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**NUCLEAR ENERGY AGENCY
NUCLEAR SCIENCE COMMITTEE**

**NEA/NSC/DOC(2007)4
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**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
PROPOSED PROGRAMME FOR THE FIRST WORKSHOP (UAM-1)**

**10-11 May 2007
NEA Headquarters, Issy-les-Moulineaux, France**

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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 -
First Workshop (UAM-1)**

OECD/NEA Headquarters, 12 boulevard des Iles, 92130 Issy-les-Moulineaux, France

10-11 May 2007

**Hosted by
OECD/NEA and CEA, Saclay
France**

PROPOSED PROGRAMME

**OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design,
Operation and Safety Analysis of LWRs -
First Workshop (UAM-1)**

**Issy-les-Moulineaux, France
10-11 May 2007**

Sponsorship

The first workshop for the OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design, Operation and Safety Analysis of LWRs (UAM-1) will be held on 10 and 11 May 2007 at the OECD/NEA Headquarters, Issy-les-Moulineaux, France, and is a follow up to recent activities at OECD/NEA.

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 to launch 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 program with steps (exercises) that would be needed to define the uncertainty and modelling task [1]. 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 [2]. This Expert Group will report to the Working Party on Scientific Issues in 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 uncertainty analysis area that would benefit from coordination of 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 this activity to 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-1) will be held in conjunction with other meetings, in order to facilitate co-ordination 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 fifth workshop for the OECD/DOE/CEA VVER-1000 Coolant Transient (V1000CT) benchmark – V1000CT-5 – scheduled for 7 May 2007, and the fourth workshop for OECD/NRC Benchmark based on NUPEC BWR Full-size Fine-mesh Bundle Tests (BFBT) – Fourth Workshop (BFBT-4), scheduled for 8 and 9 May 2007. In parallel with the BFBT-4 workshop the annual meeting of the Working Group D involved in VVER reactor dynamics and safety research is also being held at the same premises. For further details concerning this meeting please contact Soeren Kliem at s.kliem@fzd.de.

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 tentative title of this benchmark is: “**OECD UAM LWR Benchmark**”. Reference systems and scenarios for coupled code analysis will be defined to study the uncertainty effects for all stages of the system calculations. Measured data from plant operation will be made available for the chosen scenarios. The existing OECD/NEA/NSC coupled code transient benchmarks – such as BWR Turbine Trip (TT) [3], PWR Main Steam Line Break (MSLB) [4], VVER-1000 Coolant Transients (V1000CT) [5], and BWR Full Bundle Test (BFBT) [6] will be used as part of the framework for adding uncertainty analysis methodologies in the best estimate modelling for design and operation of LWRs. Such an approach will facilitate the proposed benchmark activities since many organizations have already developed input decks and tested their codes on the above mentioned coupled code benchmarks. From amongst the OECD LWR transient benchmark problems, the **Peach Bottom 2 (PB-2) BWR Turbine Trip (TT)** has been proposed as the first reference system-scenario, although provisions will be made to address the other LWR systems and scenarios such as TMI-1 PWR MSLB, PWR-RIA-ATWS, BWR-CRDA-ATWS (with boron modelling), VVER-1000 CT, etc. The Peach Bottom 2 BWR Turbine Trip is well documented, not only in the OECD/NEA/NRC BWR TT benchmark specifications [4] but also in a series of EPRI [7, 8] and PECO reports [9], which include design, operation, and measured steady-state and transient neutronics and thermal-hydraulics data. The fuel cycle depletion, steady-state and transient measured data, available at the integral parameter level and the local distribution level, are very important features of the Peach Bottom 2 BWR Turbine Trip. Integration with the OECD/NEA/NRC BWR Full Bundle Test (BFBT) benchmark and the uncertainty analysis exercises performed in its framework will also be made. The integration of the PB-2 BWR turbine trip will also be extended to the ongoing NEA/CSNI BEMUSE-3 benchmark through the NEA internal co-operation of the NSC and CSNI Committees.

The proposed technical approach is to establish a benchmark for uncertainty analysis in best-estimate modeling 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 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) will be tested in a number of benchmark exercises for which experimental data is available and for which the power plant details have been released. The testing on specific safety issues and applications in practice for safety analysis will be carried out once the methods have been proven sound and reliable.

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.

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.

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-2006 Workshop
- Discussion of draft of the General Specification for the 3 Phases of the UAM LWR benchmark
- Discussion of the proposed time schedule for the UAM LWR benchmark activities
- Discussion of the draft of a detailed specification on Phase I of UAM LWR benchmark relative to sensitivity and uncertainties for the neutronics calculations.
- Integrate feedback from participants into both specifications
- Presentations on participants' experience and expertise in uncertainty and sensitivity analysis of LWRs
- Defining a work plan and schedule outlining actions to progress the two 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 discussion of the draft of the General Benchmark Specifications on the 3 Phases of the UAM LWR benchmark, the draft of a detailed specification on Phase I of UAM LWR benchmark relative to sensitivity and uncertainties for the neutronics calculations, and the proposed time schedule for the UAM LWR benchmark activities. The participants are requested to present 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 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 Fourth 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

OECD/NEA Headquarters,
12 boulevard des Iles,
92130 Issy-les-Moulineaux, France

For the exact location with zooming options, please access <http://www.nea.fr/html/dbprog/> and click on the blue 'Map' button).

