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22 June 2018

NUCLEAR ENERGY AGENCY  
NUCLEAR SCIENCE COMMITTEE

## **Working Party on International Evaluation Co-operation**

### **30th Meeting of the working Party on International Nuclear Data Evaluation Co-operation (WPEC)**

#### **SUMMARY RECORD**

**17-18 May 2018  
OECD Headquarters  
Paris 16, France**

Michael Fleming  
+33 1 45 24 10 72  
michael.fleming@oecd.org

**JT03434004**

OECD/NEA Nuclear Science Committee

WORKING PARTY ON  
INTERNATIONAL NUCLEAR DATA EVALUATION CO-OPERATION  
30<sup>th</sup> MEETING

OECD Headquarters  
2 rue André Pascal, Paris 75016, France

17-18 May 2018

SUMMARY RECORD

1. Welcome

The WPEC Chair, **A. Plompen**, opened the meeting and welcomed all participants (a list is given in *Appendix 1*). **M. Fleming** acted as NEA/NSC WPEC Secretary.

2. Adoption of the Agenda

[\[NEA/SEN/NSC/WPEC\(2018\)1\]](#)

It was noted that, due to ongoing train strikes, the SG45 and CIELO SG proposals will be dealt with during the Thursday meeting.

The proposed agenda was adopted (see *Appendix 2*).

3. Review of the Summary Record of the 29th WPEC Meeting

It was noted from the previous summary record that action items were not collated into a final table, and this was requested for future summary records. These are included in *Appendix 3*.

4. Review of closed and closing subgroups without final reports

- Subgroups 27 and 28 are awaiting final reports. Actions were agreed to determine the status of the reports
  - **Action** for **R. Jacqmin** to determine status of SG 27 report
  - **Action** on **V. Sobes** and **A. Sonzogni** to contact M. Dunn regarding SG 28 report
- Subgroup 35. - **Action** on **M. White** to follow up on T. Kawano on SG 35 report status
- Subgroup 36 - **Action** on **A. Plompen** to follow up with P. Schillebeeckx on final report status
- Subgroups 37-41 are past the ‘closing’ stage of one year after the WPEC agreement to close the subgroup. It was noted that the NEA webpages do not reflect this status.

- **Action** for **M. Fleming** to ensure webpage update and ensure continued maintenance of the contents
- Subgroup 38 is at the end of the ‘closing’ period
  - **C. Mattoon** updated the participants on the schedule for the report, which is nearly completed and is expected by August 2018
- Subgroup 39 has had the final meeting at this WPEC and the report contents are being compiled.
  - **Action** - **G. Palmiotti** to provide remaining contributions to M. Fleming
  - **Action** - **M. Salvatores** to provide remaining contributions to M. Fleming
- The subgroup 40 (CIELO) NEA report is at an advanced draft state and will be forthcoming. It is anticipated by the end of summer 2018.
- Subgroup 41
  - **Action** - **M. Fleming** to follow up with H. Harada to determine status of the report

## 5. Review of delegates and observers

- **Action** - **M. Fleming** to update V. Sobes as a US representative
- **Action** - **M. Fleming** to prepare a pdf file of the delegate list for participants

## 6. Reports on Experimental Activities

Experimental nuclear data activities of relevance to the evaluation projects were reviewed. Detailed information about the experimental activities is given in the reports presented at the meeting.

- *China*  
**X. Ruan** reported on experimental activities from the China Institute of Atomic Energy (including the HeSAN facility for (n,2n) measurement, the Nuclear Data Benchmark Experiment and progress on the CSNS Back-n experiment), Peking University, the Institute of Modern Physics (14 MeV DT neutron irradiations and 15 MeV LINAC neutron source experiments) and the Shanghai Institute of Applied Physics (photonuclear data from SSRF/SLEGS).
- *Europe*  
**A. Plompen** reported on the experimental activities that had been presented at JEFF meetings, including elastic scattering measurements from JRC-Geel/GELINA, new inelastic scatter measurements on Fe54, 2E2v measurements from VERDI for fission observables, GSI SOFIA fission observable measurements, the FAIR proposal, GANIL NFS measurements, IGISOL-JYFLTRAP measurements for TAGS, IGISOL-BELEN, BRIKEN measurements for beta-delayed neutrons, n\_TOF measurements including EAR1, EAR2 and INFNs.
- *Japan*  
**A. Kimura** reported on measurements at the J-PARC Materials and Life Science Experimental Facility including ANNRI, Tandem measurements, including collaborations with CIAE, Konan University (n,Xn) measurements, Quantum and Radiological Science and Technology M1 strength measurements, Osaka University RCNP double-differential deuteron measurements, and NIRS-HIMAC double-differential neutron production measurements. A request was made by

M. White to ensure that, along with final inferential data, original, ‘raw’ data is provided in publications.

- *USA*

**Y. Danon** reported on GELINA measurements on Zr by ORNL, various measurements from LLNL (including TPC, Neutron STARS, Hyperion, fission products from critical assemblies), UC-Berkeley LBNL measurements from DD and cyclotron sources, various measurements from the Triangle Universities Nuclear Laboratory, LANL measurements from LANSCE, Chi-Nu and upcoming LENZ experiments, Rensselaer Polytechnic Institute measurements from the Gaertner LINAC Center.

## 7. Brief progress reports from the evaluation projects and discussion of future plans

Progress in the major nuclear data evaluation projects was presented. Detailed information about the status of the evaluated nuclear data libraries is given in the reports presented at the meeting.

- *CENDL*

**Z. Ge** presented the progress of the CENDL project, which has a 3.2 beta version. This includes 250 files with 56 updated and 14 new evaluations. Results were shown for several evaluations, as well as criticality benchmarks for a range of systems and EALFs, showing general improvement. SINBAD benchmarks, notably OKTAVIAN spheres, were shown with superior agreement in neutron spectra with CENDL data. New SAMMY-based evaluations are in progress for resonance-range data, and new covariance evaluations were generated for 11 files. A new photonuclear library, including 270 evaluations, is in production. Expected release within 1-2 years, likely after ND2019.

- *ENDF*

**D. Brown** presented the release of ENDF/B-VIII.0, which has received contributions from many US and international laboratories, institutes and agencies. The library has been validated using many benchmark suites, and benefits from both an automated, continuous integration system, as well as routine evaluation conferences. The new features of the library are highlighted in 8 publications in *Nuclear Data Sheets*. Highlights were presented for several cross sections, thermal scattering data, other observables and integral benchmark results.

