

**Summary Record of the 7th Meeting of WPEC Subgroup 39 on
Methods and approaches to provide feedback
from nuclear and covariance data adjustment
for improvement of nuclear data files**

NEA, OECD Conference Center, Paris, France

10-11 May 2016

The subgroup co-ordinators, **M. Salvatores** and **G. Palmiotti**, welcomed the participants to the meeting (see list in Appendix 1). **O. Cabellos** acts as secretary. The proposed agenda was adopted (see Appendix 2).

1. Review of actions

G. Palmiotti reminded the participants of the subgroup objectives and reviewed the actions agreed at the previous meeting.

Some participants were excused at this meeting (some actions, where they are involved, are still in progress):

- **E. Ivanov**: The action on report on MC sensitivity coefficients is in good progress.
- **A.X. Barnes**: Ongoing activities for undertaking some uncertainty analysis work on Am241 on a proper commercial footing.

2. Presentations

Session on Methods

- SG39-2: “XGPT: uncertainty propagation and data assimilation from continuous energy covariance matrix and resonance parameters covariances”, Manuele AUFIERO

M. Aufiero presented the eXtended Generalized Perturbation Theory (XGPT) which makes use of continuous-energy function sensitivity, no need for multi-group discretization of the sensitivity profiles or the covariance matrices, using direct adoption of continuous energy covariances and resonance parameters covariances. The new method has been implemented and tested in SERPENT code, and tested against Total Monte Carlo. The continuous energy XS adjustment is under investigation.

- SG39-3: “Optimal experiment utilization (REWINDing PIA)”, G. Palmiotti

G. Palmiotti presented the REWINDing-PIA methodology which has been formulated and implemented. Results compared against the standard methodology shows that the new methodology tends to produce smaller standard deviations. In the future this new methodology can be applied to the set of the comprehensive adjustment of ENDF/B-VII.0 with ~100 experiments.

Session on Experiment analysis, sensitivity calculations and benchmarks

- SG39-4: “Tripoli-4 analysis of SEG experiments”, Andrew HUMMEL

M. Hummel presented the re-analysis of the RRR/SEG Reactivity Measurements using TRIPOLI-4 code. Central reactivity worth C/E values are comparable with previous work.

Some observed discrepancies on U-235 and U-238 reactivity worth will be further investigated as well as the different normalisations used. Ongoing Work: Examine additional data libraries in TRIPOLI, and using ERANOS-2.4 code for cross-comparison and examine sensitivity coefficients. In addition, SEG3 & STEK experiments could be analysed.

- SG39-5: “Tripoli-4 analysis of BERENICE experiments”, P. Dufay (presented by Cyrille De Saint Jean)

Cyrille De Saint Jean presented the new BERENICE evaluation using the latest development in TRIPOLI-4 code. It has improved the ratio C/E for the method with the Cf252 source and for the noise method. The uncertainties due to nuclear data have the same magnitude than the experimental ones for the method with the Cf252 source, and the use of the noise method allows to reduce the experimental uncertainties. However these uncertainties make delicate the use of the experiments for data adjustments.

- SG39-6: “Preparation of sensitivities of k-eff, beta-eff and shielding benchmarks for adjustment exercise”, Ivo KODELI

I. Kodeli presented the use of kinetics measurements and shielding benchmarks in addition to criticality benchmarks suggested for ND validation & adjustment since providing a complementary view and wider scope validation. ASPIS Iron88 benchmark has been recently re-evaluated and re-analysed using M/C&SN transport and S/U codes (MCNP, DORT/SUSD3D) and ranked as experiment of benchmark quality. Sensitivity profiles, C/E values and the corresponding uncertainties are available from NEA (<https://www.oecd-nea.org/science/wpec/sg39/>, “Integral Data” section) in 33-groups for FLATTOP-Pu, SNEAK-7A & 7B and ASPIS-Fe88 benchmarks.

- SG39-7: “S&U due to Nuclear data in TWR”, Nick TOURAN

N. Touran presented S&U studies in Traveling Wave Reactor (TWR) for several integral parameters (keff, reactivity coefficients,...) showing the most important nuclides/reaction contributors. U235 capture is often the most important contributor to the parameters uncertainty. These calculations are based on OECD/NEA SG33 data. Ongoing activities are to redo calculations with ENDF/B-VII.1 library, including new integral parameters (e.g. power density) and with depletion calculations.

