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Third OECD/NRC Liquid Metal Fast Reactor Thermal-Hydraulics Benchmark (LMFR T/H) Workshop

Bologna, Italy
May 25, 2023 (Track 2 Afternoon)

Hosted by hosted by ENEA, Italy

Announcement and Proposed Program

Background and Purpose of 3rd LMFR T/H Benchmark Meeting

The third LMFR T/H Benchmark Meeting (LMFR T/H-3) will be held on May 25, 2023, in Bologna, Italy, and is a follow up to the previous workshop. The LMFR T/H meeting will be held in conjunction with other OECD/NEA Working Party on scientific issues and uncertainty of Reactor Systems (WPRS) meetings/workshops to facilitate co-ordination and sharing of work. Thirteen other meetings are being held in three parallel tracks at Bologna, Italy during the same week in order 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 22, 2023 (track 2 morning) – Ninth COBRA-TF (CTF) User’s Group (UG) Meeting (CTF-9) followed by a hands-on CTF training sessions which will be conducted on Monday afternoon, May 22, 2023 and Tuesday morning, May 23, 2023 (track 2);
- May 22, 2023 (track 1 afternoon) – First Burst-Fission-Gas Release Benchmark (BFGR-1) workshop;
- May 23, 2023 (track 1) - Sixteen OECD/NEA Light Water Reactor (LWR) Uncertainty Analysis in Modelling (UAM) Benchmark (LWR-UAM-16) workshop;
- May 23, 2023 (track 2) – OECD/NEA HTGR-TH Benchmark introductory presentation and discussions;
- May 22-23 (track 3), 2023 – OECD/NEA International School on Simulation of Nuclear Reactor Systems (SINUS);
- May 24, 2023 (track 1 morning) - OECD/NEA Task Force on Doppler Effective Fuel Temperature meeting;
- May 24, 2023 (track 2 morning) – Fourth OECD/NEA McMaster Core Thermal-Hydraulics (CTH) Benchmark (CTH-4) workshop;
- May 24, 2023 (track 1 afternoon) – OECD/NEA Task Force Artificial Intelligence & Machine Learning meeting;
- May 24, 2023 (track 2 afternoon – LFR neutronics) – May 25, 2023 (track 2 morning – LFR Thermal-hydraulics) – Second OECD/NEA Lead Fast Reactor (LFR) Benchmark (LFR-2) workshop;
- May 24, 2023 (track 1 afternoon) – May 25, 2023 (track 1 morning) - Eight OECD/NEA Time-Dependent Neutron Transport (C5G7-TD) Benchmark (C5G7-TD-8) workshop;
- May 25, 2023 (track 1 afternoon) – May 26, 2023 (track 1 morning) - Third meeting on OECD/NEA TVA Watts Bar 1 (WB1) Multi-Physics Multi-Cycle Depletion Benchmark (TVA-WB1-3) workshop;
- May 26, 2023 (track 2) - Eight OECD/NEA Sodium Fast Reactor (SFR) UAM Benchmark workshop and First Liquid Metal Fast Reactor (LMFR) Thermal-Hydraulics (T/H) Benchmark workshop (SFR-UAM-8);
- May 26, 2023 (track 1 afternoon) – Fifth meeting on Rostov-2 VVER-1000 Multi-physics Transient Benchmark (Rostov2-5).

The Liquid Metal Fast Reactor (LMFR) is one of the reactor designs included in the next generation of nuclear reactors. Many numerical and experimental studies have been performed on LMFR core geometry but a structured set of techniques for consistent and comprehensive comparisons to establish modeling and simulation tools needed for LMFR analysis is missing from the current literature. This activity has been already endorsed by the Organization for Economic Co-operation and Development Nuclear Energy Agency (OECD-NEA) and is in line with the United States Nuclear Regulatory Commission (US NRC) strategy for advanced non-Light Water Reactor (LWR) research with a focus on developing core Thermal-Hydraulic (TH) modeling and simulation capabilities for confirmatory analysis of LMFRs.

This benchmark has been divided into two Phases:

- Phase I
 - Steady-state numerical predictions of Texas A&M University (TAMU) separate effect test and comparison to experimental results; and
- Phase II
 - Numerical predictions of the Thermal Hydraulic Out of Reactor Safety (THORS) integral effect tests and comparison to experimental results.

Each phase will include several exercises and will be planned to accommodate as many numerical prediction methods as possible. The objectives of Phase I are to provide a detailed geometry of the bundle test section and boundary conditions and a high-resolution experimental database of isothermal turbulent flow and pressure drop acquired from a 61-pin wire-wrapped hexagonal fuel bundle (all from TAMU); assess the performance of numerical schemes and turbulent models currently implemented in the state-of-the-art Computational Fluid Dynamics (CFD) codes; and establish best practices for uncertainty quantification (UQ) of model geometry, initial and boundary conditions, and other associated uncertainties for CFD calculations.

The objectives of Phase II are to provide a sodium turbulent flow and heat transfer database for CFD and sub-channel model validation; emphasize the importance of uncertainty analysis for TH simulations; establish best practices for quantification of geometry modelling, input data, fluid properties, and other uncertainties associated with the complex flows in LMFR bundles; develop guidance for CFD model/code validation for LMFR fuel bundles that can be used to improve the existing standards; update the current TH models for pressure drop and inter-channel mixing; and develop the hybrid experiment/simulation database necessary to establish and calibrate the low order models with high resolution (both experimental/numerical) data.