- *JEFF*

**A. Plompen** presented the release of JEFF-3.3, demonstrating the new NEA mapping tools. He noted that fission yield covariances are not yet available but are anticipated from NEA contributions. A detailed description was provided for the various test versions. Validation from numerous criticality suites, with incremental improvement, was shown. Testing, verification and validation from numerous JEFF contributions were summarised, providing motivation for several file selection decisions. A follow up discussion on fission yield covariances generated requests for the community to share this data in a suitable format.

- *JENDL*

**O. Iwamoto** presented the JENDL/PD-2016 and JENDL/AD-2017 photonuclear data library, showing several examples of improvement with differential experimental data. New evaluations in preparation for JENDL-5 were shown, including new experimental data from measurements in Japan. A roadmap for the JENDL-5 development was presented, with sub-projects for different file aspects. Notably, a new R-matrix code, AMUR will be used for light targets and new TSL evaluations.

**K. Yokoyama** presented benchmarking and testing activities, where selections of criticality benchmarks were utilised to demonstrate lead and gadolinium-specific features.

- *TENDL*

**A. Koning** presented the TENDL-2017 nuclear data libraries, starting from the evaluation methodology. Aspects of the new version include improved TALYS input parameters, resonance parameters, translation of resonance parameter uncertainties into cross section covariances, and inclusion of the most recent CIELO and ENDF/B-VIII.0 evaluations for specific nuclides. Verification and validation of the new library was presented for several cases. The new TALYS-2.0 version is in preparation and will be both open-source and fully in modern FORTRAN.

## 8. Brief feedback reports

- *IAEA Nuclear Data Section*

**A. Koning** presented a chronological overview of all the technical meetings, consultant's meetings, and coordinated research projects over the past two years. The INDEN was presented, as well as the results from the first meeting in December 2017. This project will focus on the full suite of plutonium isotopes, as well as N, Be, Na and some structural materials.

- *NEA Data Bank Nuclear Data Services*

**F. Michel-Sendis** presented the Data Bank structure and overview of the capabilities, including the NDEC processing suite and the newly developed mapping tools that are available on the Data Bank website.

## 9. Status of ongoing subgroups

The status and activities of the ongoing expert groups and subgroups were presented by each of the subgroup co-ordinators. A list of these is provided in *Appendix 4*.

- *Expert Group/Subgroup B on Recommended Definition of Generalized Nuclear Data Structure (EGGNDs)*

**D. Brown** reported on the progress with generalized nuclear data formats, including an overview of the specifications, requirements and codes that have implemented capabilities to read and process the new implementations of the file structures. An extended mandate with deliverable adjustments was reviewed and agreed, as found in *Appendix 6.1*.

- **Action - D. Brown** to share fission yield format drafts with NEA
- **Action - NEA** to help define the fission yields format

- *Expert Group/Subgroup C on High Priority Request List for Nuclear Data (EGHPRL)*

**E. Dupont** reported on the status of SG-C/HPRL, reviewing the operation of the HPRL, including the addition of new categories for general requests and special purpose quantities. The new categorization system for progress was described, including a category for archived entries. New entries were described, as well as the recent expert group review of all request entries. An extended mandate with deliverable adjustments was reviewed and agreed, as found in *Appendix 6.2*.

- *Subgroup 39 on Methods and approaches to provide feedback from nuclear and covariance data adjustment for improvement of nuclear data files; and*

- **Subgroup 46 on Efficient and Effective Use of Integral Experiments for Nuclear Data Validation**  
**G. Palmiotti** presented findings from the use of integral benchmarks on the recent international evaluations, including CIELO, JEFF, JENDL and ENDF/B. The use of integral experiments in adjustment and validation was considered with several test problems, as well as full adjustment exercises for benchmark suites with evaluated libraries. The SG39 report outline was shown, noting that several sections have already been delivered to the NEA. A September 2018 delivery date is anticipated. The new SG46 activities highlighted compensation effects in the CIELO evaluations, test problems, examples with non-linear techniques, and the production of several guidelines for future activities.
- **Subgroup 42 on Thermal Scattering Kernel  $S(\alpha, \beta)$ : Measurement, Evaluation and Application**  
**A. Hawari** presented the progress made with *ab initio* calculations for TSL, allowing evaluations to account for coherent interference and various other improvements. The new TSL data cannot be fully processed with NJOY2016, and the FLASSH code has been developed to perform the processing of the new data. The report information has been largely developed and is expected by October 2018. A proposal for a follow-up subgroup at the 31<sup>st</sup> WPEC, including new covariance techniques, was encouraged from the participants.
  - **Action - M. Fleming** to forward templates to A. Hawari
- **Subgroup 43 on Code infrastructure to support a modern general nuclear database (GND) structure**  
**F. Malvagi** presented an overview of the application programme interfaces (APIs) that have been developed in laboratories around the world, including the full, reference implementation of LLNL, as well as cross-checking with the AMPX code.
- **Subgroup 44 on Investigation of Covariance Data in General Purpose Nuclear Data Libraries**  
**V. Sobes** presented results from several subgroup meetings during the year, including a prioritisation of covariance needs and preliminary evaluation recommendations. A draft priority list including TSL, fission products, secondary emissions, delayed neutrons and re-evaluation of resonance parameter covariances has been drafted, as well as strategies for delivery of these high-priority areas. Specific evaluations for Pb, Bi, Al, H2 and Fe56 are in progress.
- **Subgroup 45 on Validation of Nuclear Data Libraries (VaNDaL)**  
**M. White** reported on two primary missions have been identified: (1) developing QA requirements and (2) to assist in creating tools for future evaluations. Focus has been put on delayed-critical experiments, whilst others will be considered. Regional meetings will also focus on this effort, including CSWEG and JEFF. It was noted that some participants could not provide their input data to an open-source or regional repository and would require co-ordination at the NEA level. The primary objectives for the coming year are to:
  1. Collect input decks for benchmark cases from multiple labs and for multiple code systems
  2. Define repository layout and version control data within this repository system
  3. Generate prototype QA requirement specifications
    - **Action - NEA** to explore central repository held at NEA

## 10. Proposals for new subgroups

The following subgroup proposals were reviewed by WPEC. Detailed information about these proposals is provided in the proposal documents (provided in *Appendix 5*) and in presentations given at the meeting.

