



Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

Third OECD/NEA Lead-cooled Fast Reactor (LFR) Benchmark (LFR-3) Workshop

Announcement and Proposed Program

Lucca, Italy

Monday, May 20, 2024

Track 1 morning – LFR Thermal-Hydraulics Stage

Track 2 afternoon – LFR Neutronics Stage

In conjunction with the BEPU 2024 Conference

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

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

The third OECD/NEA Lead-cooled Fast Reactor (LFR) Benchmark (LFR-3) Workshop will be held on May 20, 2024, in Lucca, Italy, and is a follow up to the previous workshop. The LFR-3 meeting will be held in conjunction with the 2024 Best-Estimate Plus Uncertainty (BEPU-2024) international conference as well as 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. The other meetings will be 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)* – COBRA-TF (CTF)-10 a Hands-on Training Session (CTF-10)
- *May 19, 2024 (afternoon)* – CTF-10 User Group (UG) Meeting
- *May 20, 2024 (track 2 morning)* - Third OECD/NEA Fluoride High Temperature (FHR) Reactor Benchmark (FHR-3) 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 morning)* - Ninth OECD/NEA Time-Dependent Neutron Transport (C5G7-TD) Benchmark (C5G7-TD-9) workshop
- *May 21, 2024 (track 2 afternoon)* – Fifth Multi-Physics Pellet Cladding Mechanical Interaction Validation Benchmark (MPCMIV-5) workshop
- *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 (LWR-UAM-17) workshop
- *May 22, 2023 (track 2 morning)* – Fourth OECD/NRC Liquid Metal Fast Reactor Thermal-Hydraulics 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 TVA Watts Bar 1 (WB1) Multi-Physics Multi-Cycle Depletion Benchmark (TVA-WB1-4) workshop
- *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

Lead-cooled Fast Reactors (LFR) are rather new concepts, which are gathering increasing international attention. However, and apart from the reactors operated for the propulsion of military submarines in the former Soviet Union, no operative experience exists to support their design, verification, and licensing. Also, there are few organizations having the experimental infrastructure to investigate specific aspects in support of the LFR technology.

A series of thematic benchmarks are sought to overcome the limited experience on scientific aspects of an LFR core, leveraging – thanks to the international context provided by the NEA framework – the presence of organizations with experience on the LFR. The first in the series focuses on the neutronics of an LFR while the second one focuses on thermal-hydraulics of an LFR.

To facilitate the gaining of experience on LFRs, a «staged approach» is devised, with progressively increasing levels of complexity and detail. In a first stage – the current one – introductory benchmark studies are proposed, to start familiarizing with the key phenomena and grasping sensibility on the order of magnitude; and to establish a common understanding and share background.

Subsequent stages will then allow deepening into the phenomena, issues and challenges specific to an LFR (e.g., by addressing sensitivity and uncertainties); involving other competences by extending to other aspects or dealing with their mutual correlation (i.e., shifting to multi-physics).

The Advanced LFR European Demonstrator (ALFRED) is assumed as reference system for the LFR benchmark. ALFRED is highly representative of international projects, so to increase the relevance of the benchmark exercise, and secures availability of design information and data, to allow the complete and coherent modeling of the core representative of LFRs in the Small Modular Reactors (SMRs) segment such as to reflect the widespread interest in SMRs.

For the LFR neutronics benchmark (Stage I) three phases are devised on three levels – elementary cell (Phase I-1), assembly/supercell (Phase I-2), and whole core (Phase I-3). Draft specifications have been prepared and distributed among potential participants.

