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Fifth Workshop of the OECD/NEA-NRC Liquid Metal Fast Reactor Core Thermal-Hydraulic Benchmark (LMFR-TH-5)

3 July 2025
Department of Engineering of the University of Cambridge, Trumpington Street, CB2 1PZ, Cambridge, United Kingdom

The workshop will be held in Cambridge, UK, as part of the Benchmarks Workshops of the Working Party on Scientific Issues and Uncertainty of Reactor Systems (WPRS). The WPRS Benchmarks Workshops event with three parallel tracks combines benchmarking efforts in common areas such as neutronics, thermal-hydraulics, and multi-physics modelling and uncertainty analysis.

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Sponsorship

The fifth meeting of the OECD/NEA-NRC Liquid Metal Fast Reactor Core Thermal-Hydraulic Benchmark (LMFR-TH-5) will be held on 3 July 2025 in Cambridge, UK, as part of the Benchmarks Workshops Event of the Working Party on Scientific Issues and Uncertainty of Reactor Systems (WPRS). This event with three parallel tracks combines benchmarking efforts in common areas such as neutronics, thermal-hydraulics, and multi-physics modelling and uncertainty analysis. The full schedule for the incoming WPRS Workshops, SINUS-3 school and CTF-11 Meeting and Training is given on the public meeting web page: https://www.oecd-nea.org/jcms/pl_98752/wprs-benchmarks-workshops-2025

Executive Summary

The Liquid Metal Fast Reactor (LFMR) 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 the modeling and simulation tools needed for LMFR analysis is missing from the current literature. This activity has already been 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 subchannel 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. Comparisons to selected data from the Thermal Hydraulic Out of Reactor Safety (THORS) experimental campaign. The targeted data are from Bundles 3C, 6A, and 9. The selected data from Bundles 3C and 6A are public. Bundle 3C (19 central pins + 12 guard pins) involved steady state with blockage and transient conditions. Bundle 6A (19 pins) involved natural circulation and boiling.

Bundle 9 (61 pins) was used to thoroughly investigate behavior on a larger bundle in both steady and transient conditions. An initial version of the Phase II specification (bundles 3 and 6) has been finalized and made available to participants. The finalized version of the Phase II specification (bundles 3, 6, and 9) is ready to be released. The NCSU benchmark team has acquired and digitized a full bundle of 9 legacy documents; three Bundle 9 documents have been acquired in total, including steady-state data in tables, transient data in plots
The information about the OECD/NEA-NRC LMFR-TH benchmark is provided at:
Nuclear Energy Agency (NEA) - 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 meeting include:

- Review and discussion of the current version of specifications and support data for Phase I, including templates for submitting participants' results,
- Review and discussion of the current version of specifications and support data for Phase II, including templates for submitting participants' results,
- Participants' presentations on their modelling and results for Phases I and II,
- Presentations on other related activities linked with the benchmark,

The proposed meeting program is attached as Annex 1.

Organization of the Meeting

The meeting is organized around the discussion of the LMFR-TH benchmark specifications, preliminary results, participants' concerns, and benchmark-related activities. The participants are requested to present their expertise and experience in benchmark-related modeling and results of all the proposed exercises.

Participation in the Meeting

Meeting participation is not restricted. Benchmark 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 LMFR-TH conditions to release form can be found at:

https://www.oecd-nea.org/upload/docs/application/pdf/2024-10/lmfr_th-conditions_for_release_v2.pdf

Organization and Program Committee of the Meeting

An Organization and Program Committee has been nominated to make the necessary arrangements for the LMFR-TH-5 benchmark and to draw up the final program, etc.

The members of the Program Committee are:

Agustin Abarca – Co-Chair
North Carolina State University, USA
Maria Avramova – Co-Chair
North Carolina State University, USA
NEA Technical 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 workshop is English.

Proceedings of the Meeting

The program committee and the session Chairs will prepare a summary report on the main results of the meeting. 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

Link to the registration page for the WPRS-related workshops and meetings and the overall program: https://www.oecd-nea.org/jcms/pl_98752/wprs-benchmarks-workshops-2025

Workshop Location

The meeting place/venue for the meetings/workshops during the week of 30 June to 4 July 2025 is the Department of Engineering of the University of Cambridge:

Trumpington Street, CB2 1PZ, Cambridge, United Kingdom.

Annex 1:

Fifth Meeting of the OECD/NRC Liquid Metal Fast Reactor Core Thermal-Hydraulic Benchmark (LMFR-TH-5)

Host Organization

Department of Engineering of the University of Cambridge, in collaboration with the Cambridge Nuclear Energy Centre, University of Cambridge, United Kingdom

July 3, 2025

PROPOSED PROGRAM

LM01. Introduction and opening remarks.

LM02. Status of the LMFR-TH benchmark activities.

LM03. Phase 1 Specifications and Updates.

LM04. Phase 1Modelling and results from participants.

LM05. Phase 2 Specifications and Updates

LM06. Phase 2 Modelling and results from participants.

LM07. Round Table Discussions and Modelling Questions