

Nuclear Data Newsletter



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From the Section Head

Greetings from Vienna!

For the Nuclear Data Section, things seem slowly be getting back to normal after more than two years of trouble with the pandemic.

Several of the meetings that we organized already have more participants present in Vienna than online, and that made us feel again how important it is to have real interaction with the field rather than through a computer screen. Nevertheless, online meetings are here to stay, and from now on it is expected that there will always be some participants who can only connect remotely to our meetings, and a few of our meetings may even be entirely virtual.

As usual, this Newsletter reports about some recent products that we developed and all the meetings that were held in the past half year of which I will highlight a few:

The Nuclear Reaction Data Centre Network held its annual meeting to discuss the compilation aspects of the EXFOR databases and to report on the recent additions to EXFOR. In these times of automation and machine learning, it is important that EXFOR becomes computationally accessible and in previous Newsletters we already reported about different tools such as X4lite and the Data Explorer. This time we announce the X4pro package by Viktor Zerkin (as outlined on the next page) which gives fully relational, direct access to EXFOR data.

Another meeting which will lead to a well-evaluated and established nuclear database is the technical meeting on Thermal Neutron Capture and Resonance Integrals.

Several new measurements and compilations have emerged in the past 20 years, among others the Neutron Resonance Atlas of Said Mughabghab. The experts on the matter at this meeting discussed the quality of several data sets and how to best evaluate, digitize and make them available in computer readable format. While the INDC Committee oversees the nuclear data part of the work of our Section, the International Fusion Research Council (IFRC) advises our Atomic and Molecular Data developments. The worldwide interest in fusion is growing, also thanks to recent successes in the field, and this is visible in the IAEA program as well. We foresee an increased request of high-quality atomic data of plasma-material interaction for the various components of a future fusion reactor.

Unfortunately, this time our "in memoriam" list is quite long and for me personally especially sad that we have lost my friend Eric Bauge, who led the nuclear data development in CEA-DAM, Bruyeres-le-Chatel for so long.

I wish you all a pleasant remainder of the summer and hope to see many of you in person in the coming time.



Arjan Koning with Kristina Pleskach, NAPC Administrative Assistant finalizing the Budget planning 2024-2025

Computer Codes, Data Libraries and Web News

X4Pro - universal, fully relational EXFOR database. Professional edition.

(by V.Zerkin, under development)

X4Pro - EXFOR relational database extended with EXFOR data points in original and computational form, data for renormalizing EXFOR data (monitor and decay data) and instructions for data corrections. (Technically, this extension was done using integration of JSON data type to modern relational databases.)

Goal: to make whole content of EXFOR available for programming access to everyone - from students with homework to professionals with advanced tasks.

X4Pro allows to retrieve and automatically renormalize numeric EXFOR data using only SQL commands. It can be used from any programming language with SQL support (without developing complex, language dependent EXFOR parser and converter).

Trial version of X4Pro includes:

✓ X4Pro/SQLite database, 4Gb (incomplete)

- ✓ Fortran/C EXFOR data retrieval demo programs
- \checkmark Python demo programs:
 - retrieve and plot local EXFOR and remote ENDF data: SIG (ENDF:MF3+MF33), DA, DE, DAE, FY
 - renormalize and correct EXFOR data: automatically, by user's and expert's codes
 - recalculate EXFOR data: Ratio→SIG, [DA,LEG]→SIG
 - retrieve and plot original EXFOR covariance data

All codes tested in Windows/Linux/MacOS. Interactive plotting is done in Python codes using Plotly and Matplotlib.

Download: https://www-nds.iaea.org/cdroms/#x4pro1trial







Presentation: <u>ND2022-Zerkin</u> at "15th International Conference on Nuclear Data for Science and Technology" (ND2022).

Women in Fusion

The first meeting of the Steering Committee for Women in Fusion group was held at ITER HQ as an in-person event from 24 to 25 May 2022.

