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Department of Nuclear Engineering

OECD/NEA Deterministic Time-Dependent Neutron Transport Benchmark without Spatial Homogenization (C5G7-TD) – Ninth Workshop (C5G7-TD-9)

Lucca, Italy
Tuesday, May 21, 2024 (track 2 morning)
In conjunction with the BEPU 2024 Conference

Hosted by N.IN.E. (Nuclear and Industrial Engineering), Italy

Announcement and Proposed Program

Sponsorship

The 9th workshop for the OECD/NEA Deterministic Time-Dependent Neutron Transport Benchmark without Spatial Homogenization (C5G7-TD) benchmark – C5G7-TD-9 - will be held on May 21, 2023 (track 2 morning), in Lucca, Italy and is a follow up to the previous workshops. The C5G7-TD-9 meeting will be held in conjunction with the 2024 Best-Estimate Plus Uncertainty (BEPU-2024) international conference as well as with other OECD/Nuclear Energy Agency (NEA) Working Party on scientific issues and uncertainty of Reactor Systems (WPRS) meetings/workshops to facilitate co-ordination and sharing of work. The other meetings are being held in three parallel tracks at Lucca, Italy during the same week to combine efforts in common areas such as neutronics, thermal-hydraulics, and multi-physics modelling and uncertainty analysis and to make the participation more efficient. The meetings/workshops concerned are:

- *May 19, 2024 (morning)* – Tenth COBRA-TF (CTF) (CTF-10) Hands-on Training Session
- *May 19, 2024 (afternoon)* – CTF-10 User Group (UG) Meeting
- *May 20, 2024 (track 1 morning)* – Third OECD/NEA Lead Fast Reactor (LFR) benchmark - Thermal-Hydraulic (T/H) Stage (LFR-3 T/H) workshop
- *May 20, 2024 (track 2 morning)* - Third OECD/NEA Fluoride High Temperature (FHR) Reactor Benchmark (FHR-3) workshop
- *May 20, 2024 (track 1 afternoon)* - Third OECD/NEA Lead Fast Reactor (LFR) benchmark - LFR Neutronics (N) Stage - (LFR-3 N) workshop
- *May 20, 2024 (track 2 afternoon)* – Sixth OECD/NEA Rostov-2 VVER-1000 Multi-Physics Transient Benchmark (Rostov2-6) workshop
- *May 21, 2024 (track 1)* - Ninth OECD/NEA Sodium Fast Reactor (SFR) UAM Benchmark workshop (SFR-UAM-9)
- *May 21, 2024 (track 2 afternoon)* – Fifth Multi-Physics Pellet Cladding Mechanical Interaction Validation Benchmark workshop (MPCMIV-5)
- *May 20-21 (track 3), 2024* – 2nd OECD/NEA International School on Simulation of Nuclear Reactor Systems (SINUS-2)
- *May 22, 2024 (track 1)* – Seventeen OECD/NEA Light Water Reactor (LWR) Uncertainty Analysis in Modelling (UAM) Benchmark workshop (LWR-UAM-17)
- *May 22, 2024 (track 2 morning)* - Fourth Liquid Metal Fast Reactor (LMFR) Thermal-Hydraulic (T/H) Benchmark (LMFR T/H-4) workshop
- May 22, 2023 (track 2 afternoon) – First OECD/NEA HTGR-TH Benchmark (Based on HTTF Data) workshop (HTGR-TH-1)
- *May 23, 2024 (track 1)* - Fourth OECD/NEA Tennessee Valley Authority (TVA) Watts Bar 1 (WB1) multi-physics cycle depletion benchmark workshop (TVA-WB1-4)
- *May 23, 2024 (track 2 morning)* - Summary session with presentations of recently concluded benchmarks: OECD/NEA First Burst-Fission-Gas Release Benchmark (BFGR) and OECD/NEA McMaster Core Thermal-Hydraulics (CTH) Benchmark
- *May 23, 2024 (track 2 afternoon)* – OECD/NEA Task Force Artificial Intelligence & Machine Learning meeting (TF AI&ML)

Background and Purpose of the Benchmark Workshop

The objective of the workshop is to define, refine, conduct, and summarize the OECD/NEA Time-Dependent Neutron Transport Benchmark without Spatial Homogenization – C5G7-TD. This benchmark was proposed to the Expert Group on Radiation Transport and Shielding (EGRTS) and has been approved by the NSC WPRS in the meeting in February 2015. The benchmark team lead by NCSU is reporting the progress on benchmark activities to the Expert Group on Physics of Reactor Systems (EGPRS), Expert Group on reactor core Thermal-Hydraulics and Mechanics (EGTHM), and the Expert Group on Multi-Physics of reactor systems (EGMUP) of WPRS, NSC.

