



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

## **Second OECD/NRC Lead-cooled Fast Reactor (LFR) Benchmark (LFR-2) Workshop**

**Bologna, Italy**

**May 24, 2023 (track 2 afternoon – LFR Neutronics) – May 25, 2023 (track 2 morning –  
LFR Thermal-hydraulics)**

**Hosted by hosted by ENEA, Italy**

### **Announcement and Proposed Program**

## **Background and Purpose of 3<sup>rd</sup> LMFR T/H Benchmark Meeting**

The second OECD/NEA Lead-cooled Fast Reactor (LFR) Benchmark (LFR-2) Workshop will be held on May 24-25, 2023, in Bologna, Italy, and is a follow up to the previous workshop. The LFR-2 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 (track 2) 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 afternoon) – OECD/NEA HTGR-TH Benchmark introductory presentation and discussions;
- May 22 - May 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 (T/H)) – Second OECD/NEA Lead Fast Reactor (LFR) Benchmark (LFR-2) workshop;
- May 24, 2023 (track 3 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 2 afternoon) – Second Liquid Metal Fast Reactor (LMFR) Thermal-Hydraulics (T/H) Benchmark workshop (LMFR T/H-2);
- 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 (SFR-UAM-8);
- May 26, 2023 (track 1 afternoon) – Fifth meeting on Rostov-2 VVER-1000 Multi-physics Transient Benchmark (Rostov2-5).

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 orders 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 (Phase I) three exercises are devised on three levels – elementary cell (Exercise I-1), assembly/supercell (Exercise I-2), and whole core (Exercise I-3). Draft specifications have been prepared and distributed among potential participants.

For the LFR Thermal-Hydraulics (T/H) benchmark (Phase II) introductory exercises are proposed focusing on the fuel assembly thermal-hydraulics of an LFR. 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 exercises are devised on three scales turbulence scale (Exercise II-1) with code-to-data comparisons; bundle scale (Exercise II-2) with code-to-code comparisons; and bundle/system scale (Exercise 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/jcms/pl\\_66836/lead-cooled-fast-reactor-benchmark-lfr](https://www.oecd-nea.org/jcms/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](mailto:wprs@oecd-nea.org).

Benchmark NDA form:

[https://www.oecd-nea.org/upload/docs/application/pdf/2023-01/lfr-conditions\\_for\\_release\\_v4.pdf](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-2 meeting and to draw up the final program, etc.

The members of the Program Committee are:

**Giacomo Grasso** – *Chair and Local Host*  
ENEA, Italy

**Francesco Lodi** – *Co-Chair*  
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 LFR-2 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-2 meeting.

### **Contacts and Registrations**

The annual benchmark workshops/meetings of the [Working Party on Scientific Issues and Uncertainty Analysis of Reactor Systems \(WPRS\)](#) and LFR-2 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 LFR-2), overall program, and local information for transportation and hotels is:

[https://www.oecd-nea.org/jcms/pl\\_71612/wprs-benchmarks-workshop-2023](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 Zanhotel 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](https://www.oecd-nea.org/jcms/pl_71612/wprs-benchmarks-workshop-2023)

The program and schedule of the meetings is shown below:

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

## ANNEX 1

### OECD/NEA Lead Fast Reactor (LFR) Benchmark – Second Workshop (LFR-2)

#### Host Organization

Hosted by ENEA

Bologna, Italy

**May 24, 2023 (track 2 afternoon – LFR Neutronics)**

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**May 25, 2023 (track 2 morning – LFR Thermal-hydraulics)**

#### PROPOSED PROGRAM

##### L01-05: LFR Neutronics

- L01. Introduction and opening remarks
- L02. Overview of benchmark activities since last workshop
  - L02.01 Discussion of the Phase I specifications
  - L02.02 Presentation of template for collection of results
- L03. Presentations of related activities and reference analyses
  - L03.X Participants' presentations on their modelling and results of the LFR benchmark
- L04. Action items and schedule of benchmark activities - next workshop (LFR-3) and plans
- L05. Conclusions and closing remarks.

##### L06-10: LFR Thermal-hydraulics

- L06. Introduction and opening remarks
- L07. Participants self-introduction (Stages of interest and tools)
- L08. Phase II specifications
  - L08.01 Presentation of the specifications
  - L08.02 Discussion and feedbacks
- L09. Action items and schedule of benchmark activities - next workshop (LFR-3) and plans
- L10. Conclusions and closing remarks.