Women in Fusion is a new global group promoting and seeking gender equity and balance in all fields of nuclear fusion. The group is an IAEA-led collaboration by IAEA, ITER, General Atomics, Fusion for Energy and EUROfusion.

At the meeting, Steering Committee members were appointed, content for Women in Fusion web page finalized, mentor programs and outreach activities were reviewed as well as role of the Advisory Board was outlined.

The official Women in Fusion web page www.womeninfusion.org was launched on 20 July 2022. Web page acts as a platform for information sharing on gender issues and statistics in fusion and STEM, content and documents the group provides, fusion events and activities around the world as well as collects group memberships and provides a forum for its members.



Women in Fusion- Members of the Steering Committee

Understanding future of fusion energy development through a CRP on Hydrogen Permeation in Nuclear Materials

IAEA Story

The main objective of the CRP started in 2020 is to enhance the knowledge base and reduce uncertainties in data concerning the migration of hydrogen in materials of relevance to nuclear fusion reactors.

Materials of particular interest are tungsten, as used in the ITER divertor; various types of reduced-activation ferritic/martensitic steel (RAFM), currently thought of as candidates for the first wall of a future demonstration power reactor and likely used for some components of ITER, copper and the copper alloy known as CuCr1Zr0.1 (also proposed as a structural material for components such as the cooling system of a nuclear fusion reactor).

In December 2021, the tokamak reactor (Joint European Torus (JET) fusion device, Oxford0) produced a record-shattering 59-megajoule fusion energy pulse over a period of five seconds using powerful magnets to confine and fuse hydrogen. This was a historic break-through due to its carbon inner walls been replaced with metals – a very important change for the future of fusion energy development.

The IAEA CRP on Hydrogen Permeation is helping better understand this change and investigate the materials used in future fusion reactors. Gathering international experts from 15 countries, the IAEA and its partners are using a neutron source to recreate the conditions faced by a fusion reactor's inner wall and determine how hydrogen permeates the metallic components within it. The project's results could hold important answers to questions regarding the cost, efficiency and waste produced from large fusion experiments and reactors, such as ITER and DEMO as well as future fusion power plants.

For the full story visit <u>Neutrons Blast Fusion Materials in</u> <u>New IAEA Project | IAEA</u>

NDS Meeting Reports

(TM = Technical Meeting, RCM = Research Coordination Meeting, CM = Consultants' Meeting, WS = Workshop, CRP = Coordinated Research Project)

15th International Conference on Nuclear Data for Science and Technology

21-29 July 2022, Sacramento, USA, virtual event Web: ND2022

As the latest one in series of conferences organized every three years since 1978, ND2022 took place from 21 to 29 July as a virtual event for the first time due to the pandemic ongoing.

It is the most important conference for the Nuclear Data Section and NDS staff members had several presentations listed here with links:

Arjan Koning:

The TENDL library: progress, success, and lessons learned;

Status of TENDL

Naohiko Otsuka:

Simultaneous evaluation of uranium and plutonium fast neutron fission cross sections up to 200 MeV for JENDL-5

Viktor Zerkin: X4Pro - universal, fully relational EXFOR database

Paraskevi Dimitriou: Dissemination of nuclear structure and decay data

Decay Data for Radionuclide Monitoring Applications

Roberto Capote:

Update of the CIELO ²³⁸U resonance evaluation to improve LWR performance with burnup

Experimental spectrum average cross sections in ²⁵²Cf(sf) neutron field and its impact on evaluation of Neutron <u>Standards</u>

INDEN evaluation of neutron-induced reactions on ²³⁹Pu

Georg Schnabel:

Bayesian network evaluation of neutron-induced reactions of Fe-56

Technical Meeting on Decay Data for Monitoring Applications

18-21 July 2022, Vienna, AustriaScientific Secretary: P. Dimitriou9 participants and IAEA staff



Participants of the TM - in person and virtual

The main objective of this meeting was to monitor progress in evaluations and review of decay data assigned to members of the project for the delivery of a library of improved and up-to-date decay data destined to be used in monitoring applications. Participants agreed on deadlines for the completion of evaluations and reviews, producing the derived atomic radiation data and preparing the final project report. The summary of the discussions, reports and actions will be available in the meeting summary report published as INDC(NDS)-0859.