- SG39-8: “SA and UQ work for the VENUS-F facility using the SANDY code”, Luca FIORITO

L. Fiorito presented new tool for nuclear data uncertainty propagation, SANDY code, compatible with the ENDF-6 format and with any code and data post-processors using it. SANDY uses a variance decomposition approach to assess each parameter’s correlated and/or uncorrelated contribution to the response uncertainty. Results were presented for two different systems: 1) VENUS-F with Bi: Large keff uncertainty due to the uncertainty in U235(n,gamma) from ENDF/B-VII.1, 2) SFR benchmark: U238(n,fission) shows a large impact in the keff uncertainty. **The role and credibility of the uncertainty values have to be taken into consideration. However, the value of the work presented is essential in the demonstration of the capability of the new tool.**

- SG39-9: “KIT and INL Results of the NEA/EGIEMAM-II Calculation Benchmark on Low Void SFR Burner Core”, Fabrizio GABRIELLI

F. Gabrielli presented the evaluation of the impact of the uncertainties of MAs, U, and Na nuclear data on selected design parameters of a low void SFR MA burner model. It is based on the 1500 MWth French ASTRID low sodium void core. Preliminary results have been shown in the last EGIEMAM-II meeting (NEA Headquarter, 2016, April 6-7). Results show a reasonable agreement between the two calculations (INL and KIT) employing ERANOS-2.2 code, using ENDF/B-VII.0 and JEFF-3.1, respectively. The uncertainties associated to MA for the criticality level and for the reactivity effect due to sodium void look quite small. However, the uncertainties associated to the elastic and inelastic contribution of Na are rather large. The U-238 inelastic cross section uncertainty dominates the total uncertainty in keff.

- SG39-10: “KIT and INL Results of the NEA/EGIEMAM-II Benchmark problems for TRU’s central fission rate ratios of FCA-IX assemblies”, Fabrizio GABRIELLI

F. Gabrielli presented results of the IX-1, IX-6, and IX-7 configurations of the FCA facility, employing ERANOS-2.2 code, using two reference libraries: ENDF/B-VII.0 and JEFF-3.1. The fission reaction rates ratios (e.g. Np237/Pu239) have been evaluated and results have been compared with the experimental values. S&U analysis is performed with GPT, and COMMARA2.0 Covariance Matrix data are employed. Some impact of U-235 capture and U-238 elastic and inelastic cross section uncertainties were found.

These experiments are very useful for their future use in extended adjustment exercises.

- SG39-11: “PROTEUS FDWR-II (HCLWR) program Contribution to SG-39”, M. Hursin

M. Hursin presented the re-analysis work on HCLWR at PSI. The sensitivity work (k_{∞} , void coefficient, spectral indices) on 1D models (Core 7 and 8) is almost complete, starting the development of 3D models. Extra information (P1 moment sensitivities) will be generated with SERPENT-v2.1.19 code.

These experiments are highly valuable since they provide information on energy regions where available clean experiments are relatively scarce.

Session on Adjustments

- SG39-12 “Adjustment of U, Pu and Fe cross-sections based on k-eff, β -eff and shielding benchmark experiments”, Lucijan PLEVNIK

L. Plevnik presented the adjustment based on k-eff, β -eff (Flatop-PU, SNEAK-7A and 7B) and shielding (ASPIS Iron88, different detector reaction rates) benchmarks. Results showed the impact of different covariances, the selection of different benchmarks, different C/E values. Results of this preliminary adjustment for CIELO files were also presented.

- SG39-13: “Extended adjustment using a wider integral data base”, Guiseppe PALMIOTTI

G. Palmiotti presented the new more focused experiments used to complement the “classical” set of integral experiments (criticality, reaction rates, reactivity coefficients) in the fast energy range. These are: 1) SEG experiments, FCA-IX (selective information on inelastic, elastic, fission and capture data) 2) kinf, reaction rates, void reactivity effects performed at the PROTEUS facility (Enhanced sensitivity to the actinide cross sections in the energy range ≤ 1 keV), 3) MANTRA irradiation experiments (Enhanced capture sensitivity in the range from few hundred eV to 1 eV) 4) ASPIS-88 experiment for Fe-56 (Specific feedbacks on elastic and inelastic structural materials), and 5) β eff experiments.

PIA (Progressive Incremental Adjustment) methodology will be applied in order to avoid, if possible, compensations. In addition, reliable and improved covariance data provided by the evaluation community is also required for avoiding, as far as possible, compensations. First results are expected by September 2016

- SG39-14: “Sensitivity and Uncertainty Enhancements in SCALE 6.2”, Bradley T. Rearden

B.T. Rearden presented the enhancements in SCALE6.2: 1) Sensitivity computations with continuous-energy Monte Carlo for eigenvalue and GPT responses, 2) New statistical sampling code “Sampler” for general UQ of SCALE MG Sequences, 3) New cross section covariance library based on ENDF/B-VII.1 and previous SCALE 6.1 data (56- and 252-group energy structures), modified ENDF/B-VII.1 for ²³⁹Pu-nubar, ²³⁵U-nubar, H-capture, and several fission products, and Chi uncertainties processed from ENDF/B-VII.1 and from JENDL-4.0. 4) New fission product yield covariances, new decay data covariances,... Uncertainties for Spent Fuel Systems were presented comparing SCALE6.1 and SCALE6.2.

