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NUCLEAR ENERGY AGENCY
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OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design, operation and Safety Analysis of LWRs (OECD LWR UAM Benchmark)

Expert Group on Uncertainty Analysis

2-4 April 2008
GRS, Garching, Germany

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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 (OECD LWR UAM Benchmark)

Expert Group on Uncertainty Analysis

Second Workshop (UAM-2)

Gesellschaft für Anlagen und Reaktorsicherheit (GRS), Garching, Germany

2-4 April 2008

Hosted by
GRS, Germany

SUMMARY RECORD

Sponsorship

The second workshop for the OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design, Operation and Safety Analysis of LWRs **(**UAM-2**)** was held from 2 to 4 April 2008 in Garching, Germany, and was a follow up to the first workshop. 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.

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 Modeling” 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 Modeling" 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 Modeling 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 modeling 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 Modeling. 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 modeling, 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 modeling (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 modeling 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-2) was 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 modeling and uncertainty analysis and to make participation more efficient. The meetings concerned are the fifth workshop for the OECD/NRC Benchmark based on NUPEC BWR Full-size Fine-mesh Bundle Tests (BFBT-5), which took place on 31 March and 1 April 2008; in parallel with the BFBT-5 workshop also the annual meeting of the Working Group D involved in VVER reactor dynamics and safety research was 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 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 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 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 modeling 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 Modeling Project for Nuclear Reactor Safety”, NEA/NSC/DOC(2007)15. 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.

Scope and Technical Content of the Benchmark Workshop

The technical topics addressed at the workshop included:

- Review of the benchmark activities after the UAM-1 Workshop
- Discussion of the Specification for the Phase I of the UAM LWR benchmark
- Discussion of preliminary results of Phase I
- Discussion of output parameters and format for Phase II
- Discussion of the Priorities for Phases II and III.
- 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 meeting was organized around the discussion in depth of the specification and support data for Phase I of the UAM LWR benchmark, preliminary results of Phase I, output parameters and format for Phase II, priorities for Phases II and III, and the proposed work plan and time schedule for the UAM LWR benchmark activities. The participants presented their experience and expertise in uncertainty and sensitivity analysis of LWRs.

Organization and Programme Committee of the Benchmark Workshop

An Organization and Programme Committee has made the necessary arrangements for the first Benchmark Workshop, organized the Sessions, and prepared the final program. The general chair was S. Langenbuch (GRS), who hosted the meeting. The other members were José Aragonés (UPM), representing the NSC, Francesco D'Auria (UP), representing CSNI, Eric Royer (CEA-Saclay), D. Cacuci (CEA-Scalay), M. Zimmermann (PSI), T. Downar (PU), S. Kliem (FZR), H. Utsuno (JNES), A. Hotta (TEPSYS), Y. Hassan (TAMU), M. Williams (ORNL), and K. Ivanov (PSU), representing the UAM scientific board, and E. Sartori from OECD/NEA Secretariat.

Opening Session – Introduction and opening remarks

S. Langenbuch welcomed participants on behalf of GRS, hosting the workshop. José Aragonés, representing the NSC, provided the background. In this project, for the first time, uncertainties are propagated through the whole process from microscopic cross-sections to plant transients on a unified benchmark framework to provide credible coupled code predictions with defensible uncertainty estimations of safety margins at the full core/system level. The OECD LWR UAM benchmark framework is expected to help formulating recommendations and guidelines on how to utilize advanced and optimized sensitivity analysis and uncertainty analysis (SA/UA) methods in "best estimate" reactor simulations in licensing practices

The agenda was approved with minor amendments (see Annex I).

The workshop was attended by 53 participants from 30 organizations in 18 countries. The list of participants is given in Annex II. The group of participants in this benchmark includes experts from different fields namely in thermal-hydraulics, neutronics and uncertainty analysis. Several expert groups had been formed previously each addressing specific benchmark problems and now they are combining in this long term effort aimed at establishing best-estimate simulation methods with systematic uncertainty analysis across different phenomena (multi-physics) and different scales (multi-scales).

K. Ivanov on behalf of the benchmark team made a presentation giving an overview and status of the UAM benchmark activities. A special session on uncertainty analysis in modelling for multi-physics and multi-scale simulations will be organized at the M&C 2009 conference. Summaries for this conference are expected at the end of September, 2008.

S. Langenbuch discussed in his presentation the technology relevance of Uncertainty Analysis in Modeling (UAM) project for nuclear reactor safety. Among the expected results of this project are:

- Systematic identification of uncertainty sources;
- 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;
- All results will be represented by reference results and variances and suitable tolerance limits;
- The dominant parameters will be identified for all physical processes;
- Support of the quantification of safety margins;
- The experiences of validation will be explicitly and quantitatively documented;
- Recommendations and guidelines for the application of the new methodologies will be established.

