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**NUCLEAR ENERGY AGENCY
NUCLEAR SCIENCE COMMITTEE**

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**NUCLEAR SCIENCE COMMITTEE
and
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS**

**OECD/DOE/CEA
VVER-1000 Coolant Transient Benchmark (V1000-CT)
PROPOSED PROGRAMME FOR THE FIFTH WORKSHOP**

**7 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/DOE/CEA
VVER-1000 Coolant Transient Benchmark
(V1000-CT) – 5th Workshop**

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

7 May 2007

Hosted by
OECD/ NEA and CEA Saclay
France

PROPOSED PROGRAMME

**OECD/DOE/CEA
VVER-1000 Coolant Transient Benchmark
Fifth Workshop (V1000-CT5)**

(NEA Headquarters, Issy-les-Moulineaux, France, 7 May 2007)

Sponsorship

The fifth workshop for the VVER-CT benchmark will be held on 7th May in Paris, France, and is a follow up to:

1. the ad-hoc meeting held during the PHYSOR-2006 conference, Vancouver, Canada, on 12th September 2006;
2. the fourth workshop, hosted by University of Pisa, Italy, on 24-25 April 2006;
3. the ad-hoc meeting held during the NURETH-11 conference, Avignon, France, held on 4th October 2005;
4. the third workshop, hosted by GRS, Garching, Germany, on 4-5 April 2005;
5. the second workshop, hosted by INRNE and KNPP, Bulgaria Sofia, Bulgaria, on 5-6 April 2004;
6. the first workshop hosted by the CEA-Saclay (Paris), France, on 12-13 May, 2003; and
7. the starter meeting hosted by the Forschungszentrum Rossendorf (FZR), Germany on 30 May, 2002.

The V1000-CT Benchmark is sponsored by the US DOE, OECD, CEA, and the Nuclear Engineering Program (NEP) of the Pennsylvania State University (PSU). The NEP, PSU (USA), CEA-Saclay (France) and the Institute of Nuclear Research and Nuclear Energy (INRNE), Sofia (Bulgaria), perform these international benchmark activities in collaboration and with the assistance of the ANL (USA) and the Kozloduy nuclear power plant (KNPP), Bulgaria.

This workshop is held in conjunction with the Atomic Energy Research (AER) "VVER Dynamics and Safety " Working Group D meeting, scheduled for 8 and 9 May 2007, in Paris, in order to facilitate co-ordination and sharing of work. Two other meetings are also being held in nearby places and during the same week in order to combine efforts in common areas such as Computational Fluid Dynamics (CFD) modelling and uncertainty analysis, and make participation more efficient. The meetings concerned are: (1) the fourth workshop for the OECD/NRC benchmark based on the NUPEC BWR Full-size Fine-mesh Bundle Tests (BFBT-4), scheduled for 8-9 May 2007 (in parallel to the AER Working Group D meeting), and (2) the OECD/NEA/ first workshop on Uncertainty Analysis in Modelling (UAM-1) Light Water Reactor (LWR) benchmark, scheduled for 10-11 May 2007.

Background and Purpose of the Benchmark Workshop

The Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development (OECD) has completed, under the sponsorship of the Nuclear Regulatory Commission (NRC), a PWR Main Steam Line Break (MSLB) Benchmark against thermal-hydraulic/neutron kinetics codes. Recently another OECD/NRC coupled code benchmark was completed for a BWR turbine trip (TT) transient. During the course of defining and coordinating the OECD/NRC PWR MSLB and BWR TT benchmarks, a systematic approach was established to validate best estimate coupled codes. This approach employs a multi-level methodology that not only allows a consistent and comprehensive validation process but also contributes to determining additional requirements as well as to preparing a basis for licensing application of coupled calculations for a specific reactor type, and to developing safety expertise in analyzing reactivity transients. Professional communities have been established during the course of these benchmark

activities that allowed in-depth discussions of the different aspects relative to assessing neutron kinetics modelling for a given reactor and the way to implement best-estimate methodologies for transient analysis using coupled codes. The above examples demonstrate the benefit of establishing such international coupled standard problems for each type of reactor.

