

For Official Use

NEA/NSC/DOC(2003)18



Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

29-Jul-2003

English - Or. English

**NUCLEAR ENERGY AGENCY
NUCLEAR SCIENCE COMMITTEE**

**NEA/NSC/DOC(2003)18
For Official Use**

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

**OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark
Summary Record of the First Workshop (V1000-CT1)**

**12-13 May 2003
Saclay (Paris), France**

JT00147808

**Document complet disponible sur OLIS dans son format d'origine
Complete document available on OLIS in its original format**

English - Or. English

NUCLEAR SCIENCES COMMITTEE
and
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark - First Workshop (V1000-CT1)

12-13 May 2003
Saclay (Paris), France

Hosted by

Commissariat à l'Énergie Atomique, Centre d'Études de Saclay, France

SUMMARY RECORD

Content:

- Background and Purpose of the Benchmark Workshop
- Session 1 - Introduction
- Session 2
- Session 3
- Session 4
- Session 5
- Session 6
- Session 7 - Closing Session / Conclusions - Recommendations
- Annex 1: Workshop Programme
- Annex 2: V1000-CT1 Participants
- Annex 3: V1000CT Benchmark codes

Background and Purpose of the Benchmark Workshop

The first workshop for the VVER-1000 Coolant Transient Benchmark TT Benchmark was held on 12th and 13th May 2003. The workshop was hosted by the Commissariat à l'Énergie Atomique, Centre d'Études de Saclay, France. The VVER-1000 Coolant Transient (V1000CT) Benchmark is sponsored by the US Department of Energy (DOE), Commissariat à l'Énergie Atomique (CEA), France, the OECD, and the Nuclear Engineering Program (NEP) of the Pennsylvania State University. The Kozloduy Nuclear Power Plant (KNPP) and the Institute for Nuclear Research and Nuclear Energy (INRNE), Bulgaria, assist in providing the data and analysis of the benchmark. There is also an active co-operation with AER Working Group D (WGD), whose experience for VVER reactors is very valuable.

The V1000CT benchmark defines standard problems for validation of coupled three-dimensional (3-D) neutron-kinetics/system thermal-hydraulics codes for application to Soviet-designed VVER-1000 reactors using actual plant data without any scaling. The overall objective is to access computer codes used in the safety analysis of VVER power plants, specifically for their use in reactivity transient simulations in a VVER-1000. The V1000CT benchmark consists of two phases: V1000CT-1 – simulation of the switching on of one main coolant pump (MCP) while the other three MCP are in operation, and V1000CT-2 – calculation of coolant mixing tests and Main Steam Line Break (MSLB) scenario. Further background

information on this benchmark can be found at the OECD/NEA benchmark web site <http://www.nea.fr/html/science/transients/v1000ct.html>

The purpose of the first workshop was to review the benchmark activities after the Starter Meeting held last year in Dresden, Germany: to discuss the participants' feedback and modifications introduced in the Benchmark Specifications on Phase 1; to present and to discuss modelling issues and preliminary results from the three exercises of Phase 1; to discuss the modelling issues of Exercise 1 of Phase 2; and to define work plan and schedule in order to complete the two phases

Session 1 – Introduction: *Chair D. Caruge*

The meeting was opened by Dr. Daniel Caruge, Head of Service at CEA, Saclay that was hosting the meeting. He welcomed the participants on behalf of CEA, Saclay, and wished them a successful meeting. Enrico Sartori welcomed participants on behalf of the OECD/NEA and thanked in particular the local organisers for their hospitality. Dr. Pavlin Groudev welcomed the participants on behalf of the international benchmark team.

The meeting was attended by 33 participants from 11 countries (see Annex I). The agenda was approved with minor adjustments (see Annex II). The list of codes used in the benchmark is given in Annex 3.

P. Groudev presented an overview of the Main Coolant Pump test. K. Ivanov reviewed the status of V1000CT-1 (Phase1) benchmark activities while E. Royer gave an overview of the V1000CT-2 benchmark activities.

