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**NUCLEAR ENERGY AGENCY
NUCLEAR SCIENCE COMMITTEE**

Working Party on International Nuclear Data Evaluation Co-operation

**First Meeting of the WPEC Subgroup 47 on the Use of Shielding Integral
Benchmark Archive and Database for Nuclear Data Validation**

SUMMARY RECORD

**24 June 2019
NEA Headquarters
Boulogne-Billancourt, France**

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OECD/NEA Nuclear Science Committee

**Working Party on International Nuclear Data Evaluation Co-operation (WPEC)
First Meeting of Subgroup 47 on the Use of Shielding Integral Benchmark Archive
and Database for Nuclear Data Validation**

NEA Headquarters Room BB10
46 quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, France

24 June 2019

SUMMARY RECORD

1. Welcome

The Chair, **I. Kodeli**, welcomed the participants (see *Appendix 1*) and the WPEC Secretariat, **M. Fleming**.

2. Adoption of the agenda

The agenda as described in *Appendix 2* was adopted with an additional presentation from **C. Percher** on the LLNL pulsed spheres that was presented by **I. Kodeli**.

3. Short history of SINBAD and the SG47 objectives, I. Kodeli

I. Kodeli reviewed the history that the NEA has had in centralising and consolidating experiments into evaluated benchmarks, including the SINBAD, ICSBEP, IRPhE and IFPE databases. These are greatly valued by the nuclear data community as resources for validation and even for assimilation studies to improve future evaluations. The Shielding Integral Benchmark Archive and Database (SINBAD) is another resource of interest to the nuclear data community that has been used by the nuclear data community, but has not been fully exploited. Through engagement with experts in nuclear data verification and validation, better use may be made of the database and feedback can be used by the new SINBAD Technical Review Group (TRG) to focus efforts on future evaluation work. This feedback will be channelled directly to the WPRS EGRTS and the SINBAD TRG who are responsible for all SINBAD evaluation activities.

4. Validation of SuperMC with Fusion Shielding Benchmarks from SINBAD

J. Zou described the SuperMC computer code package, which performed Monte-Carlo particle transport and Bateman calculations. It includes a CAD-based modelling system that can be integrated with the CSG-based transport calculations, variance reduction techniques including a built-in weight-window generator, various visualisation capabilities and a cloud-based workflow

system. A large suite of SINBAD experiments have been used for validation of SuperMC, including experiments from Osaka, FNS, FNG, IPPE and Kant. Results were in generally good agreement and weight windows had been generated in some cases to accelerate the calculation convergence. The results and SuperMC models could be made available to SINBAD.

5. Analysis of shielding experiments calculations with using Russian codes and ND libraries

G. Lomakov presented calculations done with Russian nuclear codes and nuclear data libraries, including the ROZ, KASKAD and KATRIN discrete-ordinates neutron-physics codes with ABBN-93 and ABBN-RF, with the latter based on the ROSFOND-2010 library. Several ASPIS, EURACOS, JASPER and OKTAVIAN systems were considered, as well as neutron transmission measurements with Nb and Si. Calculation results were generally in good agreement with the experimental data. It was noted that quality inputs data including geometry, material, source, detector and normalisation information, it a prerequisite for validation studies of codes and nuclear data. Additional experiments for Nb and Si were proposed for SINBAD.

6. Use of Shielding Integral Benchmark Archive and Database for TRIPOLI-4® Monte Carlo code - A brief review

Y.-K. Lee presented work in validating TRIPOLI-4®, including a more than 1000 benchmark suite that is provided in the TRIPOLI-4 validation database, drawn from OECD-NEA resources including ICSBEP, IRPhE and SINBAD. Cases from SINBAD included various water and RPV-relevant cases, as well as fusion shielding and tritium breeding cases. SINBAD has been very important in the verification and validation of TRIPOLI-4®, although additional materials would be welcome. It was noted that several benchmarks have only MCNP inputs without experimental data provided outside these inputs. It was requested that these data be provided outside MCNP inputs and potentially supplemented with sensitivity analyses to help improve the quality of the database.

7. Validation of nuclear data against accelerator experiments in SINBAD

L. Fiorito presented, on behalf of **Y. Çelik**, work done to attempt to validate simulation capabilities against SINBAD experiments that utilise 75 MeV incident protons on Cu and 52 MeV incident protons on incident C. Multiple intra-nuclear cascade models were used, in addition to de-excitation models and nuclear data libraries at lower incident energies, and the simulation results were compared against data within SINBAD. It was noted that the sensitivity of the results to the neutron data library was, in many cases, much less than the variation in the proton-induced data effects. Since the analysis was based on the use of Monte-Carlo codes with built-in INC and de-excitation codes, and since these are typically many years or even decades behind the state-of-the-art models, it was acknowledged that use of more recent model codes could have a significant effect on the quality of the results, particularly since these were the most sensitive data. It was remarked that the documentation on these experiments and lack of uncertainty information both require attention to make the SINBAD entries much more valuable.

