	119 d	156Eu	15 d
42K	12 h	92Y	3.5 h	125mTe	58 d	153Gd	241 d
47Ca	4.54 d	93Y	10 h	127Te	9.3 h	160Tb	72 d
46Sc	83 d	88Zr	83 d	127mTe	109 d	166mHo	1.2 Ky
47Sc	3.3 d	95Zr	64 d	129Te	1.1 h	166Ho	26.80 h
48Sc	1.8 d	97Zr	16 h	129mTe	33 d	170Tm	128 d
44Ti	49 y	92mNb	10 d	131mTe	1.2 d	169Yb	32 d
51Cr	27 d	93mNb	16 y	132Te	3.2 d	175Yb	4.1 d
54Mn	312 d	94Nb	20 ky	123I	13.2 h	177Lu	6.7 d
56Mn	2.5 h	95mNb	3.6 d	124I	4.18 d	177mLu	160 d
55Fe	2.7 y	95Nb	34 d	125I	60 d	175Hf	70 d

Radionuclide	Half-life	Radionuclide	Half-life	Radionuclide	Half-life	Radionuclide	Half-life
59Fe	44 d	97Nb	1.2 h	126I	13.06 d	180mHf	5.5 h
60Fe	1.5 My	97mNb	58.1 s	129I	15 My	181Hf	42 d
56Co	77 d	99Mo	2.7 d	131I	8.0 d	180Ta	8.1 h
57Co	271 d	95mTc	61 d	132I	2.2 h	182Ta	115 d
58Co	70 d	96Tc	4.28 d	133I	20 h	183Ta	5.1 d
60Co	5.2 y	97mTc	90.5 d	134I	52 m	181W	121.2 d
57Ni	35.6 h	99Tc	211 Ky	135I	6.5 h	185W	75.1 d
63Ni	100 y	99mTc	6.0 h	127Xe	36 d	187W	23 h
65Ni	2.5 h	103Ru	39 d	131mXe	12 d	186Re	90.6 h
64Cu	12 h	106Ru	373 d	133mXe	2.1 d	188Re	16 h
65Zn	244 d	101Rh	3.3 y	133Xe	5.2 d	185Os	93 d
69Zn	13 h	102Rh	2.9 y	135Xe	9.1 h	191Os	15 d
66Ga	9.49 h	103mRh	56 m	135mXe	15 m	192Ir	73 d
67Ga	3.26 d	105Rh	1.4 d	137Xe	3.8 m	194Ir	19 h
68Ga	67.6 m	106Rh	29 s	138Xe	14 m	197Pt	18 h
72Ga	14.1 h	103Pd	16 d	131Cs	9.7 d	195Au	186.1 d
68Ge	270.8 d	109Pd	13 h	134Cs	2.0 y	198Au	2.6 d
77Ge	11 h	108mAg	127 y	136Cs	13 d	199Au	3.1 d
76As	1.0 d	110Ag	24.6 s	137Cs (137mBa)	30 y	197Hg	2.6 d
75Se	119 d	110mAg	249 d	138Cs	32 m	203Hg	46 d
82Br	1.4 d	111Ag	7.5 d	131Ba	11 d	200Tl	26.1 h
85mKr	4.4 h	109Cd	1.2 y	133Ba	10 y	201Tl	72.9 h
85Kr	10 y	113mCd	14.1 y	140Ba	12 d	202Tl	12 d
204Tl	3.78 y	210Po	138.4 d	231Th	25.5 h	237Np	2.1 My
207Tl	4.77 m	212Po	0.3ms	232Th	14 Gy	239Np	2.3 d
208Tl	3.0 m	216Po	0.15 s	234Th	24 d	238Pu	87 y
201Pb	9.33 h	220Rn	55.6 s	231Pa	32.8 Ky	239Pu	24 ky
203Pb	51.8 h	222Rn	3.82 d	233Pa	27 d	240Pu	6.5 ky
210Pb	22 y	223Ra	11.4 d	234Pa	6.70 h	241Pu	14 y
211Pb	36.1 m	224Ra	3.66 d	234mPa	1.1 m	242Pu	373 Ky
212Pb	10 h	226Ra	1.6 ky	232U	68 y	241Am	432 y
214Pb	26 m	227Ac	21.77 y	233U	159 Ky	242mAm	141 y
207Bi	32.2 y	228Ac	6.1 h	234U	245 ky	243Am	7.3 ky
210Bi	5.01 d	227Th	18.7 d	235U	703 My	242Cm	163 d
211Bi	2.14 m	228Th	1.9 y	237U	6.75 d	244Cm	18 y
212Bi	1.0 h	229Th	7.34 Ky	238U	4.468 Gy	252Cf	2.645 y
214Bi	19 m	230Th	75 Ky	239U	23.5 m		

Total = 259

7. Status of Evaluations

Table 2 shows the status of evaluations.

Table 2. Status of DDEP evaluations

Radionuclide[§]	Eval. Center[&]	Status Preliminary Publication	Current[*]	Publication
^{3}H (12.33 y)	KRI			TOR[#], WWW[¶]
^{7}Be (53 d)	INEEL, PTB	Rept. PTB-6.11-97-1	Updated (2001)	WWW[¶]
^{11}C (20.4 m)	LNHB		Completed (2002)	WWW[¶]
^{14}C (5730 y)	KRI			TOR[#], WWW[¶]
^{13}N (9.97 m)	LNHB		Completed (2002)	WWW[¶]
^{15}O (122 s)	LNHB		Completed (2002)	WWW[¶]
^{18}F (110 m)	LNHB		Completed (2002)	WWW[¶]
^{22}Na (2.6 y)	INEEL, PTB	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{24}Na (14 h)	INEEL, PTB	Rept. PTB-6.11-97-1	Updated (2001)	WWW[¶]
^{26}Al (720 Ky)	LBNL	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{35}S (87.5 d)	LNHB, KRI			TOR[#], WWW[¶]
^{32}P (14.3 d)	LNHB		Completed (2003)	
^{33}P (25.3 d)	LNHB		Completed (2003)	WWW[¶]
^{36}Cl (300 Ky)	KRI			TOR[#], WWW[¶]
^{41}Ar (109 m)	INEEL	Rept. PTB-6.11-00-1		
^{40}K (1.2 Gy)	INEEL			TOR[#], WWW[¶]
^{44}Sc (3.9 h)	LBNL		Completed (1999)	WWW[¶]
^{46}Sc (83 d)	INEEL		Completed (2001)	WWW[¶]
^{44}Ti (60 y)	LBNL		Completed (1999)	WWW[¶]
^{51}Cr (27 d)	INEEL, PTB	Rept. PTB-6.11-97-1	Updated (2001)	WWW[¶]
^{54}Mn (312 d)	PTB, INEEL	Rept. PTB-6.11-97-1	Updated (2001)	WWW[¶]
^{56}Mn (2.58 h)	AEA		Completed (2002)	WWW[¶]
^{55}Fe (2.7 y)	LNHB			TOR[#], WWW[¶]
^{59}Fe (44.5 d)	LNHB		Completed (2002)	WWW[¶]
^{60}Fe (1.5 My)	LBNL		Completed (1999)	
^{56}Co(77.2 d)	NPL		Work in progress (2001)	
^{57}Co (271 d)	KRI		Completed (2001)	WWW[¶]
^{58}Co (70 d)	LNHB			TOR[#], WWW[¶]
^{60}Co (5.2 y)	INEEL	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{57}Ni (35.6 h)	LBNL		Completed (1999)	WWW[¶]
^{64}Cu (12.7 h)	INEEL		Completed (2002)	WWW[¶]
^{65}Zn (244 d)	INEEL	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{67}Ga (3.26 d)	KRI		Completed (2001)	WWW[¶]
^{68}Ga(67.6 m)	PTB	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{68}Ge (270.8 d)	PTB	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{75}Se (119 d)	LBNL, PTB	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{85}Sr (64.8 d)	PTB	Rept. PTB-6.11-00-1		

Radionuclide§	Eval. Center&	Status: Preliminary Publication	Current*	Publication
^{89}Sr (50.5 d)	PTB	Rept. PTB-6.11-00-1		WWW¶
^{95}Zr (64 d)	INEEL			TOR#, WWW¶
^{88}Y (106.6 d)	PTB	Rept. PTB-6.11-00-1	Updated (2001)	WWW¶
^{93m}Nb (16 y)	KRI		Completed (2001)	WWW¶
^{95m}Nb (3.6 d)	INEEL			TOR#, WWW¶
^{95}Nb (34 d)	INEEL			TOR#, WWW¶
^{99}Mo (2.7 d)	LNHB, KRI		Completed (2001)	WWW¶
^{99}Tc (211 Ky)	LNHB		Work in progress (1999)	
^{99m}Tc (6.0 h)	LNHB, KRI		Completed (2001)	WWW¶
^{110}Ag (25 s)	INEEL		Completed (2002)	WWW¶
^{110m}Ag(250 d)	INEEL		Completed (2002)	WWW¶
^{109}Cd (1.2 y)	PTB	Rept. PTB-6.11-97-1		
^{111}In (2.8 d)	KRI			TOR#, WWW¶
^{111}In^{m} (1.6 h)	INEEL, LNHB			TOR#
^{113}Sn (115 d)	INEEL			TOR#, WWW¶
^{125}Sb (2.76 y)	CIEMAT,UNED		Work in progress (1999)	
^{123m}Te (119 d)	LNHB, PTB	Rept. PTB-6.11-97-1	Updated (2002)	TOR#, WWW¶
^{125m}Te (58 d)	CIEMAT,UNED		Work in progress (1999)	
^{123}I (13 h)	LNHB		Completed (2001)	WWW¶
^{125}I (60 d)	PTB	Rept. PTB-6.11-97-1		TOR#, WWW¶
^{129}I(1.6x10^{7} y)	KRI		Completed (2001)	WWW¶
^{131}I (8 d)	LNHB		Completed (2002)	WWW¶
^{131m}Xe(11.9 d)	LNHB		Completed (2002)	WWW¶
^{137}Cs (30 y)	INEEL, PTB	Rept. PTB-6.11-97-1		TOR#, WWW¶
^{133}Ba (10 y)	KRI		Completed (2000)	WWW¶
^{137m}Ba(2.5 m)	LNHB		Completed (2002)	WWW¶
^{140}Ba (12 d)	INEEL	Rept. PTB-6.11-00-1		
^{140}La (1.6 d)	INEEL	Rept. PTB-6.11-00-1		
^{139}Ce (137 d)	PTB, INEEL	Rept. PTB-6.11-97-1		TOR#, WWW¶
^{141}Ce (32 d)	PTB	Rept. PTB-6.11-97-1		TOR#, WWW¶
^{143}Pr (13.57 d)	BNL		Completed (1999)	
^{153}Sm (1.9 d)	INEEL	Rept. PTB-6.11-97-1	Updated (2001)	WWW¶
^{152}Eu (13.51 y)	USP, LBNL		Completed (2001)	WWW¶
^{154}Eu(8.59 y)	KRI		Completed (2002)	
^{155}Eu(4.76 y)	KRI		Completed (2001)	WWW¶
^{153}Gd (241 d)	INEEL	Rept. PTB-6.11-97-1	Updated (2001)	WWW¶
^{166}Ho (26.8 h)	PTB	Rept. PTB-6.11-00-1	Updated (2000)	
^{166m}Ho(1.2 Ky)	PTB	Rept. PTB-6.11-00-1		
^{169}Yb (32 d)	LNHB, PTB	Rept. PTB-6.11-00-1	Updated (2001)	WWW¶
^{170}Tm (128 d)	KRI		Completed (2000)	WWW¶
^{177}Lu (6.71 d)	ANL		Completed (2002)	

