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NUCLEAR ENERGY AGENCY
NUCLEAR SCIENCE COMMITTEE

OECD/NEA Rostov Unit 2 (Rostov2) VVER-1000 Multi-Physics Benchmark – First Workshop (Rostov2-1)

ANNOUNCEMENT & PROPOSED AGENDA

Garching, Germany
June 24-25, 2019

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OECD Nuclear Energy Agency
Nuclear Science Committee

OECD/NEA Rostov Unit 2 (Rostov2) VVER-1000 Multi-Physics Benchmark – First Workshop (Rostov2-1)

Hosted by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH
Garching, Germany

June 24-25, 2019

ANNOUNCEMENT & PROPOSED PROGRAMME

Sponsorship

The first workshop of the OECD/NEA Rostov Unit 2 (Rostov2) VVER-1000 Multi-Physics Benchmark (Rostov2-1) will be held in Garching, Germany on -June 24-25, 2019 and hosted by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH. It is follow up of the kick-off workshop of the Rostov2 benchmark, which was held on May 18, 2018 in Lucca, Italy in conjunction with BEPU-2018 conference in Lucca, Italy, and hosted by NINE S.r.l.

The processes for performing experiments, creating benchmarks and standard problems, and using these data to validate computer codes, have been developed and implemented for several decades, with highly satisfactory results for most standard applications. Nevertheless, the global context of nuclear technology development continues to evolve and new challenges to the status quo have been appearing:

- The development of coupled "multi-physics" codes that allow for higher fidelity in the representation of the physical phenomenology and allow for explicit representations of coupling phenomena. Validation of these new capabilities will require access to data that are representative of the depth of the modelling and of the coupling phenomena.
- Associated with a move to best-estimate methods in safety analyses, there is often a requirement for increased rigor in the validation process, particularly in the estimation of uncertainties.
- The availability of experimental facilities and associated skills capabilities have continued to decline in many countries, resulting both in the potential loss of valuable data and making reproducibility checks and fully independent peer review more difficult. For some applications there is therefore a risk of systematic biases in experimental analyses. Preservation of data with documentation is, therefore, essential.

- A common bank of certified data for clearly defined applications will save resources of vendors and regulators.

Under the guidance of the Nuclear Science Committee, the Expert Group on Multi-Physics Experimental Data, Benchmarks and Validation (EGMPEBV) was created in 2014 to deal with the activities associated with the certification of experimental data and benchmark models along with establishing the processes and procedures for using the data and benchmark models for validation of multi-physics modelling and simulation tools and data.

The organization of the EGMPEBV relies on three Task Forces, focused on 1) Experimental Data Qualification and Benchmark Evaluation; 2) Methods and Standards, and 3) Specific Applications. Task Force 1 is focused on providing better and more accurate experimental datasets, which support validation of high-fidelity multi-physics modelling and simulation (M&S) tools. At the same time, it has to consider the incompleteness of past experimental data sets (in terms of data, documentation, or uncertainties) and with the limited number of available multi-physics experimental facilities. Task Force 2 is designed to develop validation methods and guidelines, and uncertainty qualification for the new family of multi-physics, multi-scale codes in the context of emerging demands such as longer fuel cycles and power uprate. Task Force 3 is focused on applications of validation experiments and has the objective to organize multi-physics M&S benchmarks involving validation experiments.

Task Force 3 (TF3) is focused on developing example applications of validation experiments for novel experimental multi-physics benchmarks. It will be comprised of three tasks based on three different sources of experimental data. Task 1 of TF3 develops benchmarks based on plant data. An international team has selected a benchmark related to recent measurements of VVER-1000 transient behaviour and this benchmark has been already specified in detail. This benchmark is named OECD/NEA Rostov Unit 2 (Rostov-2) VVER-1000 Multi-Physics Benchmark and is subject to the announcement. As part of cooperation activities between US Department Of Energy (DOE) and OECD/NEA the DOE Consortium for Advanced Simulations of LWRs (CASL) is providing the Watts Bar Nuclear Power Plant (NPP) Cycles 1-5 data for specifying multi-physics multi-cycle benchmark. Task 2 of TF3 will focus on multi-physics benchmarks based on transient test reactor data. It will develop benchmarks based on both existing Studsvik test reactor ramp tests (PCMI validation benchmark - MPCMIV), and recently started CABRI (CEA, France) and TREAT (INL, USA) transient testing experiments. Task 3 of TF3 will develop multi-physics benchmarks based on novel experiments in university reactors.

