NUCLEAR SCIENCE COMMITTEE
and
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

OECD/DOE/CEA
VVER-1000 Coolant Transient Benchmark
Fourth Workshop (V1000-CT4)

Pisa, Italy
24-25 April, 2006

Hosted by
the University of Pisa

SUMMARY RECORD

Sponsorship

The fourth workshop for the VVER-CT benchmark was held from 24 to 25 April 2005 in Pisa, Italy, and is a follow up to following events:

(1) ad-hoc meeting held during the NURETH-11 conference, Avignon, France, on 4th October 2005;
(2) third workshop, hosted by GRS, Garching, Germany, on 4-5 April 2005;
(3) second workshop, hosted by INRNE and KNPP, Bulgaria Sofia, Bulgaria, on 5-6 April 2004;
(4) first workshop hosted by the CEA-Saclay (Paris), France, on 12-13 May, 2003, and
(5) 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 (NPP) – KNPP (Bulgaria).

This workshop was held in conjunction with the Atomic Energy Research (AER) "VVER Dynamics and Safety " Working Group D Meeting, which took place on 26 and 27 April 2006, in order to facilitate co-ordination and sharing of work. In order to combine efforts in areas of common interest such as Computational Fluid Dynamics (CFD) modelling and uncertainty analysis, two other meetings were also held at the location and during the same week. These meetings were the third workshop for the OECD/NRC benchmark based on the NUPEC BWR Full-size Fine-mesh Bundle Tests (BFBT-3), held on 26 and 27 April 2006, and the NEA/OECD meeting on "Uncertainty Analysis in Modelling", held on 28 and 29 April 2006.

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 modeling 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 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 MCPs are in operation, and V1000CT-2 concerns the 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 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 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 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 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 modelling.

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 modelling of the vessel with specific boundary conditions rather than core boundary conditions and CFD modelling of the mixing is also included as Exercise 1 of Phase 2. 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 single loop cooling and heating-up at 9 % of nominal power with all MCP in operation. It is being 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 modelling.

At its annual meeting in Paris in June 2002, the Nuclear Science Committee (NSC) of NEA/OECD, approved and endorsed this V1000CT benchmark to become an international standard problem for validation of the best-estimate safety codes for VVER applications.

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 3rd Workshop
- Discussion of participant's feedback and introduced modifications to the Benchmark Specifications
    - Presentation and discussion of final results 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 preliminary results from Exercises 2 and 3 of Phase 2
    - Defining work plan and schedule, actions to progress in completing the 2 phases

Organization of the Benchmark Workshop

The meeting was 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 modeling as well as on CFD modeling were encouraged.

Organization and Programme Committee of the Benchmark Workshop

A Programme Committee was nominated for arranging the Benchmark Workshop, to organise the Sessions, to draw up the final programme, to appoint Session Chairmen. The general chair was Francesco D'Auria (Univesity of Pisa) who is member of activities of CSNI and who also hosted the workshop. The other members were José Aragonés (UPM), representing the NSC, Pertti Siltanen (Fortum) representing the AER Group D, Emilian Popov (ORNL), and Eric Royer (CEA), Nikola Kolev (INRBE), K. Ivanov (PSU) representing the benchmark team and the OECD/NEA Secretariat.

Summary

The meeting was opened by Prof. Francesco D'Auria of the University of Pisa, that was hosting the workshop. He welcomed the participants on behalf of University of Pisa and wished them a successful meeting. Dr. Enrico Sartori welcomed the participants on behalf of the NEA Secretariat and thanked in particular the local organizers for their hospitality.

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

The meeting was attended by 37 participants from 11 countries representing 22 organisations or establishments from research, university and industry (see Annex II). The participants introduced themselves.

Discussion of final conclusions for Phase 1 (Sessions 1 and 2)

K. Ivanov from PSU, USA reviewed the status of V1000CT-1 (Phase1) benchmark activities while E. Royer from CEA, France gave an overview of the status of V1000CT-2 (Phase 2) benchmark activities.