Technical Sessions on Phase I

Sessions 1 through 8 were devoted to discussion of the Specification and Supporting Data for the **Phase I** as well as of the preliminary results obtained by participants mostly on Exercise I-1. First the approach followed in the development of the Specification for Phase I, focused on stand-alone neutronics, was discussed in more detail. As a result of this discussion the following comments and suggestions have been made.

In addition to k_{eff} and power distribution, Phase I should address kinetic parameters, and control rod worth, which are relevant for design and safety analysis. One of the objectives of the benchmark is to provide recommendations for physical and numerical models suitable for reactor physics and uncertainty analysis. For that purpose, participants will be requested to provide information about the models they use. If necessary, clusters of models/approaches can be defined for a more consistent comparison of the results. The reference solutions with Monte-Carlo simulations can be very valuable if there are several calculations with different nuclear data libraries in order to assess the effect of evaluated nuclear data on well defined problems. In order to avoid different interpretations there is a need to define more precisely in the specification (by formulas in terms of variances, covariances, standard deviations, etc.) the considered input and output uncertainties as well their correlation and their propagation. . In the requested output and corresponding templates for submission of results for different exercises in addition to the best estimate value of output parameters a place and format of the associated uncertainties should be provided.

Next the definition of each of the three exercises of Phase I was discussed in depth along with the data tools applicable to each exercise as well as the selected test problems and corresponding requested output for each exercise.

Exercise I-1 (Cell Physics) propagates the uncertainties in evaluated nuclear libraries data files (microscopic point-wise cross sections) into multi-group microscopic cross-sections used as input by the lattice physics codes. The current status of the evaluated cross-section Nuclear Data Libraries (NDL) is such that the most comprehensive covariance library is available with SCALE-5.1. For this reason it was decided to utilize the nuclide dependent multi-group covariance data from SCALE 5.1 for the purposes of Exercise I-1. It is based on a 44-group structure. For other group structures, NEA/OECD has provided the tools for handling and transforming the cross-section covariance in a consistent way. Covariance data are relative values and can be used with different NDLs. In order to analyze the results on a common ground, it is recommended to participants to use only these data and tools.

Shortcomings in some datasets were reported; these will be repaired and a revision of the covariance data issued together with a description of the changes. As to the normalisation of the sensitivities relative to fission spectrum, a paper will be issued describing the method and examples.

Suggestions were made to expand the proposed pin cell test problems (representative of PWR, BWR and VVER) by introducing in addition to HZP also HFP (at operating conditions) cases, which allow to vary the spectrum in the test problems. Depletion effects will be introduced later in the benchmark (Phase III). The NDL effect will be assessed by running Monte Carlo simulations with the major libraries: ENDF/B-VI.8, ENDF/B-VII.0, and JEFF-3.1. The KRITZ-2 LEU mini-core test cases are suggested to be utilized in Exercises I-2. The KRITZ-2 LEU pin cell test cases are already well specified, and it is proposed that they are kept as optional test cases in Exercise I-1 (in preparation for the next Exercise I-2).

Exercise 2 (Lattice Physics) determines the overall uncertainties in few-group macroscopic cross-sections used for core calculations. It was suggested that the colour-set test problems with reflector (mini-core test problems) to be removed since the reflector effect is not representative of the real core (size effect). Only colour-set test problems without reflector (in infinite geometry) are suggested to be analyzed. The sources of "uncertainties" are actually divided in two main categories: the modelling effects (or calculation bias) on one hand and the input uncertain parameters on the other hand (including nuclear data, geometry, fuel manufacturing…). It might be valuable to assess separately these two contributions and provide recommendations for reducing the total uncertainty (where the efforts will have a larger impact on the results). For the analysis of output parameters, it is suggested to focus on the standard two-group structure (with 0.625 eV cut-off) utilized in the LWR industrial calculation scheme. The lattice physics codes, which are expected to be used by the participants in this exercise, include APOLLO, CASMO, HELIOS, TRITON, etc. The output parameters should include pin power distribution and kinetic parameters in addition to the ones already defined in the Specification output parameters.

Exercise 3 (Core Physics) computes uncertainties at core level. The suggested output parameters to be compared with their associated uncertainties are k_{eff}, assembly and/or pin power distribution, control rod worth, and core average kinetic parameters. Concerning pin power, the pin power reconstruction is the main technique currently used, but direct pin-cell by pin-cell core calculations are also encouraged. The core simulators, which are expected to be used by the participants in this exercise, include CRONOS, DYN3D, NEM, PARCS, etc.