Joint Session SG39+SG40

- SG39-15: “Status of SG39 activity and perspectives of potential interest for CIELO”, Massimo SALVATORES

M. Salvatores presented advances, results and perspectives of SG39: 1) the need to use new integral experiments (e.g. PROTEUS, Beff, SEG, ASPIS, FCA) for separate physics effects as a basic requirement to avoid the compensations often associated to the use of global parameters as keff, 2) new crucial advances in the methodologies to improve the credibility and applicability of an adjustment: PIA, continuous energy XGPT adjustment and ORNL methodology, 3) the importance of validation and experimental activities based on simplicity and focused on separated physics effects: CALIBAN (CEA), MANTRA(INL) and MANTRA-2(INL), NRAD(INL), TAPIRO (ENEA).

- SG39-16: “Extended adjustment with a wider integral experiment data base”, Guiseppa PALMIOTTI
(See summary SG39-13)
- SG39-17: “Continuous energy adjustments: a potential breakthrough”, Manuele AUFIERO
(See summary SG39-2)
- SG39-18: “Adjustment of U, Pu and Fe cross-sections based on k-eff, β -eff and shielding benchmark experiments”, Lucijan PLEVNIK
(See summary SG39-12)
- SG39-19: “Overview of Cielo progress as it pertains to collaborations with SG39”, Mark CHADWICK, and SG39-20: “Summarizing Cielo data testing”, Andrej TRKOV

M. Chadwick presented the CIELO progress. SG39 support is part of the ongoing validation testing, and future feedbacks from adjustments are expected (e.g. strong sensibility to ²³⁸U inelastic) on the comparison of the trend of the adjustment obtained for the present CIELO evaluations, and on specific information for each isotope, reaction, and energy range and their impact on the C/E.

It has been agreed the exchange of information between the two groups, in order to provide validation information to CIELO, based on the sensitivity analysis performed in SG39 (G. Palmiotti and Skip Kahler)

3. Perspectives and review of pending actions.

- **Finalise deliverables**

- **Action NEA:** To edit and publish by next meeting the report based on the last versions (“Summary of Methodology” and “Comments on Covariance Data”) provided by K. Yokoyama and M. Ishikawa (JAEA).
- **Action E. Ivanov:** To finalize report on MC sensitivity coefficients. Update some bibliographic references in the report. To be done by next meeting
- **Action S. Pelloni:** To complete report on PIA method utilization (adjusted results for more reactions etc.) and possibly to contribute to propagation experiments analysis and sensitivity coefficient data bases implementation. To be done by next meeting
- **Action H. Wu:** To finalize the report on “Stress Test on 235 U(n, f) in adjustment with HCI and HMI benchmarks” To be done by next meeting
- **Action A. Barnes/Others:** Produce report on the status of uncertainties of Am-241. Initiate by criticality safety problem for space application. Progress on this action should be reported at the next meeting

- **Current activities: Methodologies and Experimental Benchmarks**

- **Action G.Palmiotti/Others:** Development of improved criteria for adjustment reliability (from methodology studies). Progress to be reported at next meeting
- **Action M.Aufiero/G.Palmiotti:** Continue to develop continuous energy data assimilation techniques. Possible application to a simple, few isotope cases. To be reported at next meeting.
- **Action I.Kodeli:** Provide sensitivities of ASPIS experiment. Done
- **Action All:** Analysing and using new experiments of elemental and separation of effects type: PROTEUS, FCA-IX, SEG, ASPIS-88, SNEAK, MANTRA. This is the key action for SG39. At present, commitment only by INL (G. Palmiotti)
- **Action All:** Providing support for new industrial emerging needs helping for data uncertainty reduction (e.g. TWR)
- **Action B.T. Rearden/ORNL:** Provide SCALE6.2 covariance data in 33 groups for SG39. By next meeting

- **Starting from CIELO new files (without uncertainties) attempt new adjustment:**

- **Action S. Kahler, G. Palmiotti:** Processed CIELO (and ENDF/B-VII.0) infinite dilution cross sections in the standard 33 groups will be available for SG39. Provide feedback by energy range, reaction, and isotope using sensitivity database and C/E developed by SG39
- **Action G. Palmiotti, I Kodeli,...:** Perform extended adjustment using more elemental type of integral experiments and new adjustment strategies using CIELO data

- **Action CIELO/SG39:** Expecting feedback from CIELO in terms of more complete and reliable covariance data in the next future. Possible first CIELO covariance data release by March 2017.