B. Ivanov made a presentation on the final report (volume) for V1000CT1 Exercise 1. This report is being published as a NEA/OECD report - "VVER-1000 Coolant Transient Benchmark: Phase I (V1000CT-1), Volume II: Summary Results of Exercise 1, Point Kinetics Plant Simulation", Boyan D. Ivanov and Kostadin N. Ivanov, © OECD 2006, NEA/NSC/DOC(2006)5

Presentation and discussion of results of Exercise 1, Phase 2 (Sessions 2, 4 and 6)

N. Kolev and E. Royer presented the analysis of the submitted results for Exercise 1. The models developed by the participants were divided in two clusters: coarse mesh description of the reactor pressure vessel with system codes on one hand, fine description with CFD codes on the other hand.

Five solutions based on system codes were submitted and compared. The reactor pressure vessel is nodalized with azimutal sectors (typically 6) and radial rings (typically 5), either by a 3D component or by 1D channels. The analysis show an overall agreement with the plant data, except for the temperature in hot leg #2. Specific investigation is necessary to explain the measurements which are questionable in this case.

Five solutions based on CFD codes were submitted before the workshop and compared. The presentation in Session 2 focused on the temperature distribution at the core inlet at the end of the transient (Steam Generator isolation on loop #1). At that time there are three main zones in the core inlet plane: the non-affected region where the temperature is almost uniform ($T \approx 542$ K), the non-mixed sector fed by water from cold leg #1 (T ≈ 555 K), and the transition zones where there is a steep temperature gradient. The experimental data displays a flow rotation counter-clockwise with respect to the inlet nozzle of loop #1. The CFD results also show this rotation but there are some discrepancies with the measurements in the transition area. This can be explained by some limitations of turbulence models, but also by the extrapolation of the measurements from core outlet to core inlet and between neighbouring fuel assemblies (when there is no thermocouple).

Participants also presented their results in Sessions 2, 4 and 6. Models were explained and analysed in detail. There were sensitivity studies on the vessel nodalization with system codes, on the turbulence model in CFD codes and also comparisons between both types of approach (system code versus CFD). New or updated results compared to submitted ones were also presented.

Discussion of the Specifications for Exercises 2 and 3 of Phase 2 (Sessions 3 and 4)

N. Kolev presented the Main Steam Line Break specifications for Exercises 2 and 3. Support calculations were carried out with Cathare and Athlet. Two scenarios are defined: *realistic* based on licensing conditions, and *pessimistic* (no pump trip and two stuck rods) for enhanced multi-dimensional effects in the core. A return to power after scram is expected in the second scenario.

The cross-sections libraries for the MSLB simulations were prepared by Penn State University with the Helios code, and presented by B. Ivanov. Compared to Phase 1, the reflector model was improved and the moderator temperature was introduced as a feedback parameter (in addition to fuel temperature and moderator density). The cross sections were verified in core calculations on Hot Full Power conditions where plant data are available, and also compared with independent BIPR predictions. Good agreement is obtained for the multiplication factor, radial power distribution, core feedback coefficients, and control rod worths. Nevertheless, the axial power profile obtained by the two systems of cross-sections and core simulator display significant discrepancies. In his presentations, B. Ivanov discussed the investigations, performed by the benchmark team, to account for this difference. These investigations indicated that the impact of assembly discontinuity factors (ADFs) and the division of cross-sections with ADFs, the utilized spectral history model, and the predicted worth of Group 10 are not the causes for the observed deviation. Since the 3-D exposure distribution from BIPR7A depletion calculations, based on a cross-section library generated with TVS (as provided by NPP Kozloduy), has been used in order to generate the V1000CT-2 cross-section library with HELIOS, the benchmark team concluded that probably the difference is coming from the different depletion modeling characteristics. For example, different energy release per fission in the fissionable isotopes in the HELIOS library and in the BIPR library could contribute to predicting different isotopic content for the same exposure value Because of the observed tilted axial exposure shape (as predicted by BIPR7A), it can result in different calculated axial power profiles by BIPR/TVS and PARCS/HELIOS. Based on his experience, P. Siltanen discussed further the compensating effects in core depletion. He suggested comparing the axial fissile isotopic content distribution in both core models.

