https://doi.org/10.61092/iaea.ayxq-8e02

IAEA
International Atomic Energy Agency

INDC(NDS)-0733
Distr. Web G,ND

INDC International Nuclear Data Committee

Summary Report of an IAEA Technical Meeting

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

Lawrence Berkeley National Laboratory, Berkeley, USA

22 – 26 May 2017

Prepared by

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November 2017

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Printed by the IAEA in Austria

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Abstract
The 22nd meeting of the International Network of Nuclear Structure and Decay Data Evaluators was convened at the Lawrence Berkeley National Laboratory, Berkeley, USA, from 22 to 26 May 2017 under the auspices of the IAEA Nuclear Data Section. This meeting was attended by 38 scientists from 12 Member States and the IAEA, all of whom are concerned primarily with the measurement, evaluation and dissemination of nuclear structure and decay data. A summary of the meeting, data centre reports, various proposals considered, technical discussions, actions agreed by the participants, and the resulting recommendations/conclusions are presented within this document.

November 2017

GLOSSARY

A	Mass Number
ADNDT	Atomic Data and Nuclear Data Tables
ALPHAD	ENSDF analysis program
AMDC	Atomic Mass Data Centre
AME	Atomic Mass Evaluations
ANL	Argonne National Laboratory, USA
ANU	Australian National University
ATOMKI	Institute of Nuclear Research of the Hungarian Academy of Sciences
A2, A4	Coefficients of Legendre expansion of γ-γ directional correlation
BIPM	Bureau International des Poids et Mesures, France
BMLW	Reduced magnetic transition probability in Weisskopf units (ENSDF)
BNL	Brookhaven National Laboratory, USA
BR	Branching Ratio
BrIcc	Program to calculate Band-Raman internal conversion coefficients
CD-ROM	Compact disk with read-only memory
CE	Conversion Electron
CEA	Commissariat à l'Energie Atomique (French Atomic Energy Commission)
CNDC	China Nuclear Data Centre, Institute of Atomic Energy (CIAE)
CRP	Coordinated Research Project (IAEA)
CSNSM	Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, France
DDEP	Decay Data Evaluation Project
DDG-NA	Deputy Director General of the Department of Nuclear Sciences and Applications (IAEA)
DIR-NAPC	Director of the Division of Physical and Chemical Sciences of the Department of Nuclear Sciences and Applications (IAEA)
DELTA	ENSDF analysis program
DOE	U.S. Department of Energy
EADL	Evaluated Atomic Data Library
EC	European Commission
EC-Beta+	Electron capture-β^+ decay
EFG	Electric field gradient
EGAF	Evaluated Gamma-ray Activation File
EMPIRE	System of codes for nuclear reaction calculations
ENDF	Evaluated Nuclear Data File
ENSDAT	ENSDF analysis program
ENSDD	European Nuclear Structure and Decay Data Network of Evaluators
ENSDF	Evaluated Nuclear Structure Data File
EU	European Union
EURATOM	European Atomic Energy Community
EXFOR	EXchange FORmat: Computer-based system for the compilation and international exchange of experimental nuclear reaction data
fm	femtometer
FMTCHK	ENSDF analysis program
FO	Frozen Orbital
FP7 ENSAR	7th Framework Programme, European Nuclear Science and Applications Research (ENSAR)
FP7 ERA-NET	7th Framework Programme, European Research Area (ERA)
FTE	Full Time Equivalent
GABS	Gamma ABSolute: ENSDF analysis program
GAMUT	Computer code for gamma-ray energy and intensity analyses of data from ENSDF
GANIL	Grand Accélérateur National d'Ions Lourds, France
GND	General Nuclear Database

GSI	Gesellschaft für Schwerionenforschung mbH, Germany
GTOL	ENSDF analysis program
HF	Hindrance Factor
HSICC	Program to calculate Hager-Seltzer internal conversion coefficients
IAEA	International Atomic Energy Agency
IC	Internal Conversion
ICC	Internal Conversion Coefficients
ICRM	International Committee for Radionuclide Metrology
ICTP	International Centre for Theoretical Physics, Italy
IFIN-HH	Horia Hulubei Institute of Physics and Nuclear Engineering, Romania
IIT	Indian Institute of Technology
IMP	Institute of Modern Physics, Chinese Academy of Sciences, China
INDC	International Nuclear Data Committee
IP	Isotopes Project at LBNL, now called Nuclear Data Groupof LBNL+UCB
IPF	Internal Pair Formation
JAEA	Japan Atomic Energy Agency
Jπ/JPI	Spin and Parity
K	Angular momentum projection on the nuclear symmetry axis
LANL	Los Alamos National Laboratory, USA
LBNL	Lawrence Berkeley National Laboratory, USA
LiveChart	Interactive nuclear structure and decay database (predominantly from ENSDF)
LNHB	Laboratoire National Henri Becquerel, France
LLNL	Lawrence Livermore National Laboratory, USA
LOGFT	ENSDF analysis program
M	Transition multipolarity
MR	Mixing ratio
MSU	Michigan State University, USA
MULT	Multipolarity
MySQL	Relational database engine
NAA	Neutron Activation Analysis
NDP	Nuclear Data Project, Oak Ridge National Laboratory, USA
NDS	Nuclear Data Sheets; journal devoted primarily to ENSDF data
NDS-IAEA	Nuclear Data Section, IAEA
NDSPUB	ENSDF code that produces PS/PDF for *Nuclear Data Sheets*
NIPNE	National Institute of Physics and Nuclear Engineering, Romania
NIST	National Institute of Standards and Technology, USA
ND	Nuclear Data
NNDC-BNL	National Nuclear Data Center, Brookhaven National Laboratory, USA
NRM	Normalized Residual Method
NSCL	National Superconducting Cyclotron Laboratory, USA
NSDD	Nuclear Structure and Decay Data network
NSR	Nuclear Science References – bibliographic file
NUBASE	Experimental nuclear properties database
NuDAT	Interactive nuclear structure and decay database (predominantly from ENSDF)
NuPECC	Nuclear Physics European Collaboration Committee
NuPNET	Nuclear Physics Network
NWC	Nuclear Wallet Cards
OECD	Organization for Economic Co-operation and Development
ORNL	Oak Ridge National Laboratory, USA
PANDORA	ENSDF analysis program
PNPI	Petersburg Nuclear Physics Institute of the Russian Academy of Sciences
RADLST	ENSDF analysis code that calculates emitted radiation based on ENSDF
RIKEN	Japan's largest research organization for basic and applied science
RIPL	Reference Input Parameter Library
RUL	Recommended Upper Limit

RULER	ENSDF analysis program
SHE	Super Heavy Elements
SQL	Structured Query Language
TJ^{π}	Proposed theoretical or recommended J^{π}
TUNL	Triangle Universities Nuclear Laboratory, USA
USNDP	US Nuclear Data Program
UCB	University of California at Berkeley
WPEC	NEA Working Party on International Evaluation Cooperation
XML	eXtensible Markup Language
XUNDL	Experimental Unevaluated Nuclear Data List

A-chain evaluation	Mass-chain evaluation: best data for the structure and decay of all nuclides with the same mass number.
Horizontal evaluation	Best values of one or a few selected nuclear parameters for many nuclides irrespective of their mass number.

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Foreword

Regular biennial meetings of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators are held under the auspices of the IAEA. The network consists of evaluation groups and data service centres in several countries, and has the objective of providing up-to-date nuclear structure and decay data for all known nuclides by means of the evaluation of all relevant experimental measurements. Data resulting from this international evaluation collaboration are included in the Evaluated Nuclear Structure Data File (ENSDF) and published in the journals *Nuclear Physics A* and *Nuclear Data Sheets* (NDS). The results represent the recommended "best values" for the various nuclear structure and decay data parameters at the time of evaluation. These data and bibliographic details are also available through the World Wide Web, CDs, wall charts of the nuclides, Nuclear Wallet Cards and other such media.

US efforts are coordinated by the Coordinating Committee of the US Nuclear Data Program, and the ENSDF master database is maintained by the US National Nuclear Data Centre at Brookhaven National Laboratory. These data are also available from other distribution centres including the IAEA Nuclear Data Section.

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

(a) coordination of the work of all data centres and groups participating in the compilation, evaluation and dissemination of NSDD;

(b) maintenance of and improvements to the standards and rules governing NSDD evaluations;

(c) review of the development and common use of computerized systems and databases maintained specifically for this activity.

Detailed studies and discussions are undertaken over a five-day period. This document represents a summary of the network meeting held at the Lawrence Berkeley National Laboratory, Berkeley, USA, from 22 to 26 May 2017. Nuclear data specialists from twelve countries along with IAEA staff attended this meeting to discuss their work as well as problems of common interest, particularly with respect to the active membership of the multinational mass chain evaluation team responsible for ENSDF.

The first two days were dedicated to a combination of organisational, administrative and technical reviews of mass-chain activities and horizontal evaluations, and the progress made and problems encountered during the previous two years. As agreed between the participants, significant segments of the third and fourth days were committed to three parallel subcommittee meetings and subsequent joint sessions devoted to (a) Policies and Procedures, (b) Codes and Formats, and (c) Experimental activities. The final day focussed on an IAEA project to improve specific ENSDF analysis codes, and the development of new codes for application to ENSDF. Other relevant measurements, planned tabulations and new facilities were also discussed

The uncertain future of the network, attributed to the ageing of the majority of existing evaluators and the observation that evaluators are overburdened with many other research activities and duties, remains an important issue, and alternative ways of organising ENSDF evaluations continue to be discussed in this context. Under these circumstances, Member States were urged to support the continuing efforts of the network to train new evaluators by providing the proper working environment in their respective institutions. The adopted agenda for the meeting is listed in Annex 1, and a list of participants is given in Annex 2.

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
16. Hamilton, Canada	06 – 10.06.2005	INDC(NDS)-0476
17. St. Petersburg, Russia	11 – 15.06.2007	INDC(NDS)-0513
18. Vienna, Austria	23 – 27.03.2009	INDC(NDS)-0559
19. Vienna, Austria	04 – 08.04.2011	INDC(NDS)-0595
20. Kuwait City, Kuwait	27 – 31.01.2013	INDC(NDS)-0635
21. Vienna, Austria	20 – 24.04.2015	INDC(NDS)-0687
22. Berkeley, USA	22 – 26.05.2017	INDC(NDS)-0733

1. INTRODUCTION

The role of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators is threefold: first, the compilation, evaluation and dissemination of nuclear structure and decay data; second, the maintenance and improvement of the standards and rules governing nuclear structure and decay data evaluations; and third, monitoring and reviewing the development and use of the computerized systems and databases maintained specifically for such activities. A primary aim of the network is that accurate and freely available data are provided to the user community so as to enhance the quality and reliability of their work. The IAEA Nuclear Data Section takes on the role of coordinator of the NSDD Network, and at the same time monitors and reviews the development and use of the computerized systems and databases maintained for such activities to ensure the smooth dissemination of nuclear structure and decay data.

Delegates to the 22nd meeting of the International NSDD Evaluators' Network were welcomed by the Director of the Division of Nuclear Science, LBNL, Prof. Barbara Jacak, and the Director of the Nuclear Science and Security Consortium, Prof. Jasmina Vujic, who both stressed the importance of all relevant measurement and evaluation programs and the need to maintain significant coordination efforts. Lee Bernstein (LBNL), the local organiser of the meeting, also welcomed participants and provided some useful information regarding the venue and other local arrangements. Finally, Paraskevi Dimitriou (IAEA, Nuclear Data Section) welcomed all attendees, emphasised full IAEA-NDS commitment to the support and coordination of network activities, and thanked LBNL staff for their willingness to host this particular biennial meeting.

Prior to the start of the main technical discussions of the network meeting, fulsome reviews and well-deserved tributes and thanks were paid to Jagdish Tuli, Balraj Singh, Rick Firestone and Coral Baglin (who were all in attendance) for their many impressive years of dedicated work undertaken on nuclear data and more specifically the ENSDF project and related studies. A series of short speeches and visual presentations initiated the proceedings, and were made by Eddie Browne (Jagdish Tuli), Alan Nichols (Jagdish Tuli and Balraj Singh), Lee Bernstein (Rick Firestone) and Shamsuzzoha Basunia (Coral Baglin).

The Agenda was approved as listed in Annex 1. E.A. McCutchan (NNDC, BNL) and P. Dimitriou (IAEA, Nuclear Data Section) were elected to co-chair the meeting at appropriate times, and A.L. Nichols (University of Surrey) was nominated to be rapporteur for the meeting. Thirty-eight nuclear data specialists attended this meeting from twelve countries, representing the majority of data evaluation and dissemination centres, and new evaluation groups (Annex 2).

A list of all ENSDF evaluation centres and groups is given in Annex 3, along with their mass-chain evaluation responsibilities as assigned for 2015-2017. Representatives from the individual mass chain evaluation centres presented progress reports on their NSDD studies, and all of these status reports can be found in Annex 5. Apart from the status reports, other technical reports on horizontal evaluations, databases, and analysis codes are included in the main body of the report. Technical presentations made by participants are available on the IAEA NSDD website, and summaries are provided in Annex 6. Links to all the reports and presentations given during the meeting are listed in Annex 7.

The first two days were primarily devoted to administrative and organisational issues, in particular the discussion of actions from previous meetings, proposals for two new Data Centres, the presentation of reports by evaluation centres, as well as reports on the USA and the IAEA Nuclear Data Programmes, the network organisational review, workshops, horizontal evaluations and databases. The final three days focussed on a wide range of technical matters in the form of three parallel subcommittees dedicated

individually to (a) Policies and Procedures, (b) Codes and Formats, and (c) Experimental activities, along with consideration of various new proposals considered in joint session. A list of actions was prepared, indicating those responsible for implementation over the forthcoming two years (see Annex 4). Continuous, Ongoing and Pending Actions list was separated into two lists, one containing the continuous, ongoing and pending actions from this and previous meetings, and the other containing a list of more permanent recommended procedures that evaluators should follow when performing their evaluations.

The meeting concluded with the announcement that the next meeting will be held in the spring of 2019, at IAEA Headquarters, Vienna International Centre, Vienna, Austria.

2. ADMINISTRATIVE MATTERS AND REPORTING

2.1. New Data Centres

The establishment of two new ENSDF Data Evaluation Centres was proposed that were subsequently approved and introduced to the network:

Cyclotron Institute, Texas A&M University, USA (N. Nica and J.C. Hardy): The evaluation effort at Texas A&M University started just over 12 years ago under the guidance of NNDC staff, resulting in the publication to date of 14 mass chains in *Nucl. Data Sheets* with others in the pipeline. Evaluation effort will be maintained at approximately 0.7 FTE devoted to the production of one major ENSDF mass-chain evaluation per fiscal year. This new data centre could take full responsibility for 9 mass chains (140, 141, 147, 148, 153, 155, 157, 158 and 160). Work will also continue on highly-relevant experimental studies of specific internal-conversion coefficients to significant accuracy. The Director of the Cyclotron Institute had been consulted, and approved the operation of an ENSDF Data Evaluation Centre at Texas A&M University. The establishment of the Texas A&M Evaluation Data Centre was endorsed by members of the network.

Department of Nuclear Engineering, University of Sofia "St. Kliment Ohridski", Bulgaria (S. Lalkovski): After undertaking equipment development initiatives in the UK and various nuclear data measurements worldwide from 2004 onwards, S. Lalkovski has become a permanent member of staff in the Department of Nuclear Engineering at the University of Sofia, Bulgaria. Since 2006, he has maintained an active interest in compiling and evaluating mass-chain data for ENSDF, with four full mass-chain evaluations published in *Nucl. Data Sheet*s from 2007 to date along with modest contributions to XUNDL. If approved, he would welcome responsibility for five mass chains (106-108, 111, 112) for the next ten years. Evaluation effort will be maintained at approximately 0.2 FTE, while work would also continue on further nuclear data measurements. After some discussion, Lalkovski was advised to seek full written approval from the appropriate professorial head of the Department of Nuclear Engineering, which he was able to seek and obtain before the end of the network meeting. Thus, the Department of Nuclear Engineering at the University of Sofia was endorsed by the members of the network to become a recognised ENSDF Data Evaluation Centre.

2.2. Network Membership

USA membership: Currently USA membership is composed of NNDC, NDP/ORNL, LBNL/UC Berkeley, ANL, MSU, TUNL and Texas A&M. From an administrative and budgetary point of view, Balraj Singh remains affiliated with NNDC-BNL.

Non-USA membership: Bulgaria will be added to the non-USA list of Data Centres, defined in terms of both institute and country.

A proposal from RIKEN, Japan, to contribute to the compilation effort of data produced by the facility (XUNDL) and eventually to evaluate data was fully endorsed at the previous network meeting in 2015. Based on a report from Prof. H. Sakurai submitted to the NSDD Scientific Secretary, a permanent RIKEN staff has already been assigned the task of compilation for XUNDL and is currently being trained by the Japanese ENSDF evaluator H. Iimura. There are plans for him to visit F.G. Kondev at ANL for special training on the preparation of XUNDL datasets.

2.3. European Effort

European contributions to the ENSDF evaluation effort remain low, bearing in mind the number of large-scale experimental facilities throughout Europe producing significant amounts of nuclear structure and decay data. European research and applications groups are also among the greatest users of ENSDF (ENSDF database and *Nuclear Data Sheets*). Currently, there are only three ENSDF Data Centres in Europe (ATOMKI, Hungary, IFIN-HH, Romania, and the newcomer Department of Nuclear Engineering, University of Sofia, Bulgaria). As noted at previous network meetings, there is a continued lack of funding at both the overall European and national levels. All existing nuclear data activities in Europe are funded through individual grants which have limited duration and are non-renewable.

Balabanski reported on the formation of a European NSDD consortium which liaises closely with WG6 of the Nuclear Physics European Collaboration Committee (NuPECC) on matters related to the compilation, evaluation and dissemination of nuclear structure and decay data. This group consists of Bulgaria, Greece, Hungary, Romania and Turkey, for whom representatives held a special meeting at MTA Atomki, Debrecen, on 29 January 2016 to discuss the European NSDD shortfall. The meeting recommended two main actions, both of which have been accomplished:

- present a paper on the European NSDD shortfall,

- liaise with NuPECC to include recommendations in favour of nuclear structure and decay data evaluation in the new NuPECC Long-Range Plan.

Identified within the NuPECC 2017 long-range plan released in June 2017 as “applications and societal benefits”, the consortium in collaboration with the NSDD network and the European scientific community should ensure that the new measurements performed in European facilities are incorporated promptly in the available databases, and are therefore used in both reaction modelling and evaluations that are important for energy and non-energy applications. Two further noteworthy recommendations were also formulated in the long-range plan:

- support activities related to the compilation, evaluation and dissemination of nuclear structure and decay data in Europe;
- maintain a high level of expertise in nuclear data evaluation to meet the requirements of a continuously developing European research and applied sciences landscape through targeted training and mentorship schemes.

In spite of the significant efforts made in the past decade to organize and apply for European funding for mass chain evaluations (financial support from IAEA since 2006; IAEA discussions with potential European evaluators and EC laboratory directors, as well as contacts with EURATOM, FP7 ENSAR committee, NuPECC and NuPNET project), there has been no success and little to no change in attitude from potential funding bodies within Europe.

However, the incorporation of the two above-mentioned recommendations supporting ENSDF evaluations in the 2017 NuPECC long-range plan under “applications and societal benefits” is expected to lead to better opportunities for ENSDF evaluators in Europe to access such funding.

2.4. Status of NSDD Evaluators' Network

As noted at the previous network meeting in 2015, IAEA report INDC(NDS)-0421 contains descriptions of the structure, principal activities and products of the Nuclear Structure and Decay Data Evaluators' Network. This IAEA document constitutes a reference document one can use when referring to the status of the NSDD evaluators' network. As previously actioned, the most recent version has been revised over the course of 2015/16 by the network Scientific Secretary (P. Dimitriou, IAEA-NDS) in consultation with the ENSDF Coordinator (E.A. McCutchan, NNDC-BNL). A draft is available on the IAEA NSDD web page for comments, suggestions and modifications prior to publication.

2.5. Organisational Review

2.5.1. XUNDL (E.A. McCutchan, NNDC-BNL)

With effect from October 2015, E.A. McCutchan (NNDC-BNL) took over from Balraj Singh as coordinator of XUNDL. A primary aim of this work is to undertake the critical compilation of recent nuclear structure publications within one month of their appearance in the public domain. Furthermore, experience has shown that such timely compilation of data helps to identify issues and problems within the published data that can be frequently resolved in useful correspondence with the original authors and aid considerably in the future ENSDF evaluation.

Throughout the course of 2015, 630 data sets were assembled for XUNDL from 360 papers, while equivalent figures for 2016 were 549 data sets from 289 papers. These XUNDL data sets for 2016 were compiled by the following data centres:

Data Centre	Papers	Data sets
McMaster University	84	189
TUNL	43	58
Millsaps College	40	59
BNL	39	75
MSU	29	57
ORNL	26	39
LBNL	11	34
UCB	8	10
ANL	7	26
international	2	2

Other points of note include the adoption of a new distribution scheme that utilizes Google Drive, and the introduction of XUNDL compilations as training exercises in the biennial IAEA-ICTP NSDD evaluation workshop. At the present time, the XUNDL database totals 7275 data sets for 2506 nuclides, and is maintained up-to-date at an average rate of 300 papers per year. Current commitment to XUNDL effort is sufficient to cover the compilation of all major experimental nuclear structure and decay journals.

2.5.2. ENSDF (E.A. McCutchan, NNDC-BNL)

As co-ordinator of the ENSDF evaluation effort, E.A. McCutchan (NNDC-BNL) provided a detailed overview of the current status of ENSDF. As of March 2017, the following are the important summary statistics for ENSDF:

Datasets: 18765 in early 2017, and 18261 in 2015

Nuclides: 3325 in early 2017, and 3261 in 2015

Evaluated 220 nuclides (12 mass chains) in 2016, and 250 nuclides (13 mass chains) in 2015

ENSDF is now updated only once per month, and all archives are available for download on the NNDC website, whereas XUNDL is still archived on a 6 month cycle. A listing of the status of mass-chain processing is provided on the NNDC website, in the Evaluator's Corner. On average, approximately 20 mass chains are undergoing review and processing at any one time. However, the in-flow of mass chain evaluations for ENSDF continues to decrease steadily, threatening the ability to achieve the desired ten-year renewal rate.

McCutchan assessed and reviewed the contents of a substantial draft submissions checklist she had prepared for consideration for subsequent adoption by network participants. The checklist would replace the pre-review stage of the submission, and allow the ENSDF manager to assess quickly whether the mass chain is suitable to be forwarded to the reviewer. The checklist was adopted unanimously by all those present.

Action on all evaluators: to ensure that their submitted mass chain or nuclide conforms to all the items on the ENSDF checklist.

