

#### Lawrence Livermore National Laboratory

7000 East Avenue, L-198, Livermore, California, 94550

SUBJECT:	Report on the 2023 ICSBEP/IRPhEP/SINBAD Technical Review Group Meetings and IRSN Collaboration Meeting		
DATE:	June 30, 2023		
то:	Dr. Ang Securit	gela Chambers, N Administration	Nuclear Criticality Safety Program Manager, National Nuclear າ / NA-ESH-21
FROM:	Cather	ine Percher (LLN	IL)
MEETING TITLE	:	ICSBEP/IRPhE T OECD NEA: 3-7	echnical Review Group and Candidate SINBAD Experiments, April 2023
MEETING LOCA	TION:	OECD Nuclear B	Energy Agency (NEA) Headquarters, Boulonge-Billancourt, France
MEETING DATE	S:	April 3-7, 2023	
ATTENDEES ON	I BEