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Nuclear Data Libraries for Advanced Systems- Fusion Devices (FENDL-3)

Summary report from the Second Research Coordination Meeting

International Atomic Energy Agency (IAEA)

Vienna, Austria

23-26 March 2010

Prepared by
Mohamed E. Sawan
University of Wisconsin, Madison, USA

June 2010

IAEA Nuclear Data Section, Vienna International Centre, A-1400 Vienna, Austria

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Abstract

The second Research Co-ordination Meeting of the Nuclear Data Libraries for Advanced Systems - Fusion Devices (FENDL - 3) was held at the IAEA Headquarters in Vienna from 23 to 26 March 2010. A summary of the meeting is given in this report along with the discussions which took place. An important outcome of the meeting was the decision to provide ENDF data libraries (FENDL-3/T) by April 2011. Finally, a list of task assignments was prepared together with the plan for future CRP activities.

June 2010

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1. INTRODUCTION

The participants of the second Research Coordination Meeting (RCM) on Nuclear Data Libraries for Advanced Systems - Fusion Devices (FENDL-3) were welcomed by N. Ramamoorthy, DIR - NAPC who stressed the important role of the IAEA Coordinated Research Projects (CRP) for development of nuclear data for fusion applications. This CRP was started by Alberto Mengoni, and the present head of NDS, Robin Forrest is the responsible Scientific Officer. In adition, he outlined the management personnel changes at NDS.

R. Forrest, gave introductory remarks that addressed the CRP history, objectives, scope and schedule. He discussed information added to the FENDL-3 website since the first RCM. The goals of the second RCM were presented. These include presenting progress by participants, modifying CRP objectives if necessary, and deciding on the way forward. U. Fischer was elected as the chairman of the meeting and M. Sawan as rapporteur. The proposed Agenda was discussed and adopted. The meeting continued with the presentations as follows.

2. PRESENTATIONS

M. LOUGHLIN – ITER, Cadarache, France

M. Loughlin gave an overview of major ITER project developments leading to a detailed presentation of the current status. The ITER organization was presented along with procurement, construction and operation plans. The latest schedule plans for first plasma in November 2019 and first DT burn in 2026 were presented. He explained the challenging design issues that include accommodating the in-vessel coils and reducing nuclear heating in the TF coils as well as the licensing process. This includes submission of a preliminary safety report and holding a public inquiry. A list of materials needed for ITER nuclear analysis was provided for inclusion in FENDL-3. While FENDL-2.1 is the reference library for ITER, FENDL-3, when released at end of the CRP, will be used for detailed analysis of critical components as the ITER design and construction proceeds.

M. SAWAN – University of Wisconsin, Madison, WI, USA

M. Sawan presented results of benchmark calculations performed in support of FENDL-3 development. These included calculations for the simple ITER calculational benchmark and FNG integral experiments. Calculations were performed to study the impact of the release of ENDF/B-VII on FENDL-2.1 results. This had minor impact on ITER relevant calculations although larger impact was found for other fusion systems with breeding blankets and/or inertial fusion targets. Using the initial release of the ACE formatted FENDL-3/SLIB2 library instead of FENDL-2.1 resulted in a large increase in some nuclear parameters behind the thick water-cooled shield. This was identified as due to a processing error and was corrected in the recently released ACE formatted files FENDL-3/SLIB2a. Using FENDL-3/SLIB2a instead of FENDL-2.1 in ITER relevant calculations gives 2-4 higher nuclear parameters in regions that are heavily shielded with water-cooled SS (e.g. vacuum vessel, magnets). It was pointed out that tin has only an elemental evaluation in FENDL-3/SLIB and isotopic evaluation is needed. A list of materials that need to be added to the FENDL-3 general purpose neutron library was provided along with six isotopes missing in FENDL-2.1.