Radionuclide[§]	Eval. Center[&]	Status Preliminary Publication	Current[*]	Publication
^{186}Re (90.6 h)	PTB	Rept. PTB-6.11-00-1		
^{188}Re (16 h)	LBNL			TOR[#], WWW[¶]
^{192}Ir (73 d)	LBNL	Rept. PTB-6.11-97-1		TOR[#], WWW[¶]
^{194}Ir (19 h)	LBNL			TOR[#], WWW[¶]
^{198}Au (2.6 d)	PTB	Rept. PTB-6.11-00-1		
^{203}Hg (46.6 d)	AEA		Completed (2002)	WWW[¶]
^{201}Tl (72.9 h)	PTB	Rept. PTB-6.11-97-1		
^{204}Tl(3.78 y)	LNHB		Completed (2003)	WWW[¶]
^{208}Tl (3.0 m)[^]	IAEA		Completed (2002)	
^{212}Pb(10.6 h)[^]	IAEA		Completed (2002)	
^{207}Bi (32.2 y)	LNHB			TOR[#], WWW[¶]
^{212}Bi (60.5 m)[^]	IAEA		Completed (2002)	
^{212}Po(0.30 μs)[^]	IAEA		Completed (2002)	
^{216}Po(0.30 ms)[^]	IAEA		Completed (2002)	
^{220}Rn(55.6 s)[^]	IAEA		Completed (2002)	
^{220}Ra (55.6 s)[^]	IAEA		Completed (2002)	
^{224}Ra (3.66 d)[^]	IAEA		Completed (2002)	
^{228}Th (1.91 y)[^]	IAEA		Completed (2002)	
^{227}Th (18.7 d)	LBNL		Completed (2002)	WWW[¶]
^{234m}Pa(1.2 m)	IAEA		Completed (2002)	
^{241}Am (432y)	KRI		Completed (2000)	WWW[¶]
^{252}Cf (2.645 y)	LNHB		Work in progress (1999)	

[#] Table of Radionuclides, Laboratoire Primaire des Rayonnements Ionisants, report ISBN 2 7272 0200 8,1999.
[*] Evaluations that have not been published yet, except for ^{123m}Te.
[¶] World Wide Web Site: http://www.bnm.fr/bnm-lnhb/DDEP.htm.
[^] In equilibrium with ^{228}Th (alpha-decay chain)
[§] Radionuclides in boldface are also on the list for the IAEA-CRP "X- and γ-ray decay data standards for detector calibration and other applications," report INDC(NDS)-437, December 2002.

[&]AEA - AEA Technology, Harwell, UK.
ANL - Argonne National Laboratory, USA
BNL - Brookhaven National Laboratory, Upton, NY, USA
CIEMAT - Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, Madrid, Spain
INEEL - Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, USA
KRI - Khlopin Radium Institute, St. Petersburg, Russia
LBNL - Lawrence Berkeley National Laboratory, Berkeley, CA, USA
LNHB - Laboratoire National Henri Bequerel, Saclay, France
NPL - National Physical Laboratory, Teddington, UK.
PTB - Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
UNED - Universidad Nacional a Distancia, Madrid, Spain.
USP - Universidade de São Paulo, Brazil.

DDEP evaluations are published in the French *Table of Radionuclides (TOR)*, although some were preliminarily published in PTB reports in 1997 and 2000. Also, a significant fraction of them are now electronically available on the World Wide Web: http://www.bnm.fr/bnm-lnhb/DDEP.htm.

A summary of the status of evaluations is given below:

Number of evaluations produced	95
Number of evaluations published in TOR	29
Number of evaluations on the WWW	69
Number of evaluations in progress	5

8. DDEP, IAEA-CRP, and ENSDF Evaluations.

Table 2 shows that almost all (62 out of 64) of the radionuclides included in the IAEA-CRP list have been evaluated also by the DDEP collaboration. In fact, these groups are presently sharing evaluated data, evaluation procedures, and some computer programs. The current trend is to consolidate both evaluation efforts so that recommended values will be either the same or mutually consistent in both evaluations. Thus, the half-life values for all the IAEA-CRP radionuclides will be evaluated at the National Physical Laboratory (UK) and used also in DDEP evaluations.

The relation between DDEP and ENSDF evaluations is also significant since a large fraction of data in DDEP evaluations comes from ENSDF. On the other hand, only a few DDEP evaluations have been included in ENSDF. A difficulty for integrating DDEP evaluations into ENSDF is the use of theoretical conversion coefficients: from Hager and Seltzer [12] in ENSDF, from Rösel et al. [4] in DDEP evaluations. Fortunately, the advent of a new calculation of conversion coefficients by I.M. Band et al. [13] may soon result in its use in both ENSDF and DDEP evaluations. This is a decision that will constitute an important step toward the integration of DDEP and ENSDF evaluations. Another difficulty has been the different data formats used in these evaluations. ENSDF uses 80-character records, whereas DDEP evaluations are entered and stored in a Microsoft Access database. Recently, however, the group at Saclay has developed a computer program to produce ENSDF data sets from the DDEP Access database. This new procedure will facilitate even more the inclusion of DDEP evaluations in ENSDF. The National Nuclear Data Center (NNDC) at Brookhaven National Laboratory (BNL) has considered installing a computer repository for ENSDF data sets from DDEP evaluations, to provide access to these data by both ENSDF data evaluators and users.

9. Availability of DDEP evaluations

The group at Saclay, France, has developed a site on the World Wide Web (WWW) for displaying DDEP evaluations: http://www.bnm.fr/bnm-lnhb/DDEP.htm. This site, as of April 2, 2003, contains data evaluations for 69 radionuclides. For each of them there is a set of tables [*table*] and a description of the arguments and statistical procedures used for producing recommended values [*comments*].

References

1. C.M. Baglin, E. Browne, E.B. Norman, G.L. Molnár, T. Belgya, Zs. Révay, and F. Szelecsényi, "^{66}*Ga: a standard for high-energy calibration of Ge detetctors,*" Nucl. Instr. and Meth. in Phys. Res. **A481**, 365 (2002).

2. S. Raman, C. Yonezawa, H. Matsue, H. Iimura, N. Shinohara, *"Efficiency calibration of a Ge detector in the 0.1-11.0 MeV region,"* Nucl. Instr. and Meth. **A454**, 389 (2000).

3. G. Audi and A.H. Wapstra, *"The 1995 update to the atomic mass evaluation,"*Nucl. Phys. **A595**, 409 (1995).

4. F. Rösel, H.M. Fries, K. Alder, H.C. Pauli, *"Internal Conversion Coefficients for all Atomic Shells,"* At. Data Nucl. Data Tables **21**, 92, 291 (1978).

5. Eckart Schönfeld, Gisela Rodloff, *"Tables of the energies of K-Auger electrons for elements with atomic numbers in the range from Z=11 to Z=100,"* report PTB-6.11-98-1, Braunschweig, October 1993.

6. Eckart Schönfeld, Gisela Rodloff, *"Energies and relative emission probabilities of K x-rays for elements with atomic numbers in the range from Z=5 to Z=100," ,"* report PTB-6.11-1999-1, Braunschweig, February 1999.

7. E. Schönfeld, H. Janssen, *"Evaluation of atomic shell data,"* Nucl. Instr. and Meth. in Phys. Res. **A369**, 527 (1996).

8. E. Schönfeld, H. Janssen, *"Calculation of emission probabilities of x-rays and Auger electrons emitted in radioactive disintegration processes,"* Appl. Rad. Isot. **52**, 595 (2000).

9. E. Schönfeld, *"Calculation of Fractional Electron Capture Probabilities,"* Appl. Rad. Isot. **49**, 1353 (1998).

10. W.L. Zijp, *"On the statistical evaluation of inconsistent measurement results,"* report ECN-197, Peten, The Netherlands (1985).

11. M.U. Rajput and T.D.MacMahon, *"Techniques for evaluation of discrepant data,"* Nucl. Instr. and Meth. in Phys. Res. **A312**, 289 (1992).

12. R.S. Hager and E.C. Seltzer, *"Internal Conversion Tables,"* Nucl. Data **A4**, 1, 397 (1968).

13. I.M. Band, M.B. Trzhaskovskaya, C.W. Nestor, Jr., P.O. Tikkanen, and S. Raman, *"Dirac-Fock Internal Conversion Coefficients,"* Atom. Data. Nucl. Data Tables **81**, 1 (2002).

14. P. Schlüter, G. Soff, *"Total and Differential Conversion Coefficients for Internal Electron-Positron Pair Creation,"* Atom. Data. Nucl. Data Tables **24**, 509 (1979).

Nuclear Structure and Decay Data Evaluations of the Georgia Tech Group

15th Meeting of the Nuclear Structure and Decay Data (NSDD) Network May 5-9, 2003

The program of horizontal systematics at Georgia Tech is most succinctly described as "mining the ENSDF Library for global nuclear structure features". The Georgia Tech Nuclear Data Search Engine (GTNDSE) is a perl script which has been developed to assist in extracting data from a database of ENSDF-formatted A-chain data files for requested nuclear data.

In the first phase of testing GTNDSE, we undertook to extract all B(E2) values for all doubly-even nuclei from the database. The program delivered ~3100 measured B(E2)'s and an additional ~500 entries which included comments and calculated B(E2) limits. Two tab-delimited text files were output: one file which contained the measured B(E2) data and one which listed other records which contained the string "B(E2)"for line-by-line inspection of the database for comparison.

Version 1 of GTNDSE was limited by the available queries (extraction of B(EL) and B(ML) values or tabulation of adopted levels and gamma rays associated with a nuclide or with a beta decay parent) and by the fixed output format. Modifications to the code allow the user to select what data will be extracted from the database and to choose the format for the output.

The modified code will be tested by extracting B(M1) systematics and by searching for K-isomers. While the B(M1) compilation does not require any changes to the present GTNDSE code, it will serve to check that no data is lost by any changes. The K-isomer search will require a high level of flexibility for both the type of data queried and the output format in order to analyze the output.

Plans for the future include adapting GTNDSE to a common gateway interface (CGI) format in preparation for disseminating the code via the web.

The current text interface requires familiarity with the code (i.e., it lacks a user-friendly interface) and the present text output requires additional effort to reorganize the data in a spreadsheet for further analysis. Documentation will include instructions for using GTNDSE and tabulations of the data extracted in testing the code.