8. UPM contribution to WPEC/SG47

O. Cabellos presented work done with a suite of MCNP inputs for the FNS, Oktavian and LLNL pulsed spheres, as well as results obtained for several nuclear data libraries, including the multiple

JEFF test versions. These provided, and continue to provide, important data for the JEFF community in testing and selecting nuclear data files to be included in the final library versions. Total Monte-Carlo uncertainty propagation using TENDL ‘random’ files was shown, as well as sensitivity analyses for the LLNL pulsed spheres using MCSEN. The MCNP inputs from UPM will be made available to participants through the subgroup, as well as calculation results and other supplementary data, such as sensitivity profiles.

9. Experience using CAD models for SINBAD

S. Lilley reviewed the contents of SINBAD, highlighting the number of input files, different code versions and limitations that these have for performing code-to-code comparisons. Based on experience at STFC, he proposed that SINBAD could include CAD descriptions of all the SINBAD experiments which could, in many cases, be directly translated into multiple input geometries for Monte-Carlo codes to perform simulations. This would allow direct code-to-code comparison with identical model definitions.

10. Remarks from use of SINBAD

S. Simakov presented feedback from the use of several SINBAD experiments and the associated resources within the SINBAD database. It was noted that

- the FNG/TUD Tungsten Experiment (NEA-1553/47) lacks a cell 932 within the MCNP input provided;
- the KFK 1977 (gamma leakage) and NIST 2000 ^{252}Cf iron sphere experiments are not in SINBAD;
- there are discrepancies in the gamma multiplicities between KFK/IPPE bare ^{252}Cf encapsulated source and ^{252}Cf fission chamber experiments;
- no data is provided in SINBAD for the 91.44cm long broomstick ORNL Tower Shielding oxygen measurements;
- the Quality Assessment of the FNS Benchmark Experiments recommendation for scaling the data in the FNS oxygen experiment is apparently incorrect in suggesting division by the cosine of the detector angle;
- tantalum experiments are not included in SINBAD while they are available, including LRC, Ohio and LLNL pulsed spheres.

Various simulation results were also shown, providing comparisons between the most recent JEFF and ENDF/B libraries.

11. Role of SG47 within the NSC activities

The Head of the NEA Nuclear Science Division, **T. Ivanova**, discussed the role of the WPEC subgroup 47 and how it will function in collaboration with the other NEA groups that are responsible for the evaluation, content and distribution of SINBAD. While the WPRS Expert Groupon Radiation Transport and Shielding (EGRTS), chaired by **R. Grove**, and the newly established Technical Review Group (TRG) for SINBAD will continue to have responsibility for SINBAD, WPEC participants are encouraged to provide feedback. In particular, the provision of target uncertainties and use of sensitivity analyses are expected to play a major role in identifying

where detailed experimental evaluation, to be done by the SINBAD TRG, will have the greatest impact.

12. Neutron leakage spectra from iron slab with D-T neutrons at CIAE

H. Wu presented experimental work done at the CIAE CNDC using a D-T 14 MeV neutron source and a set of iron samples with time of flight techniques. The experiment was described, including parameters, electronics, detector modelling and results from verification tests. Monte-Carlo calculations with various libraries were performed for the facility, comparing with the ToF measurements of leakage spectra. Highlights from the results at different energy ranges and angles were provided, including general agreement between 800 keV and 3 MeV.

13. The ANSWERS Software Service and Shielding Experiments Performed at Winfrith

C. Murphy reviewed the history of the UK AEE Winfrith, including the 9 different reactors built over several decades starting from the 1950s. This included the NESTOR reactor and various experiments that had been carried out using NESTOR to provide source neutrons, including the Iron88, NESDIP2/3 and JANUS 1 - 8 benchmarks. The collection of ANSWERS software and nuclear data libraries was reviewed, as well as different experiments from Winfrith that had not yet been included in SINBAD. It was noted that additional experiments could be made available for SINBAD, subject to suitable source of funding and permissions.