Many tests with a multitude of well-documented neutron-physics and thermal-hydraulics measurements data have been performed at Rostov Unit 2 (Rostov-2) Nuclear Power Plant (NPP). The reactor type is VVER-1000 with fuel assemblies type TBC-2M, which enable an 18-month fuel cycle length. Integral (plant) data and local (core) measured data were collected during the test, which will be used for the validation of both traditional and novel multi-physics codes. The measurement and recording of parameters was performed by the standard means available at NPP and by a special system of experimental control. The benchmark team consisting from NCSU, GRS, VNIIAES and KI, selected a test (transient), which will allow validation of novel multi-physics codes developed last years in the frame of different national and international projects. The difference in comparison with all previous OECD/NEA Benchmarks for coupled code validation is the implementation of high fidelity multi-physics simulation codes that could predict pin-by-pin power distributions and flow mixing in the primary loop, in the reactor pressure vessel including its active core part. For the OECD/ NEA Rostov-2 VVER-1000 Multi-Physics Benchmark

the reference benchmark problem chosen for simulation and comparison with the measured data is based on a test characterized by the "Reactivity compensation with diluted boron by stepwise insertion of control rod cluster into the VVER core". The selected benchmark transient allows to perform simulation tests with different levels of fidelity and complexity.

This workshop (Rostov2-1) will be held in conjunction with other meetings/workshops under the auspices of the NSC, OECD / in order to facilitate co-ordination and sharing of work. Three other meetings are being held in Garching, Germany during the same week in order to combine efforts in common areas such as modelling and simulation; verification, validation and uncertainty analysis; and applications and to make the participation more efficient. The meetings/workshops concerned are:

- *June 24 – June 25, 2019* – First Workshop on Preservation of Thermal-Hydraulics (TH) experimental data (TH-1);
- *June 26 – June 28, 2019* – OECD/NEA Second Multi-Physics Model Validation Workshop (MPMV-2);
- *June 26 – June 27, 2019* – AER group D meeting (AER-D).

The week-long events are sponsored by GRS. Kiril Velkov from GRS is the local event host.

Background and Purpose of the Benchmark Workshop

The objective of the workshop is to define, conduct, and summarise an OECD/ NEA Rostov-2 VVER-1000 Multi-Physics Benchmark – Rostov2. The proposed benchmark consists of the following phases and exercises:

Phase I - Assembly-wise (traditional) analysis:

Exercise I.1 – Thermal-Hydraulic (T-H) plant simulation using power tables

Exercise I.2 – Coupled Three-Dimensional (3-D) neutronics/core T-H response evaluation

Exercise I.2a – Hot Zero Power (HZP) state

Exercise I.2b – 75% Hot Power (HP) state

Exercise I.3 - Best-estimate coupled code plant transient modeling

Phase 2 - Full core pin-by-pin (novel) analysis:

Exercise 2.1 - Boundary condition steady-state problem

Exercise 2.2 – Boundary condition transient calculations

Exercise 2.3 – Best-estimate coupled pin-by-pin transient calculations

Benchmark Specification has been updated to Version 1.3 by the benchmark team to be discussed at the incoming first benchmark workshop along with remaining missing information and needed clarifications.

Scope and Technical Content of the Benchmark Workshop

The technical topics to be addressed at the workshop include:

a) Present updated Benchmark Specifications Version 1.3 for Phases I and II;

b) Present updated support data and cross-section libraries;

c) Present updated experimental and measured data;

d) Discuss missing information and needed clarifications;

e) Present and discuss preliminary, supporting and related simulations and results;

f) Agree on schedule of benchmark activities.

Organization of the Benchmark Workshop

The meeting is organised around the discussion in depth of the updated benchmark specifications, templates for submission of participants' results, reference solutions, supporting and preliminary results, and updated work plan and time schedule for the OECD/NEA Rostov2 benchmark activities. Institutes and organization interested in VVER technologies and their modelling and simulation are invited. The participants are requested to present their modelling and results as well as their experience and expertise in VVER-1000 multi-physics transient analysis.

