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**English - Or. English**

**NUCLEAR ENERGY AGENCY  
NUCLEAR SCIENCE COMMITTEE**

**NEA/NSC/DOC(2009)4  
Unclassified**

**OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM)  
for Design, Operation and Safety Analysis of LWRs - Third Workshop (UAM-3)**

**PROPOSED PROGRAMME**

**University Park / State College, Pennsylvania, USA  
April 29 - May 1, 2009**

<p>Enrico SARTORI sartori@nea.fr +33 1 45 24 10 72</p>
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**English - Or. English**

**NUCLEAR SCIENCE COMMITTEE**

**and**

**COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS**

**OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design,  
Operation and Safety Analysis of LWRs - Third Workshop (UAM-3)**

**University Park / State College, Pennsylvania, USA**

**April 29 - May 1, 2009**

**Hosted by**

**The Pennsylvania State University (PSU)**

**PROPOSED PROGRAMME**

**OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design, Operation and Safety Analysis of LWRs - Third Workshop (UAM-3)**

**University Park / State College, Pennsylvania, USA**

**April 29 – May 1, 2009**

**Sponsorship**

The third workshop for the OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design, Operation and Safety Analysis of LWRs (UAM-3) will be held from April 29 to May 1, 2009 in University Park / State College, Pennsylvania, USA, and is a follow up to the first and second workshops. The first workshop for the OECD UAM LWR benchmark (UAM-1) was held on 10 and 11 May 2007 at the OECD/NEA Headquarters, Issy les Moulineaux, France. The second workshop for the OECD UAM LWR benchmark (UAM-2) was held on 2 to 4 April 2008 in Garching, Germany.

In recent years there has been an increasing demand from nuclear research, industry, safety and regulation for best estimate predictions to be provided with their confidence bounds. Consequently an "in-depth" discussion on "Uncertainty Analysis in Modelling" was organized at the 2005 OECD/NEA Nuclear Science Committee (NSC) meetings, which led to a proposal for launching an Expert Group on "Uncertainty Analysis in Modelling" and the endorsement to hold a workshop with the aim of defining: future actions and a program of work.

As a result the OECD/NEA Workshop on Uncertainty Analysis in Modelling took place in Pisa, Italy, on April 28-29, 2006 (UAM-2006). The major outcome of the workshop was to prepare a benchmark work programme with steps (exercises) that would be needed to define the uncertainty and modelling task. The other proposals made during the meeting would be incorporated under the different steps (exercises) within the overall benchmark framework for the development of uncertainty analysis methodologies for multi-physics (coupled) and multi-scale simulations.

Following the results from the UAM-2006 Workshop the OECD/NEA Nuclear Science Committee at its June 2006 meeting endorsed the creation of an Expert Group on Uncertainty Analysis methods in Modelling. This Expert Group will report to the Working Party on Scientific issues of Reactor Systems (WPRS). Since it addresses multi-scale / multi-physics aspects of uncertainty analysis, it will work in close co-ordination with the benchmark groups on coupled neutronics-thermal-hydraulics simulations and on coupled core-plant problems. The Expert Group will also coordinate its activities with the Group on Analysis and Management of Accidents (GAMA) of the Committee on Safety of Nuclear Installations (CSNI). The Expert Group has the following mandate:

1. To elaborate a state-of-the-art report on current status and needs of sensitivity and uncertainty analysis (SA/UA) in modelling, with emphasis on multi-physics (coupled) and multi-scale simulations.
2. To identify the opportunities for international co-operation in the uncertainty analysis area that would benefit from coordination by the NEA/NSC.
3. To create a roadmap along with schedule and organization for the development and validation of methods and codes required for uncertainty analysis including the benchmarks adequate to meet those goals.

The NEA/NSC has endorsed that this activity be undertaken with PSU as the main coordinator and host with the assistance of the Scientific Board. The 40 participants in the UAM workshop in Pisa (from 26 organizations in 16 countries representing industry, regulatory agencies, national laboratories and research institutions) expressed interest in participating and contributing to this UAM Expert Group and proposed an uncertainty analysis benchmark activity.