Technical Sessions on Phases II and III

Sessions 9 and 10 were devoted to discussing priorities, general Specifications and support data, and output parameters and format for Phases II and III.

A new VVER-1000 coupled code benchmark based on the Kalinin-3 plant was proposed. The available data are numerous, accurate and well documented. They include a MCP switch-off transient at nominal power. The Kalinin-3 plant differs from the Kozloduy-6 plant used in the V1000CT benchmark only by the core loading and the control rods. To enhance the value of this benchmark within the UAM activities for the VVER-1000 track, it is suggested to use the Kalinin-3 plant data for Phase I stage (in addition or instead of Kozloduy-6). Hence, uncertainties could be evaluated on the neutronics cross-sections and then propagated in the coupled thermal-hydraulic/neutronics calculations of the plant (steady-state and transient conditions).

The main conclusions and recommendations of the BEMUSE benchmark activities were presented since those are relevant to the PWR track of Phase III (System Phase) of the OECD UAM Benchmark. Phase 3 (uncertainty analysis of the LOFT L2-5 experiments, Large Break LOCA type) and Phase 5 (uncertainty analysis of a PWR LB LOCA event for the Zion reactor, described by a RELAP5 input deck) provide interactions and can be utilized in the UAM activities. The BEMUSE benchmark has identified the difficulty to quantify the uncertainties on input parameters: they are mainly based on expert judgement only.

As a result of the follow-up discussion the following comments and suggestions have been made. Phase II will address the core neutron kinetics, thermal-hydraulics and fuel performances, without any coupling between the three physics phenomena. Phase III will include system thermal-hydraulics and coupling between fuel, neutronics and thermal-hydraulics for steady-state, depletion and transient analysis. A recommendation was made by University of Pisa, namely to carry out a strict evaluation of the results obtained in Phases I and II before entering in Phase III. Output parameters and targets were proposed and discussed for Exercises of Phases II and III for the three main types of LWR selected in UAM (PWR, BWR and VVER). They will be taken into account for preparing the draft Specifications of Phase II (and later Phase III). For Exercise II-1 (fuel thermal properties relevant for transient performance) the available experimental data can be identified from the CRISSUE-S data base. The available kinetics experiments (Exercise II-2) for the three LWR types will be searched by the benchmark team with the help of the participants. For fuel bundle thermal-hydraulics (Exercise II-3), data are available for the BWR bundle type (from the OECD/NRC BFBT benchmark), but there is a need for VVER bundle data (the benchmark data form the PSB facility will be examined for this purpose) and for PWR bundle data (the possibility to obtain such data from the NUPEC data base will be explored). A first list of transients to be considered for Phase III is proposed: turbine trip transient, rod ejection accident, main steam line break transient, pump trip or start-up transients, and LOCA. The transient scenarios will be defined for the three main LWR types selected for the UAM benchmark.

In the final discussion the following suggestions and recommendations were accepted by the participants in the workshop. This project is challenging and responds to needs of estimating confidence bounds for results from simulations and analysis in real applications. It will create the favorable environment for the development of these methods and their use and become a standard. In order to achieve this, the UAM scientific board members recommended that research organizations and institutions reserve the necessary funds to support this activity and that an uncertainty analysis culture is developed in nuclear engineering. The Specifications are being prepared in order to allow participation in the full Phase or only in a subset of the Exercises or in a separate Exercise. Boundary conditions and necessary input information will be provided by the benchmark team. Each organization interested in the UAM benchmark has to identify its own objectives and priorities. In particular for the preparation of Phases 2 and 3, it might be necessary to rank the priorities between the reactor types or the transients to be analyzed.

General presentations

Dan G. Cacuci provided a presentation on "Verification, Validation and Predictive Best-Estimate Model Calibration in Computational Engineering and Physics". After having noted that the terms Verification and Validation are used with different meaning in different communities (e.g. neutronics, thermal-hydraulics), participants have agreed to adopt these terms as formulated in that presentation. Nevertheless, participants also identify an intermediate step to assess the bias of a model. This is particularly relevant in neutronics since there is a reference model available to solve the transport equation, i.e. Monte-Carlo. Then one can compare a particular (simplified) model to this reference and quantify the deviation of this model using the same input data and boundary conditions (to avoid any coupling with other uncertainties). The bias should be considered separately when assessing the discrepancies between calculations and experimental data since the bias is usually well-known with a constant sign (e.g. systematic under-estimation). In "Going beyond the Current State-of-the-Art" the importance of moving to higher order procedures is shown. These proposals will be considered during the course of further developments in the suite of benchmarks.