Consultancy Meeting of the International Nuclear Data Evaluation Network – Light Elements

20-23 June 2022, Vienna, Austria Scientific Secretary: P. Dimitriou 11 participants and IAEA staff

The participants of this meeting reviewed status of evaluations of charged-particle-induced reactions forming ⁷Be compound system, alpha-induced reactions on ¹⁹F, and neutron-induced reactions on ¹⁶O, ^{14,15}N, ³⁵Cl, as well as progress in development of reduced R-matrix theory, R-matrix theory for break-up channels, and linking the optical potential to resonance region.

Presentations are available from the meeting website: <u>https://conferences.iaea.org/event/319/</u>.

Meeting report is in preparation and will be available as INDC(NDS)-0853.



Participants of the CM - in person and virtual

Technical Meeting of the International Network of Nuclear Reaction Data Centres

14 - 17 June 2022, Vienna, Austria Scientific Secretary: N. Otsuka 26 participants and IAEA staff



Participants of the NRDC Meeting - in person and virtual

16 participants representing 12 cooperative Centres from eight Member States (China, Hungary, India, Japan, Korea, Russia, Ukraine and USA) and two International Organizations (NEA, IAEA) as well as a participant from Kazakhstan attended this meeting. Main topics of the present meeting were: the EXFOR transmission statistics, EXFOR coverage and quality control, revision of coding rules and manuals, EXFOR/CINDA dictionaries as well as improved tools for compilation and dissemination.

NRDC is continuing intensive compilation of the fission product yield (FPY) to improve the coverage in EXFOR. Around 600 articles were arranged for additional compilation in the NRDC 2019 meeting, and it was confirmed that 84% of them have been already compiled in EXFOR by the responsible centres.

The definition of the cumulative cross section was discussed. It was stressed that the cumulative cross section properly measured by activation method is always higher than the sum of the corresponding cross sections due to presence of the cumulative factor. The cumulative cross section defined with this factor is sometimes referred to "supracumulative cross section" when the difference from the sum is not negligible. The participants concluded that "conditional cumulative cross section" is a more appropriate description of this quantity.

It has been known that there are some erroneous level energies in EXFOR. As a NDS intern program, a survey was performed for all level energies which do not agree with any level energy in RIPL3 within 5%, and the result was presented. The participants concluded that 177 compilation errors identified by this survey must be fixed by the originating centres.

Viktor Zerkin introduced X4Pro - fully relational EXFOR database (see paragraph in "Computer Codes , Data Libraries and Web News"). The participants expressed their support to further development and distribution of X4Pro. Requirements for public distribution of whole EXFOR database were discussed (version of EXFOR, copyrights, licence type) – formal decision to be made for the next NRDC meeting.

A summary report of the meeting is available as INDC(NDS)-0857. All progress reports, working papers and slides are available on the meeting web page (http://nds.iaea.org/nrdc/nrdc_2022/).

Preparatory Consultancy Meeting for the Injected Impurities CRP

7 – 8 June 2022, Vienna, Austria Scientific Secretary: C. Hill
14 participants and IAEA staff

The Atomic and Molecular Data Unit plans to initiate a new Coordinated Research Project (CRP), addressing data needs for the modelling of the behaviour of the impurity species deliberately injected into the plasmas of magnetic-confinement fusion devices to improve confinement, mitigate the effects of plasma disruptions and for diagnostic purposes. The participants identified the ions of nitrogen, neon and argon to be of highest priority to the project; data relating to charge exchange through collisions with isotopes of hydrogen, dielectronic recombination, and the spectral properties of these species are considered to be the focus of the CRP. Further information is available on the Unit's website at https://amdis.iaea.org/meetings/ii-cm/.