Session 2: *Chair: J. Gehin*

K. Ivanov reviewed the received participants' comments and the modifications introduced in the V1000CT-1 benchmark specifications. P. Groudev presented the thermal-hydraulic data and modeling issues of Exercise 1 of V1000CT-1. These presentations were followed by a discussion, which identified the following issues to be clarified:

- The temperature measurements including the initial conditions for loop # 3
- The time delay in temperature measurements and how to incorporate it for comparison with calculated results
- The initial values of parameters important for the transient - pressure drop in the reactor pressure vessel (RPV); core power level; and water level in the steam-generator (SG) and how they are measured
- Pressurizer level regulation and logic: set points, and mass flow in make-up/let-down systems
- Pressure drop measurements (especially for MCP #3) and mass flow rates
- Secondary side boundary conditions (BC) for SGs
- The thickness of primary loop piping (wall thickness)

Session 3: *Chair: S. Kliem*

B. Ivanov presented the neutronics data and modelling issues of Exercise 2 of Phase 1 followed by the discussion of cross-section libraries for Phases 1 and 2. K. Ivanov reviewed the modelling issues of Exercise 3. In the discussion the following questions were raised:

- Distribution of the decay heat power during the transient
- Correct equilibrium Xenon distribution for the initial steady state

Session 4: *Chair: P. Groudev*

The participants presented their preliminary results for Phase 1 of the V1000CT-1 benchmark. CEA presented their comments and suggestions. The University of Pisa analysed Exercise 1 and hot zero power (HZP) state of Exercise 2 using RELAP5/PARCS. FZR presented their models and results with the coupled code DYN3D/ATHLET for Exercise 3 of the benchmark. FZK discussed their results for Exercise 1 obtained with RELAP-5. KU presented their RELAP-3D model and results for Exercise 3 including the extreme scenario. ORNL presented their models for VVER-1000 and the obtained results with RELAP5-3D for Exercise 1 of the VVER-1000 CT benchmark for Phase 1. ORNL also made an analysis in depth of the test data, modelling challenges for the simulated transient, and associated uncertainties. The following modelling issues were addressed and the following suggestions were made by the participants in their presentations:

- Pump reverse flow rate and reverse flow losses in the line
- Individual MCP flow vs. head characteristics (pump modelling)
- Primary pressure vs. the pressurizer level relation
- Introduction of additional extreme scenario for Exercise 3 with higher scram set point of 3120 MWt power level
- Sensitivity study on refinement of cross-section library (using more reference points)
- Spacer grids and lower plate – axial locations and pressure loss coefficients
- The weighting approach for moderator temperature coefficient (MTC) and Doppler temperature coefficient (DTC) calculations
- Definition of the snapshot at maximum power for the best estimate scenario of Phase 1
- Add local parameters (in the core) – axial power distributions in selected assemblies for initial steady state and selected snapshots - in the requested outputs for Exercises 2 and 3
- To compare time histories of radial and axial power peaking factors and axial offset

Session 5: Chair: K. Ivanov

P. Groudev reviewed reference results, measured data and uncertainty ranges for Phase 1. B. Ivanov discussed the changes in requested output while J. Vedovi presented an update on methodologies for comparative analysis of participants' results. The following issues were discussed:

- The uncertainty range for the new initial power level of 824 MWt
- Measurement of uncertainty ranges for the transient
- Results to be provided for 800 seconds for all of the code-to-code comparisons
- Core exit temperatures to be compared to the measured data

Session 6: Chair: P. Siltanen

This session was devoted to a discussion of preliminary V1000CT-2 Specifications. First, N. Kolev discussed the available additional data and its modelling. Second, E. Royer presented expected experience in CFD. In the follow-up discussion, the following recommendations were made for preparing the V1000CT-2 Specifications:

- Demonstrate that neutronics is not necessary for Exercise 1 of Phase 2
- Clarify how the power distribution is defined: neutronics measurement or deltaT measurement
- Demonstrate that the core inlet flow distribution does not affect the calculation (effect of cross flows)
- Investigate the flow patterns for conditions of temperature rise or drop
- Pessimistic scenario of MSLB will be computed first because there is no flow reversal

Session 7: Chair A. Hotta

The topic of the last session was the participants' experience on VVER analysis and vessel CFD modelling. L. Sabotinov presented applications of CATHARE code for VVER accident analysis; E. Royer presented applications of Trio_U/Priceles on mixing problems in RPV. S. Kliem made an overview in three consecutive presentations on possible further VVER-1000 experiments and their modelling, coupled code calculations of VVER reactors at FZR, and CFD calculations for the RPV of VVER-440. T. Kozlowski discussed the new HEX and cross-section functionality in PARCS. S. Nikonov made a very interesting presentation and demonstration of the simulation of 3-D distribution of coolant characteristics of the RPV by the coupled code ATHLET/BIPR&KN.