- **M. White** (on behalf of **M. Chadwick**) presented a new proposal for a subgroup entitled: “CIELO: Computational methods for integration of integral and differential nuclear data insights & covariance advances, for improved international evaluated cross section databases” (see *Appendix 5.1*). This proposal includes several aspects of the evaluation process, with an objective to automate and improve the full process with machine learning techniques. It was noted that this project is of considerable interest, but very broad and currently without a detailed focus and deliverable. These views were shared by the JEFF, CENDL and JENDL representatives, and it was agreed that a revised proposal would be strongly encouraged for the next meeting.
- **I. Kodeli** presented a new proposal for a subgroup entitled “Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation” (see *Appendix 5.2*). The main outcomes of this subgroup are to identify, in collaboration with other SGs and the EGRTS, benchmarks for nuclear data validation, as well as use for nuclear data adjustments. This SG will focus on the use of nuclear data validation activities, providing valuable data for EGRTS activities and developing the capabilities of the ‘user’ nuclear data community to employ SINBAD (and other shielding) benchmarks for nuclear data evaluation. This subgroup proposal was supported by the working party.

## 11. Conferences and meetings of interest to the nuclear data community

- The upcoming WONDER2018 and JEFF November 2018 meetings were discussed, with dates and contact details for registration.
- **Z. Ge** reported on the upcoming International Conference on Nuclear Data for Science and Technology 2019 (ND2019) meeting that will take place in Beijing, China. The range of topics, organisation and dates were presented.

## 12. Any other business

The venue for ND 2022 was discussed and according to the customary principle of rotation the organisation will be due to the USA. US participants at the meeting expressed their interest.

- **Action - US participants** to agree on a proposal for ND2022 venue

## 13. Time and place of next meeting

Due to the overlap with ND2019, other regional nuclear data meetings and public holidays, May 2019 was excluded and so were early weeks in June. It was agreed that the next WPEC meeting will be held on 24-28 June 2019.

*Appendix 1***LIST OF PARTICIPANTS TO THE 30<sup>TH</sup> WPEC MEETING****Representatives from evaluation projects**

Mark CHADWICK	ENDF/SG 40 (excused)
Yaron DANON	ENDF
Mike DUNN	ENDF/SG 28 (excused)
Ulrich FISCHER	JEFF
Zhigang GE	CENDL
Hideo HARADA	JENDL/SG 41 (excused)
Mike HERMAN	ENDF (excused)
Anatoly IGNATYUK	BROND/ROSFOND (excused)
Nobuyuki IWAMOTO	JENDL
Osamu IWAMOTO	JENDL
Robert JACQMIN	JEFF/SG 27
Arjan KONING	IAEA/TENDL
Tatsuya KATABUCHI	JENDL (excused)
Atsushi KIMURA	JENDL
Robert MILLS	SG 37/JEFF (excused)
Arjan PLOMPEN	JEFF/WPEC Chair
Alejandro SONZOGNI	ENDF
Kenji YOKOYAMA	JENDL

**Subgroup coordinators**

Caleb MATTOON	SG 38/ENDF
Giuseppe PALMIOTTI	SG 39/SG 46/ENDF
Ayman HAWARI	SG 42/ENDF
Fausto MALVAGI	SG 43/JEFF
Vladimir SOBES	SG 44/ENDF
Morgan WHITE	SG 45/ENDF
Emmeric DUPONT	SG-C/EG-HPRL/JEFF
Dave BROWN	SG-B/EG-GNDS/ENDF

**Invitees**

Ivan-Alexander KODELI	JSI
Franco MICHEL-SENDIS	NEA
Xichao RUAN	CENDL
Haicheng WU	CENDL

**Observers**

David HEINRICHS	LLNL
Luiz Carlos LEAL	IRSN
Catherine PERCHER	LLNL
Jean-Christophe SUBLET	IAEA

**Secretariat**

Michael FLEMING	NEA
Tatiana IVANOVA	NEA/Head of Nuclear Science (excused)



## *Appendix 2*

### PROPOSED AGENDA

#### 1. Welcome and administrative items

- Adoption of agenda
- Approval of summary record of the past Working Party meeting
- Review of subgroups awaiting final reports

#### 2. Membership and observers

*Official WPEC delegates, observers and invitees are reviewed and confirmed*

#### 3. Reports on experimental activities

*Experimental nuclear data activities of relevance to the evaluation projects are reviewed*

- |          |                                       |            |
|----------|---------------------------------------|------------|
| • China  | Progress on Nuclear Data Measurements | X. Ruan    |
| • Europe | Report on experimental activities     | A. Plompen |
| • Japan  | Report on experimental activities     | A. Kimura  |
| • USA    | Report on experimental activities     | Y. Danon   |

#### 4. Progress reports from Evaluation Projects, discussion of future plans

- |         |  |                          |
|---------|--|--------------------------|
| • CENDL | Status Report of CENDL Project         | Z. Ge                    |
| • ENDF  | Status, ENDF/B-VIII.0 and updates      | D. Brown                 |
| • JEFF  | Status, JEFF-3.3 and JEFF-4 objectives | A. Plompen               |
| • JENDL | Status and updates                     | O. Iwamoto / K. Yokoyama |
| • TENDL | Status and updates                     | A. Koning                |

#### 5. Brief feedback reports

- |         |                                     |                  |
|---------|-------------------------------------|------------------|
| • IAEA  | The IAEA Nuclear Data Section       | A. Koning        |
| • NEADB | NEA Data Bank Nuclear Data Services | F. Michel-Sendis |

#### 6. Proposals for new subgroups

*The following subgroup proposals will be reviewed by the Working Party*

- |         |   |                           |        |
|---------|---|---------------------------|--------|
| • SG-47 | <i>Proposal for a new SG related to SINBAD</i>      | I. Kodeli                 | (JEFF) |
| • SG-48 | <i>Proposal for a follow-up SG related to CIELO</i> | M. Chadwick<br>(M. White) | (ENDF) |

#### 7. Status of active subgroups

- |         |  |            |        |
|---------|--|------------|--------|
| • SG-C  | <i>High Priority Request List</i>  | E. Dupont  | (JEFF) |
| • SG-B  | <i>Recommended Definition of General Nuclear Database Structure (GNDS)</i> | D. Brown   | (ENDF) |
| • SG-43 | <i>Code infrastructure to support a modern GNDS</i>                        | F. Malvagi | (ENDF) |

