

# **OECD/NEA WPRS/EGRFP Burst Fission Gas Release (bFGR) Benchmark Workshop**

**Bologna, Italy  
May 22, 2023 (track 1 afternoon)**

**Hosted by ENEA, Italy**

## **Announcement and Proposed Program**

## **Background and Purpose of bFGR Benchmark Meeting**

The OECD/NEA WPRS/EGRFP Burst Fission Gas Release (bFGR) Benchmark Workshop will be held on May 22, 2023, in Bologna, Italy. The bFGR benchmark workshop will be held in conjunction with other OECD/NEA [Working Party on Scientific Issues and Uncertainty Analysis 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).

Gaseous fission product release has a significant impact on nuclear fuel performance. Diffusion-based fission gas release (FGR) models are well established and well validated under steady-state conditions. However, under transient conditions gaseous fission gas release may be governed by different "burst" mechanisms which are not well captured by fuel performance codes. This benchmark is organised to examine the models for fission gas release during transients representative of anticipated operational occurrences (AOOs). The benchmark will utilize experimental cases which had transient powers high enough to ensure burst FGR, but low enough transient powers and short enough transient durations to ensure that diffusional FGR was minimal. The OECD NEA [Expert Group on Reactor Fuel Performance \(EGRFP\)](#) is leading a benchmark with the following objectives:

- Improve understanding of burst FGR amongst NEA member organisations [in particular in Anticipated Operational Occurrences (AOOs) and Design Basis Accidents (DBAs)]
- Facilitate development of new fuel performance code models, or improvements of existing models, for burst FGR
- Facilitate improvement in accuracy of FGR predictions and hence reduction in modelling uncertainties, increased margin to fuel performance limits (e.g. rod internal pressure), and increased plant flexibility

#### *Cases modeled in the benchmark*

Benchmark participants elected to use real, integral rod irradiation (rather than hypothetical cases or separate effects experiments) primarily due their interest in capturing burnup effects and the value of FGR-related measurements in the analysis. They placed emphasis on cases where:

- diffusional release during transient is expected to be minimal [moderate power increases and/or short hold times representative of AOOs]
- FGR-related measurements [FGR, RIP, Xe radial concentrations, etc]
- data are non-proprietary or can be made so
- specifications already exist
- suitably comprehensive pre-characterisation (incl. fuel grain size)

With these criteria in mind, participants selected two cases available in the [International Fuel Performance Experiments \(IFPE\) database](#):

#### REGATE

- CEA experiment which aimed to study FGR and fuel swelling during a power transient at medium burnup
- Segmented rod base irradiated in Gravelines-5 PWR to 47 MWd/kgU
- Re-irradiation in Siloé test reactor without re-fabrication
- Non-destructive PIE performed after base irradiation (incl. FGR)
- Both non-destructive & destructive PIE performed after re-irradiation (incl. FGR, radial Xe concentration (EPMA))

#### HATAC-C2

- Segment cut from commercially irradiated parent rod
- Parent rod irradiated in Fessenheim-2 PWR to 46 MWd/kgU

- Segment fitted with gas flow lines & re-irradiated in Siloé
- The aim was to investigate stable and radioactive fission gas release behaviour under power cycling
- Gas release measured by spectrometry after each transient
- PIE of both parent rod (incl. FGR) & segment (incl. ceramography)

The information about the bFGR benchmark is provided at: [https://www.oecd-nea.org/jcms/pl\\_70791/burst-fission-gas-release-fgr-benchmark-of-the-expert-group-on-reactor-fuel-performance-egrfp](https://www.oecd-nea.org/jcms/pl_70791/burst-fission-gas-release-fgr-benchmark-of-the-expert-group-on-reactor-fuel-performance-egrfp)

### **Scope and Technical Content of the Meeting**

The topics to be addressed at the workshop include:

- Summary of all participants phase I results
- Review of recommended input values, with attention to missing data and data inconsistencies within the IFPE files identified by participants.
- Description of FGR models within participant codes, detailing “basic” FGR model as well as the “burst” FGR model components. Modelers are invited to make notes of the various assumptions made within these models (ex. Thermal conductivity models)
- Discussion of how each participant approached the re-fabrication/re-start in their modeling

The proposed meeting program is attached as Annex 1.

### **Participation in the Meeting**

Participation is restricted to individuals from OECD/NEA member country institutions.

### **Organization of the Meeting**

The bFGR Benchmark workshop is organized in coordination with the Benchmark Coordinator and the NEA Secretariat of the EGRFP.

**Luana Giaccardi** – *Benchmark Coordinator*  
NINE, Italy

**Michelle Bales** - *Secretariat*  
OECD/Nuclear Energy Agency, France

### **Language of the Benchmark Workshop**

The official language of the bFGR benchmark is English.

### **Contacts and Registrations**

The annual benchmark workshops/meetings of the [Working Party on Scientific Issues and Uncertainty Analysis of Reactor Systems \(WPRS\)](#) and bFGR Benchmark Workshop 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 bFGR), 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)

### **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	<u>Morning:</u> MPCMIV <u>Afternoon:</u> 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	<u>Morning:</u> LWR UAM <u>Afternoon:</u> 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 Burst Fission Gas Release Benchmark Workshop

#### Host Organization

Hosted by ENEA

Bologna, Italy

**May 22, 2023 (track 1 afternoon)**

#### PRELIMINARY PROGRAM

14:00	Welcome	Benchmark Coordinator
14:15	Summary of all Participants Phase I Results	Luana GIACCARDI
14:45	Missing Data and Data Inconsistencies	Luana GIACCARDI
15:15	Pending	Pending
<b>15:45</b>	<b>COFFEE Break</b>	
16:15	Best estimate thermomechanical analysis plus uncertainties of VVER -1000 FR during normal operation	Plamen PETKOV
16:40	UJV calculations of bFGR Benchmark cases using Transuranus code	Martin DOSTAL
17:00	bFGR release modeling using the fuel performance code BISON	Pierre Clement SIMON (Idaho National Laboratory, Idaho Falls, ID)
17:20	Pending	Pending
17:40	Pending	Pending
18:00	Conclusions and closing remarks	