K. Ivanov reviewed the status of the new proposed BFBT Benchmark based on the NUPEC experimental data. This benchmark aims at substantially refining models for best estimate calculations based on good quality experimental data. The needs arising in this respect are not limited to currently available macroscopic approaches but are now extending to next-generation approaches that focus on more microscopic processes. It is suggested that this international benchmark be based on data made available from the NUPEC database. This high quality data would encourage advancement in the insufficiently developed field of the two-phase flow theory. Considering that the present theoretical approach is

relatively immature, the benchmark specification needs to be designed so that it would systematically assess and compare the participants' numerical models on the prediction of detailed void distributions and critical powers. The new proposal, in the form of a report describing scope, objective and expected impact, will be submitted to the June 2003 NSC meeting for endorsement.

K. Ivanov summarized the participants' comments and suggestions, provided at the Workshop, and pointed out that they are very helpful to define a unified modelling basis. The suggestions can be classified in four categories:

- Clarifying values of some parameters and provided SG BC
- Providing more information for modelling some system components
- Refining the use of the available measured data
- Performing additional sensitivity studies

E. Sartori initiated a discussion about the V1000CT benchmark schedule and the next workshop. As a result, the following V1000CT schedule and list of actions were accepted by the workshop participants:

- End-May 2003 – Draft of the Workshop Summary
- Mid-June 2003 – Final Workshop Summary
- End-June 2003 – Updated Electronic Version of the Specification
- End-August 2003 – V1000CT Benchmark Paper for the AER Symposium and Summary for PHYSOR 2004
- End-December 2003 – Draft of Specifications for Phase 2 (Exercise 1)
- Mid-February 2004 – Deadline for submitting Results for Exercises 1 and 2, Phase 1
- 5-8 April 2004 - Second V1000CT Benchmark workshop in conjunction with the AER WGD Meeting in Bulgaria

Proceedings of the Workshop

Participants will receive with these proceedings a CD-ROM containing all papers discussed at the meetings. The CD-ROM will also include all reports from previous workshops, which discuss this benchmark.

Co-operation with AER

The AER Working Group D meeting was held during 14-15 May 2003 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 have confirmed their participation in the OECD/DOE/CEA V1000CT benchmark. The summary of this meeting has been prepared separately and is available to the AER participants.

Results of Discussion at the NSC meeting (June 2003) concerning the BFBT Benchmark

The proposal for the international benchmark based on NUPEC BWR Full Size Bundle Tests (BFBT) was presented. The importance of this benchmark was stressed by many members of the NSC and its organisation was endorsed.

In general, for the benchmark activities of best estimate 3D core/plant coupling methods, appreciation was expressed by the NSC members.

Annex 1

**OECD/DOE/CEA VVER-1000 Coolant Transient Benchmark
First Workshop (V1000-CT1)**

Saclay (Paris), France
12-13 May 2003

Hosted by
Commissariat à l'Énergie Atomique, Centre d'Études de Saclay, France

AGENDA

May 12th

Session 1 – Session Chair – Daniel Caruge

09:00-09:30 Introduction and Welcome, Participation [01], Approval of Agenda [02], Codes used [03]

CEA – *Daniel Caruge*

INRNE/KNPP – *Pavlin Groudev*

OECD-NEA – *Enrico Sartori*

09:30-10:00 P. Groudev, V. Hadjiev, M. Pavlova:

Investigation of a VVER 1000 Main Coolant Pump Switching on Problem [04]

10:00-10:30 Overview and status of V1000CT-1 (Phase 1) benchmark - *Kostadin Ivanov [05]*

10:30-11:00 Overview and status of V1000CT-2 benchmark - *Nikola Kolev, Eric Royer [06]*

11:00-11:15 Coffee Break

Session 2 – Session Chair – Jess Gehin

11:15-11:45 Comments and Modifications of V1000CT-1 Specifications - *Kostadin Ivanov [07]*

11:45-12:45 Discussion of V1000CT-1 – Thermal-Hydraulics data and Modeling Issues of Exercise 1 –
Pavlin Groudev [08]

