Summary Record of the 3rd Meeting of the WPEC Subgroup 33 on

Methods and issues for the combined use of integral experiments and covariance data

NEA, Issy-les-Moulineaux, France

2 June 2010

The subgroup coordinators, M. Salvatores and G. Palmiotti, opened the meeting and welcomed the participants (cf. list in Appendix 1). It was noted that unfortunately the Russian and Chinese members could not attend the meeting. However, the Russian group (IPPE) has provided a good description of their adjustment methodology.

The proposed agenda was accepted (cf. Appendix 2). M. Salvatores reminded the participants of the objectives of the benchmark and reviewed the actions of the previous meeting. A new list of actions is given at the end of this document. G. Palmiotti updated the group on the methodology documentation progress so far. Some contributions are still missing (see new Actions 1-5).

G. Palmiotti indicated the willingness of ORNL to join Subgroup 33 and to contribute to the benchmark. After the meeting, similar requests were received from Korea (KAERI) and Switzerland (PSI).

1. Summary presentations of adjustment methodologies

R. McKnight (ANL) presented data assimilation methodology, which is based on the GMADJ code developed and used in the 1980's in support of fast reactor design activities.

D. Rochman (NRG) presented a comparison of nuclear data uncertainty propagation using Total Monte Carlo (TMC) and standard perturbation methodologies. Preliminary results on JEZEBEL show that the uncertainty on k_{eff} due to ^{239}Pu and ^{240}Pu nuclear data uncertainties differs by about 15-20 % between these two methods.

C. de Saint Jean (CEA) provided some remarks on perceived "pro and cons" of the classical adjustment methods. He presented a method to assimilate both differential and selected integral experiments information during the evaluation process.

K. Sugino (JAEA) highlighted the importance of both integral experiments and integral models covariance matrices. He also made some comments on the use of the χ square test to eliminate abnormal integral data.

2. Discussion on the assessment of adjustment methodologies

M. Ishikawa presented a comparison of adjustment methodologies used by the participants. All methods are based on the same theory and equations. However practical implementation differs and major unique features were highlighted for discussion.

Some initial proposals to define qualitative and quantitative criteria for methodology inter-comparison have been presented by G. Palmiotti and further discussed. A final assessment questionnaire will be circulated among participants to be filled up (Actions 2 and 3).

3. Preliminary results on benchmark adjustment

E. Dupont presented a format that participants will use for benchmark input/output comparison within Sg33. The format is designed to be used by both human and computer. It was proposed to add integral covariance data, as well as quantitative adjustment method criteria (e.g. global χ^2, computing time) in separate files. A few improvements were also proposed,

- To add the sum of the adjusted partial cross sections, as well as the non-adjusted total cross section in order to check the consistency of the adjustment;
- To separate experimental and modelling uncertainties of integral C/E values;
- To add the sum over energy and over nuclear data of the sensitivity coefficients.

Final benchmark input/output format specifications will be circulated among participants (Action 6).

G. Palmiotti presented simplified models and corrective factors to be used in the benchmark adjustment exercise for JEZEBEL, FLATTOP, and ZPR6-7 integral configurations. It is confirmed that the ^{237}Np spectral index is part of the benchmark to assess the spectral sensitivity of the adjustment in the 1-2 MeV energy region. However, ^{237}Np nuclear data are not adjusted.

M. Ishikawa and K. Sugino requested more detailed specifications on the corrective factor calculations, especially concerning the transport approximation to be used by the participants. G. Palmiotti will circulate explanations on how INL corrective factors have been calculated (Action 7).

K. Sugino presented simplified models to be used in the benchmark adjustment exercise for ZPPR-9 and JOYO integral configurations. New ZPPR-9 experimental spectral index values are given at the core center. A simplified (reference) and a more detailed model of JAEA FBR were also presented. The simplified model is the reference model to be used within Sg33 as an example of actual core design.

G. Palmiotti commented that a mesh width of 5 cm is quite large for ZPPR-9. M. Ishikawa answered that this mesh is part of the ANL benchmark model established 15 years ago.

G. Palmiotti requested some specifications on the conversion of the Na void reactivity measurements from cents to pcm. M. Ishikawa answered that JAEA will provide the beta fraction of delayed neutrons and associated covariance to all participants (Action 8).