Y. WATANABE – Kyushu University, Fukuoka, Japan

Y. Watanabe presented the status and benchmark of JENDL/HE-2007 for energies above 20 MeV. It includes neutron and proton induced data for 106 nuclei. JENDL-3.3 is adopted below 20 MeV. It was pointed out that JENDL/HE-2007 was used for energies above 20 MeV for 45 of the 88 nuclei in FENDL-3/SLIB. Some IFMIF relevant nuclear data were discussed with focus on the ^{1}H and potassium isotopes. A. Ignatyuk and A. Trkov remarked that the ^{1}H standard is available up to 100 MeV. Benchmark testing using integral experiments was presented. These included neutron penetration experiments for iron and concrete with 68 and 140 MeV neutrons. Comparison to measurements of differential thick target neutron yields (TTY) from (p,xn) reactions (50, 70, 113, and 140 MeV) and (d,xn) reactions (9 and 40 MeV) was given. Measurements of double differential light-ion yields and cross-sections using 175 MeV quasi mono-energetic neutrons incident on thin silicon targets were presented and compared to JENDL-HE and TENDL/2009 which resulted in a large underestimation.

S. KUNIEDA – Japan Atomic Energy Agency (JAEA), Tokai-mura, Japan

S. Kunieda gave the status of JENDL-4 to be released next month. He pointed out that 70 new materials were added to the existing materials in JENDL-3.3, which have been re-evaluated, resulting in a total of 406 nuclei in JENDL-4. The resolved resonance parameters were updated for more than 200 nuclei. The unresolved resonance parameters were extended in energy to 100 keV - 1 MeV and were re-evaluated for almost all nuclei. Examples of optical model evaluations were given with comparison to experiments and other evaluations. Calculations were performed for the FNS iron, lead and vanadium benchmark experiments that showed improvements and better agreement.

A. TRKOV – Jozef Stefan Institute (JSI), Ljubljana, Slovenia

A. Trkov discussed the FENDL-3 activities at JSI. He described the preparation of the processed library from the ENDF files of the starter FENDL-3 library. The ACE processing problem causing the large differences observed by M. Sawan was identified. This was primarily due to a change in the interpolation law in the double differential data at 20 MeV and a temporary fix to the problem was proposed. The library was reprocessed and posted at the FENDL-3 website along with various data plots. A. Trkov raised the question whether there is a need for a library for deterministic codes in MATXS format and if so in which group structure. It was agreed that this would be done after the ACE library is validated and tested. Covariances stored in MF=40 can now be successfully processed with the ERRORR module of NJOY. It was pointed out that an extension of the data above 20 MeV often results in a large discontinuity in the damage cross-sections (e.g. in ^{56}Fe the cross-section drops by a factor of 6 at 20 MeV). Significant revisions to SINBAD benchmarks have been made and a new release of the fusion-related SINBAD benchmarks is expected shortly. JSI offered evaluated nuclear data files for all naturally occurring isotopes of a range of elements including covariances. Evaluated data files can be provided with an emphasis on dosimetry reactions (e.g., ^{59}Co, ^{103}Rh, ^{55}Mn, …), subject to support from other partners. JSI will also perform data validation and address specific problems with the NJOY code and the ENDF-6 format.

U. FISCHER – Karlsruhe Institute of Technology, Karlsruhe, Germany

U. Fischer presented results for the testing of the FENDL-3/SLIB neutron cross-section data relevant to the IFMIF neutron source facility. This included testing of the neutron data library with calculations of the High Flux Test Module (HFTM). Neutronics calculations using McDeLicious Monte Carlo and a global 3-D IFMIF test cell model were performed.

Calculations of n- and γ-fluxes, nuclear heating, gas production and displacement damage in 12 HFTM irradiation rigs, made of Eurofer and liquid NaK were carried out. Comparison of the nuclear responses calculated with FENDL-3/SLIB2 and a standard IFMIF library (mostly using data from LA150) was made. Comparison was also made of relevant cross-section data extracted from the ACE data libraries. It was concluded that FENDL-3 calculations for IFMIF applications gave good results for neutron and gamma fluxes and nuclear heating. Some problems were observed for d and t production data for iron and NaK. A 20% reduction in damage production in Eurofer was observed. This is mainly due to matching problems at 20 MeV in particular for ^{56}Fe damage. Further calculations are planned for tritium release and creep/fatigue test modules in addition to shielding calculations.