12:45-14:00 Lunch

Session 3 – Session Chair – Soeren Kliem

14:00-14:30 Discussion of V1000CT-1 – Neutronics Data and Modeling Issues of Exercise 2 -
Boyan Ivanov [09]

14:30-15:00 Cross-section libraries for Phase 1 and Phase 2 of the Benchmark - *Boyan Ivanov [10]*

15:00-15:30 Discussion of V1000CT-1 – Modelling Issues of Exercise 3 - *Kostadin Ivanov [11]*

15:30-15:45 Coffee Break

Session 4 – Session Chair – Pavlin Groudev

15:45-17:30 Participants experience

- *Juswald. Vedovi, Alessandro. Petruzzi, Kostadin Ivanov, Francesco D’Auria:: “Joint Preliminary Analysis of VVER-1000 Benchmark Performed by PSU and U-Pisa” [12]*
- *Yaroslav Kozmenkov: Modelling the V1000CT-1 Benchmark with the Coupled Code DYN3D/ATHLET [13]*
- *Victor Sánchez-Espinoza, O. Metz: Preliminary Results of RELAP5 for Exercise 1 [14]*
- *Alexander Shkarupa: VVER-1000 Kozloduy Benchmark RELAP5-3D Analysis. Preliminary Results [15]*
- *Emilian Popov, Graydon L. Yoder, V. Velichkov: "Modeling Main Coolant Pump Start-up with RELAP5-3D". [16]*
- *L. Sabotinov: Application of CATHARE computer code for VVER accident analysis [17]*

17:30-18:30 Reception

May 13th**Session 5 – Session Chair – Kostadin Ivanov**

9:00-10:00 Discussion of V1000CT-1 - Reference results, measured Data and Uncertainty Ranges – *Pavlin Groudev [18]*

10:00-10:30 Discussion of V1000CT-1 - Changes in Requested output - *Boyan Ivanov [19]*

10:30-11:00 Update on Methodologies for comparative analysis of participants results [20] - *Juswald Vedovi*

11:00-11:15 Coffee Break

Session 6 – Session Chair – Pertti Siltanen

11:15-12:15 Discussion of preliminary V1000CT-2 Specifications –

Nikola Kolev, Yavor Dinkov, Georgi Kotev: Additional data and modeling – [21]

Nikola Kolev, Tsvetan Topalov, Dimitar Popov, Evgeni Lukanov; Experimental Data [22]

12:15-12:45 Discussion of preliminary V1000CT-2 Specifications – Expected experience in CFD – *Eric Royer [23]*

12:45-14:00 Lunch

Session 7 – Session Chair – Akitoshi Hotta

14:00-15:45 Participants experience on VVER analysis and vessel CFD modelling

- *Ulrich Bieder: Applications of Trio_U/PRICELES on mixing problems in the RPV [24]*
- *Soeren Kliem: Possible Further VVER-1000 Experiments and their Modelling [25]*
- *Soeren Kliem: Overview on Coupled Code Calculations for VVER Reactors [26]*
- *Thomas Hoehne, Soeren. Kliem: CFD Calculations for the RPV of a VVER-440 [27]*
- *Tomasz Kozlowski: "New HEX and cross-section functionality in PARCS"[28]*
- *Serguei P. Nikonov, A.V.Kotsarev, M.P.Lizorkin: 3D Distribution of Coolant Characteristics in the Reactor Pressure Vessel by Coupled Code ATHLET/BIPR8KN[29]*
- *Mie Azuma, Akitoshi Hotta: Strategy on VVER1000 CFD analysis expected by TEPSYS' [30]*
- *Luben Sabotinov: Application of CATHARE computer code for VVER accident analyses[31]*

15:45-16:00 Status of BFBT Benchmark – *Hideaki Utsuno (NUPEC) and Kostadin Ivanov (PSU) [32]*
OECD/NRC Benchmark Based on NUPEC BWR Full-size Fine-mesh Bundle Tests BFBT),
January 2003 [33]

16:00-16:30 Discussion – Benchmark schedule, next workshops..... - *Enrico Sartori*

16:30-16:40 Conclusion and closing remarks

Annex 2

First Workshop on VVER-1000 Coolant Transients, Saclay 12-13 May 2003)