A comprehensive statement was also provided that addressed the supportive management and technical requirements for an institute to be recognised as a NSDD data centre on the basis of respected mentoring and accumulated experience in the evaluation of mass chains. The well-worded contents not only defined the creation of such a centre, but also would aid considerably in determining whether any such centre should continue to exist in such a form:

"Requirement for recognition and creation of an NSDD Data Centre:
The individual(s) at the proposed new NSDD centre are required to demonstrate a significant understanding of the ENSDF format and policies and have made substantial contributions to the ENSDF/XUNDL database(s). Contributions can be in the form of a minimum of 2 mass chain evaluations, 30 individual nuclide evaluations, or 40 compiled papers for XUNDL. Contributions can also be demonstrated by the development of an essential ENSDF analysis or utility code. A presentation for the new centre should be made at the NSDD meeting when the above requirements have been fulfilled. The individual(s) should also provide a declaration that the data centre activity is supported by the home institute, and a clear commitment to ENSDF evaluation above an FTE = 0.1. Official recognition of the centre will follow a majority consensus among the current NSDD centres."

A priority list of nuclides for evaluation continues to be maintained at NNDC, based on the number of XUNDL compilations after the last evaluations and the age of the evaluation. Network members should not hesitate to apply to evaluate a mass chain or a nuclide of interest to them which does not fall within their particular areas of mass chain responsibility, and should contact NNDC (McCutchan) to determine the feasibility of undertaking such evaluations. The JAVA-NDS code developed at McMaster University and Michigan State University has replaced both NDSpub and Webtrend for the tabulation of ENSDF formatted data and generation of level scheme, decay scheme and band figures. The JAVA-NDS output is now used for publication in Nuclear Data Sheets and is available through ENSDF and XUNDL search applications on the NNDC website. Supplementary nuclear structure and decay data are held within a folder in the NNDC Dropbox account including: supplemental nuclear data, secondary references, authors' correspondence, and additional information for users.

Action on NNDC-BNL: to share the NNDC Dropbox account with supplementary data with all members of the NSDD.

A proposal to standardise the way ENSDF is referenced in publications and presentations was presented by McCutchan. According to the proposal, if in a given publication data are taken from less than 10 nuclei, the individual mass chain (or nuclides) evaluation should be cited, otherwise the overall ENSDF database should be referenced as follows:

"From ENSDF database as of September 3, 2016, Version available at:
http://www.nndc.bnl.gov/ensarchivals/ "

Action on NNDC-BNL: to incorporate the guidelines for referencing ENSDF in the NNDC website.

Finally, a proposal was made to draft a comprehensive ENSDF paper most likely for publication in *Nuclear Data Sheets*. NNDC staff will draft an appropriate outline, and each recognised author will be responsible for drafting text on an individual topic with very strict deadlines.

2.5.3. Status of ENSDF evaluations and estimated evaluation effort

The responsibilities of NSDD members, along with evaluation commitments for the mass chain evaluators as they stand for 2017 are summarized in the following table:

Centre		Responsible - no. mass chains	FTE staff
USA			
a	NNDC-BNL	111*	0.4
b	ORNL	9	1.15
c	LBNL	33	-- **
d	TUNL	19	0.6
e	ANL	17	0.5
f	MSU	14	1.0
g	Texas A&M	9	0.7
non-USA			
h	Russia	7	-- **
i	China Beijing	6	1.0
	Jilin	7	0.25
j	India	15	1.0
k	Japan	10	0.2
l	Canada	18	0.39
m	Australia	3	0.1
n	Hungary	5	0.4
o	Romania	6	0.4
p	Bulgaria	5	0.2
TOTAL			9.29

* 111 = 294 – number of mass chains taken by all other data centres.
** yet to be provided

Specific mass chain responsibilities have also been adjusted along with the introduction of two new NSDD data centres:

ANL gave up responsibility for A = 175, which has been transferred to NNDC-BNL;

Texas A&M University took over responsibility for A = 140, 141, 147, 148, 153, 155, 157, 158 and 160 from NNDC-BNL;

Japan gave up responsibility for A = 118, which has been transferred to Romania;

Bulgaria took over responsibility for A = 106-108 and 111, 112 from ANL.

The agreed responsibilities are listed in the following table:

Data Centre	Mass Chains
NNDC-BNL	45-50, 60-73 (ex 62-64, 67), 82, 84-88, 94-97, 99, 113-116, 136-145 (ex 140, 141), 150, 152-165 (ex 153, 155, 157, 158, 160, 164), 175, 180-183, 189, 230-240, >249
NDP	241-249
LBNL	21-30, 81, 83, 90-93, 166-171, 184-193 (ex 185, 188-190), 210-214
TUNL	2-20
ANL	109, 110, 176-179, 199-209
MSU	31-44
Texas A&M	140, 141, 147, 148, 153, 155, 157, 158, 160
Russia – St. Petersburg	130-135, 146
PRC – Beijing	51, 62, 195-198
PRC – Jilin	52-56, 63, 67
India	215-229
Japan	120-129
Canada	1, 64, 74-80, 89, 98, 100, 149, 151, 164, 188, 190, 194
Australia	172-174
Hungary	101-105
Romania	57-59, 117-119
Bulgaria	106-108, 111, 112

2.6. IAEA Workshops and Technical Meetings (P. Dimitriou, IAEA-NDS)

Highly relevant activities undertaken since the previous NSDD Evaluators' network meeting are described in the following Sub-sections. Note was also made of future IAEA-NDS staff intentions for 2017/18 concerning the organisation of meetings dedicated to (a) R-matrix, (b) Total Absorption Gamma-ray Spectroscopy (TAGS) and antineutrino spectra, (c) IAEA-ICTP NSDD workshop at ICTP, Trieste, planned for 2018, and (d) an advanced NSDD workshop also in 2018, most likely to be arranged at IAEA Headquarters, Vienna.

2.6.1. Specialized IAEA Workshop on Nuclear Structure and Decay Data Evaluations, IAEA report INDC(NDS)-0688

A specialized IAEA Workshop on Nuclear Structure and Decay Data Evaluations was held from 27-29 April 2015, at IAEA headquarters, Vienna, Austria, organized by E.A. McCutchan (NNDC-BNL) and F.G Kondev (ANL). Twenty participants attended the workshop, which was held on the first three days of the working week immediately after the 21st meeting of the International Network of Nuclear Structure and Decay Data Evaluators. Six leaders provided technical material for debate: M.J. Martin (ORNL), who extensively covered his recent revision of the Evaluators' Guidelines and updating of General Policies for ENSDF Evaluations; J.K. Tuli (NNDC-BNL) and Balraj Singh (McMaster University) considered the meaning and understanding of various ENSDF policies and assignments; T. Kibedi (ANU) provided information on various new computer codes; and E.A. McCutchan (NNDC-BNL) debated decay scheme normalizations. All attendees were also given the opportunity to present issues and problems with respect to their own experiences with mass chain evaluations.

The overall reaction of participants to this specialized workshop was one of approval, with the need for more such hands-on meetings in the future to focus on problems experienced by and of immediate relevance to the work of ENSDF evaluators. Another such specialized workshop is envisaged to take place very close to the next meeting of the International Network of Nuclear Structure and Decay Data Evaluators in 2019.

2.6.2. Joint IAEA-ICTP Workshop on Nuclear Structure and Decay Data: Theory and Evaluation

A joint IAEA-ICTP Workshop on Nuclear Structure and Decay Data: Theory and Evaluation was held from 22 August - 2 September 2016, at ICTP, Trieste, Italy, organized by P. Dimitriou (IAEA-NDS), E.A. McCutchan (NNDC-BNL), M. Thoennessen (MSU) and C. Tuniz (ICTP). Thirteen participants from seven countries attended the workshop. Various specialist lectures were given:

P. Van Isacker (GANIL) on aspects of nuclear structure theory;

F.G. Kondev (ANL), E.A. McCutchan (NNDC-BNL), P.H Regan (University of Surrey), H. Sakurai (RIKEN) and M. Thoennessen (MSU) devoted to selected topics in experimental nuclear physics;

and S. Basunia (LBNL), T. Kibedi (ANU), E.A. McCutchan (NNDC-BNL), Balraj Singh (McMaster University), J.K. Tuli (NNDC-BNL), P. Dimitriou (IAEA-NDS), M. Verpelli (IAEA-NDS) and V. Zerkin (IAEA-NDS) who covered a wide spectrum of inter-related topics from supportive IAEA-NDS projects to ENSDF, XUNDL, evaluation methodologies, analysis and utility codes, editors, Web tools, database formats and on-line retrieval software.

Hands-on exercises consisted of the evaluation of nuclear structure and decay data for nuclides within mass chain A = 217 – work on this mass chain evaluation continued after the workshop, and is in the final stages of preparation for publication in *Nuclear Data Sheets*. These studies also included a compilation of recent nuclear structure and decay papers for the XUNDL database.

After the problems experienced at the previous such workshop in 2014 that arose from an enforced/limited programme of only five days, this particular workshop had been re-established to extend over two weeks. A questionnaire about the structure and effectiveness of the workshop and hands-on exercises was circulated at the end of the workshop. Summarizing the overall participants' response to such questions, they believed that (a) more emphasis should be placed on hands-on exercises with XUNDL and ENSDF, as well as with analysis codes, and (b) the lectures should focus on experimental and theoretical studies of immediate relevance to ENSDF evaluations.

Some thoughts on the future of these workshops were considered by the NSDD network, particularly whether they should be seen as a means of attracting potential new evaluators. The survival and maintenance of ENDSF requires the continuous and full support of university departments and laboratories with their access to and provision of PhD and post-doctorate students. An additional issue of debate involved what actions need to be taken to make this type of workshop as effective as possible (mass-chain or nuclide evaluation; exercise on analysis codes and smart editors; regular discussion sessions). This debate was closed with a statement from Dimitriou that another such ICTP-based NSDD workshop was being planned for 2018.

2.6.3. Consultants' Meeting on the Evaluation of Nuclear Moments, IAEA report INDC(NDS)-0732

A group of specialists met at IAEA Headquarters, Vienna, Austria, from 27-30 March 2017, to assess and agree upon future requirements concerning the correction and evaluation of nuclear magnetic dipole and quadrupole moments to produce comprehensive data sets. Assessments were made of the different measurement techniques and necessary corrections (diamagnetism, hyperfine anomaly, half-lives and external-field parameterization for short-lived states, and new electric field gradient calculations for Q). A suitable method of approach was also proposed for the implementation of all required corrections. Furthermore, appropriate packages of work with deadlines were agreed for individuals to produce the desired tables of evaluated μ and Q data by 2018.

2.6.4. Other Relevant IAEA Technical Meetings

1. Coordinated Research Project (CRP) on Charged-particle Monitor Reactions and Medical Isotope Production (2012-2016), IAEA report INDC(NDS)-0717

Of the order of twenty CRP participants have undertaken extensive cross-section measurements and evaluations, supplemented by focussed studies of selected decay data for a more limited number of radionuclides. These measurements and evaluations were based on a number of in-depth assessments and reviews to be found in IAEA reports INDC(NDS)-0535 (2008), 0591 (2011) and 0596 (2011). Those involved in the CRP decay-data work have been F.G. Kondev (ANL), T. Kibedi (ANU), M.A. Kellett (LNHB, CEA Saclay), A. Luca (IFIN-HH) and A.L. Nichols (University of Surrey).

Nuclide decay data studied during the course of the CRP are as follows:
monitor reactions: ^{61}Cu and ^{63}Zn;
diagnostic γ emitters: ^{67}Cu, ^{99}Mo-^{99m}Tc, pure ^{99m}Tc and ^{111}In/^{111m}Cd;
β^+ emitters: ^{44}Ti half-life, ^{52}Fe/^{52,52m}Mn, ^{64}Cu, ^{66}Ga, ^{73}Se, ^{76}Br, ^{86}Y, ^{89}Zr, ^{94m}Tc and ^{120}I;
therapeutic α emitters: ^{230}U decay chain;
β^-, Auger-electron and X-ray emitters: pure ^{99m}Tc, ^{103}Pd/^{103m}Rh, ^{111}In/^{111m}Cd, ^{125}I, ^{131}Cs and ^{178g,m}Ta.

Publications are in preparation, along with on-line retrieval from the IAEA-NDS Medical Portal (https://www-nds.iaea.org/relnsd/vcharthtml/MEDVChart.html).

2. Coordinated Research Project (CRP) on Reference Database for β-Delayed Neutrons (2013-2018), IAEA reports INDC(NDS)-0683 and 0735

CRP participants have discussed and undertaken extensive compilations, assessments and evaluations of all known $T_{½}$ and P_n values. $Z < 29$: evaluated $T_{½}$, P_n data have been published (M. Birch et al., *Nucl. Data Sheets* 128 (2015) 131), while $Z > 28$ evaluations have been completed, and final checks are being made before submission for publication. New systematics were adopted, benchmarking of existing evaluated/compiled tables has been completed, and the benchmarking of new evaluated tables is in progress. All available delayed-neutron spectra are being digitized, and will shortly be made available. The third and final Research Coordination Meeting will be held on 12-16 June 2017 to finalize all data sets, and agree on the best form of database release.

3. Coordinated Research Project (CRP) on Updating the Photonuclear Data Library and Generating a Reference Database for Photon Strength Functions (2016-2020), IAEA report INDC(NDS)-0712

CRP participants have discussed the need to compile and re-evaluate all photonuclear cross sections, especially in view of the new measurements of photoneutron cross sections by means of direct multiplicity sorting. Correction factors for partial photoneutron cross sections above the Giant Dipole Resonance (GDR) region will also be assessed. A new dedicated database for Photon Strength Functions will be created, including all available data as well as models such as QRPA, SLO/MLO and TLO for e-e nuclei. Empirical M1 formula for the spin-flip and enhanced scissors mode will also be studied.

4. Technical Meeting on Fission Product Yields: Current Status and Perspective in Measurements, Theory and Evaluations, IAEA report INDC(NDS)-0713

Fission yield measurements, theories and the current status of evaluated fission yield libraries were assessed and discussed in detail by an assembled group of just over 20 specialists at a meeting held at IAEA Headquarters, Vienna, Austria, on 23-26 May 2016. Participants reviewed the status of FYs, taking into consideration existing and emerging requirements for FY data in applications such as reactor technologies, waste management and safeguards. New measurement techniques are producing more precise and reliable experimental data (Lohengrin-ILL, SOFIA-GSI, IGISOL-Jyvaskyla, TUNL-HIγs, SPIDER-LANL(2E-2ν)), along with the development of improved systematics and models for the fission process. Although significant progress has been made in measurements, models and validation techniques over the previous decade, unanimous agreement was reached that this situation is not necessarily reflected in the evaluated FY libraries. Fifteen definitive statements and a series of recommendations were prepared to assist in alleviating the current situation. An IAEA Co-ordinated Research Project was also judged to be a sound and solid starting point, with the four major fissioning actinides of ^{235,238}U, ^{239,241}Pu and ^{252}Cf chosen as a good focus for such joint efforts.

3. TECHNICAL REPORTS

Status reports from the NSDD Data Centres are given in Annex 5. Annex 6 includes summaries of technical presentations on horizontal evaluations (including DDEP), proposals and developments in ENSDF analysis codes, formats and web tools, and nuclear structure-related measurements. Brief accounts were also given of the status of the ENSDF bibliography database (NSR), and database dissemination applications NuDat, Live Chart as well as the new publication and web display code JAVA-NDS.

3.1. ENSDF databases

3.1.1. NSR (B. Pritychenko, presented by A.A. Sonzogni, NNDC-BNL)

The current NSR team consists of Boris Pritychenko and Joann Totans (BNL), Balraj Singh (McMaster University) and Emil Betak (Bratislava). Additionally, Viktor Zerkin (IAEA-NDS) has also collaborated on web dissemination projects to improve the synergy between NSR and EXFOR.

A number of major journals publishing nuclear physics articles are regularly scanned, and, if the content is deemed of interest, keywords describing the content of the article are promptly incorporated in the database: 4,215 new articles were added to NSR in FY2015 and 3,263 in FY2016, while the number of database retrievals was 209,415 in FY2015 and 442,175 in FY2016. A dump of the NSR database is regularly sent to the IAEA for uploading to their database server.

Joann Totans travelled to Oak Ridge National Laboratory in May 2016, and in coordination with Caroline Nesaraja salvaged a number of unique reports, private communications and theses. A total of 35 boxes of papers and reports were shipped back to BNL, and will be incorporated into the library and NSR database.

3.1.2. NuDat (A.A. Sonzogni, NNDC-BNL)

NuDat has been a user-friendly disseminator of ENSDF data evaluations for a long time! This JAVA-based product has been in operation since 2004. A new version was released in May 2017 that includes a number of upgrades requested by the users, such as (a) Z- and N- projections of the 2-dimensional Chart of Nuclides, including access to data; (b) more coloring options for the chart; (c) adoption of the 2016 Atomic Mass Evaluation (AME2016); (d) angular momentum vs excitation energy plots for both J and J(J+1), with points joined by gamma branching ratios or reduced transition probabilities in Weisskopff units; and (e) access to the JAVA-based RadList code. Future improvements will include a full translation of ENSDF comments into HTML format to make complete ENSDF evaluations accessible in HTML format.

There were 2.8 million database retrievals in FY2015 and 3.2 million in FY2016. About 100 e-mail messages per year are received from users spanning basic questions on format to more complicated requests on improvements to the product.

3.1.3. LiveChart of Nuclides (P. Dimitriou, IAEA-NDS)

LiveChart is continuously developed and updated by IAEA-NDS staff. Currently, the user can retrieve and plot nuclear structure and decay data from the ENSDF database interactively. Furthermore, radiation information following nuclear decay (energy, intensity) can be generated, as well as thermal neutron cross sections, charge radii, nuclear moments, and fission yields from databases that contain such data. A wide range of search and filter options are provided as a consequence of being based on MySQL. New developments include incorporation of the 2016 Atomic Mass Evaluation (AME2016) with proper estimates of uncertainties based on correlation matrices.

Atomic radiation data are based on the ENSDF analysis code RadList, although efforts are now underway to develop a new code to replace RadList. This new code includes a proper treatment of

approximate values and limits in the ENSDF file, as well as more recent atomic shell data from the Evaluated Atomic Data Library (EADL).

All the data displayed on-line can be downloaded as CSV files.

The mobile phone version of LiveChart, the Isotope Browser, is available for Android and iOS devices in all official United Nations languages (Arabic, Chinese, English, French, Spanish, and Russian), as well as Italian, Japanese, and Slovenian.

3.1.4. Medical Portal and Decay Data Portal (P. Dimitriou, IAEA-NDS)

Two new on-line retrieval interfaces are available on the IAEA web server:

Medical Portal: allows on-line retrieval of cross sections and decay data produced by a series of IAEA CRPs on cross sections for the production of medical isotopes and associated decay data. The portal provides interactive access to the data as well as plots of activation cross sections and decay schemes. Available at http://www-nds.iaea.org/medportal/

Decay Data Portal: allows on-line retrieval and comparison of decay data listed in various on-line databases: ENSDF, XUNDL, DDEP and data produced by IAEA CRPs. The purpose is to assist the user in finding and retrieving the most up-to-date nuclear structure and decay data while at the same time providing an overview of the status of their various databases. Available at http://www-nds.iaea.org/decayportal/

3.1.5. JAVA-NDS Code (J. Chen, MSU)

The JAVA-NDS code has reached a suitable level of maturity for adoption as the definitive program to produce publish-ready copies of all mass chains within ENSDF for *Nuclear Data Sheets*, including tabulations and associated comments, and suitable drawings of recommended nuclear levels and decay schemes. Development of this new code in JAVA was warmly welcomed by the network participants, and seen as a major step forward towards improving visual impact and clarity, particularly with respect to nuclear-level and decay-scheme drawings. JAVA-NDS has recently taken over from Webtrend to display all ENSDF data in tabulated and drawing forms.

System requirements and pre-requisites are 8G RAM memory; latest version of Java (JRE 8 or above) free at http://java.com/en/download/, and LaTeX compiler: Windows – MiKTEX free at http://miktex.org/download; Linux and MacOS come with the system.
Recommended cross-platform LaTeX editor is Texmaker, free at
http://www.xm1math.net/texmaker/download.html

JAVA-NDS converts the ENSDF file to a LaTex file from which a reader-friendly/publish-ready PDF file can be generated by a LaTex compiler. New features and other points of note:
Official notice of a new release will be sent out every 6 months, unless there is a major update. The latest release is kept at:
http://www.nndc.bnl.gov/nndcscr/ensdf_pgm/utility/javands/

The code can now handle particle-unbound levels in β-decay data sets by entering “R” in column 78 of the level-record card image to create a pseudo-level that accounts for a range of neutron-unbound levels.

It can also now define a local dictionary by adding the appropriate entry (“DICT”). For example, add the following line anywhere in the top comment section before data records:
・ 27P・ ·c··DICT$PB(27P,P26SI)=Pb({+27}P,p{+26}Si)·····

4. DEDICATED SUBCOMMITTEE MEETINGS

Approximately midway through the network meeting, participants broke up into three parallel subcommittee sessions so as to define and discuss particular grouped issues separately and in greater detail: (1) Policies and Procedures, (2) Codes and Formats, and (3) Experimental Activities. Important points from these deliberations and their agreed findings and recommendations were reported back to joint sessions of the full network on the Thursday afternoon.

4.1. Policies and Procedures Subcommittee

Attended by: E.A. McCutchan (Co-chair), B. Singh (Co-chair), A.A. Sonzogni, M.J. Martin, A. Jain, J. Kelley, J. Chen, S. Basunia, C. Nesaraja, E. Browne, D. Yang, X. Huang, J. Lee.

Policy and procedures discussions were led by E.A. McCutchan. Various items were considered with accompanying argument, debate and sometimes agreement:

1. Adopted gammas listings and individual datasets that include columns of α data (theoretical internal-conversion coefficients determined from the BrIcc code with Frozen Orbital approximation, unless stated otherwise) that some users have incorrectly assumed to be determined from experimental studies. Agreed that JAVA-NDS should generate a generic comment "Total theoretical internal conversion coefficients, calculated using BrIcc code with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified" – (see Annex 4, Action #30) to be implemented by MSU (Jun Chen). Also action on Kibedi to remove comment from BrIcc concerning Frozen Orbital approximation, and revise existing abstract in which BrIcc is discussed.
2. Citation of previous evaluation(s) - some data sets do not change significantly (or at all) from the previous evaluation to which proper credit should be attributed. A few lines should be added at the top of the data set stating that the recommended data have not changed significantly from the previous evaluation, and the previous evaluation should be cited (see Annex 4, Action #31).
3. Citation of XUNDL data sets – if major portions of XUNDL data sets are incorporated into an ENSDF evaluation, the evaluator should reference XUNDL in the resulting data set, and/or acknowledge the XUNDL compilers in the abstract (see Annex 4, Action #32).
4. Often encounter somewhat nebulous entries for the nuclear levels of very neutron-rich nuclides (e.g. ^{94}Se ground state with assigned $T_{½}$ > 150 ns, the Level continuation record gives %β^- =? and the comment record contains "$T_{½}$: from the time of flight through the FRS separator, which for the experiment was 150 ns"), which is all rather meaningless. Significant changes were proposed: Remove the half-life limit (can give systematic values, but not in existing half-life field); remove "?" and introduce %β^- = 100; %β^-n>0; %β^-2n>0. In the Comments add "$T_{½}$: No experimental value has been reported. A lower limit of 150 NS can be established since this was the time of flight through the FRS separator. An upper limit of 1 S can be obtained as the half-lives of ^{89,90,91}Se are shorter than this value. A systematic estimate of 50 MS can be ….. etc." for the above example (see Annex 4, Action #33).
5. Adopt Tropical year to define the days in one year → Tropical year = 365.24219 d. An Action was placed on NNDC-BNL to ensure that tropical year is implemented in all relevant nuclides (see Annex 4, Action #34).
6. Incorporation of %β^-n into β- decay datasets where %β^-n of the parent is experimentally known. Currently these datasets suffer from incomplete β-feedings and proposal was to add pseudo level to account for missing β^-n, β^-2n etc strength. A pseudo level should be marked with "R" in column 78 and given at an energy S_n+x (for β^-n case). S_n should be numerical value from latest AME and range of x indicated in level comment. β^- feeding to this level should be %β^-n value. B. Singh to send a sample dataset to all evaluators (see Annex 4, Action #35).