GTNDSE:

the GA Tech nuclear data search engine

W. D. Kulp, J. L. Wood
Georgia Institute of Technology

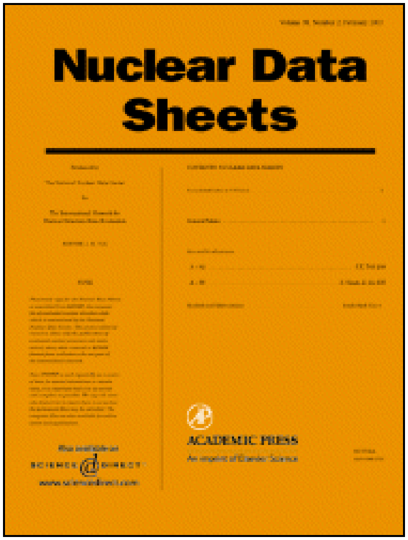
Function

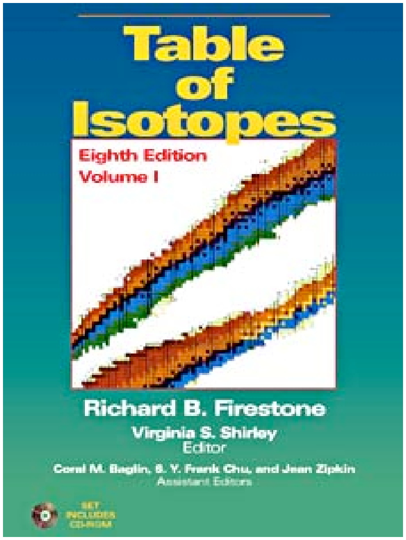
- Retrieve data from ENSDF-formatted files
- Write data in user-selected format

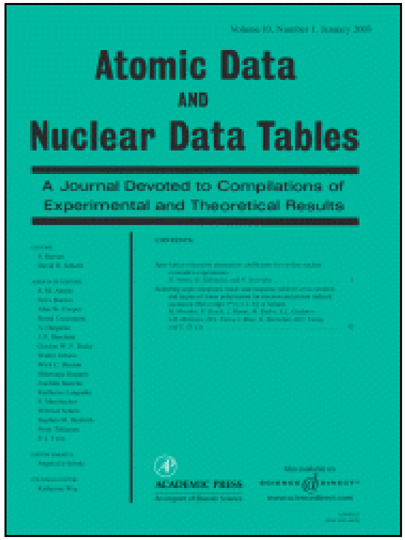
Purpose

- Horizontal systematics of nuclear mass surface
- Comparison with experimental data
- Assist in data analysis and evaluation

Available sources of nuclear data







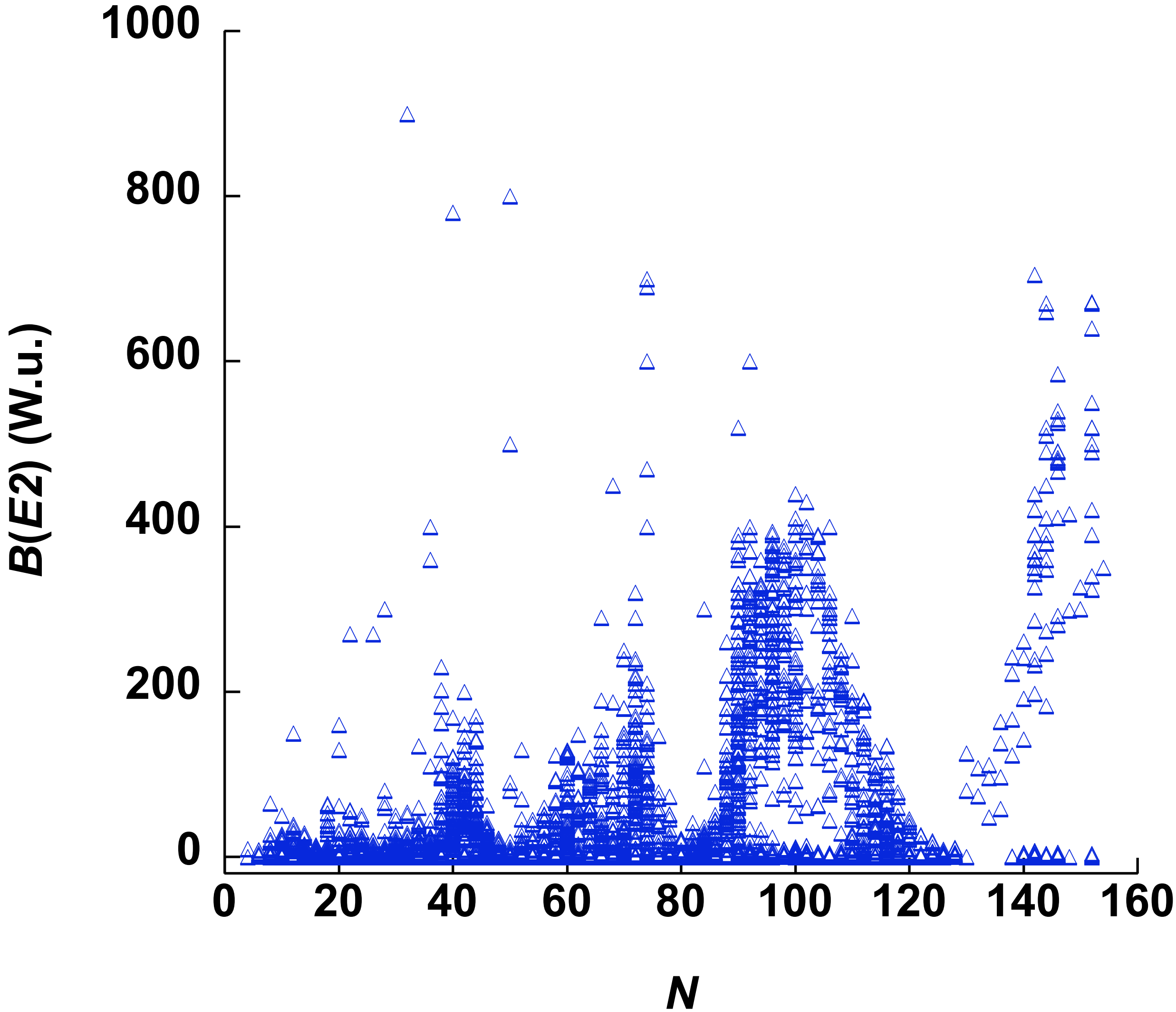
- Printed sources are cumbersome and contain very few horizontal evaluations (e.g., S. Raman, C.W. Nestor, Jr., and P. Tikkanen, At. Data Nucl. Data Tables **78**, 1 (2001).)

- Electronic sources often require particular computer operating systems and may have limited use in retrieving horizontal data: use the raw evaluated database.

U.S. Nuclear Data Program

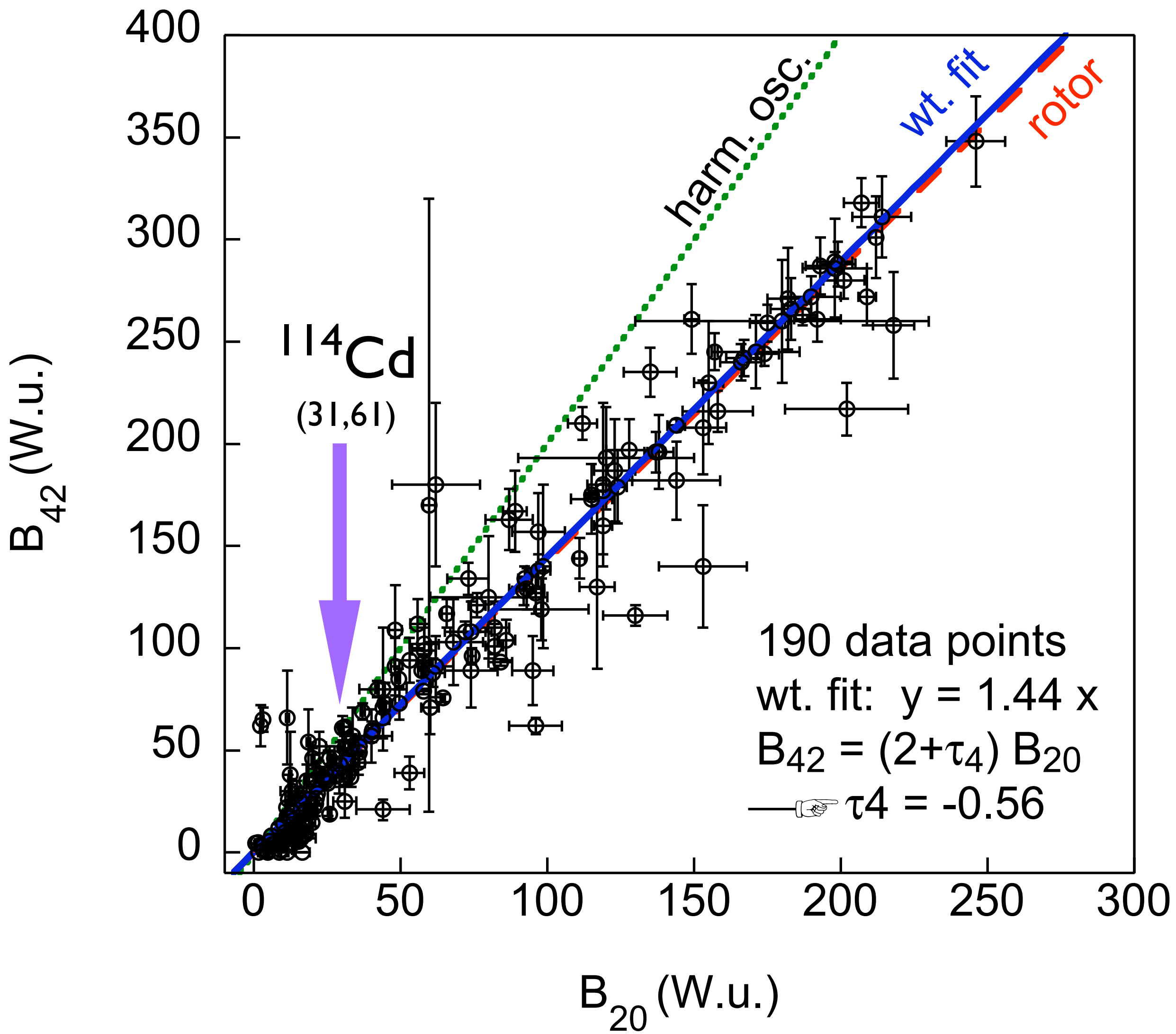
B(E2) search

- ENSDF search of even-even nuclei: 37 seconds
- >3000 *B(E2)* values returned
- >600 additional records individually evaluated



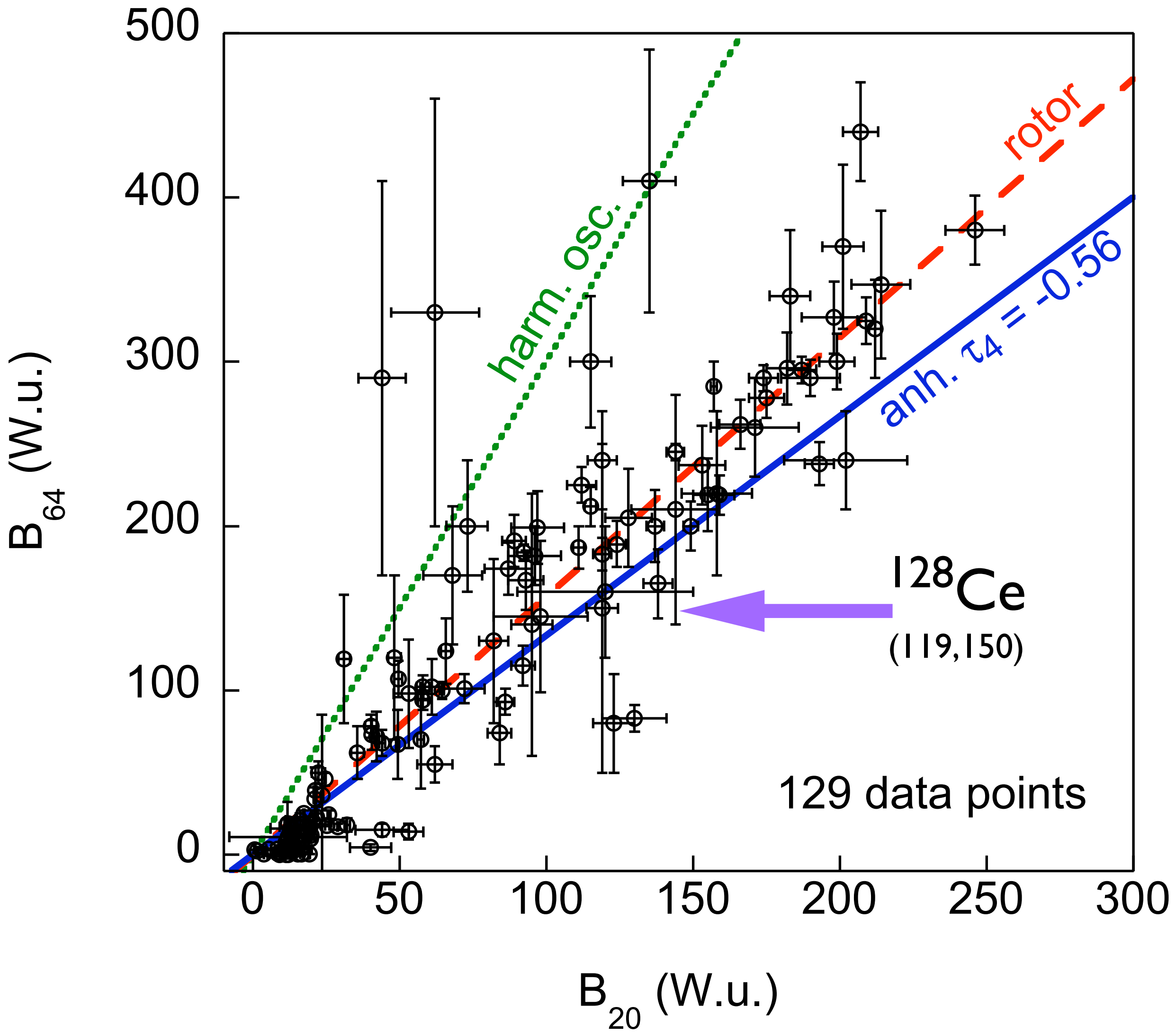
B(E2) systematics

- ENSDF search of even-even nuclei: < 1 minute
- Required evaluation (e.g., ^{114}Cd: $t_{1/2}$ w/o B_{42})