Technical Meeting on Thermal Capture and Resonance Integral Data

23-27 May 2022, Vienna, Austria Scientific Secretary: R. Capote Noy 15 participants and IAEA staff



Participants of the TM

Fifteen highly-qualified experts from ten Member States participated in this TM, the first one of a new series of IAEA Technical Meetings on thermal capture and PGAA data. This first meeting was devoted to reviewing the status of thermal capture cross sections and moving towards producing a recommended set of IAEA values. Extended discussion on different methods to measure thermal capture cross sections took place. The IAEA EGAF database was also reviewed. It was agreed to update the EGA database on the basis of new Munich reactor comprehensive measurements. It was also agreed to compile available experimental data and evaluations of thermal capture cross sections with the aim of producing a set of recommended data.

Participants' presentation summaries, discussions and outcomes will be published as INDC(NDS)-0851 which is in preparation.

Consultancy Meeting on the Evaluation of Data for Neutral Beam Modelling

18 – 20 May 2022, Vienna, Austria Scientific Secretary: C. Hill
14 participants and IAEA staff

This meeting reviewed the work of two code-comparison workshops organised as part of the AMD Unit's Neutral Beams CRP: one, *Electron Dynamics for Atomic Collisions*, compared five computational methods for calculating the ionization and state-selective electron capture and excitation cross sections for the process Be⁴⁺ + H; the second, *Neutral Beam Penetration and Photoemission*, compared the output of different Neutral Beam modelling codes with respect to a set of pre-defined test-cases, including ITER-relevant scenarios. Both exercises informed the development of the AMD Unit's new CollisionDB database which holds cross section and rate coefficient data for collisional processes in plasmas for fusion applications.



Participants of the CM -in person and virtual

23rd Meeting of the IFRC Subcommittee on Atomic and Molecular Data for Fusion

16 – 17 May 2022, Vienna, Austria Scientific Secretary: C. Hill
14 participants and IAEA staff

The International Fusion Research Council's Subcommittee on Atomic and Molecular Data for Fusion (IFRC A+M Subcommittee) recommends policies and programme priorities for, and reviews the work of the Atomic and Molecular Data Unit on a biennial basis. After virtual meetings in 2020 and 2021, this advisory body met in person for the first time in four years to discuss the progress of ongoing Coordinated Research Projects (CRPs), propose two new CRPs for the coming biennium, and to assess new Unit initiatives, including the CollisionDB database, a Technical Meeting Series on tungsten and hydrogen in edge plasmas, and the Unit's involvement in a new Women in Fusion Network (<u>https://womeninfusion.org</u>).



Participants of the TM -in person and virtual

Technical Meeting on Nuclear Heating Theory and Data

19-22 April 2022, Vienna, Austria Scientific Secretary: J.-Ch. Sublet 11 participants and IAEA staff





The purpose of the event was to review the theory of nuclear heating, as well as the data it relies upon, their processing, usage, suitability, and appropriateness in novel and traditional applications: oil logging, space, agriculture, homeland security, nuclear propulsion-reactor- power, medical, interrogation technics, waste management and high energy physics. Prompt nuclear heating, secondary radiation sources terms, are important parameters in any nuclear system or protocol, in particular in shielding, material irradiation, earth and life sciences nuclear applications. The meeting brought together the different savant societies experts able to support the necessary enhancements, processes and data forms, foreseen for the multiple energy, non-energy, applications in support of high-fidelity multiphysics simulation efforts. It clearly highlighted the need for evaluators to make the effort to account for past achievement and embed in modern evaluation the experimental information on the detailed secondary gamma production.