P. PERESLAVSTEV - Karlsruhe Institute of Technology, Karlsruhe, Germany

P. Pereslavtsev gave a presentation on the evaluation of chromium neutron data up to 200 MeV including covariances. This effort was aimed at improvements of the nuclear model simulations using the TALYS-1.0 code. The GDH model for the pre-equilibrium reactions was introduced in the code. The set of the optimal model parameters and nuclear models for the TALYS calculations was obtained for chromium isotopes. The neutron transport files for ^{50,53,54}Cr with incident energies up to 200 MeV were prepared in ENDF format. Benchmarking of the newly developed neutron data files was carried out which included correction of the evaluated data as necessary. Comparison with TENDL-2009 showed that the present data for Cr(n,xp) and Cr(n,xα) reactions agreed significantly better with R. Haight's hydrogen and helium production data. The calculations of the covariances up to 200 MeV are being performed using a Unified Monte Carlo approach. Newly evaluated resonance parameters are expected to be produced by L. Leal at the end of April 2010.

L. LEAL - Oak Ridge National Laboratory, Oak Ridge, TN, USA

L. Leal presented an evaluation of the chromium isotopes (^{50,52,53,54}Cr) in the resolved resonance region. This evaluation has more resonances than are included in the JEFF-3.1.1 and ENDF/B-VII files. He indicated that the evaluations are now complete and include resonance parameter covariances.

J-C. SUBLET - Culham Centre for Fusion Energy, Abingdon, United Kingdom

J-C. Sublet gave a presentation on data for absorbers, actinides, and compounds in FENDL-3. In the JEFF project the TALYS code was used to produce a set of new files for the major U and Pu actinides. For the first time all isotopes of the element were evaluated together. The new evaluations have been proposed for inclusion in the JEFF-3.2 beta. The suite of well established ICSBEP benchmarks served as the basis for their benchmarking and demonstrated that the files are significantly better than those in JEFF-3.1.1 in the fast energy range while being as good as the latter in the thermal region. It has also been pointed out that the ^{16}O files with reduced values of the (n,α) reactions in the new ENDF/B-VII or JEFF-3.1.1 will influence fusion benchmarking. The evaluated files for the major absorbers (silver, indium, cadmium, hafnium and gadolinium) have been reviewed and benchmarked. It has been proposed for FENDL-3 to take silver, cadmium and hafnium from ENDF/B-VII, indium from JEFF-3.1.1 and gadolinium from JEFF-3.2 beta. JEFF does not have high energy data but ENDF/B-VII does. A proper modelling for neutron slowing down below 10 eV requires either the free gas model or thermal scattering law data for compounds. All the available thermal files were reviewed (20 in ENDF/B-VII and 9 in JEFF-3.1.1). It was noted that no thermal data exist in JENDL files. Only six compounds have cryogenic temperature data but none of

these are of relevance to fusion. A demonstration of the impact of the treatment by probability tables of the unresolved resonance range has been made, concluding that its impact is far from being negligible in certain cases. Fusion neutronics analysts need to be aware of the potential impact of this specific treatment.

A. KONING – Nuclear Research and Consultancy Group (NRG), Petten, the Netherlands

A. Koning gave a presentation addressing the issue of using TALYS based evaluations for all isotopes in FENDL-3 for which there are no high quality evaluated files. Many isotopic data evaluations lack the completeness and quality to answer simulation requests for nuclear analysis of fusion systems as well as required. For this reason, the TALYS Evaluated Nuclear Data Library (TENDL) has been developed. Both the TALYS code system and the TENDL library were described. All isotopic evaluations in TENDL are equally complete and have an equal "base quality". At the moment, TENDL is proposed as a backup for FENDL-3, to fill holes in the existing library (such as missing high-energy parts, missing covariance data, and missing projectile-nuclide combinations). Comparison with differential data (EXFOR) shows that TENDL is already of equal or better quality than many existing evaluations. The authors' ambition is to develop TENDL into a worthy alternative for FENDL and other world libraries within a few years, in the process solving all quality and completeness issues. The current TENDL library is based on a suite of covariance and ENDF formatting codes, all placed around the central nuclear model code TALYS. TENDL-2009 consists of neutron, photon, proton, deuteron and alpha libraries for 2400 isotopic targets, with data for all channels up to 200 MeV and complete regarding resonance parameters, cross-sections, angular distributions, double-differential distributions, gamma production, isomer production and covariance data (uncertainties). Processed libraries (ACE format for MCNP) are available for all nuclides. For FENDL, TENDL will be adopted almost in its entirety for incident protons and deuterons, while for incident neutrons almost the entire covariance part of TENDL will be adopted, as well as the high-energy parts of many data evaluations.