The boundary conditions for the reactor pressure vessel in Exercise 2 and the requested outputs were presented respectively by N. Kolev and E. Royer. Additional parameters for Exercise 3 analysis were suggested by participants such as pressurizer water level and heat exchanged in Steam Generators. It was also decided to define clearly the requested parameters.

Presentation and discussion of preliminary results of Exercises 2 and 3, Phase 2 (Sessions 5 and 6)

Due to a very short time between the release of the MSLB specifications and the workshop, only two sets of results were submitted: one for Exercise 2 by FZR and one for Exercise 3 by GRS and KI. A comparative analysis of submitted results was not possible, and only analysis of HZP conditions in Exercise 2 were presented by E. Royer.

Four participants presented their preliminary results either for Exercise 2 or for Exercise 3. Detailed analysis of Exercise 3 was done by GRS and KI, using the BIPR specific neutronic model instead of the benchmark cross-section libraries.

Defining work plan and schedule, actions to progress in completing the 2 phases (Session 7)

For V1000CT-1, the main remaining actions are:

- Prepare and review Volume III: Coupled 3-D Kinetics/Core Thermal-Hydraulic Response Evaluation and Volume IV: Best-Estimate Coupled 3-D Core/Thermal-Hydraulic Plant Transient Modeling
- Collect final versions of papers for publication in Progress in Nuclear Energy.

For V1000CT-2, the main decisions and actions are:

1. Exercise 1
   - Print Volume I: Specifications of the VVER-1000 Vessel Mixing Problem (no additional corrections and specifications required) by summer 2006,
   - Distribute a questionnaire (in addition to templates, which should also be placed on the Web) for identifying methods and deviations from specification for better identification of the source of discrepancies,
   - Analyse hot leg #2 temperature measurements,
   - Use 2D maps for temperature analysis (to be included in the report – for sector regions or half core so that gradients are better visible),
   - Reviewers for Volume III: Comparison of Computational Fluid Dynamics and Coarse Mesh Calculations with Measured Data relative to the results of this exercise: E. Popov, T. Hoehne, M. Boettcher.

2. Exercises 2 and 3
   - Explain discrepancies on axial power profile (Helios/BIPR8) and core exposure effect (cf. P. Siltanen suggestion),
   - The queries concerning the cross-section library relative to the reduced rod-worth should be resolved by end of May 2006
   - Improve templates for requested output (extra parameters and time snapshots),
   - Distribute questionnaire (model use / deviation from specification),
   - Analyse results (deadline for submission at the latest mid-August) to be discussed during Physor-2006 to be held from 11 to 14 September 2006 at Vancouver – confirmed participants are: CEA, U-Pisa, GRS, PSU, NEA
   - Reviewers for Volume IV: MSLB Coupled 3D Neutronics / Vessel TH Simulation (Exercise 2) are P. Siltanen, S. Nikonov, J. Hadek,
   - Reviewers for Volume V: MSLB Best Estimate Coupled Simulation (Exercise 3) are K. Velkov, F. D' Auria, S. Kliem,
   - Plan journal publication in Nuclear Science and Engineering for V1000CT2: draft papers should be ready at the beginning of 2007,

– The possibility of a review paper at M&C + SNA-2007 at Monterey, Ca, USA, to be held from 15 to 18 April 2007, should be envisaged.