- SG-39      *Nuclear and covariance data adjustment methodologies*      M. Salvatores      (ENDF)
- SG-46      *Efficient use of Integral Experiments for Nuclear Data Validation*      M. Salvatores      (ENDF)
- SG-42      *Thermal Scattering Kernel : measurement, evaluation and application*      G. Noguère      (JEFF)
- SG-44      *Investigation of Covariance data in General Purpose Nuclear Data Libraries*      V. Sobes      (ENDF)
- SG-45      *Validation of Nuclear Data Libraries (VaNDaL)*      M. White      (ENDF)

#### **8. Upcoming conferences and meetings of interest to the Nuclear Data Community**

- WONDER-2018      *October 8-12, 2018*      Aix-en-Provence, France
- NEA Nuclear Data Week      *November 26-30, 2018*      NEA, Paris, France
- ND-2019      *May 19-24, 2019*      Beijing, China

#### **9. Any other business**

#### **10. Date and place of next meetings**

- May 2019, NEA Headquarters? *Note the potential conflict with ND-2019*

*Appendix 3***LIST OF ACTIONS**

<b>R. Jacqmin</b>	<b>Determine and report on status of SG 27 report</b>
<b>V. Sobes</b>	<b>Contact M. Dunn and determine status of SG 28 report</b>
<b>A. Sognozi</b>	<b>Contact M. Dunn and determine status of SG 28 report</b>
<b>M. White</b>	<b>Contact T. Kawano and determine status of SG 35 report</b>
<b>A. Plompen</b>	<b>Contact P. Schillebeeckx and determine status of SG 36 report</b>
<b>M. Fleming</b>	<b>Update WPEC website to reflect status of subgroups</b>
<b>M. Fleming and C. Mattoon</b>	<b>Determine drafting options using LaTeX for SG 38</b>
<b>G. Palmiotti</b>	<b>Prepare and submit SG39 report contents to M. Fleming</b>
<b>M. Salvatores</b>	<b>Prepare and submit SG39 report contents to M. Fleming</b>
<b>M. Fleming</b>	<b>Contact H. Harada and determine status of SG 41 report</b>
<b>M. Fleming</b>	<b>Update V. Sobes entry on ADD</b>
<b>M. Fleming</b>	<b>Prepare pdf of delegate list for participants</b>
<b>D. Brown</b>	<b>Share draft fission yield GNDS formats with NEA</b>
<b>M. Fleming</b>	<b>Submit report templates to SG 42</b>
<b>M. Fleming</b>	<b>Determine possibility of NEA repository system for private SG access to collaborate</b>
<b>US participants</b>	<b>Agree proposal for ND2022 venue</b>

*Appendix 4***STATUS OF THE SUBGROUPS AT THE 30<sup>th</sup> WPEC MEETING**

<b>SG</b>	<b>Topic</b>	<b>Co-ordinator</b>	<b>Status in May 2018</b>
27	Prompt photon production from fission products	R. Jacqmin, JEFF	Closed
28	Processing of covariance data	M. Dunn, ENDF	Closed
35	Scattering angular distributions in the fast energy range	T. Kawano, ENDF	Closed
36	Reporting and usage of experimental data for evaluation in the resolved resonance region	P. Schillebeeckx, JEFF	Closed
37	Improved fission product yield evaluation methodologies	R. W. Mills, JEFF	Closed
38	Beyond the ENDF format: A modern nuclear database structure	D. McNabb, ENDF	Closing Report 2018
39	Methods and approaches to provide feedback from nuclear and covariance data adjustment for improvement of nuclear data files	G. Palmiotti, ENDF M. Salvatores, JEFF	Closing Report 2018
40	CIELO pilot project	M. Chadwick, ENDF	Closed Report 2018
41	Improving nuclear data accuracy of <sup>241</sup> Am and <sup>237</sup> Np capture cross-sections	H. Harada, JENDL	Closed
42	Thermal Scattering Kernel S( $\alpha,\beta$ ): Measurement, Evaluation and Application	G. Noguere, JEFF A. Hawari, ENDF	Closing Report 2018
43	Code infrastructure to support a modern general nuclear database (GND) structure	F. Malvagi, ENDF	Ongoing Expected close 2019
44	Investigation of Covariance Data in General Purpose Nuclear Data Libraries	V. Sobes, ENDF C. de Saint Jean, JEFF	Ongoing Established and started 2018
45	Validation of Nuclear Data Libraries (VaNDaL) Project	M. White, ENDF D. Bernard, JEFF	Ongoing Established and started 2018
46	Efficient and Effective Use of Integral Experiments for Nuclear Data Validation	M. Salvatores, ENDF G. Palmiotti, JEFF	Ongoing Established and started 2018

**STATUS OF THE EXPERT GROUPS**

<b>EG-HPRL (SG-C)</b>	<b>High Priority Request List</b>	<b>E. Dupont, JEFF</b>	<b>Ongoing New mandate agreed at WPEC 2018 until 30 June 2020</b>
<b>EG-GNDS (SG-B)</b>	<b>Expert Group on Recommended Definition of Generalized Nuclear Data Structure (GNDS)</b>	<b>D. Brown, ENDF</b>	<b>Ongoing New mandate agreed at WPEC 2018 until 30 June 2020</b>

**STATUS OF THE WPEC**

<b>WPEC</b>	<b>Working Party on International Nuclear Data Evaluation and Co- operation (WPEC)</b>	<b>A. Plompen, JEFF</b>	<b>Ongoing Current mandate until 30 June 2019</b>
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*Appendix 5*

**DOCUMENTS PRESENTED AT THE 30<sup>TH</sup> WPEC MEETING**

**APPENDIX 5.1**

*Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation*

**I. Kodeli (JEFF)**

**APPENDIX 5.2**

*CIELO: Computational methods for integration of integral and differential nuclear data insights & covariance advances, for improved international evaluated cross section databases*

**M. Chadwick (ENDF)**

### Appendix 5.1

#### WPEC SUB-GROUP PROPOSAL

##### *Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation Justification for a Subgroup*

Nuclear cross-sections are being re-evaluated repeatedly since decades, and integral benchmark experiments proved to be valuable for validation of these cross section data. In the recent years, the evaluations have been most predominantly validated against the criticality benchmarks, and in many cases even “tuned” to match better the measurements. However, the effective multiplication factor ( $k_{eff}$ ) is a very global parameter, simply dependent on too many “free” parameters. Diversification of the validation practice by including more extensively other types of integral measurements, such as shielding benchmarks, in the validation and evaluation procedure is expected to provide a complementary view and would allow to judge on a wider-scope performance of the evaluated nuclear data. This would ultimately contribute to a production of general-purpose cross-section evaluations.