$B(E2)$ systematics

- Search ignored limits, approximations
- Additional evaluation (e.g., ^{128}Ce $B_{20}>10^5$)



Other searches

- First-excited state lifetimes (P. E. Garrett, LLNL)
- Impurities in a cocktail beam (P. Walker, Surrey)
- Known B(M1) values (F. Sarzin, TRIUMF)
- K-isomer search: lifetimes, B(EL), and B(ML) values (P. Chowdhury, Lowell; P. Walker, Surrey)
- 1:1 gamma-ray cascades (J. Hardy, Texas A&M)

Directions

- Flexible input/output interface
- Rigorous testing and evaluation
- Web-based CGI

Implementation of Band-Raman Internal Conversion Coefficients (BRICC)

Prepared for the
IAEA Nuclear Structure and Decay Data Network
Technical Meeting
Vienna, Austria
November 10 to November 14, 2003

Thomas W. Burrows

Brookhaven Science Associates
U.S. Department of Energy

BROOKHAVEN NATIONAL LABORATORY

BRICC - 1

- Completed
  - PERL script to convert table to BRICCSEQ.DAT. Similar format to ICCSEQ.DAT
    - Upper limit of 2000 keV instead of 1500 keV
    - Extended to include E5 and M5 transitions
    - More shells, subshells, and total ICC
    - Includes electron binding energies
  - Comparison of BRICCSEQ.DAT and ICCSEQ.DAT
    - ICCSEQ.DAT includes Z=3 and 6 – Not used by HSICC
    - ICCSEQ.DAT extends to 6000 keV for Z≤30 – Not used by HSICC
    - Except for K, L1, and N+ shells, ICCSEQ.DAT generally extends to lower energies – Discussed this with Raman.

Brookhaven Science Associates
U.S. Department of Energy

BROOKHAVEN NATIONAL LABORATORY

BRICC – 2

Comparison of E_γ Thresholds for Thorium

Z=90	BRICC		HSICC
	E_γ(ICC)	BE	E_γ(ICC)
L1	21.00	20.480	21.47
L2	21.00	19.700	20.69
L3	21.00	16.300	17.30
M1	21.00	5.185	6.18
M2	21.00	4.833	5.83
M3	21.00	4.049	5.05
M4	21.00	3.494	4.49
M5	21.00	3.335	4.33
N1-N7	21.00	0.338-1.330	50.00

Brookhaven Science Associates
U.S. Department of Energy

BROOKHAVEN NATIONAL LABORATORY

BRICC – 3

Low-energy γ's with α's for Th Isotopes in NuDat

Nuclide	E_γ	Mult.	α_{total}
^{227}Th	9.3 *1*	(E2)	334000.0
^{227}Th	15.2 *2*	[M1+E2]	≈12000.0
^{228}Th	18.4	[E1]	6.6

Brookhaven Science Associates
U.S. Department of Energy

BROOKHAVEN NATIONAL LABORATORY

BRICC - 4

- BLDBRT.FOR — Constructs direct access index and table files. Similar to BLDHST.FOR
  - Index also includes electron binding energies
  - Table includes E5 and M5 transitions, more shells and subshells, and total ICC
- SEQBRT. FOR — Recreates BRICCSEQ.DAT from direct access files.
- Subprogram package to calculate population fraction for valence electron subshells.
  - ≈ 89 out of 117 Z's have one or more unfilled subshells
  - May allow calculations for bound-state β^- decay??
- Subroutine to fill the arrays for internal conversion coefficients.

Brookhaven Science Associates
U.S. Department of Energy

BROOKHAVEN NATIONAL LABORATORY

BRICC - 5

- In progress or to be done
  - Cubic spline fitting and other calculational subroutines
    - For some subshells, ICC does not vary smoothly as a function of the energy ("bumps"). Also occurs in the Rösel tables (Raman).
  - Report file
    - Length of report may increase significantly
      - Only echo the ID record to the report file
    - Width of report will exceed 132 characters
      - Convert to HTML formatted file
  - Output file (CARDS.NEW) — Need to maintain downward compatibility
    - One "S G" with KC, LC, MC, NC+
    - Second "S G" record with NC, OC, PC, QC, and RC

Brookhaven Science Associates
U.S. Department of Energy

BROOKHAVEN NATIONAL LABORATORY

BRICC - 6

- Other considerations
  - $T_{1/2}$ dependencies on BE2↑'s as noted by C. Reich
  - I_{γ}-normalizations dependent on α_{tot}
  - Normalizations of I_{ce}
  - Intensity balancing
  - Explanatory material for users
    - Before cutoff date A, Hager & Seltzer and Dragoun *et al*. used except as noted.
    - Since cutoff date A, Band *et al.* used except as noted.
  - Built-in assumption of 3% uncertainty due to theory in some codes

Dissemination of ENSDF, Publications, and Services

Prepared for the
IAEA Nuclear Structure and Decay Data Network
Technical Meeting
Vienna, Austria
November 10 to November 14, 2003

Thomas W. Burrows

Dissemination of ENSDF, Publications, and Services – 2

- **Processing New Evaluations**
  - **New evaluations checked by the format and physics checking codes & errors are corrected.**
  - **Hard copy of the evaluation is for review & for final checking by the editor.**
  - **Elsevier publishes the final corrected evaluations in the Nuclear Data Sheets in eleven issues per year.**
  - **Elsevier continues to make available the contents of each NDS issue on the Web as Adobe Portable Document Format (PDF) files.**
  - **Starting with *Nuclear Data Sheets* 98 (2), the NNDC is providing the PDF directly to Elsevier.**

Dissemination of ENSDF, Publications, and Services – 3

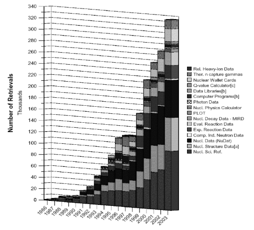
- Nuclear Wallet Cards
  - The 6th Edition of the Nuclear Wallet Cards was published in 2000 with a literature cut-off date of July 31, 1999.
  - The Wallet Cards Module of NuDat is updated every six months coinciding with the ENSDF distribution.
  - The US Department of Energy headquarters (Nuclear Materials Management & Safeguards System) has accepted the PDF version of the 6th Edition of the Nuclear Wallet Cards as the half-lives standard for all DOE inventory reporting.

Dissemination of ENSDF, Publications, and Services – 4

- **Online Data Services**
  - **Average yearly increase of 12% for retrievals between 2000 and 2002.**
  - **NSR and NuDat most popular with about 25% each of the 2002 totals.**
  - **Web retrievals dominate (94% of total in 2002).**

Dissemination of ENSDF, Publications, and Services – 5

NNDC On-Line Data Service, Web, & FTP Retrievals 1986-2003*



* Extrapolated as of September 30, 2003.
[a] Includes proton emitters (added to Web February 21, 2002).
[b] Removed from Online Data Services June 25, 2002.
[c] Added to Web September 11, 2001.

Dissemination of ENSDF, Publications, and Services – 6

- **Online Data Services (Continued)**
  - **Improvements (Web or FTP) since NSDD 2000:**
    - **Table of Magnetic Dipole Rotational Bands (A. Jain, A. K. JAIN, and B. Singh) added.**
    - **Proton Radioactivity Resources added.**
    - **Q-value Calculator added:**
      - **Decay Q-values, reaction Q-values and threshold energies, and atomic masses, binding energies, *etc*.**
    - **Table of Superdeformed Nuclear Bands and Fission Isomers (B. Singh, R. Zywina, and R. B. Firestone) added.**
    - **Table of Nuclear Moments (N. Stone) updated.**
    - **Linux versions added to ENSDF Analysis and Utility Codes distribution.**
    - **HTML tabular representation of ENSDF data improved.**
    - **Contributions to the ENSDF Evaluators' Training Workshop (April 2001) added to the ENSDF Evaluators' Corner.**
    - **HTML forms and CGI-scripts for MIRD and NuDat upgraded.**

Dissemination of ENSDF, Publications, and Services – 7

- **Online Data Services (Continued)**
  - **Digital Object Identifier (DOI) information added for APS and Elsevier journals.**
  - **NSR site using Sybase and Java Server Pages replaced site using MS SQL Server and Active Server Pages.**

Dissemination of ENSDF, Publications, and Services – 8

- **Online Data Services (Continued)**
  - **TELNET**
    - **This service is in maintenance mode.**
    - **In 2002, the Codes, Documents, and Libraries were removed from the Telnet service.**
    - **CGI scripts were recently added to the Web to allow users access to files they had placed in the Telnet open area.**
  - **Link Managers**
    - **NSR: currently being used on pages at the NNDC, the Oak Ridge RadWare site, TUNL, the IAEA Nuclear Data Section and its Brazilian mirror,** *et al*.
    - **ENSDF: not used in 2002, or in 2003 as of October 1, 2003.**

Dissemination of ENSDF, Publications, and Services – 9

- **Online Data Services (Continued)**
  - **Current Activities and Future Plans:**
    - **Major effort in converting the databases resident on the NNDC OpenVMS machine to Sybase relational databases on Linux or UNIX platforms & developing interfaces to the new databases using jsp (Java Server Pages) or Java servlets. These interfaces will have all the capabilities of the current Telnet and interfaces.**
    - **After database conversions are completed and tested, remaining portions of the NNDC site will be transferred.**
      - **Attempt to do this move in a transparent manner.**

Dissemination of ENSDF, Publications, and Services – 10

- **Network Support & User Services:**
  - Network Support:
    - ENSDF analysis & checking codes maintained, improved, and distributed.
    - Monthly NSR updates sent to evaluation centers for the A-chains assigned to them.
    - ENSDF and NuDat updates sent twice a year.
    - NSR updates sent every month.
    - ENSDF, NSR, and NUDAT updates sent to the IAEA Nuclear Data Section, the NEA Databank, the Obninsk Data Center, RFNC, Sarov and Slavutych, Ukraine.
    - Complete NSR and ENSDF retrievals are sent at the start of an evaluation to those who cannot access online the NSR or the ENSDF from the NNDC, or the NDS, IAEA.
    - Copies of hard-to-get references are sent to evaluators (with help from the NDP for older references).