7. Presentation of high-spin J_π data: values in the individual data sets should be as given by the authors of the original data. Evaluators should comment on discrepancies between these data and those chosen in Adopted Levels. Multipolarities in individual datasets should be supported by experimental evidence. Physics-based assumptions on multipolarities by the evaluator can be implemented in the Adopted Gammas. Evaluators were warned not to copy over XUNDL multipolarities – they need to be much better justified. Two actions ensued (see Annex 4, Actions #36, 37).
8. A2, A4, DCO and POL should be placed in the 2G record, and both DCO and POL need to be accompanied with explanations for their adoption. Action placed on NNDC-BNL to provide a list of the quantities that can be included in the 2G record and to ensure FMTCHK recognizes POL (see Annex 4, Actions #38, 39).
9. There are many ways of defining a configuration – they can be written in various ways. Configuration nomenclature needs to be standardized for universal adoption. An action was placed on ANL and ANU to recommend suitable standards for band configurations (see Annex 4, Action #40).
10. As well as BAND(A)$, implement the use of SEQ(A)$ for single individual levels and/or less clearly defined bands. This suggestion was agreed and adopted and has already been incorporated into JAVA-NDS and FMTCHK (see Annex 4, Action #41).
11. Energies in β-delayed proton decay: quote what is actually measured in an experiment, and not what the author quotes if found to be different (as stated in the existing guidelines).
12. The fact that ENSDF allows two different comment records (using lower case "c" and capital "C") each with their own translation scheme generates a situation where comments can be misinterpreted by the program processing them. Evaluators are encouraged to transition to only using lower case "c" for comment records.
13. Efforts should be made to ensure consistency data between Adopted Level and Decay Parent records (related to Action #27, Annex 4).
14. The abbreviation for Gamow Teller transitions (GT) is similar to the symbol currently used to represent "greater than" in C comment records. It was suggested that a new symbol for Gamow Teller transitions be defined. This item was deferred to a subsequent meeting of the policies and procedures committee.

4.2. Codes and Formats Subcommittee

Attended by T. Kibedi (Co-chair), R.B. Firestone (Co-chiar), P. Dimitriou, J.K. Tuli, M.A. Kellett, A. Hurst, I. Thompson, C. Matoon, A.L. Nichols, F.G Kondev, X.Huang.

Subcommittee members reviewed the table of codes to be found in Table 1 of IAEA report INDC(NDS)-0696, entitled "Improvement of Analysis Codes for Nuclear Structure and Decay Data Evaluations". The following noteworthy remarks and recommendations were made during the course of these discussions.

Maintenance and dissemination of ENSDF Analysis and Utility Codes – general statement and recommendation:
The Subcommittee **strongly recommends** that efforts are made to maintain the codes, and dissemination from both NNDC and IAEA web sites is well synchronized. Since the IAEA codes web site is only meant for fixed releases of the codes, the subcommittee **strongly recommends** that a continuous line of communication is maintained between the NNDC and IAEA, to ensure that, when a stable version of the code is ready for release by NNDC, the IAEA is informed and ensures the same version is made available on the IAEA web site. Dates of the updates should agree with the version dates of the codes.

1. *Nuclear Data Sheets* publications and web displays are now undertaken with JAVA-NDS – Webtrend is obsolete, and has been removed as a work programme from Table 1 of INDC(NDS)-0696.

2. T-RULER: a new code written by Kibedi to treat uncertainties by means of the distribution functions obtained via the Monte Carlo method.
    - can handle asymmetric uncertainties,
    - uncertainty limits: fixes ranges for <0.5, <+0.5,....,
    - two methods for deducing mean values and uncertainties from distribution function,
    - clear policy needed on uncertainties in order to continue work.

   Recommendation: this approach is reasonable, and should be agreed and endorsed by the network so that a beta version is completed and made available for validation.

3. NS_library module has been produced that contains all the nuclear structure data parsed from an ENSDF file. This module can then be used to run other modules to perform operations such as calculating ICC (BrIcc), normalizing decay schemes (GABS), calculation of the initial atomic vacancy distribution (BrIccEmis), calculation of reduced transition rates (T-RULER), log*ft*, etc.

4. BrIccEmis is in the process of being developed to calculate the atomic radiation database. As soon as (a) this on-going work has been completed, (b) the Monte Carlo treatment of the uncertainties has been endorsed, and (c) an agreed format has been adopted in ENSDF for the resulting atomic data, the code will be finalized and released, and an appropriate paper prepared for publication (estimated finish by the end of 2017).

   Proposed format for atomic data: 'MA', 'MX', E(TOT), I(TOT), etc. - option should be added to display atomic radiation data on the web. Add a flag in the ENSDF file to signal when the decay scheme is incomplete, and that BrIccEmis should not be run.

   The above format was agreed and adopted by the network (related to Action #25, Annex 4),

5. JGAMUT: code corrected for recoil effects, and sent to NNDC-BNL and IAEA-NDS.

6. V.AveLib: updated and modified to run on all platforms, and sent to NNDC-BNL and IAEA-NDS.

7. Checking codes (FMTCHK): continuous efforts to enhance format checking by NNDC-BNL.

8. PANDORA: enhancement of code is still required. LBNL to consider working on PANDORA (see Annex 4, Action #4).

9. New R_0 interpolating code: RadD has been completed and sent to NNDC-BNL and IAEA-NDS. This code has also been incorporated into ALPHAD (to be demonstrated by Balraj Singh on Friday) - needs to undergo final checking for bugs (see Annex 4, Action #43), and then should be released.

10. NewGTOL code written by PNPI (Russia) to handle singular matrices in conditions when GTOL fails to furnish results. Needs to be tested by experienced evaluators before any recommendations can be made. Available as part of the MyEnsdf web tool on the IAEA-NDS website.

11. LOGFT: warning messages need to be given for unphysical input data and uncertainties. Still pending.

12. BetaShape code (Mougeot, LNHB, CEA Saclay): modelling of EC transitions is missing, and forbidden non-unique transitions are handled as allowed (as in the LOGFT code). Work is in progress to model EC transitions and improve the treatment of non-unique forbiddenness that will include nuclear structure effects. Otherwise the code gives improved spectra and average beta energies, based on more advanced calculations and consideration of the experimental beta shape factors. BetaShape also reads from and writes to an ENSDF file (full demonstration will be given on Friday).

    Recommendation: LOGFT needs to be replaced with a more advanced code, and the subcommittee was pleased to learn that Mougeot is carrying out a systematic analysis of his BetaShape results - this analysis effort merits future discussion. Note: new average beta energies and spectra will shortly be made available on the LNHB web site.

13. MyEnsdf Web tool: All checking codes (Russian) are available on this web tool. NewGTOL is also there to test. An additional section for non-ENSDF analysis/utility codes is included where useful codes for evaluators can be made available. Access to MyEnsdf Web tool for those only wanting to run the codes is made free without a password.

14. Editors: There is a need for an ENSDF editor that is publicly available and can be fully supported and maintained.

    EVP editor: is continuously developed. It is obtainable upon request from A. Sonzogni (NNDC-BNL).
    Tree-editor: The subcommittee supports the efforts of Zerkin at IAEA-NDS.
    Recommendation: an expert evaluator works closely with Zerkin to implement all required features. LBNL is willing to provide the expertise.

15. Formats:

    Formats for continuous data (proposal by Sonzogni):
    Recommendation: a more thoroughly worked out proposal should be prepared for a format for continuous data accompanied by an example (see Annex 4, Action 26).
    XML: there are still some issues as to the inclusion of Comments records because they are not standardised in ENSDF. A proposal was discussed as to whether to translate the comments first and then put them into normal text.
    XML is tightly linked to GND for ENDF: a stable version of GND will be released together with the new ENDF/B VIII file by the end of the year.

Recommendation: The subcommittee endorses this effort and recommends/urges support by NNDC-BNL and USNDP.
Proposals: LBNL (Basunia) and NNDC-BNL (Sonzogni) consider the content and proposals of the LBNL report, and provide feedback to the network.
An XML example of ENSDF data should be made available on the web for all evaluators to peruse. Backward translation from XML to ENSDF should also be demonstrated (see Annex 4, Action #7).

General recommendation: all network personnel to make available any better and/or enhanced/improved codes for comparison, validation and adoption by the NSDD evaluators' network.

4.3. Experimental Activities Subcommittee

Awareness of planned and on-going experimental studies of relevance to the ENSDF database is of significant and synergic importance. ENSDF evaluations generate strong indications of inadequacies in the known nuclear structure and decay data, while registration of existing experimental studies are an important aid in defining the optimum timetabling for particular ENSDF evaluations.

Subcommittee session attended by L. Bernstein (Co-chair), A. Negret (Co-chair), Z. Elekes, S. Lalkovski, D. Balabanski, J. Batchelder, F.G. Kondev.

A number of possible activities and recommendations were formulated that were subsequently presented to a joint session of the network:

1. Create a website to contain an ordered list of issues identified by evaluators and non-evaluators (along the lines of the existing High Priority Request List of NEA-OECD)
   (a) no priority assignments will be initially made,
   (b) focus on key characteristics and missing data (rather than e.g., uncertainties in J_π).
2. Experimentalists should in response be strongly encouraged to share their existing data:
   (a) examples: Gammasphere, GEANIE, DANCE, ……..,
   (b) sort codes/experimental descriptions could be shared, and collaboration initiated,
   (c) a "third party" worker could join the collaboration if necessary, to perform analyses,
   (d) older data sets might require more effort to prepare.
3. If data do not exist, a team with access to an appropriate facility could offer to help prepare a proposal/run an experiment.

Other points of note:

- a moderator is needed, supported by a team,
- the website could help identify other efforts already underway (and avoid conflict),
- ideally, the IAEA-NDS would host the proposed website, which would also need to be adequately publicized,
- there could be a link from ENSDF and/or NUDAT.

5. JOINT PLENARY DISCUSSIONS

5.1. Subcommittee Reports

The plenary session was re-established in order to report to all participants on the proposals and recommendations aired at the individual meetings of the three subcommittees (Policies and Procedures, Codes and Formats, and Experimental Activities). The leaders of all three subcommittees outlined in turn the various topics of discussion that arose at the parallel sessions, and their agreed actions and recommendations, as reported above in Section 4.

Policies and Procedures Subcommittee

All proposals identified with (a) clarification of the tabulated α as being theoretical ICC data, (b) citation of previous evaluation(s) if they remain the source of some of the evaluated data, (c) citation of XUNDL data sets, and (d) handling of %β^-xn and non-existent half-life data for very neutron-rich nuclides were all approved, and need to be noted and adopted by all mass chain evaluators. All of these features need to be absorbed into "Guidelines for Evaluators" and other instruction sheets, along with the adoption of the Tropical year (as 365.24219 days), handling of high-spin J_π, and consideration of other specific matters listed in Section 4.1.

Thought needs to be given as to the adoption and incorporation into ENSDF of K quantum numbers for deformed nuclei, uncertainties of average energies (could use the approach adopted for half-lives), rapid and regular review of the contents of ENSDF from the point of view of the naming of the super-heavy isotopes, and the incorporation of magnetic moments into ENSDF (evaluated and recommended magnetic moments database required). Recommended and quoted uncertainty limits have evolved somewhat into subjective judgements on the part of the evaluator to values beyond the arbitrary ruling in the past of 25 (i.e., ± 2.5, ± 0.25, ± 0.0025, etc.).

Basunia (LBNL) noted that network participants often discuss and approve new formats, policies and procedures for the ENSDF database. Usually, the evaluators/compilers apply these adopted formats/policies/procedures as part of their on-going and future work. However, over the years, the size of the ENSDF database has increased considerably (148 MB in 2004 to 217 MB in 2016), while the effort to revise/update the database has fallen. Considering the current level of total effort for ENSDF and the existing downward trend in available evaluation effort, the revision time frame appears to be about 15 years for the whole database if a uniform distribution of work for all nuclides/mass-chains is assumed. That means for any newly-accepted NSDD formats/policies, 15 years would transpire for such proposals to impact fully on the whole ENSDF database – a long time. Therefore, in addition to the common practice of applying newly-accepted formats/policies for on-going work, he wished to propose that we also revise and update the existing datasets in ENSDF within a time frame of two years and report progress at the following NSDD meeting. A subcommittee of two or three members could be formed to track, coordinate, and report on implementation and progress. The practice would make the database consistent within a shorter time frame after any new formats/policies changes are agreed for subsequent adoption.

Codes and Formats Subcommittee

Code development and maintenance will always be important requirements in the production of credible nuclear structure and decay data. All attendees agreed that constant efforts are required to ensure such aims are achieved in a trouble-free manner throughout the evaluation and data processing activities. Under such circumstances, both the NNDC-BNL and IAEA-NDS web sites need to be consistently the same from the point of view of the release and stability of all data processing and format/physics checking codes.

Various codes were singled out for more detailed consideration and mention, most notably ALPHAD, BrIccEmis, JGAMUT, T-RULER, and V.AveLib. These particular codes have either been individually developed further and checked, or are in the process of being improved further. Others are undergoing more major evolutionary formulation (such as BetaShape and BrIccEmis to replace RadList). All are judged as most welcome to assist NSDD evaluators after their developers have undertaken due diligence and benchmarking checks when appropriate and feasible. Note was made that LOGFT needs to be replaced by a more advanced code, while PANDORA would benefit from further enhancement. There is also the need for an ENSDF editor that is publicly available, and can be fully supported and maintained.

Formatting discussions focused on the needs for the inclusion of continuum data, issues associated with the insertion of ENSDF Comments records in XML, as well as the need for feedback from readers of an existing LBNL report that addresses the desire for XML-based nuclear data (i.e., conversion of ENSDF data to XML format).

Experimental Activities Subcommittee

The proposal was warmly accepted to create an appropriate web site that lists issues and problems in the actual nuclear data on a nuclide-by-nuclide basis, as identified by evaluators in the course of their mass-chain or nuclide(s) evaluations. Another useful component to such a compilation would be to identify and define all known relevant on-going and planned experimental studies as a means of informing interested parties of such focused work. Agreement was also reached that such a web site should be hosted and maintained by IAEA-NDS (and possibly mirror-hosted by NNDC-BNL).

Another important evolving feature would be the production of a few pages of script written immediately after an ENSDF evaluation that detail any problems and difficulties experienced by the evaluator(s). A short description can also be included in the abstract of a mass chain evaluation. Further technical debate is required, but effort should be made over the next one to two years to launch such a useful form of known nuclear data requirements in order to aid significantly in the evolution of highly relevant measurement programmes.

5.2. Miscellaneous

Participants were of the opinion that splitting the network meeting into three specialised groups on the Wednesday/Thursday had worked well from the point of view of maximising productivity with respect to time, formulation of well-thought out responses to new proposals, and making suitable recommendations. Many open questions have been identified and addressed. However, some aired the view that the two sub-committees on Policies and Procedures, and Codes and Formats, have considerable overlap in subject matters and therefore should not be separate.

A suggestion was made that mini-ENSDF and advanced evaluation workshops should be held totally separate from the network meeting, in parallel with the network meeting, or as separately-timed meetings immediately before or after the network meeting. The latter was much preferred by those funding and organising the network meeting.

6. RECOMMENDATIONS AND CONCLUSIONS

The 22nd meeting of the IAEA International Network of Nuclear Structure and Decay Data Evaluators was held at the Lawrence Berkeley National Laboratory, and attended by 38 participants from 12 countries. Both administrative and technical issues were addressed throughout the course of the meeting, representatives from the various data centres presented their biennial progress reports, and active members of the network reported on their work as related to ENSDF. A few additional attendees who are not part of the NSDD evaluators' network presented information related to their research interests of direct relevance to NSDD activities.

Proposals were accepted to recognize the Department of Nuclear Engineering, University of Sofia, Bulgaria, and Texas A&M University, USA, as new ENSDF Data Evaluation Centres. Further steps to assure the quality and completeness of the databases were taken, and a detailed set of actions was produced covering the time period up to the next network meeting in 2019. Technical improvements to facilitate the work of evaluators were discussed, with special emphasis placed on improvements to and maintenance of the analysis codes. Related on-going studies associated with specific IAEA-NDS projects were reviewed, along with other highly-relevant code development work.

Two new subcommittees were formed to address outstanding issues related to (a) Policies and Procedures, and (b) Codes and Formats, and to prepare new proposals for discussion between the biennial NSDD meetings and final adoption at these network meetings. A third subcommittee was formed to promote better communication of the findings of ENSDF evaluations to the nuclear physics community and most particularly identification of gaps in the experimental data. Ensuring that ENSDF is up to date was re-emphasized as the main task and top priority for the NSDD network. A re-cycling time of up to ten years for each set of nuclides remains recommendable. At the very least, approximately 25 mass-chain evaluations need be renewed per a year to achieve this estimate, requiring a minimum of approximately twelve FTE evaluators. Given that this is not achievable in the foreseeable future, alternative ways of organizing evaluations and attracting new evaluators to the network need to be urgently explored.

The dedicated biennial IAEA-ICTP workshops held at ICTP, Trieste, Italy, were acknowledged to remain of value as both an educational tool and publicity in seeking new ENSDF evaluators. Requests for more specialized refresher workshops to improve the expertise and skills of existing evaluators were answered by the organisation of a more advanced workshop on 27-29 April 2015, with the agreement that they take place at the IAEA on a regular basis immediately before or after the biennial meeting of the International Network of NSDD Evaluators.

The 23rd Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators will be held at IAEA Headquarters, Vienna International Centre (VIC), Vienna, Austria, in the spring of 2019.

Annex 1

60 Years

Atoms for Peace and Development

22nd Technical Meeting of the
Nuclear Structure and Decay Data Network

Lawrence Berkeley National Laboratory, Berkeley, USA
22 – 26 May 2017

ADOPTED AGENDA

Monday, 22 May

09:00 – 09:30 **Opening Session:**
Welcome Address, Election of Chairperson and Rapporteur, Adoption of Agenda

09:30 – 10:30 **Actions Review**

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **Actions Review** cont'd

12:30 – 14:00 *Lunch*

14:00 – 15:30 **Reporting:** Data Centres (5 min each, unless indicated otherwise)

1) IAEA (15')
2) USNDP/NNDC (15')
3) ANL
4) ORNL
5) TUNL
6) LBNL/UCB
7) MSU
8) MCMASTER UNIV. (Data Centre+B(E2)+BDN) (10')
9) INDIA
10) HUNGARY
11) ROMANIA
12) JAPAN
13) CHINA (Jilin/CNDC)
14) AUSTRALIA

15:30 – 16:00 *Coffee break*

16:00 – 17:30 **Reporting** cont'd: Horizontal evaluations, NUDAT, NSR

1) AME-NUBASE
2) DDEP
3) EGAF
4) MOMENTS
5) NUDAT
6) NSR

Tuesday, 23 May

09:00 – 10:30 **Organizational Review** (McCutchan / BNL)
(incl. new Data Centres)

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **Organizational Review** cont'd

12:30 – 14:00 *Lunch*

14:00 – 15:30 **Proposals**
- Adopted Decay Data sets (McCutchan / BNL)
- Continuous data in ENSDF (Sonzogni / BNL)
- Implementation of ENSDF policies (Basunia / LBNL)
- Atomic radiation data in ENSDF (Kibedi / ANU)

15:30 – 16:00 *Coffee break*

16:00 – 17:00 **Coordination – Communication**
- IAEA CRPs, IAEA Meetings (Dimitriou / IAEA)
- USNDP 2017, USNDP White Paper (Sonzogni / BNL)
- European NSDD (Balabanski / ELI-NP)

17:00 – 18:00 **Special Session**

19:00 ***Hospitality Event***

Wednesday, 24 May

09:00 – 10:30 **Subcommittees 1-3, Session 1**

Subcmte 1[1]: *Policies and Procedures*
Subcmte 2[2]: *Codes and Formats*
Maintenance and new codes
Subcmte 3[3]: *Experimental Activities*

10:30 – 11:00 *Coffee break*

11:30 – 12:30 **Subcommittees 1-3, Session 2**

Subcmte 1[1]: *Policies and Procedures*
Subcmte 2[2]: *Codes and Formats*
New formats
Subcmte 3[3]: *Experimental Activities*

12:30 – 14:00 *Lunch*

14:00 – 15:30 **Joint Subcommittees Session**
Experimental Activities

15:30 – 17:30 ***Free Afternoon – SF Bay Area Tour – Wine Tour***

[1] E. McCutchan, B. Singh
[2] T. Kibedi, R. Firestone
[3] L. Bernstein, A. Negret

Thursday, 25 May

09:00 – 10:30 **Joint Subcommittees Session**
Policies and Procedures

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **Joint Subcommittees Session**
Policies and Procedures

12:30 – 14:00 *Lunch*

14:00 – 15:30 **Joint Subcommittees Session**
Codes (new codes, maintenance, policies issues)

15:30 – 16:00 *Coffee break*

16:00 – 17:30 **Joint Subcommittees Session**
Codes and new formats

Demos of codes

1) JAVA-NDS (Chen / MSU)
2) NS_RadList a new code to evaluate atomic radiations using the BrIccEmis data base (Kibedi / ANU)
3) UncTools propagation uncertainties in ENSDF codes using Monte Carlo techniques (Kibedi / ANU)

Friday, 26 May

09:00 – 10:30 **Demo of CODES + EDITORS**

4) BETASHAPE (Kellett / LNHB)
5) JGAMUT (Singh / McMaster)
6) ALPHAD_NEW (Singh / McMaster)
7) Interacting with (n,n'g) database at NNDC (Hurst / UCB)
8) Tree-graph editor (Dimitriou / IAEA)
9) MyENSDF (Dimitriou / IAEA)

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **TECHNICAL PRESENTATIONS**

1) Measurements of ICC (Nica / Texas A&M)
2) Table of r0 values from even-even alpha decays (Singh / McMASTER)
3) ELI nuclear photonics program (Balabanski / ELI-NP)

12:30 **Closing of the Meeting**

22nd Meeting of the *International Network of Nuclear Structure and Decay Data Evaluators*

22 – 26 May 2017
Lawrence Berkeley National Laboratory,
Berkeley, USA

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A-Chain Evaluation Responsibility

Centre	Mass Chains
a.US/NNDC	45-50,60-73(ex 62-64,67),82, 84-88,94-97,99,113-116,136-145(ex 140,141),150,152-165 (ex 153,155,157,158,160,164),175, 180-183,189,230-240,>249
b.US/NDP	241-249
c.US/LBL	21-30,81,83,90-93,166-171, 184-193 (ex 185,188-190),210-214
d.US/TUNL	2-20
e.US/ANL	109,110,176-179,199-209
f.US/MSU	31-44
g. TAMU	140,141,147,148,153,155,157,158,160
h. Russia/StP	130-135,146
i. PRC-Beijing	51,62,195-198
PRC-Jilin	52-56,63,67
j. India	215-229
k. Japan	120-129
l. Canada	1,64, 74-80,89,98,100, 149,151,164,188,190,194
m. Australia	172-174
n. Hungary	101-105
o. Romania	57-59,117-119
p. Bulgaria	106-108,111,112

