VERIFICATION OF THE WORLD EVALUATED NUCLEAR DATA LIBRARIES ON THE BASIS OF INTEGRAL EXPERIMENTS USING THE RTS&T CODE SYSTEM

I. I. Degtyarev, F. N. Novoskoltsev, E. V. Altukhova, Yu. V. Altukhov, R. Yu. Sinyukov, Institute for High Energy Physics named by A. A. Logunov of NRC “Kurchatov Institute”, Protvino, Russia
A. A. Pryanichnikov, M. A. Belikhin, A. S. Simakov, P. N. Lebedev Physical Institute of the Russian Academy of Sciences, Physical Technical Center, Protvino, Russia
A. I. Blokhin, Nuclear Safety Institute of the Russian Academy of Sciences, Moscow, Russia
M. Yu. Smetanin, Federal State Unitary Enterprise "Mayak Production Association" State Enterprise "Rosatom", Ozersk, Russia

Abstract

The basis for validation and improvement of modeling algorithms and constant systems in the radiation transport problem is the procedure of comparing a calculated functionals obtained within the framework of high precision codes using a modern data libraries with high precision experimental data.

INTRODUCTION

Over the past decade, there has been a significant update of the world's evaluated nuclear data libraries. The paper presents selected results of testing the current versions of this evaluated nuclear data libraries such as ENDF/B VII.1, ENDF/B VIII.0, ROSFOND, BROND 2.2/3.1, JENDL4.0u +, JENDL-4.0/HE, JENDL/HE 2007, CENDL 4.0, TENDL 2015, FENDL 3.0, JEFF 3.2 based on the integral experiments included in the Shielding Integral Benchmark Archive and Database (SINBAD) [1] using the RTS&T [2] reference accuracy class code system. The RTS&T code uses continuous-energy nuclear and atomic evaluated data files to simulate of trajectories and discrete interactions of the particles in the energy range from thermal energy up to 20/150/3000 MeV. In current model development all data types provided by ENDF-6 format are takes account in the coupled multi-particle transport modelling. The PREPRO2017 [3], NJOY2016 [4], GRUCON [5] and CALENDF [6] pre-processing code systems are used to prepare a transport constant files.

BENCHMARKING

In this section of the paper, selective results of verification of the world evaluated nuclear data libraries written in the ENDF-6 format are presented on the basis of comparison of the results of calculations performed within the RTS&T high precision code using the PREPRO2017 pre-processing codes with experimental data [7] included in the SINBAD data bank. Unfortunately, a free version of the PREPRO2017 package does not include a procedure similar in purpose and functionality as the THERMR module of the NJOY code system, which calculates the integrated cross sections and energy-angular distributions of scattered particles in the interaction of neutrons on free or bound atoms in the thermal energy region with considering the temperature of the medium (using the FILE 7 of ENDF-6). To perform the functions similar to those of the THERMR module, the original procedure NTHERM2017 [8] (THERMRTST) was developed and tested. The module NTHERM2017 is included in the RTS&T general data pre-processing system (Fig. 1).

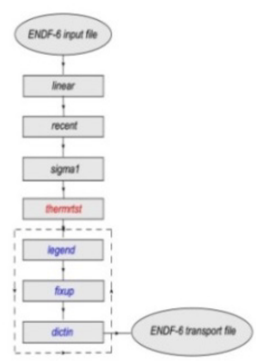

Figure 1: The sequence of procedures using for preparing the ENDF-6 transport file for the RTS&T code system.

A comparison of neutron leakage spectra from the surfaces of spherical assemblies is shown in Fig. 2. In Table 1 shows the values of $\chi 2$ / dof for all assemblies.

CONCLUSION

The analysis of a series of verification benchmark experiments taken from the international SINBAD database is carried out, selective results of calculated and experimental data comparison are presented. The results of the calculations of selected experiments show the acceptable agreement of the simulation with the experimental data.