Main actions and deadlines for V1000CT-2 are summarized in the following table:

Nr.	Action	By whom	Deadline
1	Prepare questionnaire and upload template for Exercise 1 on web site	N. Kolev, E. Royer	30-05-2006
2	Prepare and release cross-section library for scenario 2	B. Ivanov	30-05-2006
3	Update the final results for Exercise 1	Participants	30-06-2006
4	Update template for Exercises 2 and 3	N. Kolev, E. Royer	30-06-2006
5	Submit results for Exercises 2 and 3	Participants	15-08-2006
6	Organize ad-hoc session at PHYSOR conference	E. Royer, E. Sartori	01-09-2006
6	Contact NSE for special issue	E. Royer	30-10-2006
8	Organise V1000CT-5 in conjunction with AER Group D meeting	E. Royer, E. Sartori	07-05-2007

Conclusions

The coupled neutronic / thermal-hydraulic methods for nuclear power plant application have been developing fast in the last decade and have now reached a level of considerable maturity. While such work has been carried out to a very large extent in research laboratories and university institutes, industry seems not to have realized the potential of these methods nor the maturity which has been reached. In view of the expected increased activity around constructing new power plants of generation III and III+ and the need for advanced tools and methodologies for better establishing operational and safety margins, it is important that the progress made is demonstrated to industry so that their increasing involvement and support is present to adapt this progress to their future needs.

With this end in mind, it was suggested that besides presenting such work at conferences on reactor physics, mathematics and computation (e.g. ANS), it should be presented at ICONE and ASME in a specifically organized session or at the TOPSAFE conferences of ENS and ICAPP (on Advances in Power Plants), the counterpart of ANS to ICONE. More involvement of the IAEA was also suggested.

It was proposed that this be discussed at the Nuclear Science Committee and CSNI, and their members promote and organize such specific sessions at conferences in order to make industry aware of the fast development and progress in this research field.

Participants agreed to keep to the established schedule for publication of the results, although a final meting - workshop V1000CT-5 – will be organized in about one year's time to finalise this benchmark on the Kozloduy-6 NPP measurements and draw relevant conclusions on lessons learned, capability and applicability of methods, and the benefit that it represents for industrial applications. It was suggested that V1000CT-5 be held again in conjunction with the AER Group D meeting, and BFBT-4 and UAM-2 workshops in Paris, France, and be hosted by CEA-Saclay and NEA/OECD. Combining these workshops proved to be beneficial. The suggested date for V1000CT-5 is May 7, 2007 followed by the AER Group D meeting on May 8 and 9. The second day of the AER Group D meeting would be dedicated to explore the possibility of a follow-up benchmark in line with the proposal by G. Ponomarenko of Gidropress, who would make available a very comprehensive set of experimental data and transients in the KALININ-3 VVER-1000 NPP, including data from kinetics and thermal-hydraulic measurements. Such comprehensive data might also be used to investigate in detail the uncertainty analyses in methods, and how well these predictions match the experimental uncertainties. The BFBT-4 workshop will take place in parallel with the AER Group D meeting on May 8 and 9, and the UAM-2 workshop will take place on May 10 and 11.

Co-operation with AER

The AER Working Group D Meeting was held during the following days, 26 and 27 April 2006 at the same premises. The co-operation of this working group with the VVER-1000 benchmark group was endorsed by the OECD/NEA NSC and is supported by the Safety Division. The members of the AER WGD are participating actively in the OECD/DOE/CEA V1000CT benchmark. The summary of this meeting has been prepared separately and is available to the AER participants.

Annex I

OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark - Fourth Workshop (V1000-CT4)

Hotel Duomo, Pisa, Italy
24-25 April 2006

Hosted by: University of Pisa

DETAILED PROGRAMME [01]
In [nn] the identifier

April 24th

Session 1 – Session Chair – F. D'Auria

09:00-09:30 Introduction and Welcome
University of Pisa
OECD-NEA
Introduction of Participants [02]

09:30-10:00 *K. Ivanov:* Overview of V1000CT1 including PNE special issue – [03]

10:00-10:30 *N. Kolev, E. Royer and N.Petrov*: Status of the OECD V1000CT-2 – MSLB Benchmark Specifications *[04]*