Local Arrangements

Hotels conveniently located near the NEA Headquarters are listed in <http://www.nea.fr/html/general/hotels.html>.

Transportation

Public transportation is recommended. For NEA see <http://www.nea.fr/html/general/nea-access.html>

REFERENCES

- [1] "Uncertainty Analysis in Modeling UAM-2006 Workshop", Summary Record, NEA/NSC/DOC(2006)15.
- [2] "Expert Group on Uncertainty Analysis in Modeling", Mandate and Programme of Work, NEA/NSC/DOC(2006)17.
- [3] K. Ivanov, T. Beam, A. Baratta, A. Irani, and N. Trikouros, "PWR MSLB Benchmark. Volume 1: Final Specifications", NEA/NSC/DOC (99)8, April 1999.
- [4] J. Solis, K. Ivanov, B. Sarikaya, A. Olson, and K. Hunt, "BWR TT Benchmark. Volume I: Final Specifications", NEA/NSC/DOC(2001)1.
- [5] B. Ivanov, K. Ivanov, P. Groudev, M. Pavlova, and V. Hadjiev, "VVER-1000 Coolant Transient Benchmark (V1000-CT). Phase 1 – Final Specification". NEA/NSC/DOC (2002)6.
- [6] B. Neykov, F. Aydogan, L. Hochreiter, K. Ivanov (PSU), H. Utsuno, F. Kasahara (JNES), E. Sartori (OECD/NEA), M. Martin (CEA), "OECD-NEA/US-NRC/NUPEC BWR Full-size Fine-mesh Bundle Test (BFBT) Benchmark", Volume I: Specifications, © OECD 2006, NEA No. 6212, NEA/NSC/DOC(2005)5
- [7] "Core Design and Operating Data for Cycles 1 and 2 of Peach Bottom 2", EPRI NP-563, June 1978.
- [8] "Transient and Stability Tests at Peach Bottom Atomic Power Station Unit 2 at End of Cycle 2", EPRI NP-564, June 1978.
- [9] A. M. Olson, "Methods for Performing BWR System Transient Analysis", Philadelphia Electric Company, Topical Report PECo-FMS-0004-A (1988).

Annex 1

OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design, Operation and Safety Analysis of LWRs - First Workshop (UAM-1)

Hosted by
OECD/ NEA and CEA-Saclay
10-11 May 2007

PROPOSED PROGRAMME

Day 1: 10 May 2007

1. Introduction and opening remarks
2. Overview and status of benchmark activities

Technical Sessions on General Specification for the 3 Phases

3. Presentations on draft of the General Specification for the 3 Phases of the UAM LWR benchmark
4. Review of the existing OECD/NEA coupled code transient benchmarks BWR Turbine Trip (TT), PWR Main Steam Line Break (MSLB), VVER-1000 Coolant Transients (V1000CT) and their utilization in the UAM LWR benchmark.
5. Review of the BWR Full Bundle Test (BFBT) benchmark and its utilization for the UAM LWR benchmark.
6. Review and integration of the ongoing NEA/CSNI BEMUSE-3 benchmark with the UAM LWR benchmark through the NEA internal co-operation of the NSC and CSNI Committees.
7. Presentation of the basic reference system scenario - Peach Bottom 2 (PB-2) BWR Turbine Trip (TT) – and available data.
8. Discussion of interactions with BWR stability performance.
9. Discussion of a provision to address a PWR system and scenario such as TMI-1 PWR MSLB, PWR-RIA-ATWS, BWR-CRDA-ATWS (with boron modelling), and available data
10. Discussion of a provision to address a VVER system and scenario such as VVER-1000 Coolant Transients and available data.
11. Discussion of the proposed time schedule for the UAM LWR benchmark activities.
12. Participants' presentations on their experience and expertise in uncertainty and sensitivity analysis of LWRs.