J-C. SUBLET - Culham Centre for Fusion Energy, Abingdon, United Kingdom

J-C. Sublet discussed the status of the European Activation File EAF-2010. The European Activation File (EAF) project has been an ongoing process performed through European and world-wide cooperation that has led to the creation of a sequence of EAF versions. The latest release, EAF-2010, in common with EAF-2007 includes cross-section data for deuteron- and proton-induced reactions. EAF-2010 may well be the last of a generation of EAF files as it is planned to link activation data closely with the general purpose files produced by TALYS. As with EAF-2005 and -2007 all cross-sections have an upper energy limit of 60 MeV. EAF-2010 has benefited from the generation and maintenance of comprehensive activation files and the development of the processing code SAFEPAQ-II. Cross-section validation exercises against both experimental differential data, systematics and integral data, which started in 1995, enable a comprehensive and multi-faceted assessment of the data. SAFEPAQ-II is used to apply a series of modifications to the original source data. A very important set of modifications concerns renormalization and branching using experimental or systematic data. The EAF-2010 library contains 66,256 excitation functions involving 816 different targets from ^{1}H to ^{257}Fm (atomic numbers 1 to 100), in the energy range 10^{-5} eV to 60 MeV. The 3,660,206 lines that make up the point-wise file are processed into numerous group-wise files with different micro-flux weighting spectra to meet various user needs. An uncertainty file is also provided that quantifies the degree of confidence placed on the data for each reaction channel.

J. KOPECKY – JUKO Research, Alkmaar, Netherlands

J. Kopecky gave a presentation on the uncertainty file for FENDL-3/A. The European Activation File EAF-2010 forms a comprehensive data library for activation cross-sections covering all stable and radioactive targets (including isomers) with half-lives > 6 hours with cross-sections in the energy range between 10^{-5} eV and 60 MeV. This file will be used in the FENDL-3 project as the activation sub-library. The underlying uncertainty file, EAF-2010/UN, contains variances based on experimental information and/or empirical based estimates for all reactions and should also be used for FENDL-3/A. It was noted that earlier versions of FENDL/A did not have any uncertainty data. The major revisions and updates of the EAF file were shown and discussed. The starter FENDL-3/A uncertainty file (in the ENDF-6 MF = 33 format) converted from EAF-2010 is ready for testing.

A. KONING – Nuclear Research and Consultancy Group (NRG), Petten, the Netherlands

A. Koning discussed the format and validation issues for proton- and deuteron-induced transport and activation libraries. TENDL contains proton and deuteron libraries for 2400 nuclides in activation or transport library format with energies up to 60 or 200 MeV. A question was raised regarding the need for covariance data for charged-particle reactions. It was agreed that this is not regarded as a high-priority and it is necessary first to determine if it is possible to process and use the charged particle libraries themselves. Generating simplified covariance data for charged particles should not be a problem. Another question was whether activation codes (e.g., FISPACT) can use proton/deuteron activation data that are in TENDL. It was pointed out that at least the current and previous versions of FISPACT will be able to handle these data. Another issue was whether we should go to an extended set of MF/MT numbers or whether the lumped format should be used. Two options are available in the formatting code leading to these two representations of the data, and these were described in the presentation. One has with all data stored in MT5 and the other stores data in explicit MT sections. It appears that both representations can be processed by NJOY.