Annex 4

List of Continuous, New and Completed Actions

CONTINUOUS / ON-GOING / PENDING from 24 April 2015				Status 22 May 2017
No.	**Responsible**	**Reason**	**Action**	
1 (1)	ENSDF coordinator, NNDC-BNL All network participants	Keeping ENSDF up-to-date.	Maintain a list of horizontal evaluations in separate repository accessible to evaluators. Keep NNDC informed about horizontal evaluations. **Continuous**	Summaries of horizontal evaluations are now available on NNDC web. Network participants who do publish such evaluations should distribute to the network. **Continuous**
2 (2)	NNDC-BNL	ENSDF analysis and checking codes need to remain up-to-date with respect to formats, physics requirements, and needs of the community.	Update codes for approved format changes. **Continuous**	On-going. **Continuous**
3 (3)	NDS-IAEA	Maintain up-to-date information on the network.	Review, modify and correct the contents of INDC(NDS)-421. **Continuous – original update planned by mid/late 2015**	**On-going**: Dimitriou has modified and updated INDC(NDS)-421 to issue as INDC(NDS)-0700. **Draft INDC(NDS)-0700 to be distributed for participants' comments.**
4 (4)	NNDC-BNL	Facilitate evaluators' work.	Analyse Nica proposal to modify PANDORA. **Still to be undertaken**	NNDC resources to modify and enhance PANDORA unavailable. Any editor development elsewhere should adopt this proposal. Addressed by Codes and Formats Subcommittee: LBNL to consider working on PANDORA. [Sec. note: PANDORA was modified by J. Tuli (LBNL) and V. Zerkin (IAEA) subsequently to this meeting and before publication of this report.]
5 (6)	NSR manager	Generation of key numbers.	Keyword requirements for evaluators should be optional; such keywords should be encouraged as they constitute valuable information. **Continuous**	**Remains On-going and Continuous.**

Annex 4

CONTINUOUS / ON-GOING / PENDING from 24 April 2015				Status 22 May 2017
No.	**Responsible**	**Reason**	**Action**	
6 (7)	NNDC-BNL	Obscure references.	Investigate access to electronic copies of secondary references which are difficult to track down and acquire. **Continuous**	NNDC/IAEA-NDS to create pdf databases of all NSR and EXFOR refs – **on-going**, with planned maintenance by NNDC and IAEA-NDS. Evaluators should always scan and send obscure references to NNDC.
7 (8)	LBNL	ENSDF into XML.	Work with LLNL on proposed format, liaise with IAEA and report to network. **In progress** First draft format will be presented at November 2015 USNDP meeting.	XML schema: work has been completed, and document prepared by Aaron Hurst – can be downloaded from LBNL. This schema does not consider Comments records. **Action**: ENSDF evaluators to provide Hurst with their feedback on XML document. **Action** on LBNL to provide example XML file on the web, and also demonstrate backward translation from XML to ENSDF.
8 (10)	ANU	Quantification of Auger electrons.	Develop and recommend analysis codes to provide more detailed presentations of Auger-electron data. **In progress**	Discussed by Codes and Formats Subcommittee: β version of BrIccEmis available for release after ENSDF format for atomic data has been agreed and adopted. **In progress**
9 (11)	IAEA-NDS	Maintain links with horizontal evaluations	Invite representatives of atomic mass and other horizontal evaluations to the next meeting. **Continuous**	Meng Wang, Audi and Stone invited, but unable to attend due to other commitments. **Re-invite to next meeting.**
10 (12)	NDS-IAEA	Training of evaluators.	Explore need for additional training workshops. **Continuous**	**Continuous** – IAEA-ICTP NSDD planned for 2018; also will consider specialized workshop in 2018.

Annex 4

CONTINUOUS / ON-GOING / PENDING from 24 April 2015				Status 22 May 2017
No.	**Responsible**	**Reason**	**Action**	
11 (13)	NDS-IAEA/ NNDC-BNL	Information relevant to all ENSDF network members.	Regularly update network website - ensure all relevant talks are made available on website. **Continuous**	**Completed and also Continuous**
12 (15)	NNDC-BNL	Maintain up-to-date information on network.	Update website with new group responsibilities. **Continuous**	Participants should also check for correctness on web site. **Continuous**
13 (20)	ANL, NNDC-BNL,NDS-IAEA	Maintain and update codes.	Assess status of analysis codes and determine priorities as to which codes should be re-written or corrected. **Continuous**	Codes and Formats Subcommittee to consider. See Section 4.2 for details. **Continuous**
14 (22)	McMaster, ANL, NNDC-BNL	Policy clarification.	Revisit Rule 37. **On-going**	Rule 37 to be revisited by Policies and Procedures Subcommittee
15 (23)	LBNL	Incorporation of additional data into ENSDF.	Suggest way of introducing parent-daughter isomeric feeding into ENSDF decay data. **On-going**	Formatting issues – data to be explicitly defined in ENSDF – **Codes and Formats Subcommittee to consider.**
16 (25)	Martin	Modify *Guidelines for Evaluators*.	Implement in *Guidelines for Evaluators* **–** list spins in order of preference.	**Policies and Procedures Subcommittee to consider.**
17 (26)	Martin	Modify *Guidelines for Evaluators*.	Implement in *Guidelines for Evaluators* **–** unique gamma transitions should be assigned intensities of 100.	**Policies and Procedures Subcommittee to consider.**
18 (29)	All network participants	Maintain and update codes.	Utilize the GFORGE server to report bugs in codes and request enhancements. Require stronger IAEA-NDS/NNDC coordination to maintain synchronization of codes websites	GFORGE not utilized significantly by ENSDF evaluators-alternatively send email to T. Johnson. **Actions continu**e
19 (30)	NDS-IAEA / NNDC-BNL	Dissemination of codes.	Coordinate the distribution of ENSDF codes on both web sites.	**Completed/Continuous** NNDC/IAEA-NDS to ensure that descriptions of all codes are properly documented within a comprehensive manual.

Annex 4

CONTINUOUS / ON-GOING / PENDING from 24 April 2015				Status 22 May 2017
No.	**Responsible**	**Reason**	**Action**	
20 (35)	McMaster	Keep ENSDF up-to-date.	Incorporate delayed-neutron $T_{1/2}$, P_n, B(E2) and quadrupole moments into ENSDF files.	Moments are fairly straightforward. Mass chain evaluators should consult with horizontal evaluators concerning other parameters. **Requires further discussion.**
21 (42)	NNDC-BNL	Policy implementation	Run GABS on ENSDF file	Action is pending the possible implementation of Adopted Decay Datasets, where the absolute photon intensity would be given.

First column: number in brackets is the action number arise from the previous meeting (see INDC(NDS)-0687).

Annex 4

NEW ACTIONS, 22-26 May 2017			
No.	**Responsible**	**Reason**	**Action**
22	NNDC-BNL	Maintain/update ENSDF	Adoption of AME2016 data – All of ENSDF to be updated with AME2016 data by placing the 2016 Q values as a Q comment record with previous evaluated Q values to remain on Q record
23	NNDC-BNL and all network participants	Proposed journal publication	Proposed preparation of a comprehensive ENSDF paper – participants to consider proposal in principle, and provide suggestions for content by end of 2017.
24	NNDC-BNL	Provide user community with citation guidelines	Incorporate in NNDC website citation guidelines for referencing ENSDF. See Section 2.5.2 for detailed description.
25	ANU, Codes and Formats Subcommittee	On-going policy implementation for atomic radiation	Implement new format for atomic radiation. See Section 4.2 for detailed description.
26	NNDC-BNL, LBNL, Codes and Formats Subcommittee	Gamma, electron and neutron continuum spectra – policy implementation	Consider form of such spectral data in ENSDF, and submit proposal complete with tested examples.
27	NNDC-BNL	Adopted decay data - policy implementation	Provide template for the presentation of Adopted decay datasets within ENSDF, including development of policies and procedures for creating such datasets.
28	Experimental Activities Subcommittee	Dissemination of information - experimental activities website	Create website of high-priority nuclear structure and decay data measurements for information and guidance, based on recent mass chain and/or individual nuclide evaluations. See Section 4.3 for detailed description.
29	ENSDF evaluators	Short description of each completed evaluation – dissemination of technical information	Detail problems and inadequacies in their mass-chain evaluations on a few pages, as a constructive description of further recommended work to be done. Strongly related to Action 28 above.
30	Policies and Procedures Subcommittee; implemented by NNDC-BNL and MSU	Clarification of the nature of ICCs recommended in ENSDF and listed by JAVA-NDS.	Modify JAVA-NDS such that the conversion coefficient column has a footnote stating “Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on gamma-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.”
31	ENSDF evaluators	Clarification of newly evaluated ENSDF data – policy implementation	If no significant changes in existing evaluation compared with previous evaluation, current evaluator to include such a statement and acknowledge previous evaluator(s).
32	ENSDF evaluators	Direct adoption of XUNDL data sets in ENSDF – policy implementation	If major portions of XUNDL compilation are used in the construction of an ENSDF evaluation, evaluator should acknowledge XUNDL compilers in the abstract of the evaluated mass chain.

NEW ACTIONS, 22-26 May 2017			
No.	**Responsible**	**Reason**	**Action**
33	ENSDF evaluators	Policy implementation on half-life limits, and use of "?" in decay mode	For neutron-rich nuclides, follow new policy regarding $T_{1/2}$ and decay mode. See Section 4.1 for details.
34	ENSDF evaluators and NNDC	Policy implementation	Adopt tropical year to convert years to days: 1 year = 365.24219 days. BNL-NNDC to parse file and ensure that tropical year definition has been applied in all relevant nuclides.
35	ENSDF evaluators and McMaster	Policy implementation	Evaluators to include beta-delayed neutron emission branch in beta-minus decay datasets. See Section 4.1 for detailed description. McMaster to send a sample dataset to all ENSDF evaluators.
36	ENSDF evaluators	Policy implementation	High-spin J^{π} values should be given as proposed by the original authors in the individual datasets. Comment on any discrepancies only when considering values for recommended Adopted Levels.
37	ENSDF evaluators	Policy implementation	If there is no evidence for a given multipolarity in a paper, such data should not be implicitly adopted – of particular concern for high-spin states. Do not simply copy over such data from XUNDL, but rather undertake your own assessment.
38	NNDC-BNL	ENSDF processing	High-spin data: evaluators are known to add A2, A4, DCO and POL to 2G records. NNDC-BNL to provide a definitive list of quantities that can be included in the 2G record.
39	NNDC-BNL	ENSDF processing	NNDC-BNL to modify FMTCHK so that POL is recognised/accepted by this checking code.
40	ANL, ANU	Policy implementation	Recommend suitable standard(s) for band configurations - need to agree upon the adoption of a particular nomenclature.
41	NNDC-BNL	ENSDF processing	Level bands: proposed to introduce SEQ(A)$ as a new flag for less clearly defined bands, or individual single bands (already incorporated into FMTCHK and JAVA-NDS). Agreed and adopted
42	ANU	Data processing	Prepare UNCTools package for dissemination, and send to NNDC-BNL/IAEA-NDS.
43	NNDC-BNL	Data processing	ALPHAD code reports HF when no alpha-decay intensity is given. NNDC-BNL to correct the code.
44	IAEA-NDS	Data handling	IAEA-NDS to consider including JAVA-NDS code in MyEnsdf.
45	NNDC-BNL	Facilitate evaluators' work	NNDC-BNL to share ENSDF Dropbox link containing private communications and supplemental material with NSDD evaluators
46	All evaluators	Procedures	To ensure that mass chain or nuclide conforms to all items on the ENSDF checklist before submitting to NNDC-BNL

COMPLETED AND WITHDRAWN ACTIONS, 22 May 2017			
No.	**Responsible**	**Reason**	**Action**
(5)	NSR manager	Assignment of key numbers	Evaluators should be able to create NSR keynumbers remotely: evaluators to send relevant references and articles immediately to NNDC for keynumber assignments. **Withdrawn -** not sensible for evaluators to assign keynumbers (note that evaluators can suggest keywords)
(9)	Kibedi	Mixing ratios for E0, E2, M1.	Suggest changes to format in order to define mixing ratios. **Completed -** to be discussed by Codes and Formats Subcommittee.
(14)	NDS-IAEA/ NNDC-BNL	Newly evaluated nuclear moments to be made available to evaluators.	Update evaluated nuclear moments file on network website. **Part of Action 1 - Withdrawn**
(16)	NNDC-BNL	Maintain analysis codes.	AME2016 issued officially in March 2017. **Completed** for AME2016 Notification to evaluators when they should adopt specific new horizontal evaluations. AME2016 and other such horizontal requirements judged to be **part of Action 1 - Withdrawn**
(17)	NNDC-BNL/ Johnson	Policy implementation in FMTCHK.	Modify FMTCHK to read continuation record containing Jπ estimates. **Completed** – available on web
(18)	NNDC-BNL/ Johnson	Policy implementation.	Modify FMTCHK to take into account new policy that BR=NP is not needed. **Completed** – available on web
(19)	NNDC-BNL/ Johnson	Format.	Update list of element names. **Completed**
(21)	NNDC-BNL	Format.	Look into modifying NDSPUB/HTML translator for cases with >26 XREF symbols. **Withdrawn** – existing JAVA-NDS code addresses this action.
(24)	NNDC-BNL	Keep NSR up-to-date.	Ensure that references provided by Kondev are incorporated into NSR. **Completed** to an appropriate and achievable practical extent.
(27)	Tuli	NSDD Data Centre status.	Compose statement which defines the requirements for creation/recognition of a new NSDD Data Centre. **Completed** – in 2.5.1. ENSDF Sub-section of 2.5. Organizational review

COMPLETED AND WITHDRAWN ACTIONS (cont'd), 22 May 2017			
No.	**Responsible**	**Reason**	**Action**
(28)	Tuli	ENSDF processing.	Prepare summary page of what is required for submission of ENSDF mass chain for publication in NDS by means of MyEnsdf. **–Withdrawn: New submission guidelines created, see Action 46**
(31)	Kibedi, Tuli, Sonzogni	Implementation of new policy for atomic radiation.	Develop a means of introducing atomic radiations into ENSDF file. Kibedi will not develop uncertainties for atomic radiations. **Re-considered by Codes and Formats Subcommittee:** discussed, derived and adopted. **Completed**
(32)	Audi NNDC-BNL	Keep ENSDF up-to-date.	Send table of published AME2012 values to NNDC. **Completed** Replace Q values in ENSDF with recently published AME2012 values. **Completed**
(33)	Audi, Kondev NNDC-BNL	Keep ENSDF up-to-date.	Provide NNDC with isomer information from NUBASE. **Completed** Distribute this information to all evaluators. **Completed**
(34)	All ENSDF evaluators	ENSDF evaluations.	Consult NUBASE when dealing with excitation energies of isomers - adopt isomer energies that are confirmed by Penning trap mass measurements. **Completed**
(36)	NNDC-BNL	Keep ENSDF up-to-date.	Add AME2012 Q-values as Q-records in Adopted Levels and P records. Completed for Q-values in Adopted Levels, but such an action creates inconsistencies if undertaken in P records. **Partially Completed, and Withdrawn**
(37)	Kelley	Particle decay in ENSDF.	Create an example dataset for particle decay from excited levels. Kelley recommended that such data are better inserted in Comments. **Completed**
(38)	Tuli	Keep ENSDF up-to-date and prioritize.	Re-distribute a high-priority list of nuclides. **Completed** – and to be subsequently undertaken on a yearly basis every December.

First column: number in brackets is the action number arise from the previous meeting (see INDC(NDS)-0687).

COMPLETED AND WITHDRAWN ACTIONS (cont'd), 22 May 2017			
No.	**Responsible**	**Reason**	**Action**
(39)	NNDC-BNL	Keep ENSDF up-to-date and prioritize.	Covering all aspects of the evaluation process, assess the impact of switching from mass-chain evaluations to individual nuclide evaluations and report at next USNDP meeting (November 2015). **Completed**
(40)	Tuli	ENSDF coordination.	Add name of responsible person and starting date of mass-chain evaluation in the record of monthly update. **Completed**
(41)	Kibedi	Policy implementation.	Modify GABS to generate %Igamma, and include on the continuation record. **Completed**
(43)	NNDC-BNL	Policy implementation.	Modify Webtrend so that %Igamma field displays on the web in the decay data sets. **Withdrawn** – existing JAVA-NDS code addresses this action.
(44)	Heads of all NSDD Data Centres	ENSDF coordination.	Convey following information to Tuli by the end of May 2015: (1) permanent and temporary FTEs, (2) mass-chain assignments, and (3) work projection(s) covering the next 12 months. **Completed**
(45)	NNDC-BNL	Keep ENSDF traceable	Explore the implementation of ENSDF tracking, and report their findings and recommendations at the next USNDP meeting (November 2015). NNDC explored and will now implement a monthly update of ENSDF. **Completed**

First column: number in brackets is the action number arise from the previous meeting (see INDC(NDS)-0687).

ENSDF PROCEDURES			
No.	**Responsible**	**Reason**	**Extension**
1	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 NNDC in obtaining conference proceedings, meeting and laboratory reports for NSR. Copy of unpublished conference reports containing significant NSDD contribution should be sent to NNDC.
2	NNDC-BNL	Publication of ENSDF.	Continue journal publication of the mass chain evaluations in *Nuclear Data Sheets.*
3	All network participants	Misprints and errors found in NSR and ENSDF.	Report misprints and errors detected in NSR, XUNDL and ENSDF to NNDC.
4	All ENSDF evaluators	Accelerate review process.	Each ENSDF evaluator should be willing to review two mass-chain equivalents per FTE-year; reviewing process for one mass chain should take no longer than three months.
5	All network participants	Bring NSDD evaluation work to the attention of the nuclear community.	Present network activities at a wide range of appropriate conferences and meetings.
6	All network participants	Avoid duplication of work.	Participants should inform the NNDC and NDS-IAEA about any development of software related to NSDD.
7	All network participants	Young scientists to evaluate mass chains.	Encourage participation in research/evaluation of nuclear structure data.
8	All network participants	Improve NSR.	Send comments and suggestions on NSR improvements (indexing) to NNDC.
9	All network participants	Support new ENSDF evaluators.	Provide local support and mentoring to new ENSDF evaluators of mass chain evaluations.
10	All ENSDF evaluators	Check continued validity of the rules.	Inform NNDC when experimental results appear to contradict accepted rules.
11	All network participants	Improve quality of evaluations.	Solicit potential non-network evaluation reviewers, and send names to ENSDF coordinator at NNDC.
12	NNDC-BNL/ NDS-IAEA	Outreach.	Continue to pursue initiatives to improve the international contributions to the ENSDF mass chain evaluations.
13	All network participants	Outreach.	Formulate and expand contributions to mass chain evaluations within their own countries**.**

ENSDF PROCEDURES cont'd			
No.	**Responsible**	**Reason**	**Extension**
14	All ENSDF evaluators	Quality assurance.	Consider updating the evaluation cut-off date when no or little experimentally significant new data are available.
15	All ENSDF evaluators	Evaluations in progress.	Inform ENSDF coordinator at NNDC about mass chain and individual radionuclide evaluations in progress to ensure their inclusion in monthly evaluation processing report.
16	All network participants	Policies.	Inform NNDC of discrepancies in the current policies, and propose changes and additions.
17	NNDC-BNL	Analysis codes.	Notify network of new versions of analysis codes.
18	NNDC-BNL	General policy pages in NDS.	Modify policy pages, as needed.
19	All ENSDF evaluators	Keep ENSDF up-to-date.	Check NNDC monthly report for nuclides added by others to ENSDF that are in your mass-chain responsibility.

STATUS REPORTS OF NSDD DATA CENTRES AND DDEP

Status Report of the NSDD Data Center at NNDC-BNL and USNDP (2015–2017)

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Staff

As of May 2017, the NNDC staff consists of ten people, consisting of one administrative person, one librarian, two IT professionals and six scientists. A number of changes have taken place since the last NSDD Evaluators' network meeting:
(a) Gustavo Nobre transferred from postdoc to staff member in October 2015, replacing Sam Hoblit who passed away in March 2015;
(b) Libby McCutchan became XUNDL manager on 3 October 2015, and ENSDF manager and *Nuclear Data Sheets* editor on 30 April 2016;
(c) Alejandro Sonzogni became NNDC head and Mike Herman NNDC deputy head on 1 September 2016;
(d) Jagdish Tuli retired on 21 October 2016;
(e) Gulhan Gurdal worked under contract on XUNDL compilations over FY2016 (0.1 FTE).

Sadly, Charlie Dunford, former NNDC head from 1991 to 2001 (retired in 2005), passed away on 26 April 2016.

Contracts

The following people are under NNDC-BNL contract at the present time (FY2017):
(a) Balraj Singh (NSR, XUNDL, ENSDF);
(b) Emil Betak (NSR);
(c) Stanislav Hlavac and Otto Schwerer (EXFOR);
(d) Pavel Oblozinsky (Nuclear Data Sheets).
During the course of FY2016 we also had the following contractors:
(a) Eddie Browne (ENSDF), now under contract with UCB;
(b) Ninel Nica (ENSDF) from Texas A&M University who now receives direct funding from the USDoE.

Compilations

The NNDC is the sole contributor to NSR compilations, and the only US contributor to EXFOR with ~ 4000 articles per year for the former and ~ 200 datasets per year for the latter. NNDC also contributes a large number of XUNDL compilations every year.

ENSDF evaluations, administration and codes

NNDC contributed 214 ENSDF evaluations in FY2015 and 137 in FY2016. We have also taken a very active role in the revision of ENSDF policies and guidelines, as well as the implementation of the JAVA-NDS code to replace Webtrend (old *Nuclear Data Sheets* publications code). A number of format extensions are now being considered.

Dissemination

The NNDC maintains a comprehensive web site powered by five high-end servers, which disseminate a number of databases in both their basic formats as well as user-friendly outputs. We are currently experiencing about 4 million database retrievals per year. NNDC continues to publish the *Nuclear Data Sheets* journal, with an output consisting of mass-chain evaluations and specialized nuclear data articles.

Coordination

Every year we organize a Nuclear Data Week in early November. This event consists of several well-organized group discussions, including the annual meetings of the USNDP and CSEWG and (since 2015) the US Nuclear Data Advisory Committee meeting.

Other activities

The NNDC has active research programs, as evidenced by a number of recent high-profile publications:
(a) measurement of precise decay radiation for isotopes of medical interest;
(b) understanding of the physics underlying the antineutrino emissions from nuclear reactors;
(c) structure of light and heavy nuclides.
NNDC staff are also active participants in the IAEA coordinated research project on "Development of reference database for beta-delayed neutron emission", as well as B(E2) evaluations.