M. Ishikawa presented a methodology to determine the integral data covariance matrices. Integral data total uncertainties and their correlations can be evaluated from a careful analysis of random and common components of the experimental uncertainty. He also stressed the need to introduce a specific covariance matrix for modelling uncertainties and their correlations. Indeed, the uncertainty on the corrective factors should be accounted for in the adjustment method.

G. Palmiotti asked whether an experimental correlation, due to common uncertainties in the composition, should be introduced between, e.g. ZPPR9 critical mass and Na void measurements. M. Ishikawa answered that no such correlations are considered. R. McKnight added that this can be neglected.

R. McKnight commented that the k_{eff} uncertainty of ZPR6-7 will be revised in the next version of ICSBEP.

M. Salvatores said that the JAEA proposal for integral data uncertainties and their correlations is a good starting point for the benchmark. R. McKnight will peer-review the proposal and will provide revised ICSBEP uncertainty for ZPR6-7 (Action 9).

K. Sugino presented preliminary adjustment results performed at JAEA using JENDL-4.0 nuclear data and covariance, together with integral experiment correlations from previous adjustment

studies. Two adjustments were performed: (1) with and (2) without modelling uncertainties and their correlations. Results from these two routes significantly differ in some cases, e.g. ZPR6-7 critical masses, and also impact the design of target cores. It was also reported an effect dependent on the procedure used to condensate cross sections from fine groups into the broad 33 group structure.

R. McKnight commented that the neutron energy collapsing effect should be accounted for by the corrective factors. G. Palmiotti explained that cell calculations should be made with 2000 groups before condensing data to the 33 group structure. M. Salvatores said that this should be included in the benchmark specifications (Action 7).

On the ZPR6-7 issue, R. McKnight and M. Salvatores were concerned by the large prior (modelling) uncertainties on critical masses (about 600 pcm), which strongly reduce the interest of integral data assimilation.

M. Salvatores commented that all modelling errors should be negligible or corrected because adjustment cannot deal with errors, only uncertainties. R. McKnight added that corrective factors may have associated uncertainties, but they should be negligible. M. Ishikawa answered that these uncertainties should be evaluated first. G. Palmiotti proposed to repeat the calculation of corrective factors with ENDF/B-VI.8 to assess the influence of the cross section data set (Action 10).

4. Preliminary results on target-core design

K. Sugino's previous presentation included preliminary results on the critical mass calculation and uncertainty for three target cores (ABR oxide, ABR metal, JAEA FBR).

M. Herman presented the status of AFCI covariance data, which have been proposed as a common set of data to be used in step 2 of the benchmark exercise. AFCI is a group wise (33G) covariance library; which is not yet ENDF-6 formatted. The version 1.3 was released in April 2010 with new data for ^{237}Np, ^{240}Pu, ^{241}Pu(n,f), ^{242}Pu, and some structural materials. The version 2.0 will be released in August 2010 with new data for ^{240}Pu prompt neutron fission spectra, remaining isotopes of major structural materials (Cr, Fe, Ni), and minor actinides.

G. Palmiotti presented very preliminary uncertainty calculations for the ABR core (k_{eff} and sodium void) based on ENDF/B-VII.0 and AFCI-1.3 covariance data (cross sections only). Integral parameter uncertainties are affected by a few cross sections with relatively large uncertainties, which should be reduced in order to reach the requested target accuracies. In particular, a surprising peak in ^{239}Pu nu-bar uncertainty (at 10-20 keV) should be confirmed.

5. Discussion on next steps

The report on adjustment methodology cannot be further delayed and should be ready for publication before the next meeting (Actions 1-5).

All corrective factors of the selected experiments are now available. Hence, results of the first step of the adjustment benchmark can be discussed at the next meeting (Actions 6-11).

6. Next meeting

It was discussed whether the next meeting of the subgroup could be held on 28-29 October 2010 in conjunction with NEMEA-6, Krakow, Poland. Representatives from the ENDF project said it would be difficult for them to be present because of the CSEWG and other nuclear data related meetings to be organized the following week (1-5 November). M. Salvatores proposed to meet the week of the JEFF meeting, on 29-30 November 2010.