The C5G7-TD benchmark was established to develop a series of well-defined exercises to test and verify the standalone neutron transport and coupled multi-physics simulation capabilities for light water reactor (LWR) applications. The targeted solution methods in this benchmark do not utilize spatial homogenization above the fuel pin level, i.e., pin-averaged or pin-resolved methods in reactor physics and sub-channel-based methods thermal-hydraulics simulation. There are three phases planned for this benchmark:

- Phase I (Kinetics Phase): verification of methods and codes for heterogeneous time-dependent neutron transport calculations without feedback
  - Part A: Cartesian geometry exercises
  - Part B: Neutron noise analysis
  - Part C: Hexagonal geometry exercises
- Phase II (Dynamics Phase): verification of methods and codes for heterogeneous time-dependent neutron transport calculations with feedback
  - Part II-1: Prompt feedback
  - Part II-2: Complete feedback
- Phase III (High-fidelity Phase): uncertainty propagation in high-fidelity multi-physics calculations

In Phase I, both Part A and B are based on the well-established steady-state C5G7 benchmark problem in the Cartesian geometry, while Part C is designed to address the hexagonal core configuration. The specifications of Part A and B have been finalized, and that for Part C has been expanded and will be discussed at the workshop. The summary report of Part A has been finalized and the final version is posted on the benchmark SharePoint.

The cases in Phase II-1 have been defined and are currently being refined according to the feedback from participants. Specifications for Phase II-1 have been updated on the benchmark SharePoint. Results have been submitted by the participants and are being analysed. Phase II-2 specification (complete feedback) is being further developed and will be finalized after this workshop.

Scoping studies are being carried out by NCSU to obtain preliminary results and develop the specification for cases in Phase III. Discussions at the workshop will focus on making a work plan to conduct Phase III.

More information and supporting documents are available at:

https://www.oecd-nea.org/jcms/pl_32145/deterministic-time-dependent-neutron-transport-benchmark-without-spatial-homogenisation-c5g7-td

Scope and Technical Content of the Meeting

The topics to be addressed at the workshop include:

- Final report and conclusions on Phase I-A;
- Comparative analysis of submitted results for Phase I-B;
- Discussion on the final benchmark specifications for Phase I-C, as well as received comments, suggestions, and corrections;
- Corrections to Phase II-1 specifications;
- Finalization of draft the specification of Phase II-2, including new data libraries and functions prepared for it;
- Discussion of reference results for benchmark cases for Phase II;
- Discussion of final templates and methods for submission of participants' results for Phase II;
- Comparative analysis of submitted results for Phase II;
- Discussion of Phase III exercises and preliminary results;
- Presentations on participants' experience and expertise in time-dependent neutron transport calculations;
- Presentations on participants' experience and expertise in high-fidelity dynamics calculations;
- Defining a work plan and schedule outlining actions to progress on the benchmark activities.

The proposed meeting program is attached as Annex 1.

Organization of the Meeting

The meeting is organized around the discussion in depth of the benchmark specifications, templates for submission of participants' results, reference solutions, and proposed work plan and time schedule for the OECD/NEA C5G7-TD benchmark activities. The participants are requested to present their modelling and results as well as their experience and expertise in time-dependent neutron transport analysis.

Participation in the Meeting

Participation is restricted to individuals from OECD/NEA member country institutions who agree to the benchmark non-disclosure agreement (NDA). Participants are asked to sign and send the corresponding NDA form to wprs@oecd-nea.org. The benchmark NDA form can be found at:

https://www.oecd-nea.org/jcms/pl_32145/deterministic-time-dependent-neutron-transport-benchmark-without-spatial-homogenisation-c5g7-td

Organization and Program Committee of the Meeting

An Organization and Program Committee has been nominated to make necessary arrangements for the 9th Benchmark Workshop and to organize the Sessions, draw up the final program, appoint Session Chairmen, etc. The members of the Program Committee are:

> **Alessandro Petruzzi** – *Co-Chair, and Local Host*
> **NINE S.r.l., Italy**
>
> **Jason Hou** - *Co-Chair and Coordinator*
> North Carolina State University, USA
>
> **Pascal Rouxelin**
> North Carolina State University, USA

Secretariat: **Oliver Buss**
OECD/Nuclear Energy Agency, France

Proposed Program of the Meeting

The proposed program was drawn up by the Program Committee and is enclosed as Annex 1.

Language of the Benchmark Workshop

The official language of this workshop is English.

Proceedings of the Meeting

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 benchmark participants and to Delegates of the EGPRS, EGTHM, EGMUP, WPRS, and NSC. The program committee and the session Chairmen will prepare a summary report on the main results of the meeting for presentation to the EGPRS, EGTHM, EGMUP, WPRS, and NSC. Presentations will be available free of charge to the benchmark participants to download from participants' restricted area of the benchmark website after the workshop.