14. UKAEA involvement in SINBAD benchmarks

A. Valentine presented an overview of activities at the UKAEA in the development of fusion technology. The Applied Radiation Transport group at the UKAEA activities related to SINBAD were reviewed, including several efforts to benchmark Serpent-2 against MCNP with different fusion-relevant experiments. These included the ongoing FNG HCLL evaluation not yet in SINBAD, as well as FNG HCPB that is within SINBAD. Several remarks were made related to the SINBAD input decks, noting a lack of quality control, many inoperable inputs and lack of comments and/or documentation. It was also remarked that due to the complexity of some systems, it is difficult to determine what inputs are superior. The UKAEA is preparing Serpent-2 inputs that could be considered for inclusion in future SINBAD versions and will also be studying other SINBAD inputs as part of the effort to benchmark Serpent-2.

15. RC Řež benchmark spheres and slabs

B. Jansky reviewed the experimental facilities available at Centrum výzkumu Řež, including the LVR-15 and LR-0 research reactors, ^{252}Cf , AmBe and ^{238}Pu -Be sources and a DT neutron generator. Several experimental studies were reviewed, including some with iron spheres, which have shown an overestimate against the measured spectra around 300 keV and 600 keV. The IAEA Nuclear Data Section is now working on this area as part of the INDEN work on iron evaluations.

16. Strategy used for evaluating structural: angular data from resonance parameters, is it a viable option?

L. Leal presented work by at IRSN in performing resonance evaluation and direct evaluation of the angular data in MF=4. It was noted that instead of an ENDF-6 representation that relies upon

the MF=3 reconstruction of the scattering cross section, direct calculation of the MF=4 angular data using the SAMMY (Blatt-Biedenharn) method can provide a better understanding of the data. There are already processing capabilities in major nuclear data processing codes and MF=32 (resonance parameter covariances) can be directly translated into the MF=34 angular covariances. It was noted that this data could be considered in future versions of GNDS.

17. Status of SINBAD Benchmarks - Pilot study proposals

I. Kodeli reviewed a few of the experimental datasets that were not yet within SINBAD but should be considered for inclusion, including the FNG copper experiment, ASPIS cases, LLNL pulsed sphere and Řež spheres. Several remarks were made regarding resources that could or should be included to make the experimental data more valuable for the nuclear data community, including sensitivity profiles, CAD geometries, weight windows (e.g. from ADVANTG) and multiple transport code inputs. The list of all data in SINBAD was reviewed with a suggested set of quality benchmarks identified. The recent FNG Copper JSI evaluation has been made available to participants through the subgroup webpage and could be used for future SINBAD work. Comments/reviews are welcome.

18. LLNL Pulsed Spheres Evaluation Effort

I. Kodeli, on behalf of **C. Percher**, work done at LLNL on a set of pulsed sphere measurements. These have been used for many nuclear data activities due to their sensitivities to scattering and are not included in SINBAD. Current work at LLNL includes effort to create an ICSBEP-standard evaluation, including all of the required sensitivity-based uncertainty analyses. Work using COG to perform modelling of the deuteron beam is ongoing.

19. Next meeting and other business

The next meeting will take place during the week of **11-15 May 2020**.

APPENDIX 1

List of participants to the 24 June 2019 Meeting of Subgroup 47 on the Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation

	First Name	Last Name	Country	Notes
1	David	BROWN	UNITED STATES	
2	Oscar	CABELLOS	SPAIN	<i>Remote</i>
3	Marie-Anne	DESCALLE	UNITED STATES	
4	Luca	FIORITO	BELGIUM	
5	Michael	FLEMING	NEA	
6	Zhigang	GE	CHINA	<i>Remote</i>
7	Wim	HAECK	UNITED STATES	
8	Michal	HERMAN	UNITED STATES	
9	Tatiana	IVANOVA	NEA	
10	Osamu	IWAMOTO	JAPAN	
11	Bohumil	JANSKY	CZECH REPUBLIC	
12	Alexis	JINAPHANH	FRANCE	
13	Albert (Skip)	KAHLER	UNITED STATES	
14	Ivan-Alexander	KODELI	SLOVENIA	<i>Chair</i>
15	Luiz Carlos	LEAL	FRANCE	
16	Yi-Kang	LEE	FRANCE	
17	Steve	LILLEY	UNITED KINGDOM	
18	Gleb	LOMAKOV	RUSSIA	
19	Alberto	MILOCCO	ITALY	
20	Christophe	MURPHY	UNITED KINGDOM	
21	Arjan	PLOMPEN	BELGIUM	
22	Gerald	RIMPAULT	FRANCE	
23	Pablo	ROMOJARO	SPAIN	
24	Evgeny	ROZHIKHIN	RUSSIA	
25	Xichao	RUAN	CHINA	<i>Remote</i>
26	Stanislav	SIMAKOV	GERMANY	
27	Alexey	STANKOVSKIY	BELGIUM	
28	Jean-Christophe	SUBLET	IAEA	
29	Kenichi	TADA	JAPAN	
30	Alex	VALENTINE	UNITED KINGDOM	
32	Morgan	WHITE	UNITED STATES	
33	Haicheng	WU	CHINA	<i>Remote</i>
34	Michael	ZERKLE	UNITED STATES	
35	Gaspar	ZEROVNIK	SLOVENIA	<i>Remote</i>