Status report of the NSDD Coordinating Centre at IAEA (2015–2017)

P. Dimitriou

Scientific Secretary
Nuclear Data Section, IAEA, Vienna, Austria

Coordination

The 21st meeting of the NSDD network organized by NDS-IAEA was held at IAEA, Vienna, from 20 to 24 April 2015, and was attended by 36 scientists from 15 Member States involved in the compilation, evaluation and dissemination of nuclear structure and decay data. The summary report of the meeting was published as IAEA report INDC(NDS)-0687. Based on the conclusions and recommendations of that meeting, a series of actions were taken by NDS-IAEA in support of the network activities. These actions are briefly outlined below:

Financial support

Mass-chain evaluations: Two supported evaluators (S. Singh and K. Abuselam) successfully completed their mass-chain evaluations under their IAEA contracts in 2016. A new contract was awarded to S. Pascu (IFIN-HH), to perform mass chain evaluations at the NSDD Data Centre in Romania.

Horizontal evaluations/compilations: NDS-IAEA has provided support to B. Singh (McMaster University) to coordinate and finalize the horizontal evaluations of beta-delayed neutron emission probabilities and beta-decay half-lives in the fission mass region. Financial support was also given to N.J. Stone to produce a table of evaluated magnetic dipole moments and update recommended electric quadrupole moments following a Consultants' Meeting on the Evaluation of Nuclear Moments (27-30 March 2017) which was attended by world-wide experts in the field (see IAEA report INDC(NDS)-0732).

Training

A specialized workshop for active ENSDF evaluators was held at IAEA, Vienna, from 27 to 29 April 2015, immediately after the 21st NSDD Evaluators' meeting. The workshop co-ordinators, E. McCutchan (BNL) and F.G. Kondev (ANL) put together a scientific program which consisted of detailed studies of the Evaluators' Guidelines and the ENSDF General Policies manual. Additional lectures on selected items such as normalization, spin and parity assignment, treatment of super-precise data, among others, were given by the workshop lecturers and participants B. Singh, J.K. Tuli, M.J. Martin, R.B. Firestone, T. Kibedi, S. Basunia, C. Nesaraja, A. Negret, J. Timar, S. Singh,and K. Abusalem. A summary report of the workshop is published as IAEA report INDC(NDS)-0688.

A joint ICTP-IAEA Workshop on Nuclear Structure and Decay data: Experiment, Theory and Evaluation, was held from 22 August to 2 September 2016, at ICTP, Trieste, Italy. Co-directors were E.A. McCutchan (BNL) and M. Thoennessen (MSU). Thirteen participants from 10 countries and 10 lecturers attended the workshop. Hands-on exercises consisted of compilations of XUNDL data sets (25 were submitted to XUNDL database) and the evaluation of four isotopes of mass chain A = 217. Work on the mass chain evaluation continued after the workshop, and has been submitted for review and publication in *Nuclear Data Sheets*. The proposal for the next joint ICTP-IAEA NSDD Workshop was submitted and approved as a two-week event from 15 to 26 October 2018.

Codes

A second meeting of the IAEA project on Improvement of Analysis Codes for NSDD Evaluations was held from 5 to 8 October 2015. Progress made in code development was reviewed, requirements for the code developers were defined, and the results of a new code for beta decay spectra BetaShape (LNHB-Saclay) and a new ENSDF Tree-editor (V. Zerkin, IAEA-NDS) were discussed in detail. A summary report of the meeting was published as IAEA report INDC(NDS)-0696.

Dissemination

LiveChart is continuously developed and improved to take into consideration the feedback from and needs of members of the network and the broader user community. New developments include the

incorporation of masses from the 2016 Atomic Mass Evaluation (AME2016) with proper treatment of uncertainties based on the correlation matrices.

A new code is being developed to calculate atomic radiation starting from the data in an ENSDF file, which uses recent atomic shell data from the Evaluated Atomic Data Library (EADL).

A Medical Portal is now available on the IAEA web server that allows access to the new evaluated charged-particle cross sections and associated decay data produced by the IAEA CRP on Nuclear Data for Charged-particle Monitor Reactions and Medical Isotope Production (2012-2016): http://www-nds.iaea.org/medportal/

The Decay Data Library for Actinides, 2011, contains evaluated decay-scheme data for major and minor actinides as produced by a relatively recent IAEA CRP on Updated Decay Data Library for Actinides (2007-2011), and is also now available on the IAEA web server:

http://www-nds.iaea.org/act_ddl/

IAEA-NDS staff are also making an effort to ensure that all newly evaluated data produced by the most recent and ongoing CRPs (see presentation in Annex 7) are readily available to evaluators and users. For this purpose a common web site has been constructed that provides access to all the decay data produced by IAEA CRPs, as well as data from ENSDF, XUNDL and DDEP. This new retrieval interface is called Decay Data Portal and allows users to easily compare in tabulated form all the evaluated data that are available.

The Isotope Browser has been made available in all the UN official languages (English, French, Spanish, Chinese, Arabic and Russian), as well as in Italian, Slovenian and Japanese.

European effort

Following the recommendations from the 21st NSDD meeting, IAEA-NDS has supported and contributed to the efforts to promote NSDD evaluations and network activities in Europe. Specifically, NDS staff participated in the European Nuclear Data Workshop held in Debrecen on 29 January 2016, and subsequently liaised with the Nuclear Physics European Collaboration Committee (NuPECC) to incorporate nuclear structure and decay data evaluations and the NSDD network activities in the new NuPECC Long-Range Plan. NDS-IAEA gave a presentation at the NuPECC Meeting in Vienna, on 8 October 2016, and contributed several texts to the draft document. The NuPECC Long Range Plan was released in June 2017 including recommendations to support NSDD evaluations as provided by IAEA-NDS. Staff also contributed to a paper on the European NSDD effort presented at ND2016 which has been published in the conference proceedings.

Meetings

A series of Technical, Consultants' and Research Coordination meetings dealing with aspects of nuclear structure and decay data evaluation have been held at the IAEA. For more details see the relevant presentation in Annex 7.

Technical support

Apart from the development of an ENSDF editor (Tree-graph editor by V. Zerkin), the IAEA ensures that all the ENSDF analysis and checking codes made available on the IAEA ENSDF Codes web page are up-to-date and running on all platforms.

MyEnsdf

On-line web tool MyEnsdf (V. Zerkin) is kept up-to-date and has been further developed to include several codes produced by the Russian Data Centre (PNPI). Access to this web tool is now password-free. However, evaluators who have controlled access via a password can also access the EXFOR-NSR PDF database and the new ENSDF Tree-graph editors.

EXFOR-NSR PDF database

The effort to produce a complete collection of PDFs of articles compiled in the EXFOR and NSR databases is on-going in collaboration with NNDC-BNL. Thanks to generous contributions from the PNPI Data Centre (Rodionov, Shulyak) and the efforts of J. Totans (BNL), the PDF database now contains 33% of NSR papers in PDF files, and 71% of EXFOR papers. Access to this database is password controlled.

Status Report of the NSDD Data Center at Oak Ridge National Laboratory

C.D. Nesaraja

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Staff

Michael Smith (Group Leader for Experimental Astrophysics and Nuclear Data Program), Caroline Nesaraja (ENSDF evaluator and XUNDL compiler), Murray Martin (ENSDF evaluator and consultant), Eric Lingerfelt (Software Developer), and Larry Zhang (Computational Astrophysics Programmer).

2. Activities

a) Nuclear Structure Data

ENSDF

This activity consists of mass chain evaluations, and our responsibilities are in the actinide region A=241-249.

Literature cut-off dates for mass chain A=241-249 are listed below:

Mass Chain and Literature Cut-off Dates from ENSDF Database

241	C.D. Nesaraja, NDS 130 (2015) 183, Literature cut-off September 2015
242	Y.A. Akovali, NDS 96 (2002) 177, Literature cut-off September 2001
243	C.D. Nesaraja and E.A. McCutchan, NDS 121 (2014) 695, Lit. cut-off Sept. 2013
244	Y.A. Akovali, NDS 99 (2003) 197, Literature cut-off June 2002
245	E. Browne and J.K. Tuli, NDS 112 (2011) 447, Literature cut-off June 2011
246	E. Browne and J.K. Tuli, NDS 112 (2011) 447, Literature cut-off January 2011
247	C.D. Nesaraja, NDS 125 (2015) 395, Literature cut-off March 2014
248	M.J. Martin, NDS 122 (2014) 377, Literature cut-off September 2014
249	K. Abusaleem, NDS 112 (2011) 2129, Literature cut-off December 2010

Since the last NSDD meeting in 2015, several mass chains have and are being evaluated, and are in various stages of the evaluation, review and publish process, as shown below.

Mass chain	Evaluator(s)	No. of nuclides	Status
41	McCutchan and Nesaraja	11	published
241	Nesaraja	8	published
242	Martin	12	to be submitted soon
244	Nesaraja	8	post review

Both Murray Martin and Caroline Nesaraja are also reviewing mass chains as requested specifically by the National Nuclear Data Centre.

XUNDL

Involves the critical compilation of nuclear structure data from the most recent publications. Frequent one-to-one communications occur with authors of these papers to resolve inconsistencies in data and to obtain additional details of their data. At the request of the XUNDL Coordinator, current ORNL contribution is the compilation of one paper/month.

Caroline Nesaraja and Chris Smith – until August 2016.

Caroline Nesaraja – present.

b) Nuclear Astrophysics Data

Astrophysics data research is closely coupled with our program of measurements of reactions with unstable and stable nuclei. One recent example of such work involves Shisheng Zhang, a guest visitor from Beihang University in Beijing, who has collaborated with Michael Smith and others to calculate the direct capture of neutrons on ^{124,126,128,130,132}Sn with the FRESCO code adopting information from recent ^{124,126,128,130,132}Sn(d,p) measurements at ORNL. This project utilizes FRESCO input parameters that were determined in a prior project (Shi-Sheng Zhang, Jin-Peng Peng, M.S. Smith, G. Arbanas, R.L. Kozub, Phys. Rev. C 91 (2015) 045802) to give the best agreement with neutron direct capture measurements. Captures on exotic Sn nuclei with mass greater than 132 is also being carried out, using information from a RMF-based structure code. Another project involves the conversion of two recent collections of point-wise thermonuclear reaction rates into analytical functions that can be used with a wide variety of astrophysical simulation codes. This conversion required fitting the point-wise rates with functions that range over 30 orders of magnitude to a precision of approximately 2%. Approximately 90 different rates are undergoing revised fit and will soon be available for use in nucleosynthesis codes. A paper describing this work is in preparation. Other reaction compilations are being explored for parameterization and eventual incorporation into standard reaction rate libraries.

c) Other Activities in Collaboration with USNDP Members

Caroline Nesaraja: member of the organizing committee for a workshop on the Nuclear Data Needs and Capabilities for Applications (NDNCA), held at Lawrence Berkeley National Laboratory, 27-29 May 2015. The nuclear data needs and capabilities for Applications presented at this workshop have been compiled into a White Paper.

Michael Smith: member of the organizing committee for a workshop on the Nuclear Data Needs and Capabilities for Basic Science, held at the University of Notre Dame, 10-11 August 2016. The nuclear data needs and capabilities for Basic Science presented at this workshop have been compiled into a White Paper.

3. Future Activities

Future mass chains will be evaluated within the range A=241-249 assigned to ORNL, as well as others requested by USNDP/NNDC-BNL.

Status Report of the NSDD Data Center at LBNL/UCB (2015–2017)

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Introduction

Nuclear Data activities under the Nuclear Data Group of LBNL+UCB (earlier known as the Isotopes Project at LBNL) cover nuclear structure data evaluation, experiments and evaluation of neutron-capture gamma-ray data for Evaluated Gamma-ray Activation File (EGAF), and nuclear reaction studies for applied applications using neutrons from local facilities, like deuteron break-up reaction at 88-inch cyclotron at LBNL and DD neutron generator at the University of California at Berkeley (UCB) and other facilities such as the nuclear research reactors at Budapest, Hungary and FRM, Germany, and the cyclotron facility at the University of Oslo all through international collaboration. An organised Nuclear Data Needs and Capabilities for Applications (NDNCA) workshop led to the production of a white paper.

Mass chain compilations and evaluations

Over the reporting period May 2015 to April 2107, mass chains A=21, 22, 26 and 183 were published in *Nuclear Data Sheets*, mass chains A=57 (collaboration), A=59, 170, 171 and 193 are in the production process for publication, and five nuclides were updated in ENSDF (^{23}O, ^{167}Re, ^{169}Re, ^{196}Os and ^{215}U). Nuclear structure data for XUNDL was compiled from 44 papers, and generated 97 data sets. Furthermore, ^{11}B and ^{7}Li (update) for ENDF and important Pu experimental data were made available to the nuclear data community through a nuclear-data archaeologist, Naohiko Otsuka of IAEA-NDS. Neutron-capture studies of ^{2}H, ^{6,7}Li, ^{9}Be, ^{10,11}B, ^{12,13}B, ^{14,15}N, ^{16,17,18}O, ^{56}Fe and ^{185}Re targets of relevance to EGAF were carried out and published in *Phys. Rev. C*.

Two targeted horizontal activities are being pursued by our group as well. The first is a compilation of (n,n'γ) data from the Baghdad Atlas into a SQL database that has been completed and recently released through the web for users (nucleardata.berkeley.edu). The plan is to expand this compilation into a full horizontal evaluation of (n,n'γ) by incorporating adopted levels and gamma information from ENSDF, together with more recent measurements at international experimental facilities. This effort is being spearheaded by Aaron Hurst and UC visiting student Kaixin Song from Xi'an Jiaotong University in China. The second activity is a horizontal evaluation effort of beta-delayed proton emitters being led by Jon Batchelder in collaboration with Caroline Nesaraja from ORNL.

Experimental studies

The LBNL/UC group has participated in and led several targeted experimental activities. These include a measurement of the ^{56}Fe(p,p'γ) reaction by means of the GRETINA array after a complementary (n,n') study at the 88-inch cyclotron by UC student Leo Kirsch and Lee Bernstein. This research work will address the nuclear data need for the CIELO (Collaboration International Evaluated Library Organization) project. Data analyses are in progress. Kirsch has added several new levels and transitions to this important nucleus. The group has also performed two cross-section measurements at the 88-inch cyclotron (^{54}Fe(p,α)^{51}Mn and ^{90}Zr(d,αn)^{86}Y) for medical isotope production that were identified as high priority by the international community. This work was carried out by three other students: Andrew Voyles from UC, Alexander Springer from Karlsruhe Institute of Technology in Germany, and Haleema Zaneb from Lahore Regional University in Pakistan. Andrew Voyles also submitted a paper for publication in April 2017 describing measurements of the ^{64}Zn(n,p)^{64}Cu and ^{47}Ti(n,p)^{47}Sc cross sections by means of the High Flux Neutron Generator (HFNG) on the UC Berkeley campus.

Plans for the future

Future plans of Nuclear Data Group at LBNL will involve activities to aid in improving the content of the ENSDF, XUNDL, and EGAF databases. The group will also lead efforts to compile and evaluate inelastic neutron scattering cross sections important for applications. Furthermore, specific interest will be devoted to targeted cross-section and decay data measurements in support of isotope production. This will involve activation measurements with the High Flux DD Neutron Generator on the UC Berkeley campus, neutrons from the 88-inch cyclotron thick-target deuteron break-up source, a new quasi-mono energetic capability from the ^{7}Li(p,n) reaction, and light-ion charged particle beams (e.g., p, d, etc.). The experimental activities of the Nuclear Data Group at LBNL will help to establish better connection with databases like ENSDF, ENDF, EXFOR, and on many occasions identify problems so as to correct and improve the nuclear data within such databases.

Publications

Thirty-two journal papers/conference proceedings/meeting reports related to experimental activities have been published, authored/co-authored by nuclear data group members in this reporting period. This includes a report related to NSDD 2015 action #8 “ENSDF to XML - work with LLNL on proposed format, liaise with IAEA, as presented to the network and entitled: "An XML-hierarchical data structure for ENSDF", A.M. Hurst, LBNL-1004483 (2016); these studies were also presented at the Nuclear Data Week meeting at BNL in November 2015.

Group members at LBNL and UCB-NE include Lee A. Bernstein, M.S. Basunia, Aaron M. Hurst, Jon Batchelder, Richard B. Firestone, Eddie Browne, Coral M. Baglin (until September 2016), along with students Andrew Voyles, Adriana Ureche, Leo Kirsch, Amanda Lewis, and visiting students Alexander Springer (Germany), Haleema Zaneb (Pakistan) in the Nuclear Data Group.

Status Report of the NSDD Data Center at TUNL

J.H. Kelley[1,2], J. Purcell[1,4], C.G. Sheu[1,3]

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I. ENSDF

TUNL is responsible for data evaluations in the mass range A = 3-20. Since the last IAEA NSDD meeting a review of A=12 nuclides has been completed, and a review of A=3 nuclides, based on our 2010 Nuclear Physics article, was published in NDS.
A review of A=2 nuclides continues.

Recent Publications from the TUNL Data Evaluation Group

Nuclear Mass A	Publication Status
3	Nucl. Data Sheets, December 2015
12	submitted to Nucl. Phys. A

We anticipate addition of A=12 ENSDF information into the database soon after the article has been published. Future light-nuclei reviews will be published exclusively in NDS. In addition to these A-chain reviews, we have added reviews of ^{4,6}n, ^{7}H, ^{16,18}B, ^{17,18,19}C, ^{11}O, ^{15}F and ^{17,18,19}Na to ENSDF, and we have added ^{17}B(β-n), ^{17}C(β-n) and ^{18}C(β-n) delayed particle emission data sets to ENSDF.

Compilation effort covers the A=2-20 region for XUNDL, which is about five articles/month.

II. World Wide Web Services

TUNL continues to develop new WWW services for the nuclear science and applications communities. PDF and HTML documents have been posted for the TUNL and Fay Ajzenberg-Selove “Energy Levels of Light Nuclei” reviews, and GIF, PDF and EPS/PS files of the Energy Level Diagrams. We also provide focused information on thermal neutron capture data, beta decay data, and measured excitation functions for light-particle reactions relevant to A=3-20 nuclides. Recently, we have compiled a list of evaluated lifetime values for all nuclei in the A=3-20 region.

III. Related Activities, 2015/16

Grace Sheu was involved in the effort of producing print-ready and review drafts of articles in connection with the preparation of manuscripts for Nuclear Data Sheets.

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

Status Report of the NSDD Data Center at Argonne National Laboratory (2015–2017)[4]

F.G. Kondev

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I. Program overview

The Argonne Nuclear Data Program is identified with a number of scientific activities carried out within the broad framework of the US Nuclear Data Program (USNDP) Coordinated Work Plan. Emphasis is placed on nuclear structure and decay data, and their applications in nuclear physics research, and in applied nuclear technologies. Compiled and evaluated data are made available to the National Nuclear Data Center (NNDC) for inclusion in the Evaluated Nuclear Structure Data File (ENSDF) database, or results are published directly in peer-reviewed scientific journals. Contributions are also made to various specialized databases that serve specific needs in the fields of nuclear structure, nuclear astrophysics and applied nuclear physics. This effort includes the evaluation of atomic masses and complementary nuclear structure data for the Atomic Mass Evaluation (AME) and NUBASE databases, and compilations of recently published nuclear structure data for the XUNDL database (Unevaluated Nuclear Data List). Measurements aimed at providing answers to specific questions and improving the quality of existing databases in specific areas are also performed. Experiments are carried out at the US Department of Energy nuclear physics user facilities and at leading nuclear physics laboratories elsewhere through collaborative arrangements.

II. Nuclear Data Evaluation Activities for ENSDF and XUNDL

The main emphasis of the nuclear data evaluation activities at Argonne National Laboratory is on nuclear structure and decay data evaluations for the ENSDF database. The ANL nuclear data center has responsibilities for evaluating nuclei within the A=106-112, 176-179 and 199-209 mass chains. The up-to-date status of the evaluations under the ANL responsibility is presented in Table 1. During the period of time covered by this report, evaluations of the A=109 mass chain (with S. Kumar, University of Delhi and Jun Chen, ANL) and the 188 mass chain (with Prof. S. Juutinen, Jyvaskyla University and Prof. D. Hartley, US Naval Academy) were completed. Work on the A=177 mass chain is continuing. Compilations for the XUNDL database, as well as ENSDF evaluations of nuclides for which the first experimental results defining their properties become available, were also carried out.

[4] Work supported by Office of Nuclear Physics, US Department of Energy, under Contract No. DE-AC02-06CH11357.2.

[5] Change of address to Physics Division, Bldg. 203/Room F137, Argonne National Laboratory, Argonne, Illinois 60439, USA.

Table 1. Status of mass chain evaluations assigned to the ANL nuclear data center.

Mass chain	NDS publication	Evaluator(s)	Current status
106	NDS **109** (2008) 943	D. De Frenne and A. Negret	completed
107	NDS **109** (2008) 1383	J. Blachot	completed
108	updated on-line, 2008	J. Blachot	completed
109	NDS **137** (2016) 1	S.Kumar, J.Chen and F.Kondev	completed
110	NDS **113** (2012) 1315	G. Gurdal and F.G. Kondev	completed
111	NDS **110** (2009) 1239	J. Blachot	completed
112	NDS **124** (2015) 157	S. Lalkovski and F.G. Kondev	completed
176	NDS **107** (2006) 791	M.S. Basunia	completed/LBNL
177	NDS **98** (2003) 801	F.G. Kondev	completed/under review
178	NDS **110** (2009) 1473	E. Browne	completed/Argentina
179	NDS **110** (2009) 265	C.M. Baglin	completed/McMaster
199	NDS **108** (2007) 79	B. Singh	completed
200	NDS **108** (2007) 1471	F.G. Kondev and S. Lalkovski	completed
201	NDS **108** (2007) 365	F.G. Kondev	completed
202	NDS **109** (2008) 699	S. Zhu and F.G. Kondev	completed
203	NDS **105** (2005) 1	F.G. Kondev	completed
204	NDS **111** (2010) 141	C.J. Chiara and F.G. Kondev	completed
205	NDS **101** (2004) 521	F.G. Kondev	completed
206	NDS **109** (2008) 1527	F.G. Kondev	completed
207	NDS **112** (2011) 707	F.G. Kondev and S. Lalkovski	completed
208	NDS **108** (2007) 1583	M.J. Martin	completed/ORNL
209	NDS **126** (2015) 373	Jun Chen and F.G. Kondev	completed

Evaluated mass chain not assigned to the ANL regions of responsibility:

188	submitted in 2016	S. Juutinen, D. Hartley, F.G. Kondev	completed/under review

III. Other Activities

The Argonne nuclear data program has continued to contribute to the on-going evaluations of atomic masses in collaboration with scientists from CSNSM (Orsay, France), IMP (Lanzhou, China) and RIKEN (Japan).

Our program is also involved in complementary nuclear data related research activities. This effort complements the main ANL evaluation activities by providing training experience to the evaluator on modern experimental techniques and instruments that are used to determine nuclear data. Such studies have ensured that contacts have been established and maintained with a broad range of nuclear data users and with the FRIB and GRETINA research communities in particular. Contributions have been made to collaborative nuclear structure and decay research activities at the ATLAS and CARIBU facilities, with the aim of providing answers to specific questions and improving the quality of existing USNDP databases in specific areas. Decay data measurements aimed at improving decay data in the actinide region have continued. Emphasis has been placed on the properties of nuclei far from the line of stability and nuclear isomers of heavy Pu, Cm, No and Rf nuclei. Decay studies of neutron-rich nuclei in the deformed A~160 fission product region have also been initiated at the CARIBU facility.