8. Next meeting

It is proposed to hold the next SG39 meeting in conjunction with JEFF meetings during the next Nuclear Data Week at the NEA, **December 1-2, 2016**.

Dr Bradley T. REARDEN
Oak Ridge National Laboratory

Tel: +1 865 574 6085
Eml: reardenb@ornl.gov

Prof. Massimo SALVATORES
Idaho National Laboratory /EROB

Tel: +1 +33 6 43 85 25 04
Eml: salvatoresmassimo@orange.fr

Dr Vladimir SOBES
Oak Ridge National Laboratory

Tel: +1 8572098287
Eml: sobesv@ornl.gov

OECD NEA, Boulogne-Billancourt
Mr Oscar CABELLOS DE FRANCISCO
OECD/NEA Data Bank

Tel: +33 (0) 1 45 24 10 84
Eml: oscar.cabellos@oecd.org

Appendix 2

Agenda of the 7th meeting of WPEC subgroup 39

<h1 style="margin: 0;">Preliminary Agenda</h1> <h2 style="margin: 0;">SG-39</h2> <p style="margin: 0;">OECD Headquarters Conference Center 2 Rue André Pascal, Paris 75016</p> <p style="margin: 0;">Room CC 24</p> <p style="margin: 0;">Starting at 09:00 am – Ending at 06:00 pm</p>		
<p><i>Please note: Only registered participants with a valid ID card or passport will be allowed access to OECD premises.</i></p>		
<h3 style="margin: 0;">Tuesday, May 10, 2016</h3>		
12:40 – 14:00	Lunch Break	
14:00 – 14:45	“Welcome and actions review”	Giuseppe PALMIOTTI Massimo SALVATOIRES Oscar CABELLOS
	Methods	
14:45 – 15:15	“XGPT: uncertainty propagation and data assimilation from continuous energy covariance matrix and resonance parameters covariances”	Manuele AUFIERO
15:15 – 15:45	“Optimal experiment utilization (REWINDing PIA)”	G. Palmiotti (TBC)
15:45 – 16:00	Coffee Break	
	Experiment analysis, sensitivity calculations and benchmarks (1)	
16:00 – 16:30	“Tripoli-4 analysis of SEG experiments”	Andrew HUMMEL
16:30 – 17:00	“Tripoli-4 analysis of BERENICE experiments”	Pierre LECONTE
17:00 – 17:30	“Preparation of sensitivities of k-eff, beta-eff and shielding benchmarks for adjustment exercise”	Ivo KODELI
17:30 – 18:00	“S&U due to Nuclear data in TWR”, Video-conference	Nick TOURAN

Wednesday, May 11, 2016		
	Experiment analysis, sensitivity calculations and benchmarks (2)	
9:00 – 9:30	“SA and UQ work for the VENUS-F facility using the SANDY code”	Luca FIORITO
9:30 – 10:00	“KIT and INL Results of the NEA/EGIEMAM-II Calculation Benchmark on Low Void SFR Burner Core”	Fabrizio GABRIELLI
10:00 – 10:30	“KIT and INL Results of the NEA/EGIEMAM-II Benchmark problems for TRU’s central fission rate ratios of FCA-IX assemblies”	Fabrizio GABRIELLI
10:30 – 10:45	Coffee Break	
	Adjustments	
10:45 – 11:15	“Adjustment of U, Pu and Fe cross-sections based on k-eff, β -eff and shielding benchmark experiments”	Lucijan PLEVNIK
11:15 – 11:45	“Extended adjustment using a wider integral data base”	Guiseppe PALMIOTTI
	Future actions, deliverables	
11:45 – 12:00	Future actions, deliverables	All
12:00 – 13:30	Lunch Break	
	Joint Session SG39+SG40 Room CC 20	
13:30 – 13:50	“Status of SG39 activity and perspectives of potential interest for CIELO”	Massimo SALVATORES
13:50 – 14:10	“Overview of Cielo progress as it pertains to collaborations with SG39”	Mark CHADWICK
14:10 – 14:25	“Extended adjustment with a wider integral experiment data base”	Guiseppe PALMIOTTI
14:25 – 14:40	“Continuous energy adjustments: a potential breakthrough”	Manuele AUFIERO
14:40 – 14:55	“Adjustment of U, Pu and Fe cross-sections based on k-eff, β -eff and shielding benchmark experiments”	Lucijan PLEVNIK
14:55 – 15:15	Coffee Break	
15:15 – 16:15	“Summarizing Cielo data testing”	Andrej TRKOV
16:15 – 18:00	Discussion	All