7. Actions

1.	All participants	To provide, before 31 August 2010, a paper describing the adjustment methodology to be used in the benchmark exercise.
2.	G. Palmiotti	To circulate the final assessment questionnaire on the adjustment methodology.
3.	All participants	To answer, before 15 September 2010, to the assessment questionnaire.
4.	G. Palmiotti C. de Saint Jean M. Ishikawa	To critically review the participant papers describing the adjustment methodology and to write a report of the findings by 30 September 2010.
5.	E. Dupont	To assemble and circulate the report on adjustment methodology. The official draft version should be circulated for comments before 15 October 2010.
6.	E. Dupont	To revise and circulate the final benchmark input/output format specification.
7.	G. Palmiotti	To circulate complete description of the corrective factor calculations (transport approximation, collapsing procedure …) and specifications on the use of these corrective factors with simplified benchmark models.
8.	M. Ishikawa	To provide the beta fraction of delayed neutron and associated uncertainties for the calculation of ZPPR-9 Na voids.
9.	R. McKnight	To peer-review the integral uncertainties and their correlations proposed by JAEA. To provide revised ICSBEP uncertainties for ZPR6-7.
10.	G. Palmiotti	To assess the influence of the cross section data set on the corrective factors using two different data libraries.
11.	All participants	To start the benchmarking of adjustment methodologies and present results at the next meeting, 29-30 November 2010.
12.	M. Salvatores?	To review covariance data available in the different evaluated projects.
13.	E. Dupont	To update the subgroup web page with materials from this meeting and other participant contributions.

Appendix 1

Participants to the 3rd meeting of WPEC subgroup 33

NEA, Issy-les-Moulineaux, France

2 June 2010

M. Salvatores	INL, USA – CEA, France	(Coordinator)
G. Palmiotti	INL, USA	(Coordinator)
R. McKnight	ANL, USA	(Monitor)
E. Dupont	NEA, OECD	(Secretary)
M. Ishikawa	JAEA, Japan	
A. Koning	NRG, Netherlands	
A. Plompen	IRMM, JRC	
D. Rochman	NRG, Netherlands	
C. de Saint Jean	CEA, France	
K. Sugino	JAEA, Japan	
A. Trkov	IJS, Slovenia	

Appendix 2

Agenda of the 3rd meeting of WPEC subgroup 33

NEA, Issy-les-Moulineaux, France

2 June 2010

9:00 – 9:20 Welcome, approval of agenda, action items from last meeting. (M. Salvatores)

1. Summary presentations (15 minutes max each) of adjustment methodologies key features: e.g. mathematical method, input data (type of uncertainties, systematic bias, method uncertainties, etc.), output data (new covariance on adjusted data and/or experiments, etc.), computing requirements, etc.

9:20 – 9:35 ANL (R. McKnight)
9:35 – 9:50 NRG (D. Rochman)
9:50 – 10:05 CEA (C. De Saint Jean)

2. Discuss on how to assess methodologies for deliverable

10:05 – 10:30 Comparison of Methodologies (M. Ishikawa)

10:30 – 10:45 Break

10:45 – 11:30 Criteria for comparison and deliverable (C. de Saint-Jean, M. Ishikawa, and G. Palmiotti drive discussion with all participants)

3. Presentations of preliminary adjustment results if available and compatibly with distribution of models of benchmark experiments.

11:30 – 12:00 Input and output formats (E. Dupont)

12:00 – 13:30 Lunch break

13:30 – 13:50 Corrective factors and model of experiments (G. Palmiotti)
13:50 – 14:10 Model of experiments (K. Sugino)
14:10 – 14:30 Integral experiment covariance matrix methodology (M. Ishikawa)
14:30 – 14:50 Integral experiment covariance matrix methodology (R. McKnight)
14:50 – 15:20 Corrective factors, adjustment methodology and preliminary results (K. Sugino)

15:20 – 15:40 Break

4. Presentations of preliminary uncertainty evaluation of integral parameters on target systems (ABR oxide fuel, and JAEA FBR). This evaluation should be limited to Keff of the BOC core and to Na void (fuel core regions only voided) reactivity. This evaluation should be done by each participant using their uncertainty covariance data. A short description of the uncertainty data used is expected.

15:40 – 16:10 AFCI 1.3/2.0 new covariance data (M. Herman)
16:10 – 16:25 Preliminary uncertainty analysis results for ABR (G. Palmiotti)

5. Discussion on next steps.

16:25 – 17:00 Next steps, schedule, and next meeting (All)