List of Participants**BULGARIA**

DINKOV, Yavor Kozloduy Nuclear Power Plant 3321 Kozloduy, Bulgaria	Tel: Fax: Eml: ydinkov@npp.cit.bg
GRUDEV, Pavlin Institute for Nuclear Research and Nuclear Energy - BAS Tsarigradsko shaussee 72 1784 Sofia	Tel: +359 2 71 44 585 Fax: +359 2 975 3619 Eml: pavlinpg@inrne.bas.bg
KOLEV, Nikola INRNE Institute of Nuclear Research and Nuclear Energy Boul. Tsarigradsko chaussee 72 1784 Sofia	Tel: +359 2 7144502 Fax: +359 2 9753619 Eml: npkolev@inrne.bas.bg
KOTEV, Georgi Kozloduy Nuclear Power Plant 3321 Kozloduy, Bulgaria	Tel: Fax: +359 973 72762 Eml: gkotev@npp.cit.bg
LUKANOV, Evgeni Kozloduy Nuclear Power Plant 3321 Kozloduy, Bulgaria	Tel: Fax: +359 973 72762 Eml: lukanov_ep@npp.cit.bg
POPOV, Dimitar Safety Analysis Section, Engineering Support Division IO-2, EP-2 3321 NPP KOZLODUY	Tel: +359 973 723 86 Fax: +359 973 72762 Eml: dmpopov@npp.cit.bg
* TOPALOV, Tsvetan Kozloduy Nuclear Power Plant 3321 Kozloduy, Bulgaria	Tel: Fax: Eml: topalov@npp.cit.bg

CZECH REPUBLIC

HADEK, Jan Nuclear Research Institute Rez plc 250 68 Rez near Prague	Tel: +420 2 6617 2169 Fax: +420 2 6617 2334 Eml: hdj@ujv.cz
TINKOVA, Eva Nuclear Research Institute, Rez, Division Energoprojekt Vyskocilova 3 / 741, POB 158, 140 21 Prague 4	Tel: +420 2 41006 116 Fax: +420 2 41006 109 Eml: tinkova@egp.cz

FINLAND

HAMALAINEN, Anitta Senior Research Scientist VTT Processes Nuclear Energy P.O. Box 1604 FIN-02044 VTT	Tel: +358 9 456 5023 Fax: +358 9 456 5000 Eml: anitta.hamalainen@vtt.fi
SILTANEN, T. Pertti J. Fortum Nuclear Services Ltd. P.O. Box 10 Rajatorpantie 8, Vantaa FIN-00048 FORTUM	Tel: +358 1045 32412 Fax: +358 1045 33355 Eml: Pertti.Siltanen@fortum.com

FRANCE

BIEDER, Ulrich
CEA Grenoble
17 rue des Martyrs
38054 GRENOBLE
Tel: +33 4 38 78 95 14
Fax:
Eml: ulrich.bieder@cea.fr

BOURNEL-BOSSON, Christophe
Centre d'Etudes de Saclay
CEA/DEN/DM2S/SFME
91191 Gif-sur-Yvette Cedex
Tel:
Fax:
Eml: bournel@soleil.serma.cea.fr

CARUGE, Daniel
DRN/DMT/SERMA
Commissariat à l'Energie Atomique (CEA)
Centre d'Etudes Nucléaires de Saclay
F-91191 Gif-sur-Yvette CEDEX
Tel: +33 1 69 08 21 61
Fax: +33 1 69 08 85 68
Eml: daniel.caruge@cea.fr

ROYER, Eric
Centre d'Etudes de Saclay
CEA/DEN/DM2S/SFME
91191 Gif-sur-Yvette Cedex
Tel: +33 1 69 08 54 69
Fax: +33 1 69 08 85 68
Eml: eric.royer@cea.fr

SABOTINOV, Luben
Institut de Radioprotection et de
Surete Nucleaire IRSN
B.P. 17
92262 Fontenay-aux-Roses Cedex
Tel: +33 1 58 35 71 59
Fax: +33 1 47 46 86 76
Eml: luben.sabotinov@irsn.fr

GERMANY

KLIEM, Soeren
Forschungszentrum Rossendorf
Institute for Safety Research
P.O. Box 510119
D-01314 DRESDEN
Tel: +49 (351) 260 2318
Fax: +49 (351) 260 2383
Eml: kliem@fz-rossendorf.de

KOZMENKOV, Yaroslav
FZ Rossendorf
Institute of Safety Research
P.O. Box 510119
D-01314 DRESDEN
Tel:
Fax: +49 351 260 2383
Eml: Y.Kozmenkov@fz-rossendorf.de