Status Report of the NSDD Data Center at NSCL/MSU (2015–2017)

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1. Overview of NSCL/MSU data center

NSCL/MSU became a data center member of the NSDD network at the 2015 IAEA NSDD meeting in Vienna, and plays a unique role as part of the FRIB/NSCL facilities. NSCL/MSU took over responsibility for the evaluation of fourteen mass chains (A = 31–44), and also compiles data for the XUNDL database, including all future data coming from NSCL and FRIB. The centre is also helping to develop and improve the analysis and utility tools used in data compilation and evaluation.

Current centre members: Michael Thoennessen (program manager) and Jun Chen.

2. ENSDF evaluations and XUNDL compilations

In addition to the primary responsibility of mass chains A=31-44 for ENSDF data evaluation, the NSCL/MSU data center also takes on additional mass chains selected from the evaluation priority list formulated by the NNDC and coordinated within the NSDD network. Mass chains A=138, 40 and 39 have been re-evaluated at NSCL/MSU since 2015, mass chain A=38 is currently under evaluation, and the rest in A=31-44 region are up-to-date within the 10-year updating cycle. A total of 186 datasets from 86 papers have been compiled since April 2015 for XUNDL.

Status of Mass Chain Evaluations at NSCL/MSU

Mass chain	Year of last evaluation	Evaluator(s) of last evaluation	Status
31	2013	C. Ouellet and Balraj Singh	up-to-date
32	2011	C. Ouellet and Balraj Singh	up-to-date
33	2011	J. Chen and Balraj Singh	up-to-date
34	2012	N. Nica and Balraj Singh	up-to-date
35	2011	J. Chen, J. Cameron and Balraj Singh	up-to-date
36	2011	N. Nica, J. Cameron and Balraj Singh	up-to-date
37	2012	J. Cameron, J. Chen and Balraj Singh	up-to-date
38	2007	J. Cameron and Balraj Singh	evaluation underway
39	2017	J. Chen	in review
40	2015	J. Chen	up-to-date
41	2015	C.D. Nesaraja and E.A. McCutchan	up-to-date
42	2016	J. Chen and Balraj Singh	up-to-date
43	2015	Balraj Singh and J. Chen	up-to-date
44	2011	J. Chen, Balraj Singh and J. Cameron	up-to-date
138	2016	J. Chen	in review

3. Code development and maintenance

The NSCL/MSU data center takes the lead in the code development and maintenance of Java program (McMaster-MSU-JAVA-NDS) for the production of publish-ready manuscripts of mass chain evaluations for Nuclear Data Sheets. A modified version of this program is now also used to generate PDF outputs of ENSDF datasets for web-display of the ENSDF database on the NNDC website.

The NSCL/MSU data center is also responsible for the maintenance of the computer program xls2ens developed to assist XUNDL compilation. This program is distributed through the USNDP and IAEA networks.

Status Report of the new NSDD Data Center at Texas A&M

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Mass-chain nuclear structure and decay data evaluations

Since 2005, the Cyclotron Institute, Texas A&M, has invested significant effort on ENSDF mass-chain evaluations that was financed by a contract with NNDC-BNL initiated by J.C. Hardy, R.G. Helmer and J.K. Tuli. All resulting evaluation work at Texas A&M has been based on the technical input of N. Nica (ENSDF evaluator) and J.C. Hardy (scientific adviser). Furthermore, the evolution and emerging status of the center has furnished the opportunity for direct funding through a US DOE grant, and the Cyclotron Institute was approved as a new ENSDF Data Evaluation Center at the International Network of Nuclear Structure and Decay Data Evaluators meeting in 2017.

An employment level of 0.67 FTE over seventeen years at Texas A&M has resulted in the evaluation of nuclear structure and decay data for 203 nuclei, representing 15 mass chains, and involved the publication of 14 mass-chain papers in *Nuclear Data Sheets* from 2005 onwards. Measurement programmes have also been pursued to address important nuclear phenomena, and have aided considerably in the evaluation process:

1) Precise measurements and evaluations of superallowed 0^+ to 0^+ beta decay (J.C Hardy).
2) Determination of well-defined ICCs in support of the Frozen Orbital approximation to quantify conversion-electron emission probabilities (J.C. Hardy and N.Nica).

Mass chain evaluations: 200 nuclei, 15 A-chains

N. Nica, Nuclear Data Sheets for A = 252, Nucl. Data Sheets 106 (2005) 813.

N. Nica, Nuclear Data Sheets for A = 140, Nucl. Data Sheets 108 (2007) 1287.

D. Abriola, *et al*., Nuclear Data Sheets for A = 84, Nucl. Data Sheets 110 (2009) 2815.

4. N. Nica, Nuclear Data Sheets for A = 147, Nucl. Data Sheets 110 (2009) 749.
5. N. Nica, Nuclear Data Sheets for A = 97, Nucl. Data Sheets 111 (2010) 525.
6. J. Cameron, J. Chen, Balraj Singh, N. Nica, Nucl. Data Sheets for A = 37, Nucl. Data Sheets 113 (2012) 365.
7. N. Nica, J. Cameron, Balraj Singh, Nuclear Data Sheets for A = 36, Nucl. Data Sheets 113 (2012) 1.
8. N. Nica, Balraj Singh, Nuclear Data Sheets for A = 34, Nucl. Data Sheets 113 (2012) 1563.
9. Balraj Singh, N. Nica, Nuclear Data Sheets for A = 77, Nucl. Data Sheets 113 (2012) 1115.
10. N. Nica, Nuclear Data Sheets for A = 148, Nucl. Data Sheets 117 (2014) 1.
11. N. Nica, Nuclear Data Sheets for A = 141, Nucl. Data Sheets 122 (2014) 1.
12. N. Nica, Nuclear Data Sheets for A = 157, Nucl. Data Sheets 132 (2016) 1.
13. N. Nica, Nuclear Data Sheets for A = 158, Nucl. Data Sheets 141 (2017) 1.
14. N. Nica, Nuclear Data Sheets for A = 140, to be published in Nucl. Data Sheets.
15. N. Nica, Nuclear Data Sheets for A = 155, to be published in Nucl. Data Sheets.
16. N. Nica, A =160, evaluation in progress, to be published in Nucl. Data Sheets.

Texas A&M University: ENSDF data evaluation center

Proposal accepted for Texas A&M Nuclear Data Program to constitute the technical driver of a new NSDD Evaluation Center funded by US DOE grant (2017-2019):

0.67 FTE;
independent program, highly efficient with relatively low overheads;

Texas A&M University A-chain evaluation responsibilities for A=140, 141, 147, 148, 153, 155, 157, 158 and 160; all but A=153 have previously been assessed and evaluated fully by N. Nica (and 140 evaluated twice).

Other scientific research related to proposed mass-chain evaluations:

- continue existing program of precise measurements of internal conversion coefficients;
- promote original proposals for research from the re-evaluations of nuclear data.

Status Report of the NSDD Data Center at McMaster University

Report of work completed from May 2015-May 2017, and on-going work

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ENSDF: evaluations; training, computer codes, network co-ordination.
XUNDL: compilation of current papers, co-ordination.
NSR: writing key-word abstracts of papers in PRC journal.
Horizontal evaluations and compilations:
B(E2) for first 2^+ and first 4^+ states in e-e nuclei;
Beta-delayed neutron (BD-N) emitters: $\%P_n$, $T_{1/2}$ for all potential B-n emitters;
Compilation of nuclear isomers of $T_{1/2} \geq 10$ ns;
Update of 1998 Akovali table of r_0 for e-e alpha-decaying nuclei.

ENSDF evaluation work

Mass chain publications in *Nuclear Data Sheets* (May 2015 to May 2017):
A=189: T.D. Johnson and B. Singh, *NDS* 142, 1-330 (2017)
A=256: B. Singh, *NDS* 141, 327-364 (2017)
A=139: P. Joshi, B. Singh, S. Singh and A.K. Jain, *NDS* 138, 1-292 (2016)
A=42: J. Chen and B. Singh, *NDS* 135, 1-192 (2016)
A=79: B. Singh, *NDS* 135, 193-382 (2016)
A=227: F.G. Kondev, E.A. McCutchan, B. Singh and J.K. Tuli, *NDS* 132, 257-354 (2016)
IAEA-ICTP workshop - mass chain co-ordinated by B. Singh.
A=224: S. Singh and B. Singh, *NDS* 130, 127-182 (2015)
A=182: B.Singh, *NDS* 130, 21-126 (2015)
A=43: B. Singh and J. Chen, *NDS* 126, 1-150 (2015)

Nuclide updates for ENSDF: 160 additional nuclide updates for ENSDF.
Review work for ENSDF: A=158 mass chain.
Submitted for publication (May 2015-May 2017)
A=76: B. Singh and A.R. Farhan (review stage)
A=172: B. Singh and T. Kibedi (review stage)
A=57: A. Negret, B. Singh and R.B. Firestone (review stage)
A=258: B. Singh (post-review stage)
A=217: F.G. Kondev, E.A. McCutchan, B. Singh (IAEA-ICTP workshop, review stage)

Mass chains in progress:
A=164 (with J. Chen, post-review stage)
A=130 (with S. Pascu and A. Rodionov)
A=219 (with group in India)
A=266-300 even-A
A=58 (with C. Nesaraja)
A=73 (with J. Chen)
A=218, 190, 165, 98

XUNDL compilation work

May 2015-Sept 30, 2015: continued co-ordination with different data centers.
Compiled: 450 datasets from approximately 210 papers.
May 2015 to Sept 2015: reviewed 175 datasets from other centers.
Co-ordinated: XUNDL compilation work at the 2016 IAEA-ICTP workshop.

Compilation of papers on Atomic Mass measurements (since 2008):
1. Oct 29, 2015: 17 papers with 83 data points, compared to AME2012 data;
2. May 15, 2017: 22 papers with 133 data points, compared to AME2016 data.
Both files are available on *nuclearmasses.org* webpage of Michael Smith (ORNL).
Work continues on XUNDL compilations and fairly frequent communications with authors.

NSR key-wording of papers in Phys. Rev. C

May 2015-May 2017: approximately 2250 papers consulted, keyword abstracts written for approximately 1530 papers and submitted for the NSR database.

Horizontal evaluations and compilations

1. B(E2) for the first 2+ states in e-e nuclei (NNDC, BNL; McMaster University, Central Michigan, IIT-Roorkee. Publications:
i) B. Pritychenko, M. Birch, B. Singh and M. Horoi, *ADNDT* 107, 1-139 (2016);
ii) B. Pritychenko, M. Birch and B. Singh, Revisiting Grodzins systematics of B(E2) values, *Nucl. Phys.* A 962, 73-102 (2017);
iii) M. Birch, B. Pritychenko and B. Singh, On the equivalence of experimental B(E2) values determined by various techniques, *Nucl. Phys.* A 955, 145-155 (2016);
iv) B. Maheshwari, A.K. Jain and B. Singh, Asymmetric behaviour of the B(E2↑; 0+ → 2+) values in $^{104\text{-}130}$Sn and generalized seniority, *Nucl. Phys.* A 952, 62-69 (2016).

NNDC+McMaster collaborative continues for a first compilation and evaluation of B(E2) for the first 4+ states in e-e nuclei, systematic of BE2(4+ to 2+)/BE2(2+ to 0+) and E(4+)/E(2+), etc. Also update of B(E2) values continues for the first 2+ states, as this topic is very active in current experimental work.

2. Beta-delayed neutron emission probabilities (Pn) and half-lives for n-rich nuclei: part of IAEA CRP, 2012-2017 (McMaster, TRIUMF, NNDC-BNL, CIAE-Beijing, VECC-Kolkata, Valencia, CNEA-Argentina, Warsaw)
Publication: M. Birch, B. Singh, I. Dillmann, D. Abriola, T.D. Johnson, E.A. McCutchan and A.A. Sonzogni, Evaluation of Beta-Delayed Neutron Emission Probabilities and Half-Lives for Z = 2-28, *NDS* 128, 131-184 (2015). This paper deals with approximately 220 β-n emitters.

For Z>28 nuclides (total of ~ 410 nuclides), semi-final draft of Pn and half-life tables with bibliographic file has been prepared and sent to the IAEA-NDS for setting up a reference database for beta-delayed neutron precursors, first of its kind. The systematic of experimental data are being prepared using Kratz-Herrmann (1973Kr15) formalism, McCutchan *et al*. (2012Mc04,2014Mc07) novel approach, and Miernik level-density parameterization method (2013Mi23,2014Mi23). Results will be presented at the upcoming 3rd and final RCM of the CRP June 12-16, 2017. A paper based on this work is in preparation, and is expected to be submitted to *Nuclear Data Sheets* by fall 2017.

3. Atlas of nuclear isomers of half-life 10 ns or greater (IIT-Roorkee, McMaster):
Publication: A.K. Jain, B. Maheshwari, S. Garg, M. Patial and B. Singh, Atlas of Nuclear Isomers, *NDS* 128, 1-130 (2015). The search for isomers is another area of vigorously pursued experimental research, and therefore an addendum has been prepared that includes new values and revised half-lives and isomer energies (see presentation by A.K. Jain).

4. Update of 1998 Akovali radius (r_0) parameters for alpha-decay hindrance factors (Akal University, India, McMaster, IIT-Roorkee): radius parameters have been deduced for all known e-e alpha emitters (~ 190 systems) with revised half-lives and alpha branching ratios by a thorough search of the NSR database after the mass chain literature cut-off dates, and using Q(alpha) values from AME2016. Systematics have been studied, and a detailed paper is under preparation for submission to *Nuclear Data Sheets* (see presentation by B. Singh for New-ALPHAD code and incorporation of the updated 2017 r_0 table.

5. Potential new project: Update of 1998 log*ft* review by B. Singh *et al*. (1998Si17): Prof. Kai Zuber at Dresden is interested in the update of this table. He visited McMaster for a week in summer 2016 and is also visiting this summer. Hopefully, in collaboration with Mougeot from CEA Saclay, this project can be planned as a Dresden-McMaster-Saclay collaboration.

Network co-ordination and participation in workshops for computer codes

1. Participated in May 2015 ENSDF one-week workshop at the IAEA: lectures and discussion of formats for ENSDF.
2. Participated in July-August 2016 IAEA-ICTP ENSDF two-week workshop in Trieste: lectures and hands-on training in ENSDF formats through XUNDL compilations and ENSDF evaluations.
3. Participated in IAEA-ENSDF codes meeting Oct 5-8, 2015: B. Singh presented JAVA-NDS; M. Birch presented J-GAMUT and V-AVELIB converted to JAVA and a revised method (based on the Barlow approach) to handle asymmetric uncertainties in the averaging procedure. B. Singh also collaborated with S. Singh on the new ALPHAD and Rad-d codes.
4. Participated in JAVA-NDS workshop Oct 5-8, 2015 at TUNL, USA to go over fine details of the pdf output from JAVA-NDS code.

Analysis of experimental data for Y-94 decay to Zr-94

The experiment was performed in 2011 at TRIUMF with S. Yates as the spokesperson. B. Singh participated in the experimental run for a week. The data are currently being analysed by Anagha Chakraborty at Visva Bharati University in India, in consultation with B. Singh. We hope to bring analysis to completion by the end of 2017, which should be a major improvement in the knowledge of the decay characteristics of Y-94 isotope, a fission fragment, last studied by B. Singh *et al*., *J. Phys*. G 2, 397 (1976). May also prove possible to extract an independent P_n value for Rb-94 decay, as grandparent of Y-94 isotope.

Financial Support

ENSDF, XUNDL and NSR work by B. Singh was primarily supported by the US DOE through a contract from the NNDC-BNL, USA. The beta-delayed neutron horizontal evaluation work was partly supported through a contract to B. Singh for approximately 110 hours of work from the IAEA-NDS, while the graduate students (Johnson Liang and Michael Birch) involved in this work were partly supported by the NSERC of Canada. The work of Michael Birch on the J-GAMUT and V-AVELIB codes was primarily supported through a direct contract from the IAEA-NDS. B. Singh acknowledges support from the IAEA-NDS for travel-related expenses to the IAEA-organized meetings, and McMaster University for continuing to provide infrastructure facilities for the work detailed in this report.

Status Report of the NSDD Data Centre at JAEA

H. Iimura

Research Group for Nuclear Data
Japan Atomic Energy Agency

Staff

A. Hashizume (former affiliation: RIKEN), M. Kanbe (former affiliation: Tokyo City University), J. Katakura (Nagaoka University of Technology), K. Kitao (former affiliation: National Institute of Radiological Science), H. Koura (JAEA), S. Ohya (former affiliation: Niigata University), and H. Iimura (JAEA) who also serves as group leader. The group holds a meeting once a year to exchange information on the progress of each member in their evaluations. This Japanese group is a sub-group of the JENDL committee, which supports travel cost for group meetings.

2. Mass chain evaluations

The Japanese NSDD group is responsible for mass chain evaluations of A=120-129. We are now evaluating A=120 (Hashizume), 123 (Kanbe) and 126 (Iimura, Katakura, Ohya). Both A=120 and 126 have almost been completed, and first drafts will be sent to NNDC within a few months for review. Also, the references for A=122 and 124 are now being collected by Katakura, Koura and Ohya in order to start the evaluation of these mass chains.

Status of Mass Chain Evaluations.

Mass	Previous NDS publication		Status
	Year	Evaluator(s)	
118	1995	Kitao	
120	2002	Kitao, Tendow, Hashizume	Evaluation underway (Hashizume)
121	2010	Ohya	
122	2007	Tamura	
123	2004	Ohya	Evaluation underway (Kanbe)
124	2008	Katakura, Wu	
125	2011	Katakura	
126	2002	Katakurs, Kitao	Evaluation underway (Iimura, Katakura and Ohya)
127	2011	Hashizime	
128	2015	Timar, Elekes, Singh	
129	2014	Timar, Elekes, Singh	

Kitao had been undertaking the evaluation of mass chain A=118 until last year. Although some work still remains to be done to reach completion, he is unable to continue this work because of health problems. Furthermore, there are difficulties associated with other members of the Japanese group replacing him in these studies. So we are proposing that the responsibility for A=118 be shifted to another centre.

JAEA Chart of the Nuclides

The 10th edition of the JAEA Chart of the Nuclides was published in 2014. A further edition is planned (Chart of the Nuclides 2018), and compilation is in progress by Koura, Katakura, Minato and Tachibana.

Status Report of the NSDD Data Centre at CNDC

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Staff

Huang Xiaolong and Wang Jimin. Kang Mengxiao graduated in 2016, and is now working at the Beijing occupational disease hospital - he will not undertake NSDD evaluations in the future.

2. Mass Chain Evaluations

The NSDD group at the China Nuclear Data Centre (CNDC) has permanent responsibility for evaluating and updating NSDD for A=51, 62, and 195-198. Over the previous two years, mass chains A=51, 196, 197 and 198 have been revised on the basis of the available experimental decay and reaction data: A=198 has been published, A=51 and 197 evaluations are being reviewed, and A=196 is being evaluated.

A=62 was assigned to CNDC from Jilin University (JLU group, China) at the 2011 NSDD Evaluators' network meeting, and was evaluated by Balraj Singh *et al*. in 2012. The status of each mass chain is as follows:

Status of Mass Chain Evaluations at CNDC.

Mass chain A	Current status	Evaluators
51	NDS 107 (2006) 2131	Wang Jimin, Huang Xiaolong, post review
62	NDS 113 (2012) 973	Balraj Singh *et al*.
195	NDS 121 (2014) 395	Huang Xiaolong, Kang Mengxiao
196	NDS 108 (2007) 1093	Huang Xiaolong, evaluation underway
197	NDS 104 (2005) 283	Huang Xiaolong, Wang Jimin, Kang Mengxiao, undergoing review
198	NDS 133 (2016) 221	Huang Xiaolong, Kang Mengxiao

3. Decay Data Evaluations

(1) β-delayed neutron probabilities and half-lives

The CNDC group has participated in the IAEA CRP on "Reference Database for Beta-Delayed Neutron Emission". Compilations and evaluations of the delayed neutron probabilities and half-lives for the Z=51-57 region were carried out in 2015/16, and two EXCEL files were submitted to the IAEA-NDS (as Compilation and Adopted Values).

(2) DDEP decay data evaluations

The CNDC group has been a member of the DDEP decay data evaluation project since 2007. Over the previous two years, we have updated the main decay data for ^{227}Th, ^{229}Th and ^{233}U as contributions to this project.

Status Report of the NSDD Data Centre at Jilin University

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Changchun 130012, China

Staff

Huo Junde, Yang Dong, and a number of graduate students. Huo Junde is in charge of the group, and will continue his evaluation efforts.

Mass Chain Evaluations

Jilin University group is responsible for mass chains: A=52, 53, 54, 55, 56, 63, and 67. Mass chain 52 was published in 2015, and mass chain 67 is in the process of being evaluated. The status of each mass chain is given below.

Mass chain	Previous publication	Status
52	NDS 128 (2015) 185	published in 2015
53	NDS 110 (2009) 2689	
54	NDS 121 (2014) 1	
55	NDS 109 (2008) 787	
56	NDS112 (2011) 1513	
63	NDS 92 (2001)147	planned revision within two years
67	NDS 106 (2005) 159	evaluation underway; will be submitted for review soon

Other research/activities

Two experiments on nuclear structure have been performed on the tandem accelerator of the China Institute of Atomic Energy (CIAE) that involve the heavy-ion fusion-evaporation reactions of ^{7}Li+^{110}Pb and ^{32}S+^{106}Cd and γ-γ coincidence measurements. The resulting data are being analysed off-line.

An optional course is available to graduate students majoring in nuclear physics at Jilin University entitled: “introduction to the evaluation of nuclear structure and decay data”.

Status Report of the NSDD Data Centre at IIT Roorkee, India

A.K. Jain, S. Singh, G. Mukherjee and P. Joshi

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Mass Chain Evaluation - Status (A=215-229):
India has the responsibility for mass chains A=215-229. The individual status of each of these mass chains is presented in the table below.

Mass chain	Year of evaluation	Reference/Journal	Earlier evaluator(s)	New data sets, and present status
215	2013	NDS 114 (2013) 2023	Balraj Singh, *et al.*	9
216	2007	NDS 108 (2007) 1057	C. Wu	6
217	2003	NDS 100 (2003) 141	Y.A. Akovali	evaluation underway, IAEA-ICTP workshop, 2016
218	2006	NDS 107 (2006) 1027	A.K. Jain and Balraj Singh	9
219	2001	NDS 93 (2001) 763	E. Browne	evaluation underway
220	2011	NDS 112 (2011) 1115	E. Browne and J.K. Tuli	3
221	2007	NDS 108 (2007) 883	A.K. Jain, Sukhjeet Singh, Suresh Kumar and J.K. Tuli	9
222	2011	NDS 112 (2011) 2851	Sukhjeet Singh, A.K. Jain and J.K. Tuli	2
223	2001	NDS 93 (2001) 763	E. Browne	evaluation underway - assigned at Mumbai workshop, 2016
224	2015	NDS 130 (2015) 127	Sukhjeet Singh and Balraj Singh	nil
225	2009	NDS 110 (2009) 1409	A.K. Jain, R. Raut and J.K. Tuli	2
226	1996	NDS 77 (1996) 433	Y.A. Akovali	submission, June 2017
227	2016	NDS 132 (2016) 257	F.G. Kondev, *et al.*	nil
228	2014	NDS 116 (2014) 163	Khalifeh Abusaleem	nil
229	2008	NDS 109 (2008) 2657	E. Browne and J.K. Tuli	6

Mass chain evaluations - progress

Mass chains evaluated

Nuclear data sheets of A=224, *NDS* 130 (2015) 127
Nuclear data sheets of A=139, *NDS* 138 (2016) 1 co-evaluated with Balraj Singh
Nuclear data sheets of A=227, *NDS* 132 (2016) 257 only partially
A=227 mass chain was evaluated as a part of ICTP workshop, 2014: Sushil Kumar participated in this workshop, and contributed to the evaluation of ^{227}Ac.