Technical Meeting on the Effects of Hydrogen Supersaturation and Defect Stabilization in Nuclear Fusion Reactor Materials

11-12 April 2022, Aix-en-Provence, France Scientific Secretary: K. Heinola 18 participants and IAEA staff

This Technical Meeting brought together 18 scientific experts representing five Member States and ITER Organization. The event was an in-person meeting organized in Aix-en-Provence, France. Participants discussed and reviewed current experimental and computational understanding on the physical processes related to effects and formation of 1) hydrogen supersaturated layers in fusion reactor wall materials and conditions affecting the supersaturated layer formation, and 2) vacancy-type defect stabilization by hydrogen in fusion reactor materials under neutron and ion bombardment. The meeting made conclusions and recommendations on the significance of these effects to material behaviour under fusion reactor conditions, data needs for filling the knowledge gaps, e.g. define defects for future systematic DFT/MD calculations. The importance of the topic for the fusion community was acknowledged, and it was decided to pursue for a scientific publication of the meeting outcome and recommendations for future work.



Participants of the TM

Consultants' Meeting on ENSDF Evaluations, Policies and Procedures, Codes and Dissemination Tools (NSDD Spring Meeting)

4-7 April 2022, Vienna, Austria Scientific Secretary: P. Dimitriou 50 participants and IAEA staff

This meeting of the international network of Nuclear Structure and Decay Data (NSDD) evaluators was organized to discuss policies, procedures, format issues, evaluation issues, codes and evaluation tools. Members of the network also exchanged views on the functionality of the network, the ENSDF mass-chain evaluation pipeline, and efforts to enhance international contribution to mass-chain evaluations. This was a preparatory meeting prior to the 24th Technical Meeting of the Nuclear Structure and Decay Data evaluators, to be held on 24-28 October 2022, in Canberra, Australia. A special session in memory of Murray J. Martin, a founding father of ENSDF leaving behind a legacy of 60 years to live on, was held on the last day of the meeting. Presentations are available from the meeting website https://conferences.iaea.org/event/299/. The meeting report will be available as INDC(NDS)-0850.

Selected Charts, Reports and Documents

IAEA-NDS-0239 Fission Fragment Decay Calculation with the Hauser-Feshbach Statistical Decay Theory in TALYS 1.96, prepared by K. Fujio, S. Okumura and A. Koning, May 2022.

INDC(JPN)-207 Proceedings of the 2020 Symposium on Nuclear Data, 26-27 November 2020, Wako, Saitama, Japan, edited by N. Imai and H. Otsu, March 2022.

INDC(NDS)-0802 Recommended Input Parameter Library (RIPL) for Fission Cross Section Calculation, summary report of the Second Research Coordination Meeting, 7-11 October 2019, Vienna, Austria, prepared by R. Capote and M. Kowal, May 2022.

INDC(NDS)-0824 International Nuclear Data Evaluation Network (INDEN) on the Evaluated Data of Structural Materials, Summary Report of an IAEA Consultants' Meeting, 14-17 December 2020, prepared by G. Nobre, V. Proniaev and G. Schnabel, February 2022.

INDC(NDS)-0834 (alpha,n) Nuclear Data Processing, Summary Report of the Technical Meeting, 18-22 October 2021, prepared by D. Foligno, et al., January 2022.

INDC(NDS)-0836 Nuclear Data Evaluations and Data Needs, Summary Report of the Technical Meeting, 8-12 November 2021, prepared by S.S. Westerdale, A. Junghans, R.J. DeBoer, M. Pigni and P. Dimitriou, March 2022.

INDC(NDS)-0839 The E1 and M1 UPBEND in Neutron Capture Revisited, prepared by J. Kopecky and S. Goriely, March 2022.

INDC(NDS)-0842 Hydrogen Permeation in fusion-relevant Materials, Summary Report of the First Research Coordination Meeting, 23-27 November 2020, prepared by K. Heinola, January 2022.