Further continuation of the above activities is the development of a VVER-1000 coolant transient (V1000CT) benchmark, which defines coupled code standard problems for validation of thermal-hydraulics system codes for application to Soviet-designed VVER-1000 reactors based on actual plant data. The overall objective is to assess computer codes used in the safety analysis of VVER power plants, specifically for their use in reactivity transients in a VVER-1000. In performing this work, the PSU (USA) and CEA-Saclay (France) have collaborated with Bulgarian organizations, in particular with INRNE and the KNPP. The V1000CT benchmark consists of two phases: V1000CT-1 is a simulation of the switching on of one main coolant pump (MCP) when the other three MCP are in operation, and V1000CT-2 includes calculation of vessel mixing experiments and main steam line break (MSLB) scenarios. Each of the two phases contains three exercises. Original data from the Kozloduy-6 nuclear power plant are available for the validation of computer codes. The reference problem chosen for simulation in Phase 1 is a MCP switching on experiment that was conducted by Bulgarian and Russian engineers during the plant-commissioning phase at the Kozloduy NPP Unit #6 as a part of the start-up tests. The test was done because of its importance for the safety of the VVER-1000 NPP, model 320. The reactor is at the beginning of cycle (BOC) with average core exposure of 30.7 EFPD. At the beginning of the experiment there are three pumps in operation – 1st, 2nd and 4th main coolant pumps and the reactor power is at 27.47% of the nominal power level (824 MW). The control rod group #10 is inserted into the core. The group position in axial direction is at about 36% withdrawn from the bottom of the reactor core. Analysis of the initial three-dimensional (3-D) relative power distribution showed that this insertion introduced axial neutronics asymmetry in the core. At the beginning of the transient there is also a radial thermal-hydraulic asymmetry coming from the colder water introduced in one quarter of the core when MCP #3 is switched on. This causes a spatial asymmetry in the reactivity feedback, which is propagated through the transient and combined with insertion of positive reactivity. In summary, this event is characterized by a rapid increase in the flow through the core resulting in a coolant temperature decrease, which is spatially dependent. This leads to insertion of spatially distributed positive reactivity due to the modelled feedback mechanisms and non-symmetric power distribution. Simulation of the transient requires evaluation of core response from a multi-dimensional perspective (coupled three-dimensional neutronics/core thermal-hydraulics) supplemented by a one-dimensional simulation of the remainder of the reactor coolant system. Three exercises are defined in the framework of Phase 1:

- a) Exercise 1 – Point kinetics plant simulation;
- b) Exercise 2 – Coupled 3D neutronics/core thermal-hydraulics response evaluation;
- c) Exercise 3 – Best-estimate coupled 3D core/plant system transient modelling.

In addition to the measured (experiment) scenario, extreme calculation scenarios were defined in the frame of Exercise 3 for better testing of 3D neutronics/thermal-hydraulics techniques. The proposals concerned rod ejection simulations with scram set points at two different power levels.

In Phase 2, a coolant mixing experiment and MSLB scenarios are selected for simulation. Since the previous coupled code benchmarks indicated that further development of the mixing models in the integrated codes is necessary, a specific objective is the testing of vessel mixing models. Three exercises are defined:

- a) Exercise 1 – Computation of a Kozloduy-6 vessel mixing experiment

- b) Exercise 2 – Coupled 3D neutronics/vessel thermal hydraulics response evaluation (vessel boundary condition problem)
- c) Exercise 3 – Best-estimate coupled 3D core/3D vessel/plant system modelling

Exercise 1 includes an additional option of CFD modelling of the vessel with MSLB boundary conditions rather than specifying core boundary conditions. The vessel simulation can be done from the RPV inlet to the core inlet, or for the whole vessel from the inlet to the outlet. For this specific case additional data from KNPP Unit #6 are made available. The selected mixing experiment was conducted at KNPP #6 as part of the plant commissioning phase. This asymmetric experiment includes SG isolation at 9.4% of the nominal rated power, with all MCP in operation, causing single loop heating-up. It will be used to test and validate the vessel-mixing models (fine CFD, coarse-mesh and mixing matrix). Vessel boundary conditions and core power distribution are part of this exercise specification. The standard problem can be considered as pure thermal-hydraulic problem.

Exercise 2 includes modelling of the core and the vessel only. Pre-calculated reactor vessel MSLB boundary conditions are provided. Exercise 3 is to enable a full-plant test of the integrated code. The MSLB transient is initiated by a break between the steam generator and the steam isolation valve, outside of the containment. This event is characterized by a large asymmetric cooling of the core, stuck rods and a large primary coolant flow variation. Two scenarios are defined: the first scenario is taken from the current licensing practice and the second one is derived from the original one using aggravating assumptions to enhance the code-to-code comparisons. The main objective is to clarify the local 3D feedback effects depending on the vessel mixing. Special emphasis is put on testing 3D vessel thermal-hydraulics models and coupling of 3D neutronics/vessel thermal hydraulics.