Contacts and Registrations

The annual benchmark workshops/meetings of the Working Party on Scientific Issues and Uncertainty Analysis of Reactor Systems (WPRS) and CTF UG Meeting and Training will be hosted by NINE S.r.l. in Lucca (Italy). The meetings will take place in three tracks in parallel during the week of May 19 to May 23, 2024, to exchange our results and lessons-learned for the different WPRS benchmark activities and to discuss future activities.

The link to registration page for the WPRS-related workshops/meetings including CTF-10 registration, and overall program is

https://www.oecd-nea.org/jcms/pl_89133/wprs-benchmarks-workshops-2024

In addition, there is a link to registration form for the CTF-10 UG Meeting and Training is at NCSU/RDFMG website:
https://www.ne.ncsu.edu/rdfmg/cobra-tf/tenth-ctf-user-group-ug-meeting-and-training/

Workshops' Location

The meeting place/venue for the BEPU-2024 conference and the eleven meetings/workshops during the week of May 19 to May 23, 2024 is the Real Collegio, which is located inside the city walls of Lucca. The local information for transportation and hotels is given at:

https://www.nineeng.com/bepu2024/index.php/conference-info/about-the-conference

The schedule for the incoming WPRS Workshops, SINUS-2 school and CTF-10 Meeting and Training is given in the table below (all times in CEST):

The program and schedule of the meetings is shown below:

Sunday, 19 May 2024	9:00-13:00	CTF UG Training
	14:00-18:00	CTF UG Meeting
	Starting at 18:00	Registration & informal networking

		Track 1	Track 2	Track 3 (SINUS)
Monday, 20 May 2024	Starting at 8:00	Registration		
	9:00-13:00	Lead-cooled Fast Reactor Benchmark (LFR) - T/H Stage	FHR - Fluoride High Temperature Reactor Benchmark	OECD NEA International School on Simulation of Nuclear Reactor Systems (SINUS)
	14:00-18:00	Lead-cooled Fast Reactor Benchmark (LFR) - Neutronics Stage	Rostov-2 VVER-1000 Benchmark	SINUS
Tuesday, 21 May 2024	9:00-13:00	Uncertainty Analysis in Modelling (UAM) for Design, Operation and Safety Analysis of Sodium-cooled Fast Reactors (SFR-UAM)	C5G7-TD: The Deterministic Time-Dependent Neutron Transport Benchmark C5G7-TD without Spatial Homogenization	SINUS
	14:00-18:00	SFR UAM	Multi-physics Pellet Cladding Mechanical Interaction Validation (MPCMIV) Benchmark	SINUS

		Track 1	Track 2
Wednesday, 22 May 2024	9:00-13:00	Benchmark for Uncertainty Analysis in Best-Estimate Modelling for Design, Operation and Safety Analysis of Light Water Reactors (LWR-UAM)	Liquid Metal Fast Reactor Core Thermal-Hydraulics Benchmark (LMFR T/H)
	14:00-18:00	LWR UAM including session on EGMUP Task Force on Doppler effective fuel temperature	HTGR T/H Benchmark based on HTTF Data
Thursday, 23 May 2023	9:00-13:00	TVA Watts Bar Unit 1 Multi-Physics Benchmark	9:00-11:00 Summary presentations of recently concluded benchmarks: - Burst Fission Gas Release (1h) - McMaster CTH (1h) 11:00-13:00 EGMUP Task Force Artificial Intelligence & Machine Learning
	14:00-18:00	TVA Watts Bar Unit 1 Multi-Physics Benchmark	EGMUP Task Force Artificial Intelligence & Machine Learning

ANNEX 1

9th workshop for the OECD/NEA Deterministic Time-Dependent Neutron Transport Benchmark without Spatial Homogenization (C5G7-TD) – C5G7-TD-9

Host Organization

Hosted by N.IN.E. (Nuclear and Industrial Engineering)

Lucca, Italy

May 21, 2024 (track 2 morning)

PROPOSED PROGRAM

C01-14: Session code

C01. Introduction and opening remarks

C02. Overview of benchmark activities

C03. Presentations on related activities

C04. Overview of Phase I-A summary report

C05. Discussion of Phase I-B results

C06. Discussion of Phase I-C specification and cross section data

C07. Discussion of the final Specifications for Phase II-1

C08. Participants' presentations on their modelling and results for time-dependent neutron transport calculations

C09. Discussion of the draft Specifications for Phase II-2

C10. Discussion of the selected dynamics test problems and requested output for Phase II-2

C11. Participants' presentations on their expertise and experience in high-fidelity dynamics modelling and results

C12. Planning of Phase III strategies

C13. Action items and schedule of benchmark activities - next workshop (C5G7-TD-10) and plans

C14. Conclusions and closing remarks