INDC(NDS)-0843 IFRC Subcommittee on Atomic and Molecular Data for Fusion: Report on the Activities of the Atomic and Molecular Data Unit, May 2018 - June 2021, prepared by C. Hill and K. Heinola, February 2022.

INDC(NDS)-0849 8-Group Model Energy Spectra of Delayed Neutrons from Thermal Fission of ²³⁵U, prepared by A.S. Egorov, et al., May 2022.

INDC(NDS)-0854 Summary Report of a Consultants' Meeting in preparation of a Coordinated Research Project on Atomic Data for Injected Impurities in Fusion Plasmas, 7-8 June 2022, prepared by C. Hill, June 2022.

INDC(NDS)-0855 Summary Report of the Third Research Coordination Meeting on Data for Atomic Processes of Neutral Beams in Fusion Plasma, 24-26 November 2021, prepared by C. Hill, June 2022. **INDC(SEC)-0112** EXFOR-based Simultaneous Evaluation of Neutron-induced Uranium and Plutonium Fission Cross Sections for JENDL-5: Inputs and Outputs, prepared by N. Otuka and O. Iwamoto, April 2022.

Available cost-free on request only for **teachers and** scientists from developing countries:

Chart of the Nuclides 2014 JAEA Nuclear Data Centre.

Karlsruher Nuklidkarte *Wall chart of the nuclides and folding chart with booklet, 10th edition (2018).*

In Memoriam

Eric Bauge



It is with greatest sadness that we inform you of the sudden passing away of Eric Bauge on 13 May 2022.

Eric was a scientist driven by genuine curiosity beyond his area of expertise. His advances on the theoretical description of nucleon-nucleus optical models are still used today by theoretical physicists and evaluators to calculate cross sections of interest for nuclear energy applications. He was actively involved in many international collaborative projects, including the JEFF project, which he always followed despite the new functions entrusted to him. Particularly in this context, he was a major player in the evaluation of uncertainties in nuclear data with the wellknown "forward-backward" method being one of its instigators. He was constantly following novelties or results likely to make advances in nuclear physics and regularly discussed the papers he had read and which he thought might be relevant. He always contributed to the promotion of young talent and was a fervent defender of initiatives that strayed from the usual path. His commitment to sharing his knowledge internally at CEA-DAM or in an academic

setting was constant. He maintained many collaborations with renowned scientists whose testimonies of affection have poured in. Everyone underlined his constant availability, his scientific skills, his intellectual honesty, his professional commitment, his enthusiasm and, above all, his kindness. As a dear friend and a colleague, he will be greatly missed.

Edgardo (Eddie) Browne Moreno

We are very sorry to inform you that Eddie Brown passed away on 14 May 2022.

Eddie joined the Isotopes Project at Lawrence Berkeley National Laboratory (LBNL) in the mid-1970s. He was one of the Principal Authors of the Table of Isotopes, 7th Edition, 1978, as well as prime author of the Table of Radioactive Isotopes, 1986, a book containing re-evaluated decay schemes of all known radioactive nuclei. These monumental works are still used and cited by nuclear scientists worldwide. He was one of the founding members of the Decay Data Evaluation Project, based in BNM-CEA/LNHB, Saclay, France.

Eddie evaluated a huge number of mass chains for the Evaluated Nuclear Structure Data file (ENSDF), and actively participated for almost 40 years as a key member of the International Nuclear Structure and Decay Data Network under the auspices of the IAEA and with the support from the U.S. Nuclear Data Program of the DOE.

Eddie was an extremely friendly and caring person with a great sense of humor. He was always welcoming to visitors at the Isotopes Project and willing to offer his advice to students and colleagues. He will be dearly missed.



Murray J. Martin



It is with great sadness that we have to inform you that our dear colleague and friend, unwavering supporter of and dedicated contributor to the NSDD network Murray John Martin passed away on 9 March 2022.

Murray Martin was born on June 22, 1935, in Regina Saskatchewan, Canada. After obtaining an M.A. in experimental physics from the University of Saskatchewan in 1959, he moved to McMaster University in Hamilton, Ontario to pursue his Ph.D. degree in theoretical physics.