M. AVRIGEANU – National Institute of Physics and Nuclear Engineering, Bucharest, Romania

M. Avrigeanu gave a presentation on nuclear model calculations for d-induced data on Al and Cu. A simultaneous analysis of the deuteron elastic scattering and induced activation, that is essential for the engineering design of IFMIF, has been reported for ^{27}Al and ^{63,65}Cu target nuclei. Firstly, a semi-microscopic optical potential with a real double-folding potential and phenomenological imaginary and spin-orbit terms has been used in the analysis of elastic-scattering differential and total reaction cross-sections. Next, the energy and mass dependence of the breakup mechanism contributions has been properly taken into account for the enhancement of particular activation reaction cross-sections, mainly the second chance emission particles. The stripping-mechanism contributions to the (d,p), (d,n) and (d,t) reaction cross-sections through population of the low-lying discrete levels of the residual nuclei are calculated by means of the Coupled Channels code FRESCO. Finally, the pre-equilibrium emission (PE) and statistical model (SM) computer code STAPRE-H have been used to obtain the PE and SM cross-sections corrected for the breakup and stripping decrease of the total reaction cross-section. The comparison of the present calculations with predictions of the TALYS code and of the related TENDL library demonstrates the importance of the appropriate consideration of the deuteron breakup mechanism contribution to the cross-section calculations suitable for activation calculations.

T. KAWANO – Los Alamos National Laboratory, Los Alamos, NM, USA

T. Kawano gave a talk on the current status of proton-induced nuclear data libraries for light elements, up to oxygen. The available evaluated data files, ENDF/B-VII.0, JENDL/HE-2007, and TENDL-2009, are very limited. None of them covers all the light materials. For example, no evaluation exists for proton induced reactions on He-4. The data in these libraries were compared. Kawano also mentioned several updates of structural materials that have been made for ENDF/B-VII.1. These include data for titanium, iron, and nickel.

A. IGNATYUK - Institute of Physics and Power Engineering, Obninsk, Russian Federation

A. Ignatyuk gave two presentations where he discussed testing of EAF-2007 and TENDL-2009 libraries for protons and deuterons on the basis of the IAEA database for therapeutic applications and the recent measurements. It was shown that essential differences exist between evaluations and experimental data for light nuclei (A<20), where resonance structure of cross-sections plays an important role. Additional calculations with the ALICE and EMPIRE codes have been performed to study effects of input model parameters on the analyzed data. Main examples of possible improvements of the EAF-2007d and TENDL-2009d starter libraries were briefly discussed for the most important materials relevant to the IFMIF project. Special attention was devoted to the (d,p) reactions, whose evaluations can differ by more than 10-20 times from experimental data at energies near to threshold. A possibility to remove the main disagreements on the basis of the DWBA calculations was considered and an empirical simulation of the (d,p) cross-sections by means of the modified ALICE-D and EMPIRE-D codes was proposed.

F. TARKANYI – Hungarian Academy of Science, Debrecen, Hungary

F. Tarkanyi presented a status report on the Hungarian evaluation work for the activation cross-section data of proton- and deuteron-induced reactions related to the FENDL-3 project. About one thousand reactions have been investigated. Examples of new experimental measurements, compilations, and a critical evaluation of experimental data were provided along with comparison with the results of the theoretical codes and with the data in the evaluated activation files. The cross-section data of deuteron-induced reactions relevant for activation were discussed in detail indicating the poor experimental database, missing and erroneous EXFOR compilations and poor or moderate agreement with the results of the model codes and with the data in the evaluated activation data libraries.

3. DISCUSSION

An extensive discussion took place after the presentations. A major part of the discussion addressed the status of the evaluations for the 88 materials in the starter general purpose neutron library (FENDL-3/SLIB). The materials were discussed one by one with respect to adequacy of evaluation used, existence of better evaluations, and availability of high-energy (>20 MeV) data. Several changes were agreed for the choice of evaluations to be utilized. In addition, several materials were approved for addition to the library based on input solicited from the fusion neutronics community, ITER, and IFMIF. Evaluations that will be used for these added materials were identified. Issues related to availability and utilization of covariance in FENDL-3 were discussed. The activation data files for neutrons, protons and deuterons were discussed. The activation library which will be part of the FENDL-3 package will be based on EAF-2010. Issues related to the generation of the general purpose charged

particle data library were also addressed. This library will be based primarily on TENDL-2009 or -2010.