Mass chains in final phase

Nuclear data sheets of A=226, Sukhjeet Singh, Ashok Jain
Nuclear data sheets of A=223, Mumbai workshop
Nuclear data sheets of A=219 , Balraj Singh, Gopal Mukherjee, Sukhjeet Singh, Ashok Jain

Mass chains being evaluated

Nuclear data sheets of A=90, S.K. Basu
Nuclear data sheets of A=221, Paresh Joshi, Sukhjeet Singh, Ashok Jain (recently started)

IAEA CRP on beta-delayed neutron emission

Gopal Mukherjee participates in this IAEA coordinated research project – see the detailed report on this topic by Balraj Singh. We have completed the compilation and evaluation of 103 beta-delayed neutron emitters or potential bdN emitters, including isotopes from Nb (Z = 41) to Cd (Z = 48); there are approximately ten isomeric excited states in bdN.

Two tables have been assembled:

(i) Compilation table which has information on all the measurements and references with comments for each nucleus, and

(ii) Table of Adopted Values which contains only the evaluated adopted values for each nucleus.

We were also requested to review bdN evaluations undertaken by all of the participants for elements with Z = 29 – 57. This review has been completed and a report submitted, and a full paper is being prepared by Balraj Singh (co-ordinator).

2nd ENSDF Workshop, Mumbai

First ENSDF workshop was held at VECC, Kolkata in November 2012. The second ENSDF workshop took place at the Homi Bhabha Centre for Science Education (TIFR), Mumbai, 29 February – 4 March 2016.
Convener: P.K. Joshi, Co-Convener: Gopal Mukherjee.
Ten lecturers including J.K. Tuli (NNDC-BNL) and P. Dimitriou (IAEA-NDS).
Attended by 35 students from about 20 different institutes and universities within India.
Evaluation of A = 223 mass chain was also undertaken at this workshop.
Tentatively proposed to hold another ENSDF workshop in India – November 2018.

Participation at International Conference on Nuclear Data for Science and Technology, ND2016, 11 – 16 September 2016, Bruges, Belgium

Gopal Mukherjee participated in ND2016, with full financial support from the IAEA-NDS – he presented an invited talk as well as two other papers.

Horizontal Evaluations

Work has been carried out on two horizontal evaluations:
Atlas of Nuclear Isomers
Tables of MR and AMR bands
The Atlas of Nuclear Isomers has been published in *Nuclear Data Sheets* 128 (2015) 1-130, and has been very well received by the nuclear community. A huge interest in nuclear isomers exists, and therefore an update of this atlas is already being prepared and should be completed within the next few months.

Published and updated about 10 years ago, the table of MR bands is in the process of being updated further, with the intention to complete within four months. A equivalent table of AMR bands is also planned, and we hope to complete this exercise in 6-8 months.

Update of even-even radius parameter

Sukhjeet Singh, in collaboration with Balraj Singh, has completed this work and incorporated the procedure into the ALPHAD and RadD computer codes.

Status Report of the NSDD Data Centre at MTA Atomki (2015–2017)

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MTA Atomki evaluation centre

The centre at the Institute for Nuclear Research (MTA Atomki) consists of two evaluators: János Timár and Zoltán Elekes, who devote altogether 0.5 FTE to mass-chain evaluation work. We have been working on mass-chain evaluations since 2009, and our permanent responsibilities are A=101-105. Our evaluation work is currently supported non-financially by MTA Atomki.

Status of permanent responsibilities.

Mass	Previous NDS publication	ENSDF update
101	1998	2006-2010
102	2009	2008-2009
103	2009	2009-2010
104	2007	2007-2009
105	2005	2005-2011

Mass-chain evaluations and other activities, 2015-2016

• Evaluation of mass chain 128 was published (*NDS* 129 (2015) 191).
• Evaluated mass chain 101 with our Romanian colleagues (Alexandru Negret and Sorin Pascu), and submitted for review.
• Evaluated mass chain 46 - almost ready for submission (maybe submitted by the time of the NSDD Evaluators' network meeting).
• Mass chain 105 has been evaluated in collaboration with Stefan Lalkovski (University of Sofia). Our segments of the evaluation have been completed, and Stefan is working on the final isotope.
• Organized a workshop for European evaluators at MTA Atomki, where we also discussed how we could involve more people in evaluation work
(*http://users.uoa.gr/~tmertzi/NDE_Workshop/index.html*).

Plans for 2017-2018

• Publish the evaluations for mass chains 101, 105 and 46.
• Continue to work together with the Romanian data centre, and evaluate mass chain 118, followed by 103 - would also like to start on the evaluation of mass chain 104.

Status Report of the Bucharest NSDD Data Centre, (2015–2017)

A. Negret and S. Pascu

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Introduction

An NSDD Data Centre was established in IFIN-HH, Bucharest with the approval of the network meeting that took place in Vienna, May 2015. Two evaluators are involved in this activity, each of them dedicating 0.2 FTE to evaluation (total of 0.4 FTE): Alexandru Negret and Sorin Pascu. This level of activity is supported by IFIN-HH. S. Pascu submitted a Research Contract proposal for funding to IAEA-NDS, and a positive reply was recently received.

The new Data Centre has responsibility for six mass chains. The following table lists these mass chains and their cut-off dates for relevant reference/publications:

Mass	Previous ENSDF publication, Cut-off date	Status
57	24 September 1998	evaluation underway A. Negret, Balraj Singh and R.B. Firestone
58	10 January 2010	
59	8 February 2002	evaluation completed/submitted for review S. Basunia
117	1 March 2009	
118	1 November 1992	
119	December 2008	

Evaluation activities

During the period 2015-2017 the two evaluators at the IFIN-HH Data Centre have been involved in the following evaluation activities:
Full evaluation of the A=57 mass chain by A. Negret, Balraj Singh and R.B. Firestone. A. Negret and Balraj Singh are also involved in the evaluation of the individual nuclide ^{86}Sr (latest evaluation of the A=86 mass chain performed in 2015 by the same authors).
The full evaluation of the A=130 mass chain is currently being performed by S. Pascu, Balraj Singh and A. Rodionov.
The full evaluation of the A=101 mass chain was performed in collaboration with the European Data Centre established in Debrecen. A. Negret performed evaluations of ^{101}Sn, ^{101}In, ^{101}Cd and ^{101}Ag, and S. Pascu evaluated ^{101}Nb, ^{101}Mo and ^{101}Tc, while the other isotopes were evaluated by colleagues at Debrecen. The final version of the A=101 evaluation should be agreed within 2017.

Other activities

As already pointed out several times over recent years, the European contribution to ENSDF evaluations is rather limited. Much use is made of the data files within Europe, and yet only two NSDD Data Centres exist (Debrecen and Bucharest). Under these somewhat critical circumstances, the Bucharest Data Centre has been involved in trying to encourage the spread of ENSDF evaluation activities in Europe. A meeting took place in Debrecen in February 2016 to assess and discuss the unsatisfactory situation, and a few actions were tabled and debated at length:
Significant efforts were made to recognize the importance of nuclear structure evaluation activities within the Long-Range Plan prepared by the Nuclear Physics European Collaboration Committee (NuPECC). Following on from a presentation by P. Dimitriou, the final version of the 2016/2017 Long-

Range Plan acknowledged nuclear structure evaluation as a significant activity for the development of nuclear physics in Europe.
A. Negret, D. Balabanski, P. Dimitriou, Z. Elekes, Th. Merzimekis, S. Pascu and J. Timar contributed to the ND2016 conference at Bruges, Belgium, September 2016, with a short presentation and poster entitled ”Nuclear Structure and Decay Data Evaluation in Europe”. The aim was to raise the awareness of the nuclear data community towards the difficulties posed by a lack of commensurate nuclear structure evaluation activities in Europe.
A Memorandum of Understanding for the creation of a European community that brings together laboratories involved in nuclear structure compilation and evaluation, as well as outreach and educational activities, remains under consideration. Informal discussions have also taken place with various members of the nuclear physics community.

Status Report of the NSDD Data Centre at the Australian National University (2015-2017)

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Mass chain evaluations

ANU has primary responsibilities for mass chains A=172-175. Over the previous two years, the A=172 evaluation has been carried out in collaboration with Balraj Singh (McMaster University), and has recently been submitted to the NNDC for review. Mass chain A=174 evaluation undertaken in collaboration with E. Browne and J.K. Tuli is undergoing pre-review, and is expected to be submitted for review later this year.

ENSDF code developments

ANU has primary responsibility to maintain both the BrIcc and BrIccMixing programs for the international network of NSDD evaluators. We also maintain the BrIcc web interface at http://bricc.anu.edu.au/

New developments are the atomic radiation database and programs, as well extension of the NS_Lib library to propagate uncertainties by means of Monte Carlo. ENSDF codes have been long recognized as not always being able to handle uncertainties, particularly large relative uncertainties or limits. A pilot application has been developed (UncTools), which combines Monte-Carlo techniques with an equation parser in order to evaluate arbitrary equations. After extensive testing, the new uncertainty propagation modules will be used for future versions of BrIcc, BrIccEmis and TRULER.

Horizontal evaluation

E0 and mixed E0+E2+M1 transitions in atomic nuclei are in the process of being studied in collaboration with A.B. Garnsworthy (TRIUMF) and J.L. Wood (Georgia Institute of Technology). Spectroscopic information on the decay properties of pure E0 and mixed E0+E2+M1 transitions are being evaluated, and E0 matrix elements extracted from available data defining life-time or absolute transition rates. Attention is being paid to determining the E2/M1 mixing ratios in the case of E0+E2+M1 transitions. Conversion coefficients and E0 electronic factors are obtained from BrIcc (2008Ki07). A major aim of these studies is to explore the spin dependence of the monopole matrix elements which is crucial to extending our understanding of the structure of 0^+ states in atomic nuclei.

Atomic radiations in nuclear decay (with B.Q. Lee and A.E. Stuchbery (ANU))

A Monte-Carlo computational model has been adopted in the BrIccEmis code to determine the atomic radiations in nuclear decay, and has been extensively tested as part of a programme of work designed to address several problems in basic nuclear science, applications and nuclear medicine. The present version of the model uses atomic transitions rates from EADL (1991PeZY), and atomic binding energies calculated for atoms in the presence of multiple vacancies using the RAINE code (2002Ba85). A new database of pre-compiled atomic spectra for Z=6-100 is nearly complete. Numerical tools that use ENSDF files as input to calculate the complete Auger-electron and X-ray spectra based on the new database are expected to be released later in 2017.

Collaborative research with P. Jönsson and J. Ekman (University of Malmo), J. Pires Marques and J. Sampo (Universidade de Lisboa) has been initiated through bilateral visits, with the aim of calculating more accurate atomic transition energies and rates by means of a multi-configuration Dirac-Fock (MCDF) model.

Collaborative studies with A.L. Nichols (University of Surrey) and F.G. Kondev (Argonne National Laboratory) have involved nuclear structure evaluations and calculations of atomic radiations for a

range of medical radioisotopes (^{99}Mo/^{99}Tc^{m}, ^{103}Pd/^{103}Rh^{m}, ^{111}In/^{111}Cd^{m}, ^{125}I, ^{131}Cs and ^{178}Ta). This effort was part of an IAEA coordinated research project on "Nuclear Data for Charged-particle Monitor Reactions and Medical Isotope Production" (2012-2016).

The low energy electron spectrum from the EC decay of ^{125}I has been measured in collaboration with M. Vos, T.G. Tornyi and M. Alotiby (ANU). Very thin radioactive sources were prepared by I. Greguric, M. Roberts and T. Henley (ANSTO). The measured spectrum in the 2000-4000 eV energy range contains the L Auger and the K conversion electrons, and is in excellent agreement with predictions from the BrIccEmis calculations.

Publications:

A. Inoyatov, *et al*., Search for environmental effects on the KLL Auger spectrum of rubidium generated in radioactive decay, *Phys. Scr*. **90**, 2 (2015) 1-9.

B.Q. Lee, *et al*., A stochastic cascade model for Auger-electron emitting radionuclides, *Int. J. Radiat. Biol.* **92**, 11 (2016) 1-13.

P. Lobachevsky, *et al*., Strand breakage by decay of DNA-bound ^{124}I provides a basis for combined PET imaging and Auger endoradiotherapy, *Int. J. Radiat. Biol*. **92**, 11 (2016) 686-697.

N. Falzone, *et al*., Absorbed dose evaluation of Auger electron-emitting radionuclides: impact of input decay spectra on dose point kernels and S-values, *Phys. Med. Biol*. **62**, 16 (2017) 2239-2253.

Status Report from the new NSDD Data Centre at the Department of Nuclear Engineering, University of Sofia

S. Lalkovski

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Relevant features of CV (Stefan Lalkovski)

• 2004 PhD
• 2004-2017, Assistant Professor, Department of Atomic Physics, University of Sofia.
2006-2008, Post-doc, University of Brighton, UK - RISING passive stopper campaign.
• 2014-2016, UK NuStAR PM equipment built for FAIR.
• April 2017, Associated Professor, Department of Nuclear Engineering, University of Sofia.
Duties: teaching (12 h per week) and research (rest of the time).

Related activities

• Mass chain evaluations:
A=200 (F.G. Kondev and S.Lalkovski), published in 2007;
A=207 (F.G. Kondev and S.Lalkovski), published 2011;
A=112 (S. Lalkovski and F.G. Kondev), published 2015;
A=105 (in collaboration with Debrecen Data Centre), in preparation.
• Small contributions to XUNDL.
• IAEA-ICTP NSDD Workshops, Trieste 2005 and 2014.
• NSDD Evaluators' Network meetings, Vienna 2009, Kuwait 2013, Vienna 2015 and Berkeley 2017.

NSDD, ENSDF evaluation manpower of 0.2 FTE.

TECHNICAL PRESENTATIONS

Decay Data Evaluation Project (DDEP) and Related Work

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France

6.1.1.

The Decay Data Evaluation Project is supported by a small number of decay data evaluation specialists, mainly from the metrology community: Mark A. Kellett (Coordinator), Xavier Mougeot and Christophe Dulieu (IT support), LNHB, France; Alan L. Nichols, University of Surrey, UK; Aurelian Luca, IFIN-HH, Romania; Huang Xiaolong, CNDC, CIAE, China; Valery P. Chechev and Nikolai Kuzmenko, KRI, Russia; and Andy Pearce and Arzu Arinc, NPL, UK. New members joined in 2016: Brian Zimmerman, NIST, USA; Herbert Janssen, PTB Germany; and Haoran Liu, Metrology Institute, China. Additional support has also been received from Tibor Kibédi (ANU, Australia) – BrIcc and BrIccMixing codes – along with others from the wider nuclear data community who help in the review process.
Products noted: BIPM-5 monographies (*http://www.bipm.org/fr/publications/monographie-ri-5.html*), Mini Table of Radionuclides, and Nucléide Nuclear and Atomic Decay Data (CD).

The Consultative Committee on Ionising Radiation (CCRI) of the Bureau International des Poids et Mesures (BIPM) endorses and recommends the use of DDEP data by all metrology institutes.
(a) Volume 8 of Monographie BIPM-5 was published December 2016, containing decay-data evaluations for 32 radionuclides: ^{41}Ca, ^{47}Sc, ^{52}Fe, ^{58}Co, ^{61}Cu, ^{63}Zn, ^{73}Se, ^{82}Rb, ^{82}Sr, ^{88}Y, ^{89}Zr, ^{93}Zr, ^{93m}Nb, ^{94m}Tc, ^{106}Ru, ^{106}Rh, ^{109}Cd, ^{131}I, ^{127}Xe, ^{131m}Xe, ^{133}Ba, ^{140}Ba, ^{138}La, ^{140}La, ^{144}Ce, ^{144}Pr, ^{144m}Pr, ^{148}Pm, ^{148m}Pm, ^{151}Sm, ^{169}Er and ^{198}Au.
(b) A new edition of Mini Table of Radionuclides was published in March 2015; distributed and sold by EDP Sciences (25€), approximately 1300 copies have been sold to date.
(c) As of 3 March 2017, the DDEP web site contains evaluated and recommended decay data for 221 radionuclides: *www.nucleide.org* Access is also possible via Laraweb *http://www.nucleide.org/Laraweb* Furthermore, a new web site is being developed to clarify and hopefully improve user friendliness – *http://www.nucleide.org* will become *http://www.lnhb.fr/*

The MetroBeta Project is being co-funded through the European Union 2020 research and initiative programme (EMPIR) and EMPIR participating states, *http://metrobeta-empir.eu/*
Participants are as follows: CEA, France; CMI, Czech Republic; PTB, Germany; Gonetic, Netherlands; UHEI, Germany; UMCS, Poland; and CHUV, Switzerland. Various working packages have been agreed and assigned: (1) theoretical calculations of beta spectra, (2) high-resolution beta spectrometry based on Metallic Magnetic Calorimeters (MMCs), (3) measurements of beta spectra by other methods, (4) comparison and validation of measurements, (5) creating impact, and (6) management and coordination. Most notably, these studies involve new measurements of high-resolution beta spectra for both low (< 100 keV) and intermediate (< 1 MeV) end-point energy pure beta emitters: ^{14}C, ^{36}Cl, ^{99}Tc and ^{151}Sm.

Atomic Mass Evaluation, AME2016

M. Wang, G. Audi, F.G. Kondev, W.J. Huang, S. Naimi and X. Xu
presented by F.G. Kondev on behalf of the AME collaboration*

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The mass of an atom reflects the net consequence of all interactions that hold the nucleons together in the nucleus. Strong, weak and electromagnetic interactions act among the nucleons to make theoretical descriptions of nuclei very complex, for which atomic masses provide a natural opportunity to study all of these interactions together. As a fundamental property of nuclei, atomic masses are widely used in many domains of science and engineering, as illustrated in Fig. 1. A reliable atomic mass table derived from the experimental data in which the atomic masses and the relevant experimental information can be found conveniently is in high demand by the research community

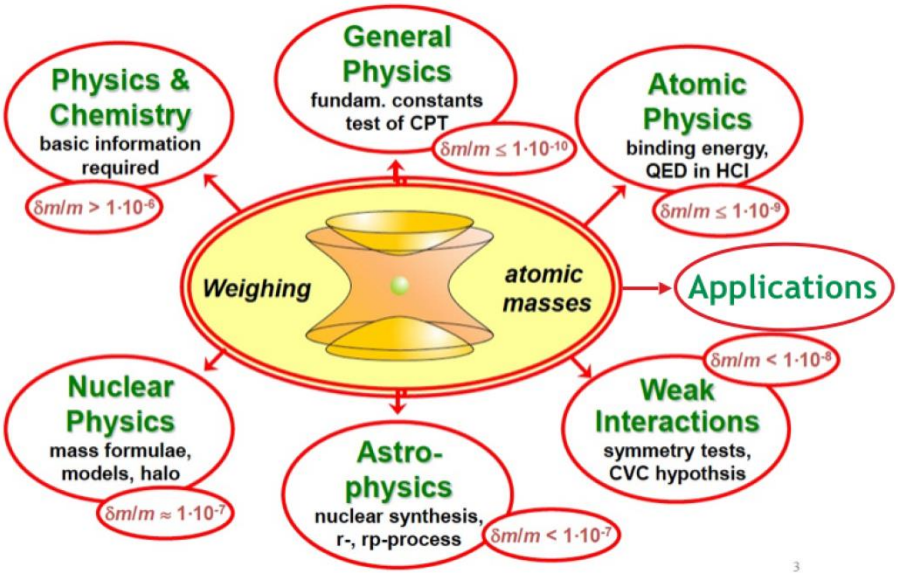

Fig. 1: Areas of basic and applied sciences which require high-precision mass data.

The Atomic Mass Evaluation (AME) was created in 1950s to meet these demands, and now serves the research community by providing reliable and comprehensive information related to atomic masses. Experimental knowledge of atomic masses has continuously expanded since then, and a large amount of data relevant to atomic masses has been published in the scientific literature. The latest AME2016 evaluation, together with the complementary NUBASE2016 database on basic nuclear properties, was recently completed and published in *Chinese Physics* C [1-3]. An overview of these latest data sets was presented.

[1] G. Audi, F.G. Kondev, M. Wang, W.J. Huang and S. Naimi, *The NUBASE2016 evaluation of nuclear properties*, Chin. Phys. **C41** (2017) 030001.
[2] W.J. Huang, G. Audi, M. Wang, F.G. Kondev, S. Naimi and X. Xu, *The AME2016 atomic mass evaluation (I). Evaluation of input data; and adjustment procedures*, Chin. Phys. **C41** (2017) 030002.
[3] M. Wang, G. Audi, F.G. Kondev, W.J. Huang, S. Naimi and X. Xu, *The AME2016 atomic mass evaluation (II). Tables, graphs and references*, Chin. Phys. **C41** (2017) 030003.

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Evaluated Gamma-ray Activation File (EGAF)

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Based on the EGAF data, we have published 14 refereed journal articles since 2003 on total thermal radiative neutron-capture cross sections for 40 nuclides: ^{2}H, ^{6,7}Li, ^{9}Be, ^{10,11}B, ^{12,13}C, ^{14,15}N, ^{16,17,18}O, ^{23}Na, ^{39,40,41}K, ^{56}Fe, ^{103,105,107,109,111}Pd, $^{122,124,125,126,128.130}$Te, ^{151,153}Eu, ^{155,157}Gd, ^{185}Re, ^{180,182,183,184,186}W and ^{238}U. We have shown that continuum γ-ray intensity de-exciting the capture state or populating the ground state decreases exponentially, and can be accurately estimated by integrating the exponential beyond the weakest transitions. Furthermore, the total intensity populating low-lying levels after thermal-neutron capture has been observed to be a strong indicator of level spin. Primary γ rays from the EGAF file are in the process of being compiled for the IAEA Coordinated Research Project on Photonuclear Data and Photon Strength Functions.

The Baghdad Atlas of (n,n'γ) Data

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An overview of the (n,n'γ) data in "Baghdad Atlas" was presented. The installation procedure of the SQL database was also described, followed by a demonstration of the methods for interacting with and visualizing the data.
For more details navigate to *http://nucleardata.berkeley.edu/*

A.M. Hurst, L.A. Bernstein and S.A. Chong, LBNL report LBNL-1007259;
https://pubarchive.lbl.gov/islandora/object/ir:1007259

A.M. Demidov, L.I. Govor, Yu.K. Cherepantsev, M.R. Ahmed, S. Al Najjar, M.A. Al Amili, N. Al Assafi and N. Rammo, Atlas of Gamma-Ray Spectra from the Inelastic Scattering of Reactor Fast Neutrons, Nuclear Research Institute, Baghdad, Iraq (Moscow, Atomizdat 1978).

Atomic Radiations in ENSDF

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6.1.2.

As actioned in the previous meeting, Kibedi and Sonzogni had prepared a proposal to include absolute atomic radiation energies and emission probabilities in the ENSDF decay data sets. Some of the symbols within the proposed format were found to be inappropriate because confusing duplication would occur, and would inevitably cause significant and prohibitive difficulties.

Other issues accepted during the course of the ensuing discussions:

1. nature of the extensive amount of atomic data involved in the decay process prohibited the quantification of data uncertainties at the present time;

2. IUPAC notation has been adopted to denote the nature of the individual X-ray and Auger-electron emissions (International Union of Pure and Applied Chemistry), which is based on the initial and final atomic levels involved in each defined transition.

All agreed that the atomic data formatting proposal should be discussed in much greater detail at the planned Codes and Formats Subcommittee meeting on Thursday, and agreement reached on this important format-labelling nomenclature.

NS_Lib Treatment of Uncertainty by Monte Carlo

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Kibedi reported on his assessment of the form and nature of the data uncertainties within ENSDF from the points of view single-assigned and unassigned uncertainties, symmetric and asymmetric uncertainties, and special handling rules. Uncertainty propagation in ENSDF codes is entirely based on the Gaussian analytical method (only valid for small $\Delta x/x$ values), and becomes difficult/impossible to manage for multi-variant functions (RULER, GABS and GTOL codes). Consideration had been given to a publication of the Joint Committee for Guides in Metrology (1993) "Guide to the Expression of Uncertainty in Measurement" (GUM framework), and the derivation of symmetric and asymmetric normal distributions (probability density function(s) (PDF)).

Monte-Carlo simulations can be used to obtain and estimate of the average value (y) and associated standard uncertainty ($u(y)$), along with a coverage interval ($[y_{low}, y_{high}]$). While considering such manipulations, the confusion generated when output numbers from a data manipulation code result in a number and uncertainty in the form 4.E6(8) – does this formulation mean 4(8)E6, or 4.0(8)E6? BrIcc can generate numbers in this form, which can be shown to represent a value and uncertainty of 4(8)E6, although as demonstrated this listing does result in an immediate lack of clarity that needs to be avoided. Other issues occur when determining ICCs for a mixed transition for which there are limits on the known mixing ratio (MR). Uncertainties are also sometimes desired for ICC data in which the MR is unknown – should one use the PDF of existing data, adopt an arbitrary uncertainty of 50%, or some other approach?

Consideration has also been given to the introduction of PDFs to treat the propagation of uncertainties in T-RULER – an example was shown in which the same data could be used to give f_ν values of 440(30) by Python, 450(5) by GUM, and 450(4) by UncTools. Kibedi proposed the introduction of a consistent Monte-Carlo treatment for all cases that would possess a much simpler program logic than at present, and adherence to a sound statistical approach even for larger relative uncertainties and limits. Disadvantages are extensive CPU usage, and the observation that the resulting mean may not agree with the directly calculated value.

A Modern Format for ENSDF?

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ENSDF is a premier source of nuclear structure and decay data, and serves a multitude of applications and problem-specific databases. These data have to be reformatted into RIPL which is used by many reaction-modelling codes (EMPIRE, TALYS, COH) to generate applications-based ENDF evaluations, provide reaction data that drive radiation-transport calculations (MCNP), and adopt in a wide range of applications including EGAF comparisons of ENSDF with statistical-model calculations. One significant problem is that the format of ENSDF is based on obsolete 80-character mixed-record punch-cards:

- difficult to parse, and restrictive;
- not easy to extend non-standardised "Comment fields" that are used to capture additional data;
- difficult to write applications that can manipulate the format which also makes data dissemination challenging.

"Revitalizing the Nuclear Data Pipeline" is a Topic Area of NDWG, of which Task 1 is "Nuclear Structure Data Infrastructure Modernization" (LBNL, UCB, LLNL and BNL). These multi-laboratory studies have been associated with a possible solution whereby translation software would be develop to create XML-structured hierarchy consistent with the GND format (Mattoon, LLNL). Work has begun to parse ENSDF data sets: (i) to extract numerical data for general purposes, and (ii) generate RIPL format for specific applications. Interpreted data can be represented in different formats. Specific actions have resulted from an initial feasibility study:

- XML-hierarchy for "some" records presented at the IAEA NSDD Evaluators' network meeting in 2015.
- IAEA Action Item #8 ⇒ generate representative XML schema for all standard one-card (primary) records in ENSDF, and present at US Nuclear Data Week.

Representative XML-translation for all standard one-card (primary) ENSDF records is available in LBNL laboratory report: "An XML-hierarchical data structure for ENSDF", A.M. Hurst, LBNL-1004483 (March, 2016)
https://pubarchive.lbl.gov/islandora/object/ir%3A1004483
Presented during the Nuclear Data Week at BNL, 2015 (Lee Bernstein), and document distributed within the network - thanks to David Brown (BNL) and Caleb Mattoon (LLNL) for their feedback. Not a funded activity at present.

Envisaged future work:

- QA and continuation records (already underway, e.g., particle-decay modes for RIPL translation);
- round-trip translation: ENSDF-to-XML and XML-to-ENSDF;
- Comment records?

Current effort does not impact on adopted ENSDF practices and procedures, and future effort should not disturb evaluators.

Risk #1: Instability of GND format - changes to GND impact XML.
Risk #2: Several analysis and utility codes for ENSDF built-up around the existing infrastructure.
Backward-compatibility important.

JGAMUT Code for Recommended Gamma-ray Energies and Intensities

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Java GAMUT (JGAMUT) is a revitalization of the original GAMUT code by R.B. Firestone (see Firestone, R. B. (1991), GAMUT: A Computer Code for Gamma-ray Energy and Intensity Analysis, LBL report LBL-26024). The purpose of this software is to assist evaluators in creating the "ADOPTED LEVELS, GAMMAS" dataset in an ENSDF evaluation. JGAMUT provides two ways of taking input gamma-ray energy and intensity measurements and producing adopted values. (1). "Gamma-by-gamma" method where, for each gamma-ray, all measurements of that gamma's energy and intensity are averaged to produce the adopted values. (2). Using the algorithms of the original GAMUT code, which use global (over all input datasets) fitting routines to produce the adopted energies and intensities. For gamma-by-gamma approach, the code uses V-AVELIB to calculate averages (developed earlier by M. Birch, and available on NNDC webpage).

Status

First version of the code was sent to the IAEA-NDS in August 2015. Later found that the recoil correction in gamma-ray energies had inadvertently been left out. A revised version incorporating this correction was made available, and was demonstrated by B. Singh at the 2017-NSDD meeting. The current version has the additional capability of handling the decay data evaluation for a certain nuclide from several papers, e.g. reading an input Excel-spreadsheet file with gamma-ray energies and intensities reported in several papers. Averaging can be done performed using both of the approaches stated above. Intensities are kept on a relative scale throughout the spectrum, and not as relative branching ratios, as for Adopted datasets in the ENSDF evaluations. Some further checks still need to be made. Expected to distribute the second version of the code by early November 2017 for testing purpose. Detailed manual to run the code, structure of input and output files, procedural details and adopted algorithms is available with the code.

New-ALPHAD Code for Hindrance Factors and Updated r_0 Parameters for e-e Nuclei

S. Singh and S. Rathi, Akal University, India
B. Singh, McMaster University, Canada (presenter)
A.K. Jain, IIT, Roorkee, India

ALPHAD code

Calculates theoretical partial half-lives for alpha transitions to the excited states by means of spin-**independent** formalism of M.A. Preston: PR 71, 865 (1947). Alpha-hindrance factors (HF) are calculated for alpha transitions to the ground and excited states of the daughter nuclei. HF = partial $T_{1/2(exp)}$ / partial $T_{1/2(theory)}$, under the assumption that HF=1 for ground state to ground state transitions of even-even nuclei, for which the r_0 radius parameter is deduced for all even-even alpha emitters.

ALPHAD-NEW code for odd-A or odd-odd nuclei

At present, r_0 radius parameter needed for HF calculations is deduced manually by interpolation procedure from r_0 parameters given for neighbouring e-e nuclides in the Akovali r_0 table (1998Ak04, *NDS* **84**, 1 (1998)), then inserted manually in the ENSDF-formatted file. The ALPHAD-NEW code computes r_0 automatically for odd-A and odd-odd cases by adopting the table of r_0 parameters for e-e nuclei as an input file, with the option of specifying user-preferred values of r_0 via the code. By default, our 2017 updated table of r_0 values is used as an input file to the ALPHAD-NEW code.

2017 update of 1998Ak04 table of r_0 values

Table of r_0 values has been updated by incorporating Q(alpha) values from AME-2016 and adopting half-lives, decay branching ratios, and alpha-particle branches from the ENSDF database as well as current literature. A total of 182 alpha decays of known e-e nuclei from Z=52 to 118 were analyzed to deduce r_0 parameters. Systematics of r_0 parameters for certain Z values were presented at the meeting, as well as an updated table of r_0 values for e-e nuclei and a detailed summary file of data input and calculations for all 182 even-even alpha emitters. Operational aspects of the ALPHAD-NEW code were demonstrated at the meeting. The code will soon be released to the network for test purposes, after a minor bug in the original ALPHAD code is removed by NNDC- BNL staff.

BetaShape: A New Code for Improved Calculations of Beta Spectra

X. Mougeot
(presented by M.A. Kellett)

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BetaShape is a C++ code that has been developed to calculate the mean beta energies, log *ft*, β^-/β^+ and correlated $\bar{\upsilon}_e/\upsilon_e$ spectra and multiple transitions from ENSDF files. Certain issues remain that have been addressed, or in the process of being studies:

(a) modifications to the modelling have been developed to improve the calculations for all types of allowed and forbidden non-unique transitions, whereas issues remain as how best to handle unique transitions;
(b) modelling of EC transitions – Dirac equation has been numerically solved, forbiddenness extended, and realistic shell occupancy introduced, along with other studies (more precise overlap and exchange corrections, hole effect, and shake-up and shake-off effects);
(c) consideration of atomic effects (high precision calculations of screening and exchange effects for allowed transitions that need to be extended to forbidden unique transitions);
(d) introduction of nuclear structure for beta decay that should result in more precise calculations of forbidden non-unique transitions.

A database of 130 experimentally determined shape factors for beta transitions has been assembled in order to act as benchmarks in the calculation of recommended values bt means of BetaShape. The derivation of data uncertainties is dependent on the propagation of the uncertainties in Q-value, level energies, half-life, and branching ratio, or the code estimates a relative uncertainty of ~ 60% (warnings are given in the output files for the latter case). Asymmetric uncertainties are symmetrized (yet again, warnings are given in the output files). Examples of resulting calculations from BetaShape have been compared with the equivalent calculations of the LogFT code, along with examples of data output listings and improved spectral shapes are shown in the relevant PDF file accessible from Annex 7.

Progress in MyEnsdf Web Tools for ENSDF Evaluators

V. Zerkin (presented by P. Dimitriou)

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1400 Vienna, Austria

MyEnsdf is a web-tool application that was developed by V. Zerkin (NDS, IAEA) to allow the user to upload an ENSDF file and run the analysis, checking and publishing codes remotely (see full list below). Recent improvements include the addition of checking and analysis codes developed by the PNPI Data Centre (ENSDF_checking, NEWGTOL - program for cases where GTOL does not give results due to matrix singularity), as well as another non-ENSDF analysis code from PNPI that could be of use to the evaluator (BARON).

MyEnsdf can be accessed without the need for a password for users wishing to run the analysis and checking codes. With password controlled access, MyEnsdf can function as a portal to various other useful tools:

- PDF database: as of 2017-11-16, contains PDF files for 101,181 NSR Entries (45%)

- ENSDF viewers: Interpreted and iTree and Web-editor

More information is given in the Presentation (PDF file accessible via Annex 7).

List of codes running under MyEnsdf

Checking and utility codes
1) FMTCHK Checking ENSDF format /10.4, 10-May-2017/
2) chk_ENSDF Total ENSDF checker/v-0.4.7, 10-Apr-2014/
3) chk_PARENT Checking PARENT-records in DECAY datasets/24-Jan-2009/
4) chk_brackets Pair brackets checker from ENSDF-format files/20-Apr-2012/
5) PREPRO preprocessing /2014/
6) XPQCHK checks consistency of quantities given on p-card /2014/
7) ENSDF_to_XML converts file ENSDF to XML /G.Shulyak, PNPI, Nov-2016/

Analysis codes
8) ALPHAD Alpha Hinderance Factor Program (AHF, AHFYE, ALPHAD) /v-2.0a, 06-Nov-2006/
9) ALPHAD_RADD Alpha Hinderance Factor Program (AHF, AHFYE, ALPHAD) /v-2.0a,2016/
10) BrIcc calculates conversion coefficients and E0 electronic factors /v2.3b, 16-Dec-2014/
11) BrIccMixing calculates Mixing Ratio (MR) and Normalization Factor (R) /v2.3b, 16-Dec-2014/
12) GABS Gamma-ray absolute intensity and normalization calculation /v-11c, 08-Jan-2017/
13) GTOL+NewGTOL Determines level energies from a least-squares fit to Eγ's & feedings /2013/
14) LOGFT Calculates log ft for beta decay /v-7.2, 7-Feb-2001/
15) PANDORA Checks physics of ENSDF files/v-7.1c, 12-Oct-2017/
16) RADLST calculates the nuclear and atomic radiations associated with the radioactive decay /88/
17) RULER Calculates reduced transition probabilities /v-3.2d, 20-Jan-2009/

Other evaluation tools/codes
18) BARON calculates model parameters for nuclear rotation bands /v1.0, 23-Jun-2014/

Publication tools
19) Upload your ENSDF file to working database to modify NDSPUB result /Sept. 2014/
20) NDSPUB ENSDF publication program /v-12.26b, 15-Jul-2008/

NEWGTOL Program

A.A. Rodionov (in absentia)

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Work to improve the performance of the GTOL code has been undertaken by the Data Centre group (Petersburg Nuclear Physics Institute of the Russian Academy of Sciences). The group is directly involved in the activities of the International Network of Nuclear Structure and Decay Data Evaluators, which consists of 18 centres and groups working with the latest published nuclear data to undertake evaluations of the nuclear level properties for all isotopes. Data include bibliography information (Nuclear Science References, NSR) and evaluated nuclear data (Evaluated Nuclear Structure Data File, ENSDF) that all have computer-oriented form. The newest version may be obtained via the Internet from the Brookhaven National Laboratory (*http:/www.nndc.bnl.gov*), and printed versions of the evaluated data are presented in *Nuclear Data Sheets*.

At present, the existing GTOL program is used to calculate the energies of levels and their uncertainties from measured values of the energies of transition and corresponding experimental uncertainties. Mathematically the problem can be reduced to the solution of system of linear equations. All data sets from ENSDF file (March, 2008) have been calculated with the regular GTOL-7.2e program, and the ANGTOL database and special subroutines are used to sort out the level information. The problem of solvability of the equations concerns various classes of incorrect mathematical problems that occur. A total of approximately 6000 data sets satisfy the prescribed inequality for solvability, including 1633 adopted level data sets. However, the program also encounters a number of fatal problems in the solution of the system for 4.2% of all cases, making the introduction of regularizing algorithms necessary. Four types of problem files have been detected that can be addressed and overcome by separating these systems into a number of independent sub-systems of smaller dimensions for independent solution. These solutions involve matrix inversion, and in the majority of cases the problems experienced can be solved by employing the NEWGTOL program. Further details can be found in the relevant PDF file available via Annex 7, and directly from PNPI staff.

Precise Electron Conversion Coefficient Measurements of Transitions in ^{127m}Te, ^{125m}Te, ^{103m}Rh

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Internal conversion coefficients (ICCs) play an important role in balancing the transition intensities of decay schemes. They are important parameters in the assembly of evaluated nuclear data databases, for which calculated values have been used for many decades despite differing theoretical values occurring as a consequence of the defined conditions of particular calculations. Under these circumstances, theoretical calculations alone cannot produce accurate and precise results without guidance from experimental measurements. Therefore, we have promoted a programme of benchmark ICC measurements as part of our highly-precise capabilities at the Cyclotron Institute.

A survey of ICCs from both theoretical and experimental points of view made by Raman et al. 2002 questioned the theoretical treatment of the atomic vacancy created by the conversion of the electron [1]. Some calculations include such a theoretical treatment, while others do not. ICC measurements at the ±1% precision level become critical in answering such a question, and our very precise efficiency-calibrated HPGe detector is well suited to measure them [2]. Starting in 2003, a series of ICC measurements was completed covering the atomic range $48 \leq Z \leq 78$ [3], with the important conclusion from all of these results that *the atomic vacancy should be taken into account in the calculations.*

Since our last report at the 21st Technical Meeting of NSDD in 2015, we have studied three more ICC transitions using the same Kx-rays to γ-ray ratio method [3]:

88.2-keV, *M4* transition in ^{127m}Te: $\alpha_{K,exp}$ = 484(6) [4] compared with calculated values of α_K(NH) = 468.6(17) and α_K(FO) = 486.4(17)[1].

109.3-keV, *M4* transition in ^{125m}Te: $\alpha_{K,exp}$ = 185.0(40) [5] compared with calculated values of α_K(NH) = 179.5(1) and α_K(FO) = 185.2(1); $\alpha_{T,exp}$ = 350.0(38) [5] compared with calculated values of α_T(NH) = 348.7(3) and α_T(FO) = 355.6(3)[2].

39.7-keV, *E3* transition in ^{103m}Rh: $\alpha_{T,exp}$ = 1435(44)[3] compared with calculated values of α_T(NH) = 1389 and α_T(FO) = 1404. This preliminary study was performed on ^{103}Pd ε decay, and will be followed by a complementary study of the same transition populated in ^{103}Ru β^- decay.

The overall conclusion of these three new cases confirms that drawn from the previous studies [3]: *the atomic vacancy should be taken into account in the calculations.*

[1] S. Raman, *et al.*, *Phys. Rev*. C **66** (2002) 044312.
[2] J.C. Hardy, *et al.*, *Appl. Radiat. Isot*. **56** (2002) 65; R.G. Helmer, *et al.*, *Nucl. Instrum. Methods Phys. Res*. **A511** (2003) 360; R.G. Helmer, *et al.*, *Appl. Radiat. Isot*. **60** (2004) 173.

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[1] Calculated value of α_K(NH) is obtained by ignoring the atomic vacancy ("no-hole" (NH) approach), and α_K(FO) is obtained by including the vacancy in the calculations ("frozen orbital" (FO) approach). The uncertainties for both calculated values are propagated from the uncertainties in the transition energy.

[2] α_K is the K-shell ICC, and α_T is the total ICC.

[3] Preliminary result deduced by adopting the average value of the two theoretical calculations, α_K(NH) = 127.4(18) and α_K(FO) = 135.2(19), with an uncertainty equal to one half of their difference.

[3] N. Nica, *et al.*, *Phys. Rev*. C **70** (2004) 054305; *Phys. Rev*. C **71** (2005) 054320; *Phys. Rev*. C **75** (2007) 024308, *Phys. Rev*. C **77** (2008) 034306, *Phys. Rev*. C **80** (2009) 064314; *Phys. Rev*. C **89** (2014) 014303, *Phys. Rev*. C **93** (2016) 034305; *Nucl. Data Sheets* **120** (2014) 91; also J.C. Hardy, *et al.*, *Appl. Radiat. Isot*. **64** (2006) 1392, *Appl. Radiat. Isot*. **66** (2008) 701, *Appl. Radiat. Isot*. **87** (2014) 87.
[4] N. Nica, *et al.*, *Phys. Rev*. C **95** (2017) 034325.
[5] N. Nica, *et al.*, *Phys. Rev*. C **95** (2017) 064301.

Experimental Facilities: ELI-NP

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6.1.4.

A new irradiation facility is in the process of being constructed at IFIN-HH in Romania that goes by the name of Extreme Light Infrastructure-Nuclear Physics (ELI-NP) for nuclear physics studies with high-intensity lasers and brilliant γ beams: laser-target interactions, photonuclear physics; exotic nuclear physics and astrophysics. ELI-NP represents a major facility in the "Nuclear Physics Long-Range Plan in Europe" programme for which a gamma beam system and detector arrays are already in place, and the low-energy accelerator section from 0.2 to 3.5 MeV has been operational since December 2015 (high-energy accelerator section has also been proposed (3.0 – 19.5 MeV)).

Experiments with high-brilliance gamma beams have included NRF, photodisintegration, photofission, GANT and various applications. Available equipment and on-going/proposed studies include:

1. ELIGANT-GN array: use of thirty $LaBr_3$ and $CeBr_3$ detectors, twenty ^{7}Li glasses and thirty liquid scintillators → GDR and PDR studies of ^{90}Zr and ^{208}Pb;
2. (γ,n) cross-section experiments with the ELIGANT-THN array: thirty ^{3}He counters with 40% detector efficiency;
3. flagship $^{16}O(\gamma,\alpha)^{12}C$ experiment with a mini-eTPC detector;
4. astrophysics-based studies with ELISSA (three rings of 12-position sensitive X3 silicon-strip detectors, two end-cap detectors, 320-channel read-out) and $^{7}Li(\gamma,t)\alpha$ – potential important high-energy measurements;
5. IGISOL studies at ELI-NP;
6. cultural heritage studies: provision of tuneable energy γ rays from inverse Compton scattering of laser light on a high-energy electron beam to allow NRF studies of isotope-specific trace element distributions with unprecedented sensitivity;
7. medical radioisotopes: feasibility studies to produce ^{99}Mo/^{99m}Tc, ^{187}Re and ^{225}Ra/^{225}Ac. Also considering the possibility of producing ^{195m}Pt.

All of this recent and on-going work was briefly described, with the prevailing message that those interested in such studies should also consider whether they and their affiliated institute might be interested in establishing collaborative nuclear physics and structure programmes and projects with ELI-NP.

22nd Meeting of the *International Network of Nuclear Structure and Decay Data Evaluators*

22 – 26 May 2017
Lawrence Berkeley National Laboratory,Berkeley, USA

Links to Presentations

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Data Centre Reports			
1	Dimitriou	IAEA	PDF
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12	Negret	Romania ND2016 poster	PDF PDF
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15	Yang	Jilin	PDF PDF
16	Lalkovski	Bulgaria	PDF

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2	McCutchan	ENSDF Organizational Review	PPT
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8	Bernstein	Experimental Activities Committee	PDF

Links to Presentations cont'd

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Technical Presentations and Codes			
1	Singh	New ALPHAD code for Hindrance Factors and updated r0 parameters for e-e nuclei	PPT
2	Singh	New JGAMUT code	PPT
3	Nica	Status of precision measurements of ICC	PDF
4	Balabanski	Status of ELI-NP	PDF
5	Chen	Java-NDS code	PDF
6	Kibedi	UncTools, T-RULER, Radlist	PDF
7	Hurst	A modern format for ENSDF	PDF
8	Mougeot	BetaShape code	PDF
9	Rodionov	NewGTOL	PDF
10	Zerkin	Recent progress in Myensdf Web Tools for ENSDF Evaluators	PDF
Special Session			
1	Nichols	On Jagdish Tuli and Balraj Singh	PPT
2	Firestone	On Balraj Singh	PPT
3	Bernstein	On Rick Firestone	PPT

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