To summarize, in addition to LWR best-estimate calculations for design and safety analysis, the different aspects of uncertainty analysis in modelling (UAM) are to be further developed and validated on scientific grounds in support of its performance. There is a need for efficient and powerful analysis methods suitable for such complex coupled multi-physics and multi-scale simulations. The proposed benchmark sequence will address this need by integrating the expertise in reactor physics, thermal-hydraulics and reactor system modelling as well as uncertainty and sensitivity analysis, and will contribute to the development and assessment of advanced/optimized uncertainty methods for use in best-estimate reactor simulations. Such an effort can be undertaken within the framework of a program of international co-operation that would benefit from the coordination of the NEA/NSC and all participants by interfacing with the CSNI activities.

This workshop (UAM-3) will be held in conjunction with other meetings, in order to facilitate coordination and sharing of work. Two other meetings are being held during the same week in order to combine efforts in common areas such as CFD modelling and uncertainty analysis and to make participation more efficient. The meetings concerned are the First OECD Kalinin-3 VVER-1000 Benchmark Workshop (Kalinin-2009) and the OECD/NRC BFBT-6 benchmark workshop. The OECD/NRC BFBT-6 and the First OECD Kalinin-3 workshops will be held in parallel on April 27-28, 2009 followed by the OECD UAM-3 benchmark workshop (April 29 - May 1, 2009) and will be hosted by PSU, USA. The 3 workshops will take place in University Park / State College, Pennsylvania (located in the Happy Valley) – home of PSU. There will be a special session on LWR UAM in multi-physics multi-scale simulations at the M&C 2009 Conference in Saratoga Springs, NY, USA (6. hours drive from PSU). The M&C 2009 conference will take place on May 3-7, 2009 (the week after the Benchmark workshops at PSU).

### **Background and Purpose of the Benchmark Workshop**

The objective of the work is to define, conduct, and summarize an OECD benchmark for uncertainty analysis in best-estimate coupled code calculations for design, operation, and safety analysis of LWRs. The title of this benchmark is: “**OECD UAM LWR Benchmark**”. Reference systems and scenarios for coupled code analysis are defined to study the uncertainty effects for all stages of the system calculations. Measured data from plant operation are available for the chosen scenarios.

The proposed technical approach is to establish a benchmark for uncertainty analysis in best-estimate modelling and coupled multi-physics and multi-scale LWR analysis, using as bases a series of well defined problems with complete sets of input specifications and reference experimental data. The objective is to determine the uncertainty in LWR system calculations at all stages of a coupled reactor physics/thermal hydraulics calculation. The full chain of uncertainty propagation from basic data, engineering uncertainties, across different scales (multi-scale), and physics phenomena (multi-physics) are tested on a number of benchmark exercises for which experimental data are available and for which the power plant details have been released. The principal idea is: a) to subdivide the complex system/scenario into several steps or Exercises, each of which can contribute to the total uncertainty of the final coupled system calculation, b) to identify input, output, and assumptions for each step, c) to calculate the resulting uncertainty in each step; d) to propagate the uncertainties in an integral systems simulation for which high quality plant experimental data exists for the total assessment of the overall

computer code uncertainty. The main scope covers uncertainty (and sensitivity) analysis (SA/UA) in best estimate modelling for design and operation of LWRs, including methods that are used for safety evaluations. As part of this effort, the development and assessment of different methods or techniques to account for the uncertainties in the calculations will be investigated and reported to the participants.

The general frame of the OECD LWR UAM benchmark consists of three phases with three exercises for each phase:

Phase I (Neutronics Phase)

- Exercise 1 (I-1): “Cell Physics” focused on the derivation of the multi-group microscopic cross-section libraries
- Exercise 2 (I-2): “Lattice Physics” focused on the derivation of the few-group macroscopic cross-section libraries
- Exercise 3 (I-3): “Core Physics” focused on the core steady state stand-alone neutronics calculations

Phase II (Core Phase)

- Exercise II-1: Fuel thermal properties relevant for transient performance
- Exercise II-2: Neutron kinetics stand-alone performance (kinetics data, space-time dependence treatment, etc.)
- Exercise II-3: Thermal-hydraulic fuel bundle performance

Phase III (System Phase)

