

## OECD

The Convention establishing the Organization for Economic Cooperation and Development (OECD) was signed on the 14<sup>th</sup> of December 1960.

Pursuant to Article 1 of the Convention, the OECD shall promote policies designed:

- To achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- To contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- To contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The current Signatories of the Convention are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, the Federal Republic of Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

## NEA

The OECD Nuclear Energy Agency (NEA) was established on 1<sup>st</sup> of February 1958 under the name of the OEEC European Nuclear Energy Agency. NEA membership today consists of all European Member countries of OECD as well as Australia, Canada, Japan, Republic of Korea, Mexico, and the United States. The Commission of the European Communities takes part in the work of the Agency.

The primary objective of NEA is to promote cooperation among the governments of its participating countries in furthering the development of nuclear power as a safe, environmentally acceptable and economic energy source.

NEA works in close collaboration with the International Atomic Energy Agency (IAEA), with which it has concluded a Cooperation Agreement, as well as with other International Organizations in the nuclear field.

## CSNI

The NEA Committee on the Safety of Nuclear Installations (CSNI) is an international committee made up of scientists and engineers insofar as they effect the safety of such installations. The Committee's purpose is to foster international cooperation in nuclear safety amongst the OECD Member countries.

## NSC

The NEA Nuclear Science committee promotes cooperation among NEA member countries in fields of nuclear science relevant to the purposes of the Agency. Areas of activities include basic nuclear data measurements and evaluations, physics of plutonium recycling and innovative fuel cycles, nuclear criticality safety, radiation shielding and reactor physics benchmarks.

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

**OECD/DOE/CEA  
VVER-1000 Coolant Transient Benchmark.  
(V1000-CT) – 2<sup>nd</sup> Workshop**

Sofia, Bulgaria  
5-6 April 2004

Hosted by  
INRNE and KNPP, Bulgaria

**PRELIMINARY ANNOUNCEMENT**

Deadline for Registration:

22 March 2004

**OECD/DOE/CEA  
VVER-1000 Coolant Transient Benchmark  
Second Workshop (V1000-CT2)**

(Sofia, Bulgaria, 5-6 April 2004)

**Sponsorship**

The second workshop for the VVER-CT benchmark will be held on 5<sup>th</sup> and 6<sup>th</sup> April 2004 in Sofia, Bulgaria, and is a follow up to the first workshop hosted by the CEA-Saclay (Paris), France, on 12-13 May, 2003, and to 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) at 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 Kozloduy nuclear power plant (NPP) – KNPP (Bulgaria).

This workshop will be held in conjunction with the Atomic Energy Research (AER) "VVER reactor safety analysis" Working Group D Meeting, scheduled for 7-8 April 2004 at the same place, in order to facilitate co-ordination and sharing of work.

**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 has been 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 of licensing application of the coupled calculations for a specific reactor type and to developing a safety expertise in analyzing reactivity transients. Professional communities have been established during the course of these benchmark activities that allowed in-depth discussions of different aspects of assessing neutron kinetics modeling for a given reactor and how 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 the KNPP and the INRNE. The V1000CT benchmark consist 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 concerns calculation of coolant mixing tests and main steam line break (MSLB) scenarios. Each of the two phases contains three exercises.

The reference problem chosen for simulation in Phase 1 is a MCP switching on when the other three main coolant pumps are in operation in a VVER-1000. It is an 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, as it is important for the safety of the NPP with VVER-1000, 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 – 1<sup>st</sup>, 2<sup>nd</sup> and 4<sup>th</sup> main coolant pumps and the reactor power is at 27.47% of the nominal power level (824 MWt). 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 ¼ 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 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 modeled 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 3-D neutronics/core thermal-hydraulics response evaluation;
- c) Exercise 3 – Best-estimate coupled 3-D core/plant system transient modeling.

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

Since the previous coupled code benchmarks indicated that further development of the mixing computation models in the integrated codes is necessary, a coolant mixing experiment and a MSLB scenario are selected for simulation in Phase 2 of the benchmark. The introduction as an additional option of CFD modeling of the vessel with specific boundary conditions rather than core boundary conditions and CFD modeling of the mixing is also included as Exercise 1 of Phase 2. For this specific case additional data from KNPP Unit #6 is made available. The selected mixing experiment was conducted at KNPP #6 as part of the plant commissioning phase. This asymmetric experiment includes single loop cooling and heating-up at 9 % of nominal power with all MCP in operation. It will be used to test and validate vessel-mixing models (CFD, coarse-mesh and mixing matrix). Vessel boundary conditions and core power distribution are part of this exercise specification.