10:30-11:00 Coffee Break

Session 2 – Session Chair – P. Siltanen

11:00 11:30 *B. Ivanov, K. Ivanov:* Presentation of final report (Volume II) for V1000CT1 Exercise 1 – [05]

11:30-13:00 *N. Kolev, E. Royer, N.Petrov, J.Donov, U.Bieder:* Comparative analysis of Exercise 1 of the V1000CT-2 Benchmark: Coarse-mesh results [06a]
- *N. Kolev, N. Petrov, J. Donov, E. Royer* V1000CT-2 Exercise 1 - CFD Final results[06b]
- *A. Shkarupa and I. Kadenko:* VVER1000-CT2 benchmark analysis performed by KU with RELAP5-3D code [07]
- *Fabio Moretti , Daniele Melideo, Fulvio Terzuoli, Francesco D'Auria, Alexander Shkarupa:* "Application of CFX-10and RELAP5-3D to the Simulation of Coolant Mixing Phenomena in RPV of VVER-1000 Reactors" [08]

13:00-14:30 Lunch

Session 3 – Session Chair – E. Popov

14:30-15:00 *N. Kole* General presentation of Specifications for V1000CT2 Exercises 2 and 3 (MSLB) –*v* [09]

15:00-15:30 Cross-sections libraries for MSLB – *B. Ivanov, K. Ivanov, N. Kolev* [10]

15:30-16:00 Coffee Break

Session 4 – Session Chair – K. Velkov

16:00-16:30 *N. Kolev, E. Royer and N.Petrov*: Boundary Conditions for Exercise 2 of the OECD VVER-1000 MSLB Benchmark [11]

16:30-17:00 *N. Kolev, N. Petrov, J. Donov, E. Royer*: MSLB Requested outputs [12]

17:00-17:30 Participants' presentations
- *E. Popov (ORNL), B. Ivanov and K. Ivanov (PSU:).* "Simulations of the VVER-1000 CT2 Coolant Mixing Test"[13] [1 Video]

April 25th

Session 5 – Session Chair – E. Royer

09:00-10:30 Participants' presentations
- *A. Bousbia Salah, C. Parisi, and F. D'Auria:* Analysis of the OECD/DOE/CEA VER1000 CT-2 Benchmark Ex. 2 by RELAP5 - PARCS Coupled Codes [14]
- *B. Ivanov (PSU), and K. Ivanov (PSU:)* "TRACE/PARCS Modeling and Results for Exercise 2 of V1000CT2" [15]
- *S. Nikonov, K. Velkov, S. Langenbuch., M.Lizorkin, A. Kotsarev* "Results of Exercise 3, Phase 2 – the effect of reactor pressure volume nodalization on local core parameters"[16] [9 Videos]

10:30-11:00 Coffee Break

Session 6 – Session Chair – S. Kliem

11:00-12:00 Participants' presentations – cont.
- *Y.Kozmenkov, S.Kliem, T.Höhne* "First Results of V1000CT2 Exercise 2 Simulation with DYN3D/ATHLET"[17]
- *T. Höhne,:* "CFD-Simulation of Thermalhydraulic Benchmark V1000CT-2 Analysis with Advanced Turbulence Models"[18] [5 Videos]
- *M. Böttcher:* "CFX Analyses of a VVER-1000 RPV"[19] [2 Videos - 1 Audio]

12:30-13:00 *N. Kolev, E. Royer:* V1000CT-2 Exercises 2 & 3 results [20]

13:00-14:30 Lunch

Session 7 – Session Chair – D'Auria

14:30-15:00 *N. Kolev, E. Royer:* V1000CT-2 Summary and main issues [21]

15:00-15:30 Discussion of the schedule and next meetings – *E. Sartori*

15:30-15:45 Conclusion and closing remarks

The presentations are available on the cumulative CD-ROM prepared by OECD, and distributed to all benchmark participants.

Annex II

4th Workshop on VVER-1000 Coolant Transients, Pisa, 24-25 April 2006 (V1000CT4)

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