**Subgroup Monitor(s):** O. Cabellos, L. Leal

**Subgroup Coordinator:** I. Kodeli

**Subgroup Participants:** TBD among experimentalists and nuclear physics and nuclear data experts

#### **Project Definition and Proposed Activities**

The latest version of Shielding Integral Benchmark Archive and Database (SINBAD) distributed by the NEA and RSICC includes over 100 shielding benchmark experiments covering fission reactor shielding (48 benchmarks), fusion blanket neutronics (31), and accelerator shielding (23) applications.

Interest in using SINBAD shielding benchmarks was expressed by nuclear data communities in the scope of several WPEC Subgroups, and within the JEFF and EFF projects. Progress in SINBAD compilations slowed down in the recent years and a new “kick-off” of this activity would be beneficial to assess and respond to the expectations and needs of different nuclear data communities. Multiple challenges and objectives will be considered, including:

- To provide feedback on the existing database and contribute in this way to the quality review as started about 10 years ago at the NEA. The feedback would consist of developing and contributing input models for different transport codes, judging the completeness and consistency of the available benchmark information, identifying the missing or inconsistent data, in particular concerning the evaluation of the sources of experimental uncertainty. The quality review, which covers now about 50% of the SINBAD benchmarks, concentrates on the verification of the description of the experimental setup, the neutron source specifications, the detector characteristics, the geometry and precise material composition of the components. The main criteria for judging the quality of the experiment are its completeness and the consistency of the experimental information (on the geometry, materials, the procedure to derive data-unfolding, etc.), with a particular emphasis on the evaluation of the different sources of uncertainties, be it experimental, engineering and modelling;
- Provide recommendations on the SINBAD evaluations based on the experience, needs and expectations of the nuclear data community;

- To participate in establishing the priority list of relevant benchmarks according to the needs of the nuclear data community, in particular among new and more recent benchmarks; promote including the selected benchmarks in SINBAD; contribute the available sensitivity profiles to be included in the database;
- To participate, in coordination with the EGRTS WPRS, in establishing the review group and organisation of pilot exercise of SINBAD evaluations. The recent evaluations of the FNG benchmarks which are underway in the scope of the Fusion for Energy (F4E) project of the European Commission represent good candidates to be used for pilot exercises.

The proposed SG would work in close coordination with other NEA activities such as EGRTS, WPEC SG45, SG46, CIELO and JEFF project, where this work could be used to guide the evaluations. Feedback from these groups on the specific needs and the use of SINBAD data is expected. SINBAD evaluation work shall be tightly coordinated with the interest of SG46 on “Efficient and Effective Use of Integral Experiments for Nuclear Data Validation”. Past experience in integral benchmark evaluations from the ICSBEP, IRPhE and SINBAD projects will be valuable.

### **Relevance to Evaluated Data Files**

Providing means for validation of general-purpose Evaluated Data Files  
Time Schedule and Deliverables

It is anticipated that the experts of this SG should complete and document the activities (mandate) listed above within 3 years.

### **Deliverables**

May 2018 - June 2019

- In coordination with other SGs and EGRTS identify potential SINBAD benchmarks to serve as pilot exercises for nuclear data evaluation;
- Identify other potential benchmarks which are not included in SINBAD to be used in this work (old Benchmarks, e.g. LLNL pulsed spheres, and recent benchmarks, e.g. FNG, FNS); Establish a priority list of relevant benchmarks according to the needs of the nuclear data community and promote including the selected benchmarks in SINBAD;
- Organise the working group participants to perform benchmark analysis using the data available; participants are encouraged to use different nuclear data and transport codes; define the criteria and specification for the review and distribute the tasks.

May 2019 - June 2020

- Benchmark analysis of the subset of shielding benchmarks and collection of the experience and results from the participants;
- Contribute the available sensitivity profiles to be included in the database;
- Distribute and discuss the review of the selected shielding benchmarks serving as a prototype for future work;
- Select benchmarks from the priority list to promote the evaluation in the SINBAD database.



May 2020 - June 2021

- Coordinate with EGRTS new benchmark evaluations and benchmark reviews, for the integration in SINBAD and release of the evaluation to be used by other SGs;
- Draw conclusions on the evaluation process and provide recommendation of good practices useful for future nuclear data validations using Shielding and Transmission Benchmarks. Of particular interest is the feedback on the completeness and consistency of the available uncertainties and correlations, which shall contribute to the revision and consolidation of uncertainties, including those in neutron sources, engineering and others.

## *Appendix 5.2*

### **WPEC SUB-GROUP PROPOSAL**

#### **CIELO: Computational methods for integration of integral and differential nuclear data insights & covariance advances, for improved international evaluated cross section databases**

##### **Justification for a Subgroup**

The CIELO pilot project, WPEC subgroup 40, was recently completed. It represented a large international nuclear science community effort, and led to 2 main evaluation options (in ENDF and JEFF), with advances in JENDL too, for evaluated cross sections and covariances on isotopes of H, O, Fe, U, Pu. Major peer reviewed publications on this work were released in a 2018 Nuclear Data Sheets issue. The products created already represent major advances in our understanding, and provide substantially-improved capabilities for our users.

The leaders of CIELO have discussed best mechanisms to continue the progress on CIELO, with leaders from the NEA and the IAEA. The conclusion is that an international collaboration on the continued improvement of the underlying cross sections and covariances will be coordinated by the IAEA (the INDEN project); while integral performance of criticality and transport, data sensitivity studies, and covariance impact on integral criticality assessments, will be coordinated by a NEA WPEC subgroup. This latter effort is the focus of this new WPEC proposal.