Dissemination of ENSDF, Publications, and Services – 11

- **Network Support & User Services (Continued):**
  - User Services:
    - Special retrievals made from NSR and ENSDF:
      - Requests for these specialized retrievals are satisfied on a case-by-case basis.
      - Only if user needs cannot be met on line are requests processed in-house.
    - Hard copy and CD-ROM:
      - Nuclear Wallet Cards booklet distributed on request.
      - Some CD-ROM's distributed:
        - PCNuDat, ENDF, and ENDF Utility Codes

Status of the ENSDF Analysis & Utility Codes

Prepared for the
IAEA Nuclear Structure and Decay Data Network
Technical Meeting
Vienna, Austria
November 10 to November 14, 2003

Thomas W. Burrows

A. Changes since the last NSDD meeting
B. In progress and future plans

Status of the ENSDF Analysis & Utility Codes — 2

- Changes since the last NSDD meeting
  - Linux versions of all codes except RadList made available.
  - COMTRANS
    - Converted to FORTRAN 95 & ISAM dictionary replaced by direct access dictionary
    - Increased stability & other problems fixed
  - ENSDAT
    - Converted to FORTRAN 95 & ISAM dictionary replaced by direct access dictionary
    - ENSWIN replaced by option in ENSDAT to invoke a PostScript viewer

Status of the ENSDF Analysis & Utility Codes — 3

- FMTCHK
  - Several errors corrected and some changes in severity of messages.
  - Updated check on J field for new formalism of J, J1, … and added other checks to the J field.
  - Added warning on missing RI if absolute normalization, $E_\gamma \leq 400$ keV, and no α_{tot} but $I_{(\gamma+ce)}$ given on G record.
  - Allow non-unique forbidden UN for B and E records.
  - Added check to see if value for "FL=" consistent with E_{level}-E_γ.
  - Added checks for possible duplicate "S E" records.
  - Added check for capture fractions to be ≤1 and consistent with $I_\varepsilon/I_{\varepsilon+\beta+}$.

Status of the ENSDF Analysis & Utility Codes — 4

- PANDORA — Increased the allowed decay modes.
- RULER — Several problems fixed.

- In Progress and Future Plans
  - GAMUT — Converted to MS Windows by Dr. Choi.
    - Extensive testing required.
    - Upgrade to current ENSDF formats and standards.
    - Port to Linux and OpenVMS.
  - GTOL — Increase levels to 500 and gammas to 2000.
  - HSICC
    - Work in progress on converting the HSICC package to use the new Band, *et al*. ICC's.

Status of the ENSDF Analysis & Utility Codes — 5

- LOGFT
  - Logic from the LBNL program ft has been incorporated to calculate 3rd and higher order unique forbidden transitions.

    Extensive testing and intercomparison with LBNL Codes still remains before release.
  - Update to use the electron-capture data of Schönfeld, *et al*.
- RadList
  - Converting current in-house version of RadList to FORTRAN 95. Linux, MS Windows, and OpenVMS versions planned.
  - Add calculation of subshell conversion- & Auger-electron & X-ray intensities and improve calculation of continua spectra.
  - Incorporate logic from LOGFT after new version of LOGFT released.
- In calendar year 2005, maintenance of OpenVMS versions will cease.

ENSDF Analysis and Utility Codes Overview

Prepared for the
IAEA Nuclear Structure and Decay Data Network
Technical Meeting
Vienna, Austria
November 10 to November 14, 2003

Thomas W. Burrows

ENSDF Analysis and Utility Codes *Platforms*

- Most of the programs are available for the following:
  - ANS standard Fortran 77
  - Linux (Gnu f77 or Lahey-Fujitsu compiler)
  - OpenVMS
  - Windows 95/98/ME/NT/2000 (COMPAQ/DEC Visual Fortran)
- For Linux, OpenVMS, and Windows, executables are also provided.

ENSDF Analysis and Utility Codes *Overview*

- ADDGAM — Adds gammas to an adopted dataset
- ALPHAD — Calculates α R_0's, Hindrance Factors and theoretical $T_{½}(\alpha)$'s
- COMTRANS (Comments Translation) — Translates comment records in ENSDF dataset to a "rich text" format
  - **Should not** be used on ENSDF or XUNDL data submitted to the NNDC.
- DELTA — Analyzes angular correlation data (Does not use ENSDF-formatted files as input).
- ENSDAT (Evaluated Nuclear Structure Drawings and Tables) — Produces high quality drawings and tables in the Nuclear Data Sheets style
- FMTCHK (Format Checking) — Format and syntax checking

ENSDF Analysis and Utility Codes *Overview — 2*

- GABS — Calculates absolute ΔI_γ's and normalizations
- GTOL (Gamma to Level) — Determines level energies from a least-squares fit to E_γ's and feedings
- HSICC (Hager-Seltzer Internal Conversion Coefficients) — Interpolates internal conversion coefficients
- LOGFT — Calculates log *ft*'s, $<E_{\beta\pm}>$'s, $I_{\beta+}$, I_ε, and capture fractions
- NSDFLIB (ENSDF Library) — Support subprograms for many codes

ENSDF Analysis and Utility Codes *Overview — 3*

- PANDORA (Physics Analysis of Nuclear Data to Outline Required Adjustments) — Physics check of ENSDF data sets. Aids with adopted gammas and XREF
- RadList (Radiation Listing) — Calculates atomic & nuclear radiations. Checks energy balance
- RULER — Calculates reduced transition probabilities and compares to the Recommended Upper Limits (RUL)
- TREND (Tabular Representation of ENSDF) — Tabular display of ENSDF data

ENSDF Analysis and Utility Codes *Usage*

- All types of datasets
  - Applicable programs are FMTCHK, ENSDAT, PANDORA, and TREND.
  - FMTCHK should be run after any manual changes to the file.
  - ENSDAT may be used to visually check the data.
  - If you are considering combining several datasets (*e.g.*, from XUNDL), PANDORA may be useful.
  - TREND may be used to visually check the data.

ENSDF Analysis and Utility Codes
Usage — 2

- Adopted Levels, Gammas
  - Applicable programs are ADDGAM, GTOL, HSICC, PANDORA, and RULER.
  - ADDGAM and PANDORA are useful in constructing the dataset.
  - PANDOR used iteratively to aid in physics decisions, checking assignments, and updating source datasets based on changes in the adopted data.
  - GTOL useful only in obtaining the least-squares adjustment of the level energies.
    - Matrix may occasionally be singular.

Brookhaven Science Associates
U.S. Department of Energy

ENSDF Analysis and Utility Codes
Usage — 3

- RULER may be used in two modes:
  - Comparison mode to provide additional information in obtaining γ-multipolarity assignments.
  - Should also be run to provide the BEλW's and BMλW's.
  - HSICC should be run before RULER.
- HSICC should be run to provide the internal conversion coefficients.
  - Note that there is no need to delete the "S G" records generated by code.

Brookhaven Science Associates
U.S. Department of Energy

ENSDF Analysis and Utility Codes
Usage — 4

- Decay datasets
  - Applicable programs are ALPHAD (for α decay), GABS, GTOL, HSICC, LOGFT (for $\beta^{\pm}/\varepsilon$ decay), RadList, and RULER.
  - ALPHAD should be used to obtain the hindrance factors and, for even-even ground-state nuclei, R_0. For other nuclei, an R_0 must be supplied.
  - GABS may be used to combine the data from up to three sources to obtain I_γ-normalization (NR), the branching ratio (BR), and absolute I_γ's.
    - HSICC should run on the input data or the α's from the adopted dataset should be used.

Brookhaven Science Associates
U.S. Department of Energy

ENSDF Analysis and Utility Codes
Usage — 5

- GTOL may be used to:
  - Provide a least-squares adjustment of the level energies.
  - Check the uncertainties and placement of the γ's.
  - Obtain the intensities of particles feeding the levels.
    - Should be done before ALPHAD and LOGFT are employed.
  - May be useful in deriving I_γ-normalization (NR).
- HSICC may be used to:
  - Check experimentally measured α's against theory.
  - If the adopted α's are not used, to produce this information for the data set.
    - Should be done before using RadList.

Brookhaven Science Associates
U.S. Department of Energy

ENSDF Analysis and Utility Codes
Usage — 6

- LOGFT is required to obtain the log *ft*'s, $I_{\beta+}$ and I_ε, and partial electron-capture fractions.
  - Should be done before using RadList.
  - If one is not using measured intensities, GTOL should be used to obtain $I_{\beta-}$ and $I_{\varepsilon+\beta+}$.
- RadList should be used to:
  - Check the calculated energy deposited with that based the Q-value and branching ratio.
  - To compare to experimentally obtained X-ray intensities
  - Check results against integral measurements (*e.g.*, $<E_{\beta\pm}>$)
  - Unresolved discrepancies should be noted in the dataset.
  - HSICC and LOGFT should have been used before doing these checks.

Brookhaven Science Associates
U.S. Department of Energy

ENSDF Analysis and Utility Codes
Usage — 7

- RULER may be used to check or further limit multipolarities based on other methods (*e.g.*, from experimental conversion coefficients).

Brookhaven Science Associates
U.S. Department of Energy

ENSDF Analysis and Utility Codes
Usage — 8

- Reaction datasets
  - Applicable programs are GTOL, HSICC, and RULER.
    - For (thermal n,γ) datasets, RadList may also prove of use.
  - GTOL's primary use is to do a least-squares adjustment of the level energies and to check the uncertainties and placement of the γ's.
    - If ΔE_γ's are not given and a good estimate of these cannot be obtained, it may be better to use the author's level energy values.
    - Also useful for checking for intensity imbalance problems if relative intensities are given.

ENSDF Analysis and Utility Codes
Usage — 9

- HSICC may be used to check experimentally measured α's against theory.
  - Very useful to include α's and partial α's for (thermal n,γ) datasets.
- RadList may be used to check the energy balance of (thermal n,γ) datasets by "tricking" the program.
  - Change the DSID on the ID record to indicate IT decay
  - Add an appropriate Parent record (E_{level}=S_n)
  - Add a BR of 1.0 on the Normalization record.

ENSDF Analysis and Utility Codes
Additional Details

2001 ENSDF Evaluators' Workshop
(www.nndc.bnl.gov/nndc/evalcorner/workshop2001.html)

In particular:
www.nndc.bnl.gov/nndc/evalcorner/ensdfcodes2.pdf

NNDC Database Migration Project

Prepared for the
IAEA Nuclear Structure and Decay Data Network
Technical Meeting
Vienna, Austria
November 10 to November 14, 2003

Thomas W. Burrows
Charles L. Dunford

NNDC Database Migration Project — 2
Background

- Why the migration?
  - Replace obsolete hardware and software
  - Relational databases are an Industry Standard
    - Mature software
    - Large base of supporting software for administration and dissemination
    - Replication and synchronization tools
  - Improved user access
    - Interface
    - Speed
- Preliminary Investigations
  - NNDC - NSR
    - MS Access – Slow
    - MS SQL-Server/Active Server Pages (asp) for Web. Public since June 1999.
    - Sybase Adaptive Server Enterprise (ASE)/Java Server Pages (jsp). Replaced MS SQL in June 2002.
  - NDS – Nuclear Reaction Databases

NNDC Database Migration Project — 3
Background (cont.)

- Migration Issues
  - Software choice
  - Database design specification
  - Data and legacy code migration
  - Administration and dissemination code
  - Replication procedures
  - *Current production activities must be maintained during migration*
- Software Criteria
  - Support SQL, ODBC, and JDBC
  - Handle scope and scale of data center needs
  - Development tools
  - Replication support
  - Reasonable cost, including internet access
  - Available on multiple operating systems

NNDC Database Migration Project — 4
Background (cont.)