* LANGENBUCH, Siegfried
Gesellschaft fuer Anlagen und
Reaktorsicherheit mbH
Postfach 13 28
Forschungsgelaende
D-85748 GARCHING
Tel: +49 (89) 3200 4424
Fax: +49 (89) 3200 4599
Eml: lab@grs.de

SANCHEZ-ESPINOZA, Victor Hugo
Institute of Reactor Safety (IRS)
Forschungszentrum Karlsruhe GmbH
Hermann-von-Helmholtz-Platz 1
D-76344 Eggenstein-Leopoldshafen
Tel: +49 7247 82 2283
Fax: +49 7247 82 3718
Eml: sanchez@irs.fzk.de

HUNGARY

HEGYI, György
Reactor Analysis Department
KFKI Atomic Energy Research Institute
H-1525 BUDAPEST 114
P.O. Box 49
Tel:
Fax: +36 1 395 9293
Eml: ghegyi@sunserv.kfki.hu

KERESZTURI, Andras
Reactor Analysis Department
KFKI Atomic Energy Research Institute
H-1525 BUDAPEST 114
P.O. Box 49
Tel: +36 1 392 2297
Fax: +36 1 395 9293
Eml: kere@sunserv.kfki.hu

ITALY

PETRUZZI, Alessandro
 Universita degli Studi di Pisa
 Dept. of mechanical, nuclear
 & production engineering
 Via Diotisalvi, 2
 I-56126 PISA

Tel: +39 050 836653
 Fax: +39 050 836665
 Eml: alexpetruzzi56@hotmail.com

JAPAN

* ASAHI, Yoshiro
 JAERI
 Center for Neutron Science Research
 TOKAI-Mura
 Ibaraki-ken 319-1195

Tel: +81 (29) 282 6096
 Fax: +81 (29) 282 6438
 Eml: asahi@mike.tokai.jaeri.go.jp

AZUMA, Mie
 In-Core Fuel Managment Dept.
 TEPCO Systems Corporation
 Tokyo Bijyutsu Club Building
 6-19-15 Shinbashi, Minato-ku
 TOKYO 105-0004

Tel: +81 3 4586 6745
 Fax: +81 3 4586 1190
 Eml: azuma-mie@tepsys.co.jp

HOTTA, Akitoshi
 TEPCO Systems Corporation
 In-Core Management Systems Dept.
 Tokyo Bijyutsu Club Building
 6-19-15 Shinbashi, Minato-ku
 TOKYO 105-0004

Tel: +81 (3) 4586 6742
 Fax: +81 (3) 4586 1190
 Eml: hotta-akitoshi@tepsys.co.jp

RUSSIAN FEDERATION

DANILIN, Sergey
 RRC "Kurchatov Institute"
 Institute of Nuclear Reactors
 VVER Department
 Kurchatov sq. 1
 123182 Moscow

Tel: +7 (095) 196 7750
 Fax: +7 (095) 196 6172
 Eml: serg@vver.kiae.ru

NIKONOV, Sergey
 Russian Research Center
 Kurchatov Institute
 Kurchatov Square 1
 Moscow 123182

Tel: +7 095 196 76 83
 Fax: +7 095 196 6172
 Eml: niks@vver.kiae.ru

UKRAINE

SHKARUPA, Alexander
 International Nuclear Safety Center
 National University of Kyiv
 Building 11
 Glushkov avenue 2
 KYIV 03022

Tel: +380 44 239 31 16
 Fax: +380 44 266 92 16
 Eml: shkarupa@i.kiev.ua

UNITED STATES OF AMERICA

* DOWNAR, Thomas J.
 School of Nuclear Engineering
 Purdue University
 1290 Nuclear Engineering Bldg
 W. LAFAYETTE, IN 47907-1290

Tel: +1 (765) 494 5752
 Fax: +1 (765) 494 9570
 Eml: downar@ecn.purdue.edu

GEHIN, Jess C.
 Oak Ridge National Laboratory
 Building 6025, MS-6363
 Bethel Valley Road
 P.O.Box 2008
 OAK-RIDGE, Tennessee 37831-6363