Despite the advances made for CIELO, the previous subgroup 40 collaboration identified a variety of gaps and deficiencies that need further attention. The following topics will be the focus of the next WPEC subgroup:

- Use of modern computational tools
- Machine learning (ML) techniques
- Use of fundamental data
- Use of integral information
- Use of neutron transmission data
- Covariances and calibration
- Feedback to HPRL
- Processes for continuous improvement

This set of topics for WPEC CIELO focus would be advanced in concert with close collaboration with the future IAEA/INDEN coordinated CIELO collaboration. Feedback on the performance of the CIELO evaluations - both those existing today and those that get produced by the IAEA collaboration- will be fed back to the IAEA international INDEN evaluators.

The value of having a new WPEC subgroup that is separate to the important new work in Subgroups 44, 45, 46, 47 is that this subgroup will focus on the integration of all these advances to improve the CIELO product. Thus, as well as exploring CIELO-related issues, and new computational method opportunities including machine learning, it will closely coordinate with Subgroups 44, 45, 46, 47.

**Subgroup Monitor:** TBD: possibilities include Plompen, Bauge, Cabellos

**Subgroup Coordinator:** M.B. Chadwick, Co-leader TBD (possibilities include Talou, Herman, and others)

## Subgroup Participants

Draft proposal – the data projects will identify appropriate participants from their respective communities.

### Project Definition and Proposed Activities

This WPEC subgroup proposal is a continuation of the CIELO project. The anticipated end-product after 3 years will be: (a) development of new evaluation methods, including machine-learning approaches, that addresses how best to integrate differential and integral data, with covariances, into a suite of evaluated data files that jointly perform well; (b) integration of insights from Subgroups 44 (covariances), 45 (validation), 46 (efficient & effective use of integral experiments), and 47-planned (shielding) to advance the CIELO product; and (c) improved and refined CIELO cross section evaluation options (informed by the IAEA/INDEN project) that can be considered as input to the major evaluation efforts (ENDF, JEFF, JENDL, CENDL, etc.) of the future. The following topics will be the focus of the next WPEC subgroup:

- **Computational tools.** These will be advanced for CIELO library applications involving covariance/uncertainty quantification (UQ), sensitivity studies, and optimization methods. These will build upon tools developed by the NEA, IAEA, INL, LANL, LLNL, BNL, ORNL, CEA, JAEA and other labs. These tools will help expedite the identification of best nuclear data solutions - in a complex multidimensional space - that optimally represent fundamental data, integral measurements, and insights from theory. We will explore new machine learning methods that are being developed at many laboratories (a growth area at LANL) and universities, as described next.
- **Machine learning (ML).** This requires identifying a large enough suite of benchmarks specifically sensitive to the CIELO isotopes and reactions; developing the metadata infrastructure needed to apply ML algorithms; using the sensitivity tools already mentioned; and applying some ML techniques already well-established such as decision trees and adaptive boosting.
- **Fundamental data.** CIELO will continue to endeavour to use the best information coming from fundamental cross section experiments and assessments from the Standards group. As the Standards are updated - for example to use new fission cross section data becoming available - the CIELO databases will be updated.
- **Integral information.** Integral criticality studies using CIELO files, with sensitivity and criticality computational tools (NDAST, MCNP/WHISPER, SENSMSG, etc.), will help us understand the impact of uncertainties, and sensitivities, of different reaction channels. This analysis will benefit from close collaboration with Subgroup 46 and will help prioritize future work that is needed. Subgroup 46 will also provide valuable feedback from the user community.
- **Neutron transmission.** Neutron transmission and gamma-ray production integral data will be studied, versus simulations of mean values and uncertainties, to identify deficiencies in the current CIELO files, and point to future work that is needed. This will be supported by an evolving WPEC focus (Subgroup 47-planned) in neutron transmission/shielding benchmarks.
- **Covariances.** Covariances in CIELO for various channels often differ significantly by different subject matter experts (ENDF and JEFF), that need to be understood and resolved. Sometimes the covariances differ by factors of as much as 5-10. This was documented in the recent NDS2018 CIELO paper. We also need to better understand covariance correlations (between low-energy and higher energy parts of the library; between fission phenomena described by a consistent fission theory; and through use of integral data). This represents an area of study that will involve both the NEA (Subgroup 44) and IAEA collaborations; integration of advances made here will improve the CIELO product, our goal being the development of more reasonable/credible covariances.

- **Covariances and calibration.** It is understood that forward-propagation of CIELO covariances (uncertainties) leads to integral criticality uncertainties much larger than observed in the integral  $k$  values. This is because the mean values of CIELO data were tuned, or calibrated to the integral criticality results. This topic will be further investigated to define future methodologies, taking advantage of insights from Subgroup 44. Furthermore, benchmarks used in a calibration process should be explicitly known by users, for avoiding duplication when adjustment processes are used.
- **HPRL.** Feedback will be given on future priority experiments to the High Priority Request List (HPRL) WPEC coordinator.
- **Continuous improvement.** CIELO collaborators will survey feedback from the previous WPEC CIELO Pilot project, together with feedback from the user community, and develop and document ways in which the evaluation process can be improved within the context of technical rigor, thoroughness in documentation, robustness, and timeliness.

### Relevance to Evaluated Data Files

This will be a continuation of the high-impact work of the CIELO project, which has resulted, and is expected to result in, the production of the evaluated nuclear data files for essential isotopes.

## *Appendix 6*

### **CURRENT MANDATES: WPEC AND EXPERT GROUPS AS OF 18 MAY 2018**

#### **APPENDIX 6.1**

*Mandate for the Working Party on International Nuclear Data Evaluation Co-operation (WPEC) – Chair A. Plompen*

#### **APPENDIX 6.2**

*Mandate for the WPEC Expert Group on the High Priority Request List for Nuclear Data (EGHPRL) – Chair E. Dupont*

#### **APPENDIX 6.3**

*Mandate for the WPEC Expert Group on the Recommended Definition of a General Nuclear Database Structure (EGGNDS) – Chair D. Brown*