The transient to be analyzed in Phase 2 is initiated by a MSLB in the VVER-1000 NPP 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 3-D feedback effects depending on the vessel mixing. Special emphasis is put on testing 3-D vessel thermal-hydraulics models and coupling of 3-D neutronics/vessel thermal-hydraulics. The MSLB scenario simulation is divided into two exercises: Exercise 2 consists of coupled 3-D neutronics/vessel thermal-hydraulics simulation using specified vessel thermal-hydraulic boundary conditions, and Exercise 3 consists of best-estimate coupled 3-D core/3-D vessel/plant system modeling.

In June 2002 the Nuclear Science Committee (NSC) of NEA/OECD, at its annual meeting in Paris, 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 safety research on the proposed VVER-1000 coolant transient benchmark is 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 meeting will be held during 7-8 April, 2004 at the same premises in Sofia, Bulgaria.

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

The technical topics presented at this workshop are shown below. In addition, the preliminary workshop schedule is attached at the end of this announcement:

- Review of the benchmark activities after the 1<sup>st</sup> Workshop
- Discussion of participant's feedback and introduced modifications to the Benchmark Specifications on Phase 1
- Presentation and discussion of submitted results from Exercise 1 of Phase 1
- Presentation and discussion of submitted results from Exercise 2 of Phase 1
- Presentation and discussion of modeling issues and preliminary results of Exercise 3, Phase 1
- Discussion of the draft of the Specifications for Exercise 1 of Phase 2
- Discussion of modeling issues of Exercises 1 and 2 of Phase 2 – CFD modeling and the available experimental data, and the MSLB scenario
- Defining work plan and schedule, actions to progress in completing the 2 phases

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

The meeting will be organized around the discussion of the Specifications of Phase II and submitted results on the Exercises 1 and 2 and preliminary results for Exercise 3 of Phase 1. Presentations on related experience in VVER core and system modeling as well as on CFD modeling are encouraged.

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

As usual for Benchmark Workshops sponsored by the Nuclear Science Committee (NSC) and Committee on the Safety of Nuclear Installations (CSNI), participants will be 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 are provided as Annex) and in particular to participants in this study.

The meeting is open to a small number of 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 and it includes participants of AER organizations and Kiev University, Ukraine.

Anyone who wishes to participate should fill in the attached Participant Registration Form and send it before March 22, 2004, to both Dr. Nikola Kolev, and Dr. Enrico Sartori (addresses on the form). A hotel reservation form is also included.

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

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

**Prof. Jordan Stamenov**  
**Chairman**  
Director of INRNE  
Boul. Tsarigradsko chaussee 72  
1784 Sofia, Bulgaria

**Jordan Georgiev**  
Member of Board of Directors  
Kozloduy Nuclear Power Plant  
3321 Kozloduy, Bulgaria

**Alexander Nikolov**  
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### **Final Programme of the Benchmark Workshop**

The final programme drawn up by the Programme Committee will be distributed to the registered participants before the Workshop.

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

The official language of the Second Benchmark Workshop will be 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 and CSNI. In addition, copies of presentations will be distributed free of charge to all participants at the meeting.

### **Workshop Location**

Hotel "Kopito, National Park Vitosha, Sofia, Bulgaria

### **Local Arrangements**

The **hotel information** is as follows:

1. "KOPITO": recommended by the organisers: Double room: 65 EUR - incl. breakfast and use of different facilities. Reservations must be made through INRNE hotel registration
2. "ROTASAR": downtown: Double room: 35-40 EUR - bed and breakfast. Microbus transportation to the conference place is provided by the organisers.
3. "RAI": downtown: Double room: 35-40 EUR - bed and breakfast next to ROTASAR. Microbus transportation to the conference place is provided.

### **Transportation**

1. From/to Airport Sofia
  - Microbus by the organisers or taxi to Hotel Kopito (~30 km).
  - Microbus by the organisers or taxi to hotel Rotasar or Rai (~6 km).
2. Transportation from the city to the conference place
  - Microbus by the organisers every morning and evening from/to Hotel Rotasar,
  - Hotel microbus transport of Hotel Kopito,
  - A shuttle microbus provided by the organisers.

Additional information will be distributed as necessary before the workshop.

NUCLEAR SCIENCE COMMITTEE  
and  
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

**OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark - Second Workshop  
(V1000-CT2)**

Sofia, Bulgaria  
5-6 April 2004

Hosted by: INRNE/KNPP

**PARTICIPANT REGISTRATION FORM**

To be sent as soon as possible, and not later than 22 March 2004, to

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Name:

Organization:

Address:

E-mail:

Fax:

I will attend the V1000 CT-2 workshop \_\_\_\_\_ I will attend the AER Working Group D Meeting \_\_\_\_\_

If you are attending, will you be giving a presentation? \_\_\_\_\_

If yes, what is the title of this presentation, authors, and session?