Tel: +1 865 576 5093
 Fax: +1 865 574 9619
 Eml: gehinjc@ornl.gov

IVANOV, Boyan
 Nuclear Engineering Programme
 The Pennsylvania State University
 16 Reber Building
 University Park PA 16802-1408

Tel: +1 (814) 865 3926
 Fax: +1 (814) 865 8499
 Eml: bivanov@psu.edu

NEA/NSC/DOC(2003)18

IVANOV, Kostadin
Associate Professor
Nuclear Engineering Programme
The Pennsylvania State University
230 Reber Building
University Park PA 16802

Tel: +1 (814) 865 0040
Fax: +1 (814) 865 8499
Eml: knil@psu.edu

KOZLOWSKI, Tomasz
School of Nuclear Engineering
Purdue University
1290 Nuclear Engineering Bldg
W. LAFAYETTE, IN 47907-1290

Tel: +1 (765) 494 5752
Fax: +1 (765) 494 9570
Eml: tomasz@ecn.purdue.edu

VEDOVI, Juswald
Nuclear Engineering Program
Dpt. Mechanical & Nuclear Engineering
The Pennsylvania State University
231 Sackett Building
University Park PA 16802-1408

Tel: +1 (814) 865-8751
Fax: +1 (814) 865-8499
Eml: juvl@psu.edu

YODER, Graydon L.
Thermal Hydraulics and
Irradiation Engineering Group
PoBox 2009, MS 8045
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-8045

Tel: +1 (865) 574 5282
Fax: +1 (865) 574 2032
Eml: yoder@gljr@ornl.gov

International Organisations

SARTORI, Enrico
OECD/NEA Data Bank
Le Seine-Saint Germain
12 boulevard des Iles
F-92130 ISSY-LES-MOULINEAUX

Tel: +33 1 45 24 10 72 / 78
Fax: +33 1 45 24 11 10 / 28
Eml: sartori@nea.fr

* regrets not to be able to attend
33 participants from 11 countries

Annex 3

List of Codes

Country / Participant	Establishment	Code(s) Used
BULGARIA		
DINKOV, Y.	KNPP	CATHARE 3D
GRUDEV, Pavlin	INRNE	RELAP5/MOD3.2
KOLEV, Nikola	INRNE	CATHARE 3D
KOTEV, Georgi	KNPP	CATHARE 3D
LUKANOV, E.	KNPP	CATHARE 3D
TOPALOV, Ts.	KNPP	CATHARE 3D
CZECH REPUBLIC		
HADEK, Jan	NRI REZ	RELAP5-3D or DYN3D/ATHLET
TINKOVA, E.	NRI REZ	
FINLAND		
HAMALAINEN, Anitta	VTT	HEXTRAN-SMABRE
SILTANEN, T. Pertti J.	FORTUM	
FRANCE		
BIEDER, Ulrich	CEAGRENOBLE	
BOURNEL-BOSSON, C.	CEASACLAY	
CARUGE, Daniel	CEASACLAY	
ROYER, Eric	CEASACLAY	
GERMANY		
KLIEM, Soeren	FZR	
KOZMENKOV, Yaroslav	IFZR	DYN3D/ATHLET
SANCHEZ-ESPINOZA, Victor Hugo	FZK	RELAP5/PARCS
HUNGARY		
HEGYI, György	KFKI	
KERESZTURI, Andras	KFKI	
ITALY		
PETRUZZI, Alessandro	UNIPISA	RELAP5/PARCS
JAPAN		
AZUMA, Mie	TEPCO	
HOTTA, Akitoshi	TEPCO	
ASAHI, Yoshiro	JAERI	THYDE-NEU
RUSSIAN FEDERATION		
DANILIN, Sergey	RRCKI	
NIKONOV, Seguey	IRRCKI	ATHLET/BIPR8KN
UKRAINE		
SHKARUPA, Alexander	INSC	

Country / Participant	Establishment	Code(s) Used
UNITED STATES OF AMERICA		
Downar, Tom J.	UPURDUE	
GEHIN, Jess C.	ORNL	RELAP5-3D
IVANOV, Boyan	PSU	TRAC-PF1/NEM
IVANOV, Kostadin	PSU	TRAC-PF1/NEM
KOZLOWSKI, Tomasz	UPURDUE	
VEDOVI, Juswald	PSU	
YODER, Graydon L.	ORNL	RELAP-3D
International Organisations		
SARTORI, Enrico	NEA	