- Software tested
  - Extensive testing of Sybase Adaptive Server Anywhere (ASA) and Adaptive Server Enterprise (ASE), InterSystems Caché, Microsoft SQL Server, plus Java-native databases Pointbase and Cloudscape.
  - Less extensive investigation of Oracle, IBM DB2, MySQL, PostgreSQL.

NNDC Database Migration Project — 5
Current

- Relational Database Management System (RDBMS)
  - Sybase Adaptive Server Enterprise (ASE)
    - Relatively easy to move between different RDB systems (*e.g.*, MySQL, MS SQL-Server, or MS Access).
  - Structured Query Language (SQL)
  - Administrative tools (*e.g.*, loading or updating database or reports) written in Java
- Linux or UNIX platforms
  - Red Hat Linux for development machines and Web servers
  - Red Hat Linux or HPUX for database servers

NNDC Database Migration Project — 6
Current (cont.)

- MS Windows for Administrative Work
- Web
  - Apache Server with Tomcat
  - Java server pages (jsp) for nuclear structure data (NSR, ENSDF, NuDat)
  - Java servlets for nuclear reaction data (CINDA, CSISRS/EXFOR, ENDF)
  - Some PERL CGI scripts retained but rewritten to use PERL modules such as SybPERL or FreeTDS to access the databases.
  - Full functionality of the current Web and TELNET services
  - After thorough testing of the interfaces and databases, remaining Web pages will be transferred and the TELNET and anonymous FTP services will be terminated.

NNDC Database Migration Project — 7
Current (cont.)

- Legacy FORTRAN Codes
  - Database related – Write Java replacements or replace current DBMS/TEXT library routines with ones using a C/ODBC interface to the new databases
  - Publication codes – Replace current DBMS/TEXT library routines with ones using a C/ODBC interface to the new databases
  - ENSDF Analysis & Utility codes – Linux versions already exist for most of these.
  - Other codes – Port to Linux (g77 or Lahey-Fujitsu)

NNDC Database Migration Project — 8
Current (cont.)

- External Distributions & Other Collaborator Support
  - Exchange formats will be supported.
    - Stored as tables or binary large objects (BLOB's) in database.
  - Monthly NSR updates will be continued.
  - Twice yearly ENSDF/NuDat updates will be continued.
  - Future exchanges between dissemination centers (*e.g.*, NNDC and NDS) may be done using replication technology or XML.

NNDC Database Migration Project — 9
Current (cont.)

- The FTP site for depositing and picking up data (ftp.nndc.bnl.gov; username: bnlndc) will be retained if feasible.
  - If not feasible (*i.e.*, firewall problems at BNL or other institutions), a replacement will be provided, probably through the Web.

NNDC Database Migration Project — 10
Current (cont.)

- Current Status of Nuclear Structure Databases
  - NSR – Separate presentation
  - ENSDF
    - Includes Archival ENSDF and XUNDL. Prepublication ENSDF to be done.
    - Procedures developed to update ASE database from OpenVMS version.
    - Loading program improved to replicate sort order and provide the indexing of OpenVMS version.
    - Web interfaces under development.
    - Demonstration Web site up by end of 2003.
  - NuDat2 – Separate presentation
  - Completion of nuclear structure migration planned by the end of 2003.

NSR Modifications

- During spring/summer of 2003, all NSR administrative functions (entry preparation, keynumber assignment, dictionary maintenance, etc.) were moved to Linux/Sybase environment.
- Relational database management system (RDBMS) replaces Codasyl DBMS/Text library database on OpenVMS.
- OpenVMS version is still updated weekly with new and modified entries.

Multiplatform aspects of new NSR

- RDBMS software available from many vendors, for many platforms.
- In principle, centers wishing to maintain local instances of NSR can do so with compatible software of their choosing.
- New administration and dissemination programs written in platform-independent Java, using JDBC interface to the database.
- RDBMS-dependent portions of Java code in separate library, with documented interface.

Web-based dissemination of relational NSR

- Web-based retrieval of relational database available since 1999. Originally used Microsoft ASP technology, now uses Java Server Pages (JSP) and Apache/Tomcat server.
- Allows multi-parameter searches on indexed quantities such as author, nuclide, reaction ...
- Also provides for text search of title and keyword fields, and retrieval by keynumber.
- Most indexed quantities have “Browse” feature to help find valid criteria.

Digital object identifiers (DOI)

- DOI's are assigned by the publisher and registered with a DOI registration agency (see www.doi.org).
- They can be used to generate URL's which will redirect to publisher-maintained interface to the reference.
- Began adding DOI information to NSR entries in late 2002. Not currently distributed with exchange format, could be added in the future.

IAEA Coordinated Research Project:

"Development of Database for Prompt Gamma-ray Neutron Activation Analysis"

Led by: R. Firestone, Isotopes Project, LBNL

Participants: China, Hungary, India, Korea, US, Vietnam

Mission: To improve accuracy, completeness and availability of thermal (n,γ) data needed for prompt-gamma neutron activation analysis.

Status:

- Commenced November 1999, final meeting March 2003.
- Produced 'EGAF' (Evaluated Gamma-ray Activation File) database of 35,000 evaluated prompt and decay gamma-ray cross-sections for thermal-neutron capture on any stable element from H to U.
- Prepared TECDOC publication with CD-ROM (in press).
- Created web site (in press) and developed software for searching database on CD-ROM and on the web.
- Energies and cross sections adopted by the CRP will also be published in *Handbook of Prompt Gamma-ray Activation Analysis* (Kluwer).

Impact of EGAF on ENSDF

- ENSDF-format files will be available to us in the very near future, probably from a new database set up at NNDC to accommodate them.
- They will impact all existing thermal-neutron capture γ-ray datasets in ENSDF.
- For each nuclide there will be 2 or 3 datasets provided:
  1. Energies and cross sections adopted by the CRP (primary and secondary gamma rays).
  2. New data from elemental measurements at the Budapest reactor (not yet published).
  3. An evaluated dataset prepared independently by Reedy and Frankle (At. Data & Nucl. Data Tables **80**, 1 (2002)); available primarily for the lighter nuclides.
- Existing ENSDF datasets will need to be modified appropriately; the CRP (adopted) datasets can **not** replace them (they do not include the ENSDF file's comments, documentation, conversion data, etc.).

Examples

1. Data Adopted for CRP.

```
17O      16O(N,G) E=THERMAL: ADOPTED                    2003IAEA
17O  C   Evaluated Gamma-ray Activation File (EGAF).
17O2C    Evaluated by R.B. Firestone (LBNL).
17O  C   SIGMAN=0.000189 {I8}              ← Newly deduced σn
17O  C   SIGMAN=0.000190 {I19} (1981MuZQ)
17O  CG RI$ Elemental sigma(gamma) assuming %Abundance=99.757 16.
17O    N  1.00239 15         1.0
17O   CN  NR$ Isotopic sigma(gamma)=NR*RI.
17O 2CN  Divide by SIGMAN for intensity per neutron capture.
17O    L     0.0   5/2+              STABLE
17O    L    870.71  6 1/2+           179.2 PS  18
17O    G    870.68  6 1.77E-4 11
17O    L   3055.28 9 1/2-             0.08 PS   +6-4
17O    G   2184.42 7 1.64E-4   7
17O    L  4143.06 10 1/2+                    ← Newly deduced Sn
17O    G    1087.75 6  1.58E-4   7
17O    G    3272.02 8  3.53E-5 23
```

2. New Data from Budapest

```
17O      16O(N,G) E=THERMAL: BUDAPEST                   2003BUDA
17O  C   Budapest Reactor data measured with thermal beam.
17O  CG RI$ Elemental sigma(gamma) assuming %Abundance=99.757 16
17O    N  1.00239 15         1.0
17O    L       0.0      5/2+
17O    L    870.70  3 1/2+           179.2 PS 18
17O    G    870.68 3 1.75E-04 11
17O    L   3055.27 5 1/2-             0.08 PS  +6-4
17O    G   2184.38 4 1.75E-04 11
17O    L   4143.04  5 1/2+
17O    G    1087.71 3 1.51E-04  9
17O    G    3272.11 7 3.53E-05 25
```

3. Evaluation by Reedy and Frankle (Los Alamos)

```
17O      16O(N,G) E=THERMAL           1977MC05,1993TI07        LANL2002
17O   C            For energies of the gamma rays made by thermal-neutron
17O AC  capture with 16O, I used the level energies in Tilley et al. (1993)
17O BC  [1993Ti07]. For the gamma-ray intensities, I used McDonald et al.
17O CC  (1977) [1977Mc05]. The absolute error in the intensities is about +-3%
17O DC  (e.g., 18+-3%). Tilley et al. (1993) accepted these gamma-ray
17O EC  intensities and their errors. The set is complete.
17O   N  1.0
17O   L       0.0       5/2+
17O   L     870.73    1/2+
17O   G     870.71    100.000
17O   L    3055.36    1/2-
17O   G    2184.48     82.000
17O   L    3842.80     5/2-
17O   L    4143.33    1/2+
17O   G    1087.93     82.000
17O   G    3272.26     18.000
```

The Good News and the Bad

Not so Good!

- The existing ENSDF datasets are often VERY large and will need to be reworked.
- Both the CRP (adopted) and CRP (Budapest) datasets give **elemental cross sections** (not relative Iγ) in the RI field (so it is not immediately obvious which of the 'old' values has been changed).

On the Positive Side …

- Primary and secondary intensities are now available on the same scale.
- The intensity normalization has been done for us.
- We will gain access to a large volume of data from Budapest and some of those gamma-ray intensity and energy data will be superior to what we already have.

Annex 7. Proposals/Position Papers.

1. Response to Action 30 in NSDD2000
F.E. Chukreev, CAJaD, Kurchatov Institute, Russia.

2. Obtaining r_0 Parameters for HF Calculations of Alpha's from Odd-A and Odd-Odd Nuclei
Y.A. Akovali, ORNL, USA.

3 The Mentoring in Nuclear Information Technology (MINT) Initiative
M.S. Smith, ORNL, USA
R.A. Meyer, RAME', Inc., Teaticket, USA.

4. Beta Transitions (β^-, β^+, and ε decay)
Y.A. Akovali, ORNL, USA
B. Singh, McMaster University, Canada

5. Level Scheme Construction and Allocation of Transitions on the Basis of Ritz Combination Principle
I.A. Mitropolsky, Data Centre of PNPI, Gatchina, Russia.

6. CD-ROM Version of ENSDF
V.G. Pronyaev, Nuclear Data Section of IAEA, Austria.

Response to Action 30 in NSDD2000

F.E. Chukreev (CAJAD, Moscow)

In the cases, where level energy (A≤61) agrees with the formulae:

$$E(N,Z)= E_b(N,Z) - E_b(N + 1,Z - 1) + 1.484\ (Z - 1/2)/À^{1/3} - 1.293 \text{ MeV for } N>Z$$

$$E(N,Z)= E_b(N,Z) - E_b(N - 1,Z + 1) - 1.484\ (Z + 1/2)/À^{1/3} + 1.293 \text{ MeV for } N£Z$$

then isobaric spin =isobaric spin (g.s) +1 may be assigned for the level.

In the formulae ***E_b*** is binding energy.