The information about the LMFR T/H benchmark is provided at:

https://www.oecd-nea.org/jcms/pl_32180/liquid-metal-fast-reactor-core-thermal-hydraulics-benchmark-lmfr-t/h

Scope and Technical Content of the Meeting

The topics to be addressed at the workshop include:

- Review and discussion of specifications of LMFR T/H Benchmark Phases I and II,
- Presentations on preliminary results of LMFR T/H Benchmark Phases I and II,
- Discussion of templates for submitting participants' results for different phases,
- Feedback and concerns of benchmark participants,

- Presentations on other related activities such as model developments, efficiency improvements, verification and validation efforts and applications, and
- Defining a work plan and schedule for LMFR T/H activities.

The proposed meeting program is attached as Annex 1.

Organization of the Meeting

The meeting is organized around the discussion of the LMFR T/H benchmark specifications, preliminary results, participants' concerns and benchmark-related activities. The participants are requested to present their expertise and experience in benchmark-related modeling, verification and validation, uncertainty quantification and applications.

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.

Benchmark NDA form:

https://www.oecd-nea.org/jcms/pl_62381/conditions-for-participation-to-lmfr-t/h-benchmark

Organization and Program Committee of the Meeting

An Organization and Program Committee has been nominated to make the necessary arrangements for the LMFR T/H-3 meeting and to draw up the final program, etc.

The members of the Program Committee are:

Maria Avramova – *Principal Investigator and Chair*
North Carolina State University, USA

Yassin Hasan – *Co-Principal Investigator and Co-Chair*
Texas A&M University

David Holler - *Co-Chair*
North Carolina State University, USA

Giacomo Grasso – *Local Host*
ENEA, Italy

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 the LMFR T/H-3 meeting is English.

Proceedings of the Meeting

A summary of the LMFR T/H-3 meeting will be published by the program committee after the meeting. The summary will be distributed free of charge to the participants in the meeting. The

presentations will be available free of charge to the participants to download from participants' restricted area after the LMFR T/H-3 meeting.

Contacts and Registrations

The annual benchmark workshops/meetings of the [Working Party on Scientific Issues and Uncertainty Analysis of Reactor Systems \(WPRS\)](#) and LMFR T/H Benchmark Meeting will be hosted by ENEA in Bologna (Italy). The meetings will take place in two tracks in parallel during the week of 22 May to 26 May 2023 to exchange 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 LMFR T/H-2), overall program, and local information for transportation and hotels is:

https://www.oecd-nea.org/jcms/pl_71612/wprs-benchmarks-workshop-2023

The link to registration page for the CTF-9 UG Meeting and Training is:

<https://www.ne.ncsu.edu/rdfmg/cobra-tf/ninth-ctf-user-group-ug-meeting-and-training/>

Workshop Location

The meeting place for the ten meetings/workshops during the week of May 22 – 26, 2023, in three tracks is at the Zanol Hotel Europa, Bologna, Italy (in-person meeting). As mentioned above the local information for transportation and hotels is given at:

https://www.oecd-nea.org/jcms/pl_71612/wprs-benchmarks-workshop-2023

The program and schedule of the meetings is shown below:

	Track 1	Track 2	Track 3
Monday, May 22	Morning: MPCMIV Afternoon: Burst Fission Gas Release	Morning: CTF UG Afternoon: CTF Training	Morning: SINUS Afternoon: SINUS
Tuesday, May 23	Morning: LWR UAM Afternoon: LWR UAM	Morning: HTGR-TH Afternoon: HTGR-TH	Morning: SINUS Afternoon: CTF Training
Wednesday, May 24	Morning: Task Force on Doppler Effective Fuel Temperature Afternoon: Task Force on AI & ML	Morning: McMaster CTH Afternoon: LFR Neutronics	
Thursday, May 25	Morning: C5G7-TD Afternoon: TVA-WB1	Morning: LFR TH Afternoon: LMFR TH	
Friday, May 26	Morning: TVA-WB1 Afternoon: Rostov-2	Morning: SFR-UAM Afternoon: SFR-UAM	

ANNEX 1

OECD/NEA/US NRC Liquid Metal Fast Reactor Thermal-Hydraulic (LMFR T/H) Benchmark – Second Workshop (LMFR T/H-3)

Host Organization

Hosted by ENEA

Bologna, Italy

May 25, 2023 (Track 2 Afternoon)

PROPOSED PROGRAM

LT01-08: Session code

May 25, 2023 (Track 2 Afternoon)

LT01. Introduction and opening remarks

LT02. Overview of benchmark activities since last workshop

LT03. Presentations of related activities and reference analyses

LT04. Discussion of the Phase I specifications

LT05. Discussion of the Phase II specifications

LT06. Participants' presentations on their modelling and results of the LMFR T/H benchmark

LT07. Action items and schedule of benchmark activities - next workshop (LMFR T/H-4) and plans

LT08. Conclusions and closing remarks