ISBN 978-3-95450-197-7

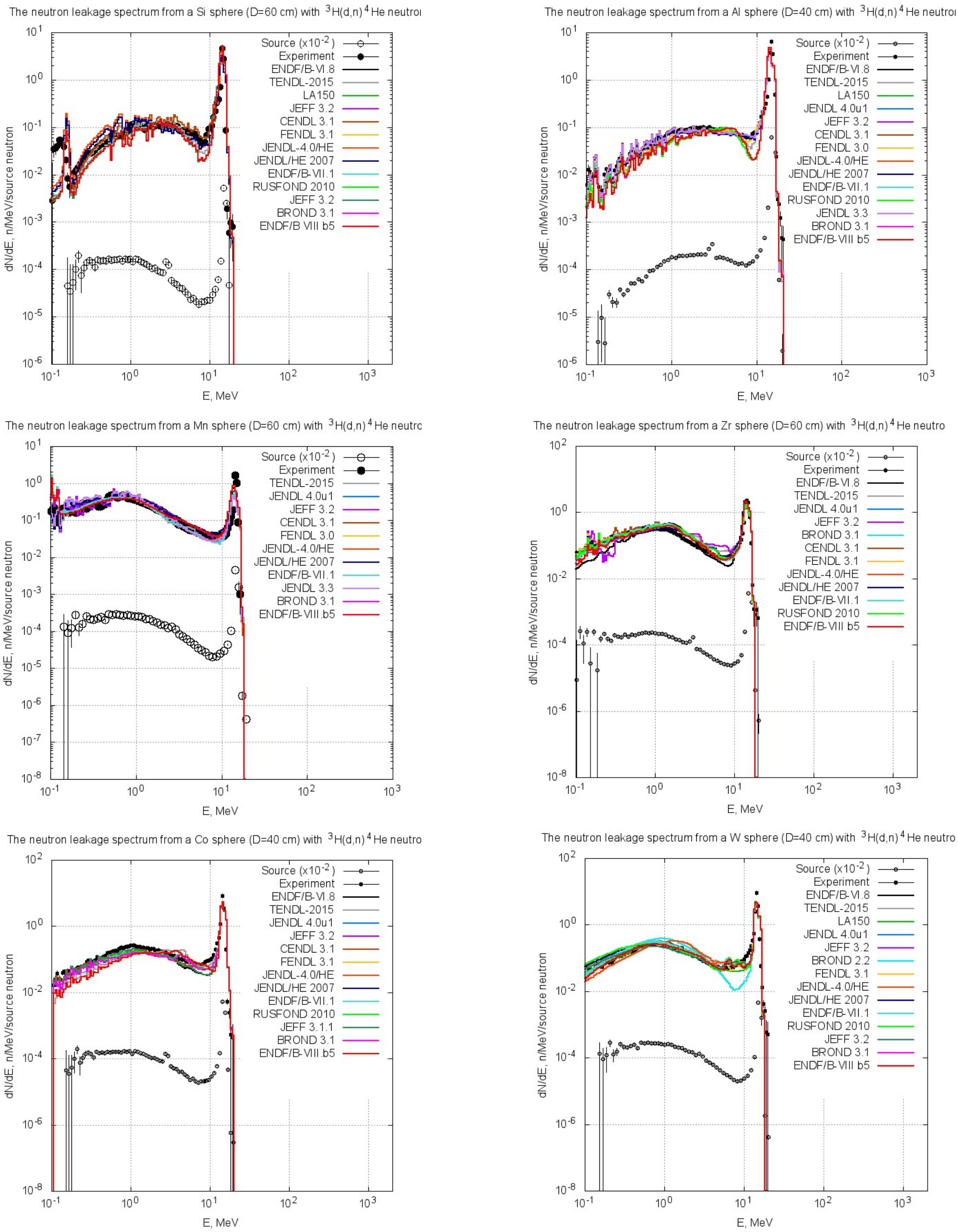

Figure 2: Leakage neutron spectra from various sphere piles.

ISBN 978-3-95450-197-7

Table 1: Summary of $\chi 2$/dof

Evaluated nuclear data library	**Assembly material**					
	Al	**Si**	**Mn**	**Co**	**Zr**	**W**
BROND 3.1	34.1072311	0.1409222	0.0376164	0.1777702	0.0196693	0.2955392
CENDL 3.1	34.5067024	0.0848230	0.0262865	0.1747213	0.0197966	-
ENDF/B VII.1	34.1160583	0.1284287	0.0432632	0.1752771	0.0246908	0.2955631
ENDF/B VIII.b5	34.1074867	0.1209213	0.0376164	0.1742702	0.0193236	0.2955359
FENDL 3.1	-	0.1258727	0.0353412	0.1752771	0.0189309	0.2939239
JEFF 3.2	34.3725700	0.1421800	0.0353412	0.1752814	0.0251943	0.2917682
JENDL 4.0	34.7610397	0.0738185	0.0403688	0.1750326	0.0189309	0.3003758
JENDL 4.0-HE	34.5016556	0.0738185	0.0403688	0.1750326	0.0227736	0.3003764
JENDL-HE-2007	34.4260254	0.0806130	0.0251958	0.1775477	0.0227728	0.2930388
RUSFOND 2010	34.1160583	0.1421800	-	0.1750326	0.0196335	0.3059505
TENDL 2015	34.6310806	0.0660777	0.0335942	0.1788945	0.0204340	-

RFERENCES

[1] I. Kodeli, A. Milocco, P. Ortego, E. Sartori, 20 Years of SINBAD (Shielding Integral Benchmark Archive and Database), Progress in Nuclear Science and Technology Volume. 2014, vol. 4, pp. 308–311, https://www.oecd-nea.org/science/wprs/shielding/sinbad/.

[2] I.I. Degtyarev, F.N. Novoskoltsev, O.A. Liashenko, E.V. Gulina, L.V. Morozova, RTS&T 2014 Code Status, Nuclear Energy and Technology 1(2015) pp. 222-225.

[3] D.E. Cullen. The 1996 ENDF/B pre-processing codes. Technical Report IAEA-NDS-39 (Rev. 17), The International Atomic Energy Agency, Vienna, Austria, 2017.

[4] Jeremy Lloyd Conlin, A. C. Kahler, Austin P.McCartney, OpenSource Release of NJOY2016 and NJOY21, Los Alamos National Laboratory, Los Alamos, NM 87545, https://njoy.github.io/NJOY2016.

[5] V.V. Sinitsa, A.A. Rineisky, GRUKON - Package of applied computer programs and operating procedures of functional modules, Rep. IPPE -7220, Obninsk (1986) (in Russian), Rep. INDS (CCP)-344,Vienna,1993 (in English), https://www-nds.iaea.org/grucon/.

[6] J.C. Sublet, P. Ribon, M. Coste-Delclaux, CALENDF-2010: User Manual, Tech. Rep. CEA-R-6277, ISSN 0429-3460, CEA (2011).

[7] Ch. Ichihara et al., Leakage Neutron Spectra from Various Sphere Piles with 14 MeV Neutrons, JAERI-M 94-014, p. 63, 1994.

[8] I.I. Degtyarev, O.A. Liashenko, F.N. Novoskoltsev, L.V. Morozova, E.V. Altukhova, Certificate of state registration of computer code No. 2017619910.

ISBN 978-3-95450-197-7