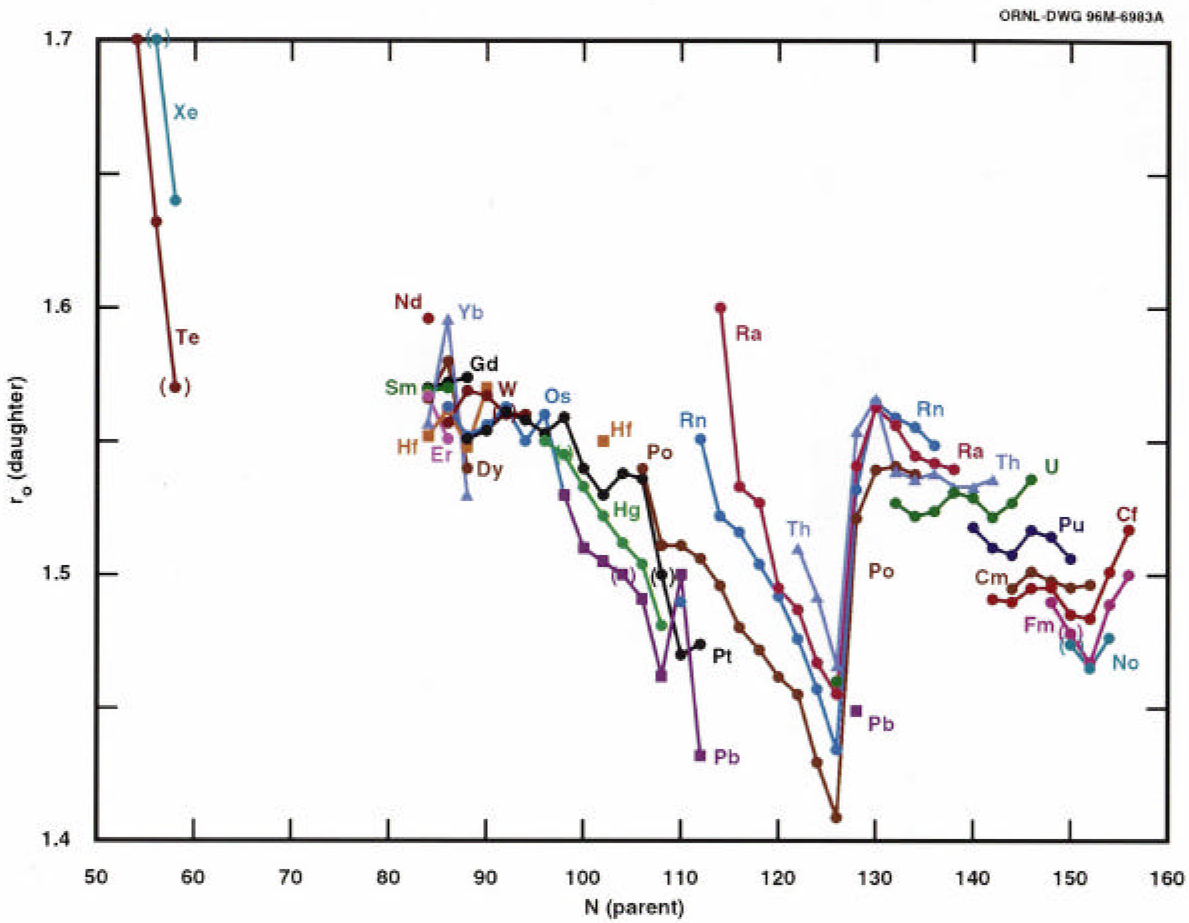
Reference:

2002Bo12 I.N.Boboshin, V.V.Varlamov, B.S.Ishkhanov. Bull.Rus.Acad.Sci.Phys. 66, 813 (2002)
Formula for Energy of First Excited Nuclear State with Isospin T>

Obtaining r_0 parameters for HF calculations of alpha's from odd-A and odd-odd nuclei

Yurdanur Akovali
Oak Ridge National Laboratory

In order to calculate hindrance factors for alpha's from an odd-A and from an odd-odd nucleus, the alpha-hindrance factors program requires a r_0 parameter as an input. These parameters are chosen from the r_0 values calculated for the even-even nuclei (see Y.A.Akovali, Nucl.Data Sheets 84,1 (1998); and figure below).


ORNL-DWG 96M-6983A
r_o (daughter)
N (parent)
1.7
1.6
1.5
1.4
50
60
70
80
90
100
110
120
130
140
150
160
Xe
Te
Nd
Yb
Gd
Sm
W
Os
Hf
Er
Dy
Hf
Po
Rn
Ra
Hg
Th
Pt
Pb
Po
Pb
Rn
Ra
Th
U
Pu
Cf
Cm
Fm
No

(1) For an even Z, odd N nucleus, the r_0 parameters may be chosen as the average of the neighboring N-1 and N+1 isotopes:

$$r_0(\text{even } Z, \text{odd } N) = \frac{1}{2}\left[r_0(Z,N-1) + r_0(Z,N+1)\right]$$

(2) For odd Z nuclei, the r0 plots are chosen to be in between the r_0 curves for the neighboring even-even nuclei. The r_0's for odd Z, even N then is the average of r_0's for Z+1 and Z-1 isotones:

$$r_0(\text{odd } Z, \text{even } N) = \tfrac{1}{2}\,[r_0(Z+1,N) + r_0(Z-1,N)]$$

(3) For odd Z-odd N nuclei, the r_0 curves for the odd Z nuclei described in above are used. As it is done for even-even nuclei, r_0's for the odd N nuclei are the average of r_0's for the adjacent even N nuclei with the same Z number:

$$r_0(\text{odd } Z, \text{ odd } N)$$

$$= \tfrac{1}{2}\,[r_0(Z,N+1) + r_0(Z,N-1)]$$

This is equivalent to averaging four r_0's of adjacent even-even nuclei.

$$r_0(\text{odd } Z, \text{ odd } N)$$

$$= 1/4\,\{r_0(Z+1,N+1) + r_0(Z+1,N-1) + r_0(Z-1,N+1) + r_0(Z-1,N-1)$$

The evaluators must use their judgements, and may exclude any of the r0's for the adjacent even-even nuclei in these averaging, depending on their accuracies, preciseness, and fit to systematic trend.

The Mentoring in Nuclear Information Technology (MINIT) Initiative

M. S. Smith, Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA
R. A. Meyer, RAME', Inc., Teaticket, MA, USA

In the United States, the nuclear data evaluation workforce is in crisis. There are currently only 8 ENSDF evaluators in the US Nuclear Data Program (USNDP), down 50% in 10 years. Of the remaining evaluators, 42% are retired, 50% are over age 60, and 83% are over age 55. Without some mechanism to bring young scientists into the program, the loss of the program's knowledge base is imminent.

This crisis could not come at a worst time, as US scientists prepare for the Rare Isotope Accelerator (RIA), a billion-dollar facility that is the top priority for new construction in nuclear physics. A major scientific goal of RIA is to explore the limits of stability by populating nuclei never before accessible in the laboratory. The US needs to build up its nuclear data evaluation infrastructure to prepare for the surge of information expected from RIA. Without action, the USNDP will not be able to respond to this, and other, future developments in nuclear science.

The **Mentoring in Nuclear Information Technology (MINIT)** Initiative has been developed and proposed as a possible mechanism to rebuild and revitalize the evaluation capabilities within the USNDP. The goal is to attract, train, and retain a new generation of evaluators into the USNDP, and transfer the expertise of senior evaluators to them. Because of the importance of computer programming and information technology to carrying out evaluations and disseminating them to the research community, these evaluators need to be equally comfortable with Java as they are with J^{π} values, with HTML as they are with Hamiltonians. We refer to these evaluators as Nuclear Information Technologists.

The approach proposed to attract and retain these scientists into the data program is based on mentoring, on coupling evaluations to research, and on promotion to research staff positions. The MINIT Initiative involves hiring, each year, two new postdoctoral appointees for three-year terms. During the first year, the appointees would train with experienced evaluators and information technologists at the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory, where the USNDP is managed. During the second and third years, these appointees would be on assignment at a USNDP site, where they would be mentored by senior evaluators and involved in research projects related to the their evaluation work. At the end of the third year, the best appointees would be promoted to research staff at the USNDP site. Some appointees may not choose to continue in nuclear data, but their working familiarity with both data techniques and the need for nuclear data work may greatly benefit our community in the future. The close coupling of research and evaluation activities has been strongly endorsed by formal reviews of USNDP activities, will help attract appointees and keep these at the cutting edge of science, and will be healthy for evaluation activities in the future.

It is envisioned that this program, managed out of the NNDC, will have a finite lifetime of approximately 6 years as required to change the demographics of the evaluation manpower workforce in the USNDP. MINIT requires new funding to cover the appointee salaries during their training period. Furthermore, a commitment to staff positions upon completion of their third year is absolutely crucial for the success of this program. Without a guarantee of available positions, the ability to attract and retain young scientists to the data program will be jeopardized. Given the shrinking evaluation workforce in the US, this investment is consistent with a commitment to continue nuclear data activities at a level that is only modestly enhanced from the current funding level. Some funding growth is anticipated to cover the increased activities of a revitalized evaluation program.

MINIT is a proactive initiative to bring young scientists into the USNDP, train them, and keep the best as staff. Establishing a USNDP-wide initiative like MINIT to revitalize the USNDP evaluation activities will ensure uniform training, quality control and strategic placement of staff hires across the program, and greater exposure for USNDP activities. MINIT will form a pipeline of young scientists into the USNDP, transfer the knowledge of senior evaluators to them, couple their evaluation activities to research, and retain the best appointees in permanent positions. It will help the USNDP reverse a negative trend in evaluation manpower and enable the program to respond to increased data needs expected from RIA and other future developments in nuclear science.

The MINIT Initiative may have some features that would provide useful to other international evaluation centers as they address their manpower issues. Hopefully, MINIT will spur some community-wide discussions of ways to proactively resolve the current manpower crisis in nuclear data evaluations.

Beta Transitions (β^-, β^+, and ε decays):

Y.A. Akovali, Oak Ridge National Laboratory
and
B. Singh, McMaster University
(October 27, 2003)

Beta transitions are classified as allowed or forbidden.

(a) Allowed transitions occur between states with the same parity ($\pi_i \bullet \pi_f$ =+1) and with a spin difference of J_i - J_f =ΔJ=0 or ±1.

The spins of the emitted beta and neutrino can couple to S=0 (called Fermi transitions) or to S=1 (called Gamow-Teller transitions). Transitions with ΔJ=±1 are pure Gamow-Teller decays, and pure Fermi transitions can only occur between J=0 nuclear states. All other ΔJ=0 transitions are mixed Fermi and Gamow-Teller decays.

(b) Forbidden transitions are further subdivided into their order of forbiddenness, the transitions becoming slower as the order increases. A general definition for an n–times forbidden beta transition is

$\Delta\pi=\pi_i \bullet \pi_f =(-1)^n$, ΔJ=n, n+1 (except first-forbidden which may have ΔJ=0)

ΔJ= n+1 transitions are called n^{th} forbidden-unique beta transitions

Therefore:

- first-forbidden transitions (n=1) occur between states with different parity ($\pi_i \bullet \pi_f$ =-1) and with a spin difference of ΔJ= 0, ±1, ±2; those with ΔJ= ±2 are specified as being first-forbidden unique;
- second-forbidden (n=2) beta transitions occur between states with same parity ($\pi_i \bullet \pi_f$ =+1) and ΔJ=±2, ±3; the ΔJ=±3 transitions being further specified as second-forbidden unique;
- for third-, fourth-forbidden, etc., transitions, n=3, 4, etc., respectively.

An allowed/forbidden beta transition may also be hindered or may be fast as a result of the nuclear structure of the initial and final states involved. See, for example, 1966Ko30 for a detailed discussion of the operators involved in various types of beta transitions. The selection rules for Nilsson states in deformed regions are tabulated in 1971El12. Violation of these selection rules could slow a beta transition. The beta transitions, therefore, may be hindered due to structures of the states involved. Definitions of some of the frequently used terms are given below:

- If a ΔJ=0 transition occurs between analog states (i.e. states having the same isospin and configuration), then the decay is very fast and is called "superallowed."
- Special cases of "allowed unhindered" (au) transitions in deformed region are discussed in section 33.
- "Isospin-forbidden" transitions refer to the decays between J=0 states of different isospin (*i. e.* non-analog states).
- "*l*-forbidden" transitions are those with Δ*l* > ΔJ, where Δ*l* is the change in *l* between the initial and final shell-model states.
- In deformed regions, if ΔK, the change in the K quantum number between the initial and final states, is larger than the spin change, ΔJ, the transition is called "K-forbidden."