I will not attend but send me a summary \_\_\_\_\_

Computer code, which you are planning to use:

Additional Comments:

NUCLEAR SCIENCE COMMITTEE  
and  
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

**OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark - Second Workshop  
(V1000-CT2)**

Sofia, Bulgaria  
5-6 April 2004

Hosted by: INRNE/KNPP

**HOTEL RESERVATION FORM**

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To be sent as soon as possible, and not later than 22 March 2004.

I wish to reserve for the following nights: 3, 4, 5, 6, 7, 8, 9  
(please cross out or remove nights for which reservation is not to be made)

at

- |   |        |
|---|--------|
| - Hotel KOPITO at 65 Euros / night double room and breakfast  | yes/no |
| - Hotel ROTASAR at 35 Euros / night double room and breakfast | yes/no |
| at 40 Euros/ night double room deluxe and breakfast           | yes/no |
| - Hotel RAI at 35 Euros / night double room and breakfast     | yes/no |
| at 40 Euros/ night double room deluxe and breakfast           | yes/no |

Name:

Organization:

Address:

E-mail:

Fax:

**OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark - Second Workshop  
(V1000-CT2)**

Sofia, Bulgaria  
5-6 April 2004

Hosted by: INRNE/KNPP

**PROPOSED PROGRAMME**

**April 5<sup>th</sup>**

**Session 1 – Session Chair** – Nikola Kolev

09:00-09:30 Introduction and Welcome  
INRNE – *Jordan Stamenov*  
KNPP – *Jordan Georgiev*  
OECD-NEA – *Francesco D’Auria*

09:30-10:00 Overview and status of V1000CT-1 (Phase 1) benchmark - *Kostadin Ivanov*  
10:00-10:30 Overview and status of V1000CT-2 benchmark - *Eric Royer*

10:30-10:45 Coffee Break

**Session 2 – Session Chair** – Grady Yoder

10:45-11:15 Comments and Modifications of V1000CT-1 Specifications – *Boyan Ivanov*  
11:15-11:45 Discussion of Exercise 1 of V1000CT-1 – *Pavlin Groudev*

11:45-13:15 Lunch

**Session 3 – Session Chair** – Soeren Kliem

13:15-13:45 Comparative Analysis of the Participants’ Results for Exercise 1 of  
V1000CT-1 - *Boyan Ivanov*  
13:45-14:15 Discussion of Exercise 2 of V1000CT-1 - *Kostadin Ivanov*  
14:15-14:45 Comparative Analysis of the Participants’ Results for Exercise 2 of  
V1000CT-1 - *Boyan Ivanov*

14:45-15:00 Coffee Break

**Session 4 – Session Chair** – Pavlin Groudev

15:00-15:30 Discussion of Exercise 3 of V1000CT-1 – *Kostadin Ivanov*  
15:30-17:00 Participants’ presentations on Phase 1 – V1000CT-1

17:00-18:00 Reception

**April 6<sup>th</sup>**

**Session 5 – Session Chair** – Eric Royer

- 9:00-10:00 Participants' presentations on Phase 1 – V1000CT-1  
10:00-10:30 Discussion of V1000CT-1 modelling issues and obtained results -  
*Kostadin Ivanov*  
10:30-11:00 Discussion of the schedule for Phase 1 activities – *Enrico Sartori*  
11:00-11:15 Coffee Break

**Session 6 – Session Chair** – Pertti Siltanen

- 11:15-11:45 Overview of the Mixing Tests – *KNPP* 11:45-12:15  
11:45-12:15 Discussion of the Specifications of Exercise 1 of V1000CT-2 – *Nikola Kolev*  
12:15-12:45 CFD modelling and preliminary results on Exercise 1 of Phase 2 – *Eric Royer*  
12:45-14:00 Lunch

**Session 7 – Session Chair** – Jan Hadek

- 14:00-14:30 MSLB Scenarios for Phase 2 - *Nikola Kolev and Eric Royer*  
14:30-15:30 Participants experience on VVER analysis and vessel CFD modelling  
15:30-15:45 Coffee Break  
15:45-16:15 Discussion of the schedule on Phase 2 and next workshops - *Enrico Sartori*  
16:15-16:45 Discussion of the impact of the benchmark activities involving coupled 3-D neutron kinetics  
and thermal-hydraulics on the Nuclear Reactor Safety, Design and Operation - *Francesco*  
*D'Auria and K. Ivanov*  
16:45-17:00 Conclusion and closing remarks – *Jose-Maria Aragonés*

**Annex 1**(For detailed address information please look up <http://www.nea.fr/add/>)

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