- Exercise III-1: Coupled neutronics/thermal-hydraulics core performance (coupled steady state, coupled depletion, and coupled core transient with boundary conditions)
- Exercise III-2: Thermal-hydraulics system performance
- Exercise III-3: Coupled neutronics kinetics thermal-hydraulic core/thermal-hydraulic system performance

The expected impact and benefits of the OECD LWR UAM benchmark activity for LWR safety and licensing are summarized in “Technology Relevance of the Uncertainty Analysis in Modelling. Project for Nuclear Reactor Safety”, NEA/NSC/DOC(2007)15:

- a) Systematic identification of uncertainty sources;
- b) Systematic consideration of uncertainty and sensitivity methods in all steps. This approach will generate a new level of accuracy and will improve transparency of complex dependencies;
- c) All results will be represented by reference results and variances and suitable tolerance limits;
- d) The dominant parameters will be identified for all physical processes;
- e) Support of the quantification of safety margins;
- f) The experiences of validation will be explicitly and quantitatively documented;

- g) Recommendations and guidelines for the application of the new methodologies will be established.

This benchmark project is challenging and responds to needs of estimating confidence bounds for results from simulations and analysis in real applications. Separate Specifications will be prepared for each Phase in order to allow participation in the full Phase or only in a subset of the Exercises. Boundary conditions and necessary input information are provided by the benchmark team. The intention is to follow the calculation scheme for coupled calculations for LWR design and safety analysis established in the nuclear power generation industry and regulation. The specification document that covers Phase I (which includes the first 3 Exercises) was distributed to the participants - "Benchmark for Uncertainty Analysis in Modelling (UAM) for Design, Operation and Safety Analysis of LWRs. Volume 1 – Specification and Supporting Data for the Neutronics Cases (Phase I) Version 1.0", NEA/NSC/DOC(2007)23. The Version 2 of the Volume 1 of OECD LWR UAM Benchmark Specification (Phase I) based on the participants' feedback obtained during the UAM-2 workshop will be distributed to the participants in March 2009. Draft of Volume 2 of OECD LWR UAM Benchmark Specification (Phase II) will be also distributed to participants before the UAM-3 workshop in order to be discussed at the workshop.

### **Scope and Technical Content of the Benchmark Workshop**

The technical topics to be addressed at the workshop include:

- Review of the benchmark activities after the UAM-2 Workshop
- Discussion of the updated final specification for Phase 1
- Discussion of submitted results of Phase 1
- Participants' presentation on their modelling and results for Phase I
- Discussion of draft Specification for Phase 2
- Discussion of priorities for Phase 3
- Presentations on participants' experience and expertise in uncertainty and sensitivity analysis of LWRs
- Defining a work plan and schedule outlining actions to progress on the three phases of the benchmark activities

The proposed workshop programme is attached as Annex 1.

### **Organization of the Benchmark Workshop**

The meeting is organized around the in-depth discussion of the specifications (Volumes I and II) and support data for Phases I and II of the UAM LWR benchmark, comparative analysis of submitted results for Phase I, output parameters and format for Phase II, priorities for Phases III, and the proposed work plan and time schedule for the UAM LWR benchmark activities. The participants are requested to present their modelling and results for Phase I as well as their experience and expertise in uncertainty and sensitivity analysis of LWRs.

### **Participation in the Benchmark Workshop**

For Benchmark Workshops sponsored by the Nuclear Science Committee (NSC) and the Committee on the Safety of Nuclear Installations (CSNI), participation is restricted, for efficiency, to participants in this study and to experts (research laboratories, safety authorities, regulatory agencies, utilities, owners' groups, vendors, etc.) from OECD Member countries nominated by delegates to the Committees in consultation with official authorities concerned and with the assistance of members of the Nuclear Science Committee and the Committee on the Safety of Nuclear Installations (information about members are provided as Annex 3 and 4).

### **Organization and Programme Committee of the Benchmark Workshop**

An Organization and Programme Committee has been nominated to make the necessary arrangements for the first Benchmark Workshop and to organize the Sessions, draw up the final programme, appoint Session Chairmen, etc. Its members are:

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### **Proposed Programme of the Benchmark Workshop**

The proposed programme was drawn up by the Programme Committee and is enclosed as Annex 1

### **Language of the Benchmark Workshop**

The official language of the Third Benchmark Workshop is English.