A fast (strong) beta transition has a low *ft* value; forbidden transitions have larger *ft* values. Compilations of log *ft* values for known and well-established beta transitions appear, for example, in 1998Si17 and 1973Ra17.

The rules for various types of beta transitions are given below. Note that for nuclei at, or very near to, closed shells, values may be smaller. For example, in the mass region around Z=82, the upper limit of 5.9 given in #7 below could be 5.1.

#7 through #11 (No change)

See "b-Decay Rate Probabilities" on page vii.
Note that log $f^{1u}t$=log f¢t + 1.079

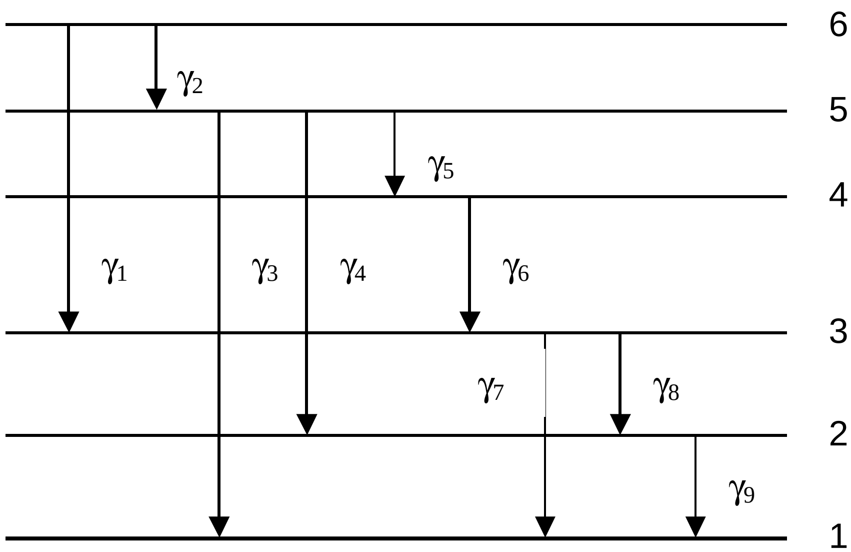
(Delete Note)

LEVEL SCHEME CONSTRUCTION AND ALLOCATION OF TRANSITIONS ON THE BASIS OF RITZ COMBINATION PRINCIPLE

I.A. Mitropolsky

Data Center of Petersburg Nuclear Physics Institute, Russia

Consider a scheme of levels with the energies $E_i^{(L)}$ and their errors $\Delta E_i^{(L)}$ and a set of unplaced γ-transitions $E_k^{(G)}$ with their quoted errors $\Delta E_k^{(G)}$:



In the ideal case we have got some identities:

$$E_6^{(L)} - E_1^{(G)} = E_4^{(L)} - E_6^{(G)} = E_1^{(L)} + E_7^{(G)} = E_2^{(L)} + E_8^{(G)},$$

$$E_6^{(L)} - E_2^{(G)} = E_4^{(L)} + E_5^{(G)} = E_2^{(L)} + E_4^{(G)} = E_1^{(L)} + E_3^{(G)}$$

and so on…

Theory

Ritz combinations e_m with their errors Δe_m are defined as

$$e_{ik}(\Delta e_{ik}) = E_i^{(L)}\left(\Delta E_i^{(L)}\right) \pm E_k^{(G)}\left(\Delta E_k^{(G)}\right) = e_{ik}\left(\sqrt{\left(\Delta E_i^{(L)}\right)^2 + \left(\Delta E_k^{(G)}\right)^2}\right)$$

If N Ritz combinations e_i with equal errors Δe are randomly distributed in energy interval E, then the probability of their *m*-multiple coincidence in the interval $2\Delta e$ is:

$$p_m = \frac{1}{(m-1)!}\left(\frac{2\Delta e N}{\mathrm{E}}\right)^{m-1} \exp\left(-\frac{2\Delta e N}{\mathrm{E}}\right)$$

For simplification we use here the Poisson distribution instead of binomial one. It is good approximation provided that $2\Delta e N/\mathrm{E} < 1$. The value $k = p_m N$ gives approximately the expected number of *m*-multiple coincidences.

In practice we calculate

$$p_m = \frac{1}{(m-1)!}\left(2\sum_{i=1}^{N}\Delta e_i \Big/ \mathrm{E}\right)^{m-1} \exp\left(-2\sum_{i=1}^{N}\Delta e_i \Big/ \mathrm{E}\right).$$

Algorithm

1. We calculate all Ritz combinations $\{e\}$ for all the given energies $\{E^{(L)}\}$ and $\{E^{(G)}\}$.

2. We sort the set of e_m in an increasing order:
$e_1(\Delta e_1) \leq e_2(\Delta e_2) \leq \mathrm{K} \leq e_{\max}(\Delta e_{\max})$.

3. Total energy scale $[e_1, e_{\max}]$ is divided in small intervals $\{\mathrm{E}\}$ (50÷100 keV).

4. Consider that in an interval E we have got N Ritz combinations, then we can calculate the mean error $\Delta e = \sum_{m=1}^{N} \Delta e_m \Big/ N$, the probable number of chance coincidences $n = 2\sum \Delta e / \mathrm{E}$, and multiplicity m of the coincidences for some postulated, in advance, probability, say, $p_m < 0.01$.

5. Then starting with $i = 1$, we check energy-coincidence $x_{ik} = e_k - e_i$ of some combinations nearest to i-th one, provided that $x_{ik} < A(\Delta e_i + \Delta e_k)$, where $k = i + m - 1$, and $A \approx 1$.

6. We calculate the probability of the chance coincidence $p_m(x_{ik})$. If the value is too large, say $p_m > 0.01$, we reject this set and go back to point #4 with $i = i + 1$.

7. The points #4 and #5 are reiterated to choose from all sets $\{x_{ik}\}$ the set with a minimum probability.

Applications

1. Level scheme of ^{242}Am (Y.A. Akovali, *NDS, 2002, v.96, p.177*) includes 38 excited states and places 118 transitions out of 246. It has χ^2=6.6 and 10 transitions with uncertainty between 3 and 8 σ. With these 10 transitions removed, the χ^2 becomes 1.9, and all transition have $\Delta E < 3s$.

Then using the combinatorial method, the scheme was extended by S. Sakharov to 73 excited states and 208 transitions with χ^2=1.26, and 9 of 10 above mentioned transitions included with $\Delta E < 1s$.

2. Old scheme of ^{132}Ba (Yu.V. Sergeenkov, *NDS, 1992, v.65, p.277*) contained 25 levels and 85 transitions. New scheme (A.A. Rodionov and B. Singh, *NDS* in preparation) includes 97 levels and 320 allocated transitions. Many levels were introduced only by 1 (15 levels) or 2 (5 levels) transitions! The scheme has χ^2=2.4 with assumed transition errors $\Delta E^{(G)} = 0.1$ keV. There are 11 transitions with uncertainty $\Delta E > 3s$, 22 – with $2s < \Delta E < 3s$, and only 210 transitions with $\Delta E < 1s$.

To prove the method, we took all 25 old levels plus 14 the best new levels as given above and removed from the set of new transitions all old ones. The Ritz combination method gave us the scheme with 63 levels and 210 placed transitions. It had χ^2=1.7 and $\Delta E < 3s$ for all transitions. The method confirmed all 39 levels with new transitions!

At last, for all new transitions we get the scheme with 63 levels and 283 allocated transitions. It has χ^2=1.4, for all transitions $\Delta E < 3s$, and 187 transitions have $\Delta E < 1s$.

Conclusion

The combinatorial method is *a priori* effectively working for the levels, which cannot be obtained by a method of coincidences "from below". For example, isomer levels or the levels, which decay by strongly converted transitions.

This method is a good means for independent checking of complex level schemes in the evaluation procedures.

No attempt has been made to take intensities and multipolarities of the transitions into account, so some of the proposed levels may not survive. It is for the evaluator to make further judgments.

CD-ROM version of ENSDF

V.G. Pronyaev

Nuclear Data Section, IAEA

6 November 2003

"CD-ROM solution" – database and retrieval system aimed on extensive personal use and integration with local applications.

This can give two major advantages to the CD-ROM users, comparing with the Internet users:

- Larger functionality
- Higher effectiveness
- Possibility to develop new applications and user-specific requests.

Other reasons why ENSDF should be on CD-ROM if we have INTERNET:

- Some user still have no or no good access to the World Area Network (WAN) – with a rate below 20 kB/sec the retrieval and downloading of data can be a boring process. IAEA has many such users.
- Results of the retrievals requested by the users in RDB environment are less controlled as before (in FORTRAN formulated requests with a limited number of parameters). They can be large in size. Even with good network performance the downloading files with a size larger than 5 MB is not simple and time consuming. Inclusion of the graphics in the retrieval option may substantially increase the size of the transferred files.
- "CD-ROM" solution at present allows create new relations between client (user) and server (master file keeper). Eg., "installing CD-ROM" you can use remote database server for the up-to-date retrievals of the requested data sets with the following processing of the data (running different applications) and their presentation in the forms which require large memory at the local PC. Then the size of the files transferred through network will be minimal.

NuDat (and PC NuDat - CD-ROM with NuDat) was good example of (partial) ENSDF on CD-ROM with some additional data processing and presentation to satisfy the needs of the users. NuDat as interface package to the ENSDF is most popular at our Web site and on number of requested CD-ROMs. With migration of ENSDF at RDB environment, the number of parameters (and their combinations) on which retrievals could be done could be substantially increased. CD-ROM version of ENSDF on its functionality will be equal or higher comparing with Web retrieval version. This naturally requires the full ENSDF database on CD-ROM.

The modern retrieval system on CD-ROM with a full-scale EXFOR/CINDA database developed by V. Zerkin (NDS) can be shown during the demonstration session (planned for Friday, 14:00). The main features of the EXFOR/CINDA CD-ROM are the following:

1. CD-ROM does not require any installation, the retrievals can run from CD-ROM or with easy copying of the files on HD.

2. Larger functionality and similar layouts of the Web EXFOR retrievals are preserved at the CD-ROM (including interactive data plotting capabilities).

3. Flexible configuration allows to retrieve data can be done either from database at local PC as well as from remote database through LAN or via Internet.

4. CD-ROM retrieval version can be run at PC with Windows or Linux and does not depend much from commercial software vendors.

5. Preparing the CD-ROM version authentic to the Web version requires the contribution into programming only once. This is done for EXFOR/CINDA reaction database and experience accumulated can be used for NSDD databases.

To prepare ENSDF CD-ROM with version authentic to the ENSDF Web retrieval version, as well as to create different applications with direct access to the ENSDF, developed schemes, tables, data processing programs (if any) and pages with request forms should be available to the developer.

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
cable: INATOM VIENNA
telex: 1-12645
telephone: (43-1) 2600-21710

Online: TELNET or FTP: iaeand.iaea.org
username: IAEANDS for interactive Nuclear Data Information System
usernames: ANONYMOUS for FTP file transfer;
FENDL2 for FTP file transfer of FENDL-2.0;
RIPL for FTP file transfer of RIPL;
NDSONL for FTP access to files saved in "NDIS" Telnet session.
Web: http://www-nds.iaea.org