Details of the decisions made and action items are given below. A reference to TENDL means TENDL-2009 or TENDL-2010 when available. JENDL-HE means the latest update expected to be available in about six months. The Russian BROND library will be replaced by the new Russian library RUSFOND.

4. FENDL-3.0 GENERAL PURPOSE NEUTRON LIBRARY

4.1. Revised Evaluations for Existing Starter Library Materials:

Following the review of the evaluations used for the 88 materials in the starter library, several changes were agreed on. In the following list TENDL refers toTENDL-2009 or -2010 as available.

H-1: Currently has data from ENDF/B-VII that extends to only 20 MeV.
Action: Y. Watanabe: to provide extension to higher energy using data from JENDL-HE.
Action: T. Kawano: the standards only extend to 20 MeV, to check if extension is possible.

D-2: no change.

H-3: no change although data only to 20 MeV.

He-3, He-4: no change although data available is only up to 20 MeV. No high energy data are available.

Li-6, Li-7: currently has data from ENDF/B-VII that extends to only 20 MeV.
Action: Y. Watanabe / S. Kuneda: to join to TENDL data above 20 MeV.

Be-9, B-10, B-11: same procedure as for Li.

C-12: no change.

N-15: use new Russian RUSFOND evaluation to 20 MeV and join to TENDL at higher energies.

N-14, O-16, F-19: no change.

Na-23: use most recent JENDL-HE that is expected in 6 months. Consider the new better evaluation from BNL.
Action: T. Kawano to check the availability of this file.

Mg-24,-25,-26: no change.

Al-27: no change.

Si-28,-29,-30: keep from ENDF/B-VII but check and consider using the new JENDL evaluation because of unsatisfactory benchmark results.
Action: Y. Watanabe (Konno) to check.

P-31: change to TENDL because the ENDF evaluation used below 20 MeV is old.

S-32,-33,-34,-35: Keep data ENDF/B-VII.0 below 20 MeV and join to TENDL. Also consider replacing totally by TENDL for better quality.
Action: A. Koning to check current evaluation.

Cl-35,-37: no change.

K-39,-40,-41: no change but to consider possible use of new resonance evaluation for K isotopes in ENDF/A. Also to consider replacing totally by TENDL for better quality.
Action: A. Koning to check.

Ca isotopes: to be kept.
Action: A. Koning will check the more in-depth JEFF-3.1 evaluation for possible inclusion.

Ti isotopes: to be kept but consider new ENDF evaluation below 20 MeV.
Action: T. Kawano (L. Leal) to check current evaluation.

V-51: use JENDL-HE.

Cr isotopes: JEFF evaluation to be adopted subject to justification and approval.
Action: U. Fischer (Perslavtsev, Leal).

Mn-55: keep JENDL-HE but consider the option of using the IAEA evaluation.
Action: A. Trkov.

Fe-56: keep JEFF with HE extension (recoils)
Action: to be fixed by A. Koning.

Fe-54,-57: keep ENDF/B-VII.

Fe-58: switch to JEFF.
Action: A. Koning to check.

Co-59: no change.

Ni-58,-60: keep JEFF.
Action: Covariances and resonance data to be rechecked in JEFF and ENDF/A by A. Trkov (L. Leal).

Ni-61,-62,-64: keep ENDF/B-VII.

Cu-63,-65: no change.

Ga isotopes: no change.

Zr isotopes: no change.

Mo isotopes: no change.

Sn: isotopic evaluations from RUSFOND files (or JENDL-4 if available) to be joined to TENDL at 20 MeV. Otherwise use TENDL only.
Action: Y. Watanabe to justify switch to JENDL-4.

W isotopes: use the IAEA evaluation.

Ta-181: no change.

Au-197: no change.

Pb-206,-207: use JEFF.

Pb-208: use JEFF.

Bi-209: switch to JEFF.

4.2. Materials to be added to the Library:

Several materials listed below were approved for addition to the library based on input contributed by the fusion neutronics community for ITER and IFMIF. These are 23 elements with their constituent isotopes. Only 3 actinide isotopes will be added as they are needed for

neutron measurement by fission chambers (U) or exist in the ITER concrete (Th). Evaluations that will be used for these added materials are identified here:

Re: TENDL

Zn: JENDL-HE

Ag: ENDF/B-VII+TENDL for the HE part.
Action: A. Ignatyuk to check the resonance parameters.

Ba: ENDF/B-VII+TENDL

Y: ENDF/B-VII+TENDL

Cd: ENDF/B-VII+TENDL.
Action: A. Trkov to replace resonance data with new better data.

Ce: ENDF/B-VII+TENDL

Ar: JENDL-HE

Er: ENDF/B-VII+TENDL

Sb: ENDF/B-VII+TENDL

Rh: JEFF.
Action: H. Kim to compare with recent ENDF evaluation.

Sc: JEFF (new in-depth evaluation)

Br: JENDL-4+TENDL

Ge: JEFF (new in-depth evaluation)

I: JEFF+TENDL

Lu: TENDL

La: TENDL

Cs: JENDL-4+TENDL

Pt: TENDL

Hf: ENDF/B-VII (includes high energy part).
Action: S. Kunieda to compare with JENDL-4.

Gd: JEFF-3.2 (includes high energy part).
Action: S. Kunieda to compare with JENDL-4.

U-235,-238: use standard, i.e. ENDF/B-VII for E<20 MeV with extension by JENDL-HE.

Th-232: ENDF/B-VII. No need to extend to high energy.

In addition, six isotopes were identified as missing in both the FENDL-2.1 and FENDL-3/SLIB libraries. These will be added to FENDL-3 as follows:
C-13: TENDL;

O-17,-18: TENDL;

V-50: JENDL-4+TENDL;

W-180: IAEA evaluation;

Pb-204: JEFF.

5. COVARIANCE DATA LIBRARY

The shadow library coming from TENDL-2010 will include the same reactions as FENDL. Those evaluations in FENDL that have covariance data will be used in the shadow library. It will be recommended to use the shadow library if the full set of covariance data is required for a calculation.

Comparison of covariance data will be performed by means of calculations with defined spectra (thermal, Cf, ITER and IFMIF). The last two spectra will be provided by U. Fischer in 640 group structure plus extension an extension for the IFMIF spectrum.
Action: A. Trkov.

Covariance format will be recommended to A. Koning. The approach of using MF=40 to be checked by A. Trkov to confirm if it is processable.

6. ACTIVATION FILES

EAF-2010 should be adopted as the activation file. This includes new uncertainty data as shown in the presentation by J. Kopecky.

The file must be converted into ENDF data format and should also include converted uncertainty data
(*Action:* J-C. Sublet and A. Trkov to produce the conversions).

The proposal for a format extension involving a new set of MT numbers has been sent to CSEWG. Space is reserved and can be used. No MT numbers were allocated to date, but this may be changed at a future meeting.

Use EAF data for proton- and deuteron-induced reactions. Leave basically EAF-2007d and p as they are but integrate improved calculated data from M. Avrigeanu and A. Ignatyuk, and experimental data from F. Tarkanyi (*Action:* J.-C. Sublet). No uncertainty data will be included in the proton- and deuteron-induced data.

F. Tarkanyi will provide his compilation of experimental deuteron-induced data by summer of 2010 and by September 2010 for protons.

7. GENEREAL PURPOSE CHARGED PARTICLE DATA LIBRARIES

Proton library ENDF/B-VIIp (LA-150) has 30 nuclides; TENDL-2009 has 1170 nuclides. A. Koning noted that a quality assessment has been made by A Konobeev.

R. Capote Noy will look into 30 ENDF/B-VII evaluations and compare with JENDL-HE. The latter is probably better because it is more recent.

Silicon, aluminium, molybdenum and iron proton-induced data to 200 MeV from Korea could be considered for addition.
Action: H. Kim.

Use proton- and deuteron-induced starter libraries from TENDL-2010 with stable targets, then replace important targets by improved evaluations coming from other sources (if any).
Action: Roberto Capote Noy.