APPENDIX 2

OECD/NEA Nuclear Science Committee

Working Party on International Nuclear Data Evaluation Co-operation (WPEC) Meeting of Subgroup 47 on the Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation

NEA Headquarters Room BB10

46 quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, France

24 June 2019

AGENDA

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| 1. Welcome and introductions | Chair |
| 2. Adoption of the agenda | All |
| 3. Short history of SINBAD and the SG47 objectives | I. Kodeli |
| 4. Validation of SuperMC with Fusion Shielding Benchmarks from SINBAD | J. Zou |
| 5. Analysis of shielding experiments calculations with using Russian codes and ND libraries | G. Lomakov |
| 6. Use of Shielding Integral Benchmark Archive and Database for TRIPOLI-4@ Monte Carlo code - A brief review | Y-K. Lee |
| 7. Validation of nuclear data against accelerator experiments in SINBAD | L. Fiorito |
| 8. UPM contribution to WPEC/SG47 | O. Cabellos |
| 9. Experience using CAD models for SINBAD | S. Lilley |
| 10. Remarks from use of SINBAD | S. Simakov |
| 11. Role of SG47 within the NSC activities | T. Ivanova |
| 12. Neutron leakage spectra from iron slab with D-T neutrons at CIAE | H. Wu |
| 13. The ANSWERS Software Service and Shielding Experiments Performed at Winfrith | C. Murphy |
| 14. UKAEA involvement in SINBAD benchmarks | A. Valentine |
| 15. RC Rez benchmark spheres and slabs | B. Jansky |

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| 16. Strategy used for evaluating structural: angular data from resonance parameters, is it a viable option? | L. Leal |
| 17. Status of SINBAD Benchmarks - Pilot study proposals | I. Kodeli |
| 18. LLNL Pulsed Spheres Evaluation Effort | C. Percher |
| 19. Next meeting and any other business | |

APPENDIX 3

Actions agreed at the 24 June 2019 Meeting of Subgroup 47 on the Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation

1. **(G. Lomakov, IPPE)**: Provide comments and review of the FNG Cu benchmark evaluation (beginning 2020)
2. **(G. Lomakov, IPPE)**: Provide information on the Neutron transmission experiments (1960th) to be included in SINBAD (next meeting)
3. **(S. Simakov, KIT)**: Provide KFK-1977 gamma measurement data for potential SINBAD evaluation
4. **(S. Simakov, KIT)**: Contribute models for Oxygen ORNL broomstick benchmark and 91.44 cm liquid O data if of interest (sufficient quality) for SINBAD
5. **(Simakov, Kodeli, Milocco)**: resolve the issue of dividing by cosine for FNS-O.
6. **(Y.-K. Lee, CEA)**: Contribute TRIPOLI input data of few SINBAD benchmarks to WPEC SG47 (2020 meeting).
7. **(Y.-K. Lee, CEA)**: Present a description of the Mn bath experiment for potential inclusion in SINBAD (2020 meeting).
8. **(S. Lilley - UKRI STFC, I. Kodeli)** Provide CAD geometry for IPPE, FNS, FNG, ASPIS and ISIS benchmarks
9. **(Jun Zou, FDS)**: Provide SuperMC inputs for the set of SINBAD benchmarks (e.g. OKTAVIAN, FNS, FNG, IPPE, Kant) (beginning 2020)
10. **(J. Zou, FDS)**: : Proposals of potential FDS shielding benchmarks to be included in SINBAD, such as HINEG (2020 WPEC meeting)
11. **(H. Wu, CIAE)** Contribute 14 MeV Fe benchmark data to SINBAD (ASAP)
12. **(B. Jansky, CVREZ)** Contribute Rez Fe sphere and slab benchmark data to SINBAD (ASAP)
13. **(C. Murphy, Winfrith)** Investigate the possible release of ASPIS benchmark data which are not yet in SINBAD (ASAP)
14. **(O. Cabellos, UPM)** Provide MCNP models and sensitivity profiles for LLNL, FNS, Oktavian benchmarks
15. **(I. Kodeli, IJS)** Provide updated SINBAD data for ASPIS Fe88 benchmarks