### **Proceedings of the Workshop**

A summary of the Workshop will be published by the OECD/NEA after the meeting. The summary will be distributed free of charge to the participants in the Workshop and to delegates of the NSC and CSNI. The programme committee and the session chairmen will prepare a Summary Report on the main results of the meeting for presentation to the NSC and CSNI. In addition, copies of presentations will be distributed free of charge to all participants at the meeting.

### **Workshop Location**

The Third workshops will take place in University Park / State College, Pennsylvania (located in the Happy Valley) – home of PSU. For State College Airport (SCE) there are flight connections from Washington DC (United), Philadelphia (US Air) and Detroit (Northwest). State College is on 2 and 1/2 hours drive from Pittsburgh, 3 and 1/2 hours drive from Philadelphia, 4 hours drive from Washington DC and 5 hours drive from New York City.

### **Local Arrangements**

The organisers propose accommodation at the hotels in State College, which will be managed by:

Donna M. Gensimore  
Administrative Support Assistant  
Dept. Mechanical and Nuclear Engineering  
336-C Reber Building  
(814) 865-5947  
FAX: (814) 863-4848  
E-mail: [dmgl@engr.psu.edu](mailto:dmgl@engr.psu.edu)

Please fill the registration form for the series of workshops and accommodation, which can be found as Annex 2.

### **Transportation**

At the State College Airport there is taxi and shuttle transportation available to hotels and downtown.

Annex 1

**OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design,  
Operation and Safety Analysis of LWRs - Third Workshop (UAM-3)**

Hosted by  
The Pennsylvania State University (PSU), USA  
April 29 – May 1, 2009

**PROPOSED PROGRAMME**

**Day 1: 29 April 2009**

1. Introduction and opening remarks
2. Overview and status of benchmark activities including the special session on LWR UAM in multi-physics multi-scale simulations at the M&C 2009 Conference in Saratoga Springs, NY, USA
3. Overview of Updated Specification for Phase I
4. Discussion of the updated definition for Exercise 1 of Phase I (I-1) - Cell Physics
5. Discussion of the updates of the covariance data and tools distributed for the Exercise I-1
6. Discussion of the updated test problems for Exercise I-1
7. Discussion of updated requested output for Exercise I-1
8. Presentation and discussion of submitted results on Exercises I-1
9. Participants' presentations on their modelling and results for Exercise I-1 as well as on their expertise and experience relative to Exercise I-1 - sensitivity and uncertainty analysis on the derivation of the multi-group microscopic cross-section libraries
10. Discussion of the updated definition for Exercise 2 of Phase I (I-2) - Lattice Physics
11. Discussion about the updates of data and tools applicable to Exercise I-2
12. Discussion on the updated selected test problems for Exercise I-2
13. Discussion on updated requested output for Exercise I-2
14. Presentation and discussion of submitted results on Exercises I-2
15. Participants' presentations on their modelling and results for Exercise I-2 as well as on their expertise and experience relative to Exercise I-2 - sensitivity and uncertainty analysis on the derivation of the few-group macroscopic cross-section libraries

**Day 2: 30 April 2009**

16. Discussion of the updated definition for Exercise 3 of Phase I (I-3) - Core Physics
17. Discussion on the updates of data and tools applicable to Exercise I-3
18. Discussion on the updated selected test problems for Exercise I-3
19. Discussion on updated requested output for Exercise I-3
20. Presentation and discussion of submitted results on Exercises I-3
21. Participants' presentations on their modelling and results for Exercise I-3 as well as on their expertise and experience relative to Exercise I-3 - sensitivity and uncertainty analysis on the core steady state stand-alone neutronics calculations
22. Overview of Draft Specification for Phase II
23. Presentation of the University of Pisa Proposal for Phase II
24. Discussion of the definition for Exercise 1 of Phase II (II-1) - Fuel thermal properties relevant for transient performance
25. Discussion of the data and tools applicable to Exercise II-1
26. Discussion of the selected test problems for Exercise II-1
27. Discussion of requested output for Exercise II-1
28. Participants' presentations on their expertise and experience relative to Exercise II-1
29. Discussion of the definition for Exercise 2 of Phase II (II-2) - Neutron kinetics stand-alone performance
30. Discussion of the data and tools applicable to Exercise II-2