*Appendix 6.1*

**MANDATE**  
**WORKING PARTY ON INTERNATIONAL NUCLEAR DATA EVALUATION CO-  
OPERATION (WPEC)**

**Chair:** Dr Arjan Plompen (JEFF project)

**Member(s):** Representatives of the co-operating nuclear data evaluation projects, nominated by the projects

**Date of creation:** 30 October 1989

**Date of expiration:** 30 June 2019

**Mandate:**

- Status of the NEA Nuclear Science Committee Projects and their Evolution in 2007  
[\[NEA/SEN/NSC\(2006\)2\]](#)
- Summary Record of the 17th Meeting of the Nuclear Science Committee (NSC)  
[\[NEA/SEN/NSC\(2006\)3\]](#)
- Approved at the 20th Meeting of the Nuclear Science Committee [\[NEA/SEN/NSC\(2009\)3\]](#)
- Extended at the 21st Meeting of the Nuclear Science Committee [\[NEA/NSC/DOC\(2010\)3\]](#)
- Revised and extended at the NEA Nuclear Science Committee Bureau in December 2010  
[\[NEA/NSC/DOC\(2010\)14\]](#)
- Revised and extended at the 24th Meeting of the Nuclear Science Committee in June 2013  
[\[NEA/NSC/DOC\(2013\)2\]](#)
- Revised and extended at the 27th Meeting of the Nuclear Science Committee in June 2016  
[\[NEA/SEN/NSC\(2016\)2\]](#)

Extract from document [\[NEA/SEN/NSC\(2016\)2\]](#)

**Purpose, scope and membership**

The goal of the Working Party is to improve the quality and completeness of evaluated nuclear data available for use in science and technology and to promote the efficient use of available resources through international collaboration.

The Working Party will consist of up to five representatives of each of the following four nuclear data evaluation projects: ENDF (United States), JEFF (NEA Data Bank member countries), JENDL (Japan), RUSFOND/BROND (Russia), as well as up to five representatives of non-NEA nuclear data evaluation projects, such as CENDL or TENDL. The participation from projects in non-NEA member countries will be channelled through the Nuclear Data Section of the International Atomic Energy Agency (IAEA). At least one member of each group will be a representative of the nuclear data measurement community, and another one a representative of the nuclear application community.

A Working Party chairperson shall be elected for a two-year period, with possible yearly extensions; the guiding principle being an alternating chairmanship between the ENDF, JEFF, JENDL and

RUSFOND/BROND projects. Eligible candidates are representatives of the evaluation projects in NEA member countries.

## Objectives

The Working Party will promote the exchange of information on all nuclear data related topics (i.e. evaluation, measurement, theory/modelling and validation) and foster the adoption of best practices. The Working Party will provide a framework for co-operative activities between the participating projects. The Working Party will assess the needs for nuclear data improvements and address those needs by initiating joint evaluation and/or measurement efforts. The improvements will be reflected in all major evaluated data files and will gradually help eliminate inconsistencies in these files.

In the three-year period, the Working Party will set out to complete the following tasks:

- Recommend improvements in evaluated nuclear data (including covariance data) for fission and fusion applications, in response to indications from sensitivity and uncertainty analysis, integral validation/assimilation activities and new experimental/theoretical information.
- Recommend updates in codes, formats, methods and practices for further improving the nuclear data evaluation process and streamlining their processing and use.
- Monitor and update the “High Priority Request List for Nuclear Data” (HPRL) to stimulate specific nuclear data measurement and evaluation activities.
- Address any other emerging important nuclear data needs.

The Working Party will liaise closely with other Nuclear Science Committee activities to ensure that data needs of nuclear science applications are properly addressed.

## Deliverables

- An up-to-date version of the “High Priority Request List for Nuclear Data”, accessible through the NEA internet web pages.
- A report on Prompt photon production from fission products.
- A report on Processing of covariance data in the resonance region.
- A report on Scattering angular distribution in the fast range.
- A report on Evaluation of experimental data in the resolved resonance region.
- A report on fission yield evaluation methodologies and recommended improvements.
- A report on the development of a modern nuclear database structure beyond the current ENDF format.
- A report on methods and approaches to provide feedback from nuclear and covariance data adjustments to evaluators and experimentalists.
- A report on a joint assessment of six key isotopes-  $^1\text{H}$ ,  $^{16}\text{O}$ ,  $^{56}\text{Fe}$ ,  $^{235,238}\text{U}$ ,  $^{239}\text{Pu}$  - in the framework of a pilot project of a Collaborative International Evaluated Library Organization (CIELO).
- A report on improving nuclear data accuracy of  $^{241}\text{Am}$  and  $^{237}\text{Np}$  capture cross-sections.
- A report on Thermal Scattering Kernel  $S(a,b)$ : Measurement, Evaluation and Application

*Appendix 6.2*

**MANDATE**  
**WPEC EXPERT GROUP ON THE HIGH PRIORITY REQUEST LIST FOR NUCLEAR DATA**  
**(EGHPRL)**

<b>Chair:</b>	Dr Emmeric Dupont (France)
<b>Member(s):</b>	Representatives of the co-operating nuclear data evaluation projects (ENDF, JEFF, JENDL, ROSFOND/BROND) or NEA member countries
<b>Observer(s):</b>	International Atomic Energy Agency (IAEA) By agreement
<b>Date of creation:</b>	30 May 1991
<b>Duration:</b>	30 June 2020

**Mandate**

- Agreed at the 16th meeting of the Working Party on International Nuclear Data Evaluation Co-operation [[NEA/SEN/NSC/WPEC\(2004\)2](#)]
- Extended as a part of WPEC activities at the 23rd meeting of the Nuclear Science Committee in June 2012 [[NEA/SEN/NSC\(2012\)3](#)]
- Revised and extended at the meeting of the NEA Nuclear Science Committee in June 2013 [[NEA/NSC/DOC\(2013\)2](#)]
- Revised and extended at the 26th meeting of the Working Party on International Nuclear Data Evaluation Co-operation [[NEA/SEN/NSC/WPEC\(2014\)2](#)] and endorsed by the NEA Nuclear Science Committee in June 2014 [[NEA/SEN/NSC\(2014\)2](#)]
- Revised and extended at the 28th meeting of the Working Party on International Nuclear Data Evaluation Co-operation [[NEA/SEN/NSC/WPEC\(2016\)2](#)] and endorsed by the 27th NEA Nuclear Science Committee in June 2016 [[NEA/SEN/NSC\(2016\)2](#)]
- Revised and extended at the 30th meeting of the Working Party on International Nuclear Data Evaluation Co-operation [[NEA/SEN/NSC/WPEC\(2018\)2](#)]

Extract from documents [[NEA/SEN/NSC/WPEC\(2018\)2](#)]

**Purpose, scope and membership**

The concept of a nuclear data request list has a long history in applied nuclear science. The concept is that if requests from applied users of data are collected in a convenient location, it should provide a stimulus to measurers, modellers, and evaluators to undertake work that could lead to certain requests becoming satisfied.