Stefano Tarantola presented the "role of global sensitivity analysis in modeling". In the following discussion he agreed to co-operate with the benchmark team in order to demonstrate the usefulness of their method.

Tatiana Ivanova presented the activities of the expert group UACSA (Uncertainty Analysis for Criticality Safety Assessment). She explained that the scope and objectives of this activity, concerns away from reactor issues and criticality safety margins and not reactor physics issues.

Conclusions, Actions and Schedule

In summary, at the UAM-2 workshop the benchmark team presented in total 19 presentations supplemented by 14 presentations from participants. The action items and schedule of benchmark activities were discussed. They are provided in the following list:

List of Agreed Actions

1. End of April 2008 – Summary of the UAM-2 workshop (NEA/NSC document).

2. End of April 2008 – Deadline for intent of participation in the UAM special session during the M&C 2009 conference (please send e-mail to kni1@psu.edu).

3. End of May 2008 – 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

4. End of July 2008 – Templates for submission of results for the 3 exercises of Phase I

5. End of September 2008 – Input data for different exercises for participants who want to participate only in selected exercises.

6. End of September 2008 – deadline for submission of a 1500 words abstract for the UAM special session during the M&C 2009 conference.

7. End of December 2008 – Deadline for submission results for Exercise I-1

8. End of March 2009 – Deadline for submission preliminary results for Exercises I-2 and I-3

9. April 29 – May 1 2009 - Third Workshop of the OECD LWR UAM Benchmark (UAM-3) will be hosted by PSU, USA

The UAM-3 workshop will be held in conjunction with the OECD/NRC BFBT-6 benchmark workshop and the First Kalinin-3 Benchmark Workshop. The OECD/NRC BFBT-6 and Kalinin-3 workshops will be held in parallel on April 27-28 2009 and will be also 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 (5 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). Participants in the OECD LWR UAM benchmark will get preference for invitation to contribute to this session.

The objectives of the next workshop (UAM-3) will be the following:

a) Discussion of submitted results of Phase 1

b) Discussion of draft Specification for Phase 2

c) Discussion of priorities for Phase 3.

Annex I

OECD/ Nuclear Energy Agency
Working Party on Scientific Issues of Reactor Systems (WPRS)

OECD Benchmark for Uncertainty Analysis in Best-Estimate Modelling (UAM) for Design, Operation and Safety Analysis of LWRs - Second Workshop (UAM-2)

Hosted by
GRS mbH, Garching
April 2-4 2008

PROGRAMME [U201]

Day 1: 2 April 2008

Opening Session – Chair S. Langenbuch

09:00 - 09:15 Introduction and opening remarks, participants– S. Langenbuch, J. Aragones [U202]

09:15 – 09:30 Overview and status of benchmark activities – K. Ivanov [U203]

09:30 – 09:50 Technology relevance of the Uncertainty Analysis in Modelling – F. D'Auria, S. Langenbuch, E. Royer [U204]

Technical Sessions on Phase I

Session I – Chair Eric Royer

09:50 – 10:15 Overview of Specification for Phase I – K. Ivanov, M. Avramova, I. Kodeli, E. Sartori [U205]

10:15 – 10:45 Discussion in depth of the definition for Exercise 1 of Phase I (I-1) - Cell Physics – K. Ivanov, M. Avramova, I. Kodeli, E. Sartori [U206]

10:45 – 11:00 Coffee Break

Session II – Chair S. Kliem

11:00 – 11:30 Introduction to discussion of the covariance data and tools distributed for the Exercise I-1 - K. Ivanov [U207]

11:30 – 12:00 Further work in upgrading the quality of some of the cross-section covariance data and their use in SCALE, and brief presentation on the GPT TSUNAMI products - B. Rearden [U208]

12:00 – 12:30 Sensitivity and Uncertainty Analysis Tools Available / Developed at the NEA Data Bank - I.A. Kodeli (presented by E. Sartori) [U209]

12:30 – 14:00 Lunch

Session III – Chair B. Rearden

14:00 – 14:20 Discussion of the selected test problems for Exercise I-1 – K. Ivanov, M. Avramova, Federico Puente Espel [U210]

14:20 – 14:35 Discussion of requested output for Exercise I-1 – K. Ivanov, M. Avramova [U211]

14:35 – 15:00 Verification, Validation and Predictive Best-Estimate Model Calibration in Computational Engineering and Physics – D. Cacuci (presented by E. Sartori) [U212]

Participants' presentations on their expertise and experience relative to Exercise I-1

15:00 – 15:25 UAM Phase 1 test accomplished with SCALE 5.1 TSUNAMI – P. Vertes [U213]