**Day 3: 1 May 2009**

31. Discussion of the selected test problems for Exercise II-2
32. Discussion of requested output for Exercise II-2
33. Participants' presentations on their expertise and experience relative to Exercise II-2
34. Discussion of the definition for Exercise 3 of Phase II (II-3) - Thermal-hydraulic fuel bundle performance
35. Discussion of the data and tools applicable to Exercise II-3
36. Discussion of requested output for Exercise II-3
37. Participants' presentations on their expertise and experience relative to Exercise II-3
38. Discussion on the priorities for Phase III
39. Discussion of output parameters and format for Phase III
40. Discussion on general Specification and support data for Phase III
41. Participants' presentations on their experience and expertise in uncertainty and sensitivity analysis of LWRs relative to Phases III.
42. Action items and schedule of benchmark activities - next workshop (UAM-4) and plans
43. Conclusions and closing remarks

Annex 2

**OECD/NEA Workshops in University Park / State College, PA, USA**

**OECD LWR UAM Benchmark – Third Workshop  
(UAM-3)**

Host Organization  
The Pennsylvania State University (PSU), USA  
April 29 – May 1, 2009

PARTICIPATION AND HOTEL REGISTRATION FORM

Even if you attend more than one of the following workshops (BFBT-6, Kalinin-2009, UAM-3), please send only one form as soon as possible, and in any case not later than April 14, 2009, both to:

**Kostadin Ivanov**

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E-mail: [sartori@nea.fr](mailto:sartori@nea.fr)

Name:

Company or organization:

Address:

E-mail:

Tel:

Fax:

I need an invitation from the organisers to obtain a **visa** to enter USA (Yes/No)

Please fill in the following table:

<b>Workshop / Date /Contact Person</b>	<b>Attendance / Presentations / Comments – Requests</b>
<b>Sixth workshop of the OECD/NRC Benchmark based on NUPEC BWR – Full-size Fine-mesh Bundle Tests (BFBT) – (BFBT-6)</b>	<i>Will you attend BFBT-6?</i>
	<i>If so, will you be giving a presentation?</i>
	<b>April 27-28</b>
	<i>Please specify titles, authors, and sessions for the presentation(s)</i>
	<i>I shall not attend but send me the summary. (Yes – No)</i>
<b>First OECD Kalinin-3 Coupled Code Benchmark (Kalinin-2009)</b>	<i>Will you attend the Kalinin-2009 workshop?</i>
	<i>If so, will you be giving a presentation?</i>
	<b>April 27-28</b>
	<i>Please specify titles, authors, and sessions for the presentation(s)</i>
	<i>I shall not attend but send me the summary. (Yes – No)</i>
<b>Third workshop for the OECD Uncertainty Analysis in Modelling (UAM) Light Water Reactor (LWR) benchmark – (UAM-3)</b>	<i>Will you attend the UAM-3?</i>
	<i>If so, will you be giving a presentation?</i>
	<b>April 29 – May 1</b>
	<i>Please specify titles, authors, and sessions for the presentation(s)</i>
	<i>I shall not attend but send me the summary. (Yes – No)</i>

Accommodation is proposed at the following hotel – Atherton Hotel – within walking distance from the workshops’ location. A set of **40 rooms** have been pre-reserved. The organising committee will take care of the hotel reservation.

*Do you wish to stay at Atherton Hotel?*

*If so, please specify the type of room, check in and check-out dates:*

*Type of room (Single or Double):*

*Check in:*

*Check out:*

Alternative hotels are listed herewith for which participants are requested to do their own booking at:

### **Other Hotels**

A map with the location of the hotels and the venue can be found at <http://www.pahotels.com/cities/State-College/>

### **Workshop Location**

The three workshops will take place in the same building in University Park (the campus) – Reber Building Rooms 135, 125 and 214 and conference rooms of Atherton Hotel.

The exact location can be found at <http://www.campusmaps.psu.edu/buildings/reber.shtml>

**Annex 3**(For detailed address information please look up <http://www.nea.fr/add/>)

OECD Nuclear Energy Agency NSC (NUCLEAR SCIENCE COMMITTEE MEMBERS)

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