A revised High Priority Request List (HPRL) for nuclear data needed for applications has been in existence under the auspices of the OECD Nuclear Energy Agency (NEA) for several years. This list provides a point of reference for nuclear data stakeholders and developers and has led to many new initiatives in nuclear data measurement, evaluation and validation. Its effectiveness in stimulating new



measurements, evaluations and verification actions required to meet the expressed needs is well established.

A standing expert group is essential to maintain the HPRL as a point of reference in nuclear data research and development. The expert group will consist of at least three representatives from each data project: one from the data user, one from the evaluation and validation community and one from the experimental community. The expert group may have additional representatives from the IAEA Nuclear Data Section, as well as countries not represented in the above mentioned projects.

The HPRL will reflect the actions undertaken by WPEC and will help guide future activities. The expert group will report to WPEC.

### **Objectives**

The expert group is responsible for managing the activities related to the HPRL, in particular for guaranteeing that the entries are up-to-date and well-motivated by current interests in the field of nuclear energy and other nuclear applications. The expert group is also responsible for stimulating follow-up to the entries and collecting the feedback provided by any of the related activities that may further the resolution of a request. The expert group will work mainly by electronic mail exchanges. Physical meetings will be held typically once a year.

The HPRL is organised as follows:

1. The list consists of one list with truly high priority requests, a list with general requests and a list with special purpose quantities divided in categories. This third list is an extension to the present list.
2. Stringent criteria are applied for entries on the lists. These will be evaluated by the expert group that will take the final decision for adopting a request.
3. A “high priority request” is justified by quantitative sensitivity studies (or the equivalent) and sufficiently documented.
4. A “general request” is well motivated for a specific quantity on a specific nucleus and is documented, but lacks a detailed backing by a sensitivity analysis or an impact study.
5. A “special purpose request” in a well-defined category is of interest to a recognised important subfield of applied nuclear science for which it is essential to stimulate new activity. Such a request may not satisfy the criteria as in the case of points 3 and 4 above.

The request lists will be subjected to periodic review to monitor progress and determine whether each individual request should continue to be included in these lists.

### **Deliverables**

- An up-to-date publication on the status of all requests describing completed activities and outlook
- An up-to-date online version of the “High Priority Request List for Nuclear Data” including new requirements for fission reactors

### *Appendix 6.3*

#### **MANDATE** **WPEC EXPERT GROUP ON THE RECOMMENDED DEFINITION OF A GENERAL NUCLEAR DATABASE STRUCTURE (EGGND)**

<b>Chair(s):</b>	Dr David BROWN, United States
<b>Members:</b>	Representatives of the participating projects
<b>Full Participant:</b>	European Commission Under the NEA Statute
<b>Date of creation:</b>	31 May 2016
<b>End of mandate:</b>	31 May 2020

**Mandate (Document reference):**

- Agreed at the 28<sup>th</sup> meeting of the Working Party on International Nuclear Data Evaluation Cooperation in May 2016 [[NEA/SEN/NSC/WPEC\(2016\)2](#)]
- Approved at the meeting of the NEA Nuclear Science Committee in June 2016 [[NEA/SEN/NSC\(2016\)2](#)]
- Revised and extended at the 30<sup>th</sup> meeting of the Working Party on International Nuclear Data Evaluation Co-operation [[NEA/SEN/NSC/WPEC\(2018\)2](#)]

**Mandate (Document extract):**

Extract from document [[NEA/SEN/NSC/WPEC\(2018\)2](#)]

**Context**

The ENDF-6 nuclear data format has had a long and fruitful history as the preferred format for storing and exchanging evaluated nuclear data. Together with processing codes, it plays a pivotal role connecting nuclear physicists and reactor physicists, allowing them to exchange data between different computer codes. Today, however, it is showing signs of age. In particular, the ENDF-6 format places unnecessary limitations on the types of reactions and the level of precision at which data can be stored, making it more difficult to ensure quality and consistency of the data. Modern users are applying nuclear data towards solving a broad range of problems (in medical physics, global security and advanced detector designs among others) that stretch the ENDF-6 format beyond its original design.

**Purpose, scope and membership**

The WPEC Subgroup 38 was formed to solicit feedback from international stakeholders and develop a new General Nuclear Database Structure (GNDS) for storing nuclear data to replace the legacy ENDF-6 format. SG38 has met its stated goal to develop a nuclear data structure definition that can meet the needs of a broad set of nuclear data users and providers.

In order to take the next step, it has become necessary to establish an international expert group to endorse, promote and maintain the new format as the future international standard for disseminating nuclear reaction databases. Therefore, the WPEC/EGGNDs will become the steward of a new international definition for the modern nuclear database structure.

This expert group will consist of a governance body that manages the new recommended definition of GNDs. Up to two official representatives from each WPEC nuclear data evaluation project or institution will form the Governance Board. Currently these entities include ENDF, JENDL, ROSFOND/BROND, JEFF, CENDL and the IAEA. Only NEA members have voting rights with respect to the adoption of a new recommended definition by the WPEC, but the larger group serves the goal of meeting the needs of the broader community.

### **Goals and activities**

The main motivations of this subgroup are to make the GNDs:

1. easier for new users, as well as current users, to contribute to the community;
2. general and useful enough that it could also be used to organise nuclear structure data, experimental data and other nuclear data products;
3. adhere to high quality assurance and documentation practices.

Other goals include the development of better open source infrastructure to manipulate, search, plot, process, translate and check nuclear data and the development of new nuclear data products heretofore not possible. The expert group, in close collaboration with the subgroup on infrastructure (WPEC/SG43), will ensure that important and useful tools for using the new recommended definition are developed and maintained.

The expert group will guide the creation of new infrastructure and promote better evaluation practices. It is foreseen that it will release new GNDs versions with appropriate documentation as necessary, without overburdening stakeholders.

### **Deliverables**

The subgroup will ensure the recommended definition of the GNDs meets the needs of major international nuclear data communities. In addition, this subgroup will work on the following deliverables:

- Release the initial GNDs version and periodic updates.
- Choose a collaborative platform and establish practices to maintain and discuss the recommended definition.
- Organize workshops to train evaluators and other members, especially users, of the nuclear data community the new structure.