13. Discussion on General Specifications for the 3 phases of UAM LWR benchmark

Day 2: 11 May 2007

Technical Sessions on Phase 12 – Discussions of the draft of a detailed specification on Phase I of UAM LWR benchmark relative to sensitivity and uncertainties for the neutronics calculations

14. Presentation of a draft of detailed specification for Exercise 1 of Phase I (I-1) - Derivation of the multi-group microscopic cross-section libraries (nuclear data, selection of multi-group structure, etc.).
15. Review of experimental and evaluated data along with covariance information from existing data libraries from national laboratories, OECD, and literature
16. Review of processing methods and available tools/codes at NEA/OECD and RSICC/ORNL to process the cross section data and associated covariance data for the multi-group libraries utilized as input in lattice physics codes.
17. Presentation of a draft of detailed specification for Exercise 2 of Phase I (I-2) - Derivation of the few-group macroscopic cross-section libraries (energy collapsing, spatial homogenization, etc.)
18. Review of different techniques for the cross section energy collapsing, self-shielding treatment and spatial homogenization techniques and associated uncertainties
19. Evaluation of the influence of energy collapsing of the covariance data on the final uncertainty estimation.
20. Presentation of a draft of detailed specification for Exercise 3 of Phase I (I-3) - Criticality (steady state) stand-alone neutronics calculations (k_{eff} calculations, diffusion approximation, etc.).
21. Review of different approximations for solving neutron balance equation and spatial discretization schemes and associated uncertainties in core calculations.
22. Review of the available criticality experimental data and how they can be utilized for Exercise I-3.
23. Participants' presentations on their expertise and experience relative to sensitivity and uncertainties for the neutronics calculations.
24. Discussion on Phase 1
25. Action items and schedule of benchmark activities
26. Next workshop (UAM-2) and plans
27. Conclusions and closing remarks

Annex 2

OECD/NEA Workshops in Paris and Issy-les-Moulineaux

Host Organization
CEA-Saclay and NEA/OECD
7-11 May 2007

PARTICIPATION FORM

Even if you attend more than one of the following workshops (V1000CT5, BFBT4, AER-WG-D-2006, UAM-1), please send only one form as soon as possible, and in any case not later than 20 April, 2007, both to:

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If you are attending the **AER-WGD-2007** meeting, please send a copy also to Soeren Kliem at s.kliem@fzd.de.

Name:

Company or organization:

Address:

E-mail:

Tel:

Fax:

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

Please fill in the following table (only once if you attend more than one meeting):

Workshop / Date / Location	Attendance / Presentations / Comments – Requests
Fifth V1000CT Workshop (VVER-1000 Coolant Transients) – (V1000CT-5)	<i>Will you attend V1000CT-5?</i>
7 May	
OECD/NEA, 12 boulevard des Iles, 92130 Issy-les-Moulineaux	<i>I shall not attend but send me the summary. (Yes – No)</i>
OECD/NRC Benchmark based on NUPEC BWR - Full-size Fine-mesh Bundle Tests (BFBT) – (BFBT-4)	<i>Will you attend the BFBT-4?</i>
	<i>If so, will you be giving a presentation?</i>
8-9 May	<i>Please specify titles, authors, and sessions for the presentation(s)</i>
Hotel Citadines Les Halles 4 rue des Innocents 75001 Paris	
	<i>I shall not attend but send me the summary. (Yes – No)</i>
Workshop / Date / Location	Attendance / Presentations / Comments - Requests
AER-WGD-2007 Workshop (VVER Dynamics and Safety)	<i>Will you attend the AER workshop?</i>
	<i>If so, will you be giving a presentation?</i>
8 – 9 May	<i>Please specify titles, authors, and sessions for the presentation(s)</i>
Hotel Citadines Les Halles 4 rue des Innocents 75001 Paris	
	<i>I shall not attend but send me the summary (Yes – No)</i>
Dinner 9 May Restaurant « Le Sous Boc »	<i>I will attend (Yes - No)</i>
First workshop for the OECD Uncertainty Analysis in Modelling (UAM) Light Water Reactor (LWR) benchmark - (UAM-1)	<i>Will you attend the UAM-1?</i>
	<i>If so, will you be giving a presentation?</i>
10 – 11 May	<i>Please specify titles, authors, and sessions for the presentation(s)</i>
OECD/NEA, 12 boulevard des Iles, 92130 Issy-les-Moulineaux	
	<i>I shall not attend but send me the summary. (Yes – No)</i>

The BFBT4 and AER Group D workshops will take place at the Hotel Citadines, Les Halles, Paris, while the other two will take place at NEA Headquarters (for the exact location with zooming options please access <http://www.nea.fr/html/dbprog/> and click on the blue 'Map' button).

Exact location and information for Hotel Citadines are available at:
http://fr.federal-hotel.com/hotel-information_hotel-citadines-paris-les-halles_2870.htm

Hotels conveniently located near the BFBT4 and AER Group D meetings are the Hotel of the meetings and others you may find via Internet in that neighbourhood.

Those conveniently located near the NEA Headquarters are listed in
<http://www.nea.fr/html/general/hotels.html>.

Public transportation is available to reach both premises. For more information please see
<http://www.ratp.info/informer/anglais/> and more specifically for NEA <http://www.nea.fr/html/general/nea-access.html>

Annex 3

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

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