8. FENDL-3 PROCESSSING

ENDF data libraries (FENDL-3/T) to be provided by April 2011. This will be followed by processing with NJOY ACER, testing and correction before release at end of 2011. Processed ACE files to be available two months after release of ENDF data files to allow time for testing and benchmarking before the next RCM meeting in fall of 2011. Neutron library processing will be provided by A. Trkov. NDS will provide documentation and organization for proton library. Deuteron library will be provided by A. Koning. Multi-group processing will follow testing of ACE files.

9. SCHEDULE

It was proposed to hold video/audio conference in May of 2011 to decide on content of the libraries. The date is still to be decided. The third RCM is expected to be held around October 2011.

IAEA 2nd Research Coordination Meeting on

"Nuclear Data Libraries for Advanced Systems – Fusion Devices"

IAEA Headquarters, F 0817

Vienna, Austria

23 - 26 March 2010

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IAEA
International Atomic Energy Agency

2nd Research Co-ordination Meeting (RCM) on

Nuclear Data Libraries for Advanced Systems – Fusion Devices (FENDL 3.0)

IAEA Headquarters, Vienna, Austria

23 – 26 March 2010

Room F0817

AGENDA

Tuesday, 23 March

08:30 - 09:30 Registration (IAEA Registration desk, Gate 1)

09:30 - 10:30 Opening Session

- Welcoming address – N. Ramamoorthy
- Introductory remarks – Robin Forrest
- Election of Chairman and Rapporteur
- Acceptance of Agenda

10:30 – 11:30 Break for administrative matters

11:30 – 12:50 Start presentations

- *Status of ITER*, M. Loughlin
- *Benchmark calculations in support of FENDL-3 development*, M. Sawan

12:50 - 14:00 Lunch break

14:00 - 17:50 Presentations (continued)

- *Status and benchmark of JENDL/HE-2007 for energies above 20 MeV*, Y. Watanabe
- *JENDL-4*, S. Kunieda
- *FENDL-3 activities at JSI*, A. Trkov
- *Testing of FENDL-3/SLIB Neutron Cross-Section Data for Applications to the IFMIF Neutron Source Facility*, U. Fischer
- *Evaluation of n+Cr cross section data up to 200 MeV neutron energy including covariances*, P. Pereslavstev

(Coffee break as appropriate)

Wednesday, 24 March

9:30 - 12:40 Presentations (continued)

- *Absorbers, actinides and compounds in FENDL-3*, J-Ch. Sublet
- *Filling up FENDL with an all-in-one nuclear data evaluation and validation system around TALYS*, A. Koning
- *The European Activation File: EAF-2010*, J-Ch. Sublet
- *The Uncertainty file for FENDL-3/A*, J. Kopecky

(Coffee break as appropriate)

12:40 - 14:00 Lunch break

14:00 - 17:30 Presentations (continued)

- *Proton and deuteron transport and activation libraries: format and validation issues*, A. Koning
- *Evaluations on Charged Particle-induced Reactions in KAERI*, H. Kim
- *Consistent nuclear model calculations for deuteron induced reactions on Al and Cu*, M. Avrigeanu
- *Summary of proton-induced reaction data on light elements*, T. Kawano
- *Testing of FENDL-3 for protons and deuterons*, A. Ignatyuk

(Coffee break as appropriate)

19:30- Social event: dinner at Melker Stiftskeller
(http://members.aon.at/melkerstiftskeller/)

Thursday, 25 March

9:30 - 12:30 Presentations (continued), start discussion; task assignments

- *Activation cross section data of deuteron induced reactions*, F.T. Tarkanyi, B. Kiraly
- *Simulation of the (d,p) and (d,t) cross sections*, A. Ignatyuk

(Coffee break as appropriate)

12:30 - 14:00 Lunch break

14:00 - 17:30 Discussion on agreed FENDL topics (1)

(Coffee break as appropriate)

Friday, 26 March

9:30 - 12.30 Discussion on agreed FENDL topics (2)

(Coffee break as appropriate)

12:30 - 14:00 Lunch break

14:00 - 17:30 Drafting of the 2nd RCM report

Close

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