15:25 – 15:50 Uncertainty Analysis in Modelling Benchmark Phase I-1, Cell Physics - A. Santamarina, Claire Vaglio [U228]

15:50 – 16:00 Coffee Break

Session IV – Chair R. Macian

16:00 – 16:15 Preliminary calculations at VTT - M. Pusa [U214]

16:15 – 16:35 Presentation of UACSA (Uncertainty Analysis for Criticality Safety Assessment) - T. Ivanova, E. Letang [U215]

16:35 – 17:00 Preliminary results on Exercise I-1 by SCALE5.1 code - C. Parisi, F. D'Auria [U216]

16:00 – 17:20 Use of the SUHAM-U Code for Phase-I of Benchmark for Uncertainty Analysis in Modeling of LWRs", V.F. Boyarinov, V.S. Odintsov [U217]

17:20 – 17:48 Discussion of Exercise I-1

<u>**Day 2: 3 April 2008**</u>

Session V – Chair V. Boyarinov

09:00 – 09:30 In depth discussion of the definition for Exercise 2 of Phase I (I-2) - Lattice Physics - K. Ivanov, M. Avramova [U218]

09:30 – 10:00 Discussion about the data and tools applicable to Exercise I-2 – K. Ivanov [U219]

10:00 – 10:30 Discussion on the selected test problems for Exercise I-2 – K. Ivanov, M. Avramova [U220]

10:30 – 10:45 Discussion of Exercise I-2

10:45 – 11:00 Coffee Break

Session VI – Chair A. Pautz

11:00 – 11:30 Discussion on requested output for Exercise I-2 – K. Ivanov, M. Avramova [U221]

11:30 – 12:00 In-depth discussion of the definition for Exercise 3 of Phase I (I-3) - Core Physics - K. Ivanov, M. Avramova [U222]

12:00 – 12:30 Discussion on the data and tools applicable to Exercise I-3 – K. Ivanov [U223]

12:30 – 14:00 - Lunch

Session VII – Chair D. Panayotov

14:00 – 14:30 Discussion on the selected test problems for Exercise I-3 – K. Ivanov, M. Avramova [U224]

14:30 – 15:00 Discussion on requested output for Exercise I-3 – K. Ivanov, M. Avramova [U225]

15:00 – 15:20 Discussion of Exercise I-3

15:20 – 15:35 Coffee Break

Session VIII – Chair C. Parisi

Participants' presentations on their expertise and experience relative to Exercises I-2 and I-3

15:35 – 16:00 The role of global sensitivity analysis in modeling – S. Tarantola [U226]

16:00 – 16:25 Effect of Nuclear Data on Core Calculations - W. Zwermann [U227]

16:50 – 17:15 KAERI Experience on the uncertainty evaluation for reactor physics code package - K.S. Kim [U229]

<u>Day 3: 4 April 2008</u>

Session IX – Chair J. Macek

Participants' presentations on their experience and expertise relative to Phases II and III

09:00 – 09:25 Specification of a Benchmark based on Kalinin-3 data
S.Langenbuch, A.Kolychev, M.Lizorkin, S.Nikonov, K.Velkov [U230]

09:25 – 09:50 Presentation on BEMUSE Activities - A. De Crecy [U231]

09:50 – 10:15 Analysis of the Uncertainty of Void Fraction on the BWR MCPR using TRACE - Y. Xu and T. Downar (presented by K. Ivanov) [U232]
[not available]

10:15 – 10:40 Ideas and Suggestions for Phases II and III – A. Petruzzi, C. Parisi, F. D'Auria [U233]

10:40 – 11:55 – Coffee Break

Session X – Chair K. Ivanov

10:55 – 11:05 Why the UAM Initiative – Eric Royer [U239]

11:05 – 11:20 Discussion on the priorities for Phases II and III – K. Ivanov [U234]

11:20 – 11:30 Discussion on output parameters and format for Phase II – K. Ivanov [U235]

10:30 – 11:40 Discussion on general Specification and support data for Phase II – K. Ivanov [U236]

11:40 – 11:50 Discussion on output parameters and format for Phase III – K. Ivanov [U237]

11:50 – 12:00 Discussion on general Specification and support data for Phase III – K. Ivanov [U238]

12:00 – 12:20 Discussion of Phases II and III

12:20 – 12:30 Action items and schedule of benchmark activities - next workshop (UAM-3) and plans - E. Sartori

12:30 -12:40 Conclusions and closing remarks – S. Langenbuch

Annex II

UAM-2 (2nd Workshop on Uncertainty Analysis in Modelling, Garching 2-4.IV.08)

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