Participation in the Benchmark Workshop

For Benchmark Workshops sponsored by the Nuclear Science Committee (NSC), participation is restricted, for efficiency, to participants in this study and to experts (research laboratories, safety authorities, regulatory agencies, utilities, owners' groups, vendors, etc.) from OECD/NEA member countries nominated by Delegates to the Committee in consultation with official authorities concerned and with the assistance of members of the Nuclear Science Committee.

Organisation and Programme Committee of the Benchmark Workshop

An Organisation and Programme Committee has been nominated to make necessary arrangements for the Kick-off Benchmark Workshop and to organize the Sessions, draw up the final programme, appoint Session Chairmen, etc. The members of the Programme Committee are:

Kiril Velkov - Local Co-Chair and Co-ordinator
GRS, Germany

Maria Avramova – Co-Chair and Co-ordinator
North Carolina State University (NCSU), USA

Pavel Gordienko
National Research Centre "Kurchatov Institute", Russian Federation

Aleksandr Denisenko
VNIIAES, Russian Federation

Kostadin Ivanov
Chair of WPRS at NCS, OECD/NEA
North Carolina State University, USA

Tim Valentine
Chair of EGMPEBV at NSC, OECD/NEA
Oak Ridge National Laboratory (ORNL)

Secretariat **Shuichi Tsuda**
Elena Poplavskaia
OECD/Nuclear Energy Agency, France

Proposed Programme of the Benchmark Workshop

The proposed programme for the Rostov2-1 Benchmark Workshop was drawn-up by the Programme Committee and is enclosed as ***Appendix 1***.

Language of the Benchmark Workshop

The official language of the Rostov2-1 Benchmark workshop is English.

Proceedings of the Workshop

A summary of the workshop will be published by the OECD/NEA after the meeting. The summary will be distributed free of charge to the participants in the Workshop and to Delegates of the NSC. The programme committee and the session Chairmen will prepare a summary report on the main results of the meeting for presentation to the NSC. Presentations will be available free of charge to the participants to download from participants' restricted area after the workshop.

Contacts and Registrations

A common registrations webpage is made available for the participants of the Rostov2-1, TH-1, MPMV-1 and AER-D workshops/meetings:

https://www.oecd-nea.org/science/egmpebv/workshops_grs_2019/

Inquiries about registrations can be directed to Shuichi Tsuda:

Shuichi.TSUDA@oecd-nea.org

Please send the titles and authors of your presentations for Rostov2-1 workshop to Kiril Velkov:

Kiril.Velkov@grs.de

Workshops' Location

The meeting place for the four workshops/meetings during the week of June 24-28, 2019 is the GRS, Garching, Germany.

The information for transportation and hotels is provided also at the link given above. There is no registration fee for participating in the workshops. Coffee breaks, lunches and a banquet will be provided also free of charge.

Appendix 1

OECD/NEA Rostov Unit 2 (Rostov2) VVER-1000 Multi-Physics Benchmark – First Workshop (Rostov2-1)

Host Organization
Hosted by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH
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PROPOSED PROGRAMME

R1-15: Session code

- R1. Introduction and opening remarks
- R2. Overview of the status of benchmark activities
- R3. Presentations on related activities
- R4. Discussion of the updated Specifications for Phase I
- R5. Presentation of updated experimental and measured data for Rostov-2 benchmark
- R6. Presentation of updated support data and cross-section library for Phase I
- R7. Presentation and discussion preliminary, supporting and related results for Phase I
- R8. Participants' presentations on their modelling and results for VVER-1000 multi-physics transient calculations
- R9. Discussion of the updated Specifications for Phase II
- R10. Presentation of updated support data and cross-section library for Phase II
- R11. Discussion of reference solutions for Phases II
- R12. Participants' presentations on their expertise and experience in high-fidelity plant transient modelling and results
- R13. Discussion of missing information and needed clarifications in the benchmark
- R14. Action items and schedule of benchmark activities - next workshop (Rostov2-2) and plans
- R15. Conclusions and closing remarks