At its annual meeting in Paris in June 2002, the Nuclear Science Committee (NSC) of NEA/OECD approved and endorsed the developed V1000CT benchmark problem to become an international standard problem for validation of the best-estimate safety codes for VVER applications. Collaboration with the AER Working Group D involved in VVER reactor dynamics and safety on the proposed VVER-1000 coolant transient benchmark has been established and the AER participates actively in the benchmark activities. The co-operation of this working group with the V1000CT benchmark group was endorsed by the OECD/NEA NSC, and is supported by the Safety Division. The AER Working Group D meeting will be held from 8 to 9 May, 2007, also in Paris, France.

Scope and Technical Content of the Benchmark Workshop

The technical topics presented at this workshop are shown below. In addition, the proposed workshop programme is attached as Annex.

- Review of the benchmark activities after the 4th Workshop and the ad-hoc meeting during PHYSOR-2006
- Conclusions of Phase 1
- Presentation and discussion of final results from Exercise 1 of Phase 2
- Discussion of the Specifications for Exercises 2 and 3 of Phase 2
- Presentation and discussion of final results from Exercises 2 and 3 of Phase 2
- Definition of a work plan and schedule, actions to progress in completing the 2 phases

Organization of the Benchmark Workshop

The meeting is organized around the discussion of the Specifications of Exercises 2 and 3 of Phase 2, final results for Exercise 1 of Phase 2 and preliminary results for Exercises 2 and 3 of Phase 2. Presentations on related experience in VVER core and system modelling as well as on CFD modelling are encouraged.

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 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 is provided as Annexes 3 and 4) and in particular to participants in this study.

The meeting is open to experts from Central and Eastern European Countries, and the New Independent States of the ex-Soviet Union who are in a position to provide a substantive contribution to this study. Participation of these experts will be arranged by the NEA Secretariat including participants of AER organizations and Kiev University, Ukraine.

Organization and Programme Committee of the Benchmark Workshop

An Organization and Programme Committee was nominated to organise the Benchmark Workshop, arrange the Sessions, draw up the final programme, and to appoint Session Chairmen, etc. Its members are:

Eric Royer (chairman)

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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 as soon as possible 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 Working Party on Scientific Issues in Reactor Systems (WPRS) and CSNI. In addition, copies of presentations will be distributed free of charge to all participants at the meeting.

Workshop Location

OECD/NEA Headquarters,
7th floor
12 boulevard des Iles,
92130 Issy-les-Moulineaux

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>

Annex 1

**OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark - Fifth Workshop
(V1000-CT5)**

Issy-les-Moulineaux, France
7 May 2007

Hosted by: OECD/NEA and CEA Saclay

PROPOSED PROGRAMME

May 7th

Session 1 – Session Chair – E. Royer

- 09:00-09:30 Introduction and Welcome
CEA Saclay, OECD-NEA, Benchmark team (Penn State University, INRNE), AER WG D
Introduction of Participants
- 09:30-10:00 Status and final actions of V1000CT1 – *K. Ivanov*
- 10:00-10:30 Overview and status of V1000CT2 benchmark – *N. Kolev, E. Royer*
- 10:30-10:45 Coffee Break

Session 2 – Session Chair – S. Kliem

- 10:45-11:15 Presentation of final results for V1000CT2 Exercise 1 (Volume III of V1000CT2)
- *N. Kolev, E. Royer*
- 11:15-12:00 Presentation of final Specifications for MSLB Exercises (Volume II of V1000CT2)
Cross section libraries – *B. Ivanov*
Requested outputs – *N. Kolev*
- 12:00-12:30 Presentation of submitted results for V1000CT2 Exercise 2 – *N. Kolev et al.*
- 12:30-14:00 Lunch

Session 3 – Session Chair – K. Ivanov

- 14:00-14:30 Presentation of submitted results for V1000CT2 Exercise 3 – *N. Kolev et al.*
- 14:30-16:00 Participants' presentations
Results for V1000CT2 Exercise 2
Results for V1000CT2 Exercise 3
- 16:00-16:15 Coffee Break

Session 4 – Session Chair – E. Sartori

- 16:15-16:30 Summary of technical issues and remaining actions for V1000CT2 – *N. Kolev, E. Royer*
- 16:30-16:45 Discussion of the schedule for completing the benchmark – *E. Sartori*
- 16:45-17:00 Conclusion and closing remarks

Annex 2

OECD/NEA Workshops in Paris and Issy les Moulineaux

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

PARTICIPATION FORM

Even if you attend more than one of the following workshops (V1000CT4, BFBT3, AER-WG-D-2006, UAM-2006), please send only one form as soon as possible, and in any case not later than 31 March, 2006, both to:

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If you are attending the **AER Working Group D** 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 Working Group D 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 where the meetings will take place and others you may find via Internet in that neighbourhood.

Those conveniently located near the OECD/NEA 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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