Following his graduation in 1962, Murray accepted a job with the Nuclear Data Project led by Katherina Way in Washington, D.C. In 1964 the Data project was moved to the Physics Division at Oak Ridge National Laboratory (ORNL) where Murray spent his professional career until his retirement in 1997. He eventually became head of the group and Editor-in-Chief of the journal Nuclear Data Sheets. After retirement, he continued to work part-time as a consultant to the Data Project (ORNL).

Murray's numerous achievements include the Guidelines for Evaluators and the seminal work on the logft tables for beta decay which are still widely used to date.

Murray was a kind and thoughtful person, who offered his wisdom generously and cared for his colleagues and students deeply. He will be sorely missed.

Vasily Nikolaevich Manokhin



Professor and Doctor of Sciences in Physics and Mathematics, passed away on February 6, 2022.

He took an active part in the formation and implementation of the MINATOM programs for the creation of neutron constant systems for nuclear power and other fields of nuclear applications.

Under his guidance and with his direct participation, numerous scientific, technical and organizational problems of nuclear data exchange with foreign data centers were solved, and Russian contribution to the creation of the international bibliographic and nuclear data bases such as CINDA and EXFOR was made.

For more than 30 years, he was the Head of Russian Nuclear Data Centre (CJD) until 2006, and was a participant of many NRDC meeting

He will be remembered for his kindness and professionalism.

Henry Tellier

Sad news reached us that Henry Tellier passed away on 30 January 2022.

He was a world known expert in the field of nuclear crosssection evaluations and validation, and worked as nuclear physicist at CEA Saclay until his retirement.

He was a true reactor physicist, specialist in decay process with gift to catch an audience attention while giving lectures. He will be greatly missed.

Nuclear Data Services – Contact Points

<u>For services to customers in USA and Canada</u>: US National Nuclear Data Center, Bldg. 197D, Brookhaven National Laboratory, P.O. Box 5000, Upton, NY 11973-5000, USA. Tel. +1 631-344-2902; Fax +1 631-344-2806; Website: <u>http://www.nndc.bnl.gov/</u> Email: <u>nndc@bnl.gov</u> For information regarding on-line services, contact: B. Pritychenko: <u>pritychenko@bnl.gov</u> For information regarding general NNDC services, contact: Letty Krejci: <u>lkrejci@bnl.gov</u>

For services to customers in OECD/NEA Data Bank member countries: NEA Data Bank, OECD Nuclear Energy Agency, 46, quai Alphonse Le Gallo F-92100 Boulogne-Billancourt, France. Tel. +33 1 7321 (plus extension); Website: <u>http://www.oecd-nea.org/databank/</u>

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Website: http://cdfe.sinp.msu.ru/
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For services to customers in China: China Nuclear Data Center, China Institute of Atomic Energy, P.O. Box 275(41), Beijing 102413, China. Tel. +86 10-6935-7275; Fax +86 10-6935-8119 Contact: Ge Zhigang, Email: gezg@ciae.ac.cn;

Computer codes of US origin to all countries (there are charges and release restrictions): Radiation Safety Information Computational Center (RSICC), Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831-6003, USA. Tel. +1 865-574-6176; Fax +1 865-241-4046; Email: pdc@ornl.gov

Computer codes of non-US origin to all countries (there may be release restrictions): NEA Data Bank (see above) Contact: A. Dufresne, Email: <u>Alice.DUFRESNE@oecd.org</u>, Tel.: +33 1 73 21 28 30

IAEA-NDS on-line services at Website <u>https://nds.iaea.org/</u> Users in India, China, Russia and neighbouring countries may use IAEA-NDS mirror websites:

http://www-nds.org.in (India); http://www-nds.ciae.ac.cn/ (China); http://www-nds.atomstandard.ru/ (Russia).

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