For the LFR Thermal-Hydraulics (T/H) benchmark (Stage II) introductory exercises are proposed focusing on the fuel assembly thermal hydraulic of an LFR core. The specific purpose of this LFR T/H benchmark is to: practice with the modelling of the T/H of an LFR core; to assess confidence in the capability of simulating the T/H of an LFR core; and to derive best practices and areas for improvement. The phases are devised on three scales: turbulence scale (Phase II-1) with code-to-data comparisons; bundle scale (Phase II-2) with code-to-code comparisons; and bundle/system scale (Phase II-3) with code-to-data comparisons. The progressive nature of the benchmark will allow participants to familiarize and validate the purely dynamic turbulence modelling of the grid spacers effects, especially of CFD codes, for a full scale bundle; apply the gained knowledge when moving to lead coolant in the simulation of the ALFRED fuel assembly; and test built modelling experience via comparison with representative steady state experimental data so to arrive at an integral code to experiment validation. Draft specifications have been prepared and distributed among potential participants.

The information about the LFR benchmark is provided at:

https://www.oecd-nea.org/icms/pl_66836/lead-cooled-fast-reactor-benchmark-lfr

Scope and Technical Content of the Meeting

The topics to be addressed at the workshop include:

- Review and discussion of specifications of LFR Benchmark Phases I and II,
- Presentations on preliminary results of LFR 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 LFR activities.

The proposed meeting program is attached as Annex 1.

Organization of the Meeting

The meeting is organized around the discussion of the LFR neutronics and 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/upload/docs/application/pdf/2023-01/lfr-conditions_for_release_v4.pdf

Organization and Program Committee of the Meeting

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

The members of the Program Committee are:

Giacomo Grasso – *Co-Chair of Neutronics Stage*
ENEA, Italy

Francesco Lodi – *Co-Chair of Thermal-Hydraulics Stage*
ENEA, Italy

Alessandro Petruzzi – *Co-Chair, and Local Host*
NINE S.r.l., 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 LFR-3 meeting is English.

Proceedings of the Meeting

A summary of the LFR-2 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 LFR-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 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/>

Workshop 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	<u>9:00-13:00</u>	CTF UG Training		
	<u>14:00-18:00</u>	CTF UG Meeting		
	<u>Starting at 18:00</u>	Registration & informal networking		
		Track 1	Track 2	Track 3 (SINUS)
Monday, 20 May 2024	<u>Starting at 8:00</u>	Registration		
	<u>9:00-13:00</u>	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)
	<u>14:00-18:00</u>	Lead-cooled Fast Reactor Benchmark (LFR) - Neutronics Stage	Rostov-2 VVER-1000 Benchmark	SINUS
Tuesday, 21 May 2024	<u>9:00-13:00</u>	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
	<u>14:00-18:00</u>	SFR UAM	Multi-physics Pellet Cladding Mechanical Interaction Validation (MPCMIV) Benchmark	SINUS

		Track 1	Track 2
Wednesday, 22 May 2024	<u>9:00-13:00</u>	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)
	<u>14:00-18:00</u>	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	<u>9:00-13:00</u>	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
	<u>14:00-18:00</u>	TVA Watts Bar Unit 1 Multi-Physics Benchmark	EGMUP Task Force Artificial Intelligence & Machine Learning

ANNEX 1

OECD/NEA Lead Fast Reactor (LFR) Benchmark – Third Workshop (LFR-3)

Host Organization

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

Lucca, Italy

Monday, May 20, 2024

Track 1 morning – LFR Thermal-Hydraulics Stage

Track 2 afternoon – LFR Neutronics Stage

L01-05: LFR Thermal-hydraulics

L01. Introduction and opening remarks

L02. Overview of benchmark status

L02.01 Presentation of the specifications and participants

L02.02 Discussion and feedbacks

L03. Participants' presentations on their modelling and results of the LFR benchmark

L03.X Participants' presentations on their modelling and results of the LFR benchmark

L04. Action items and review of schedule of benchmark activities - next workshop (LFR-4) and plans

L05. Conclusions and closing remarks.

L06-10: LFR Neutronics

L06. Introduction and opening remarks

L07. Overview of benchmark activities since last workshop

L07.01 Discussion of specifications

L08. Presentations of related activities and reference analyses

L08.X Participants' presentations on their modelling and results of the LFR benchmark

L09. Action items and schedule of benchmark activities - next workshop (LFR-4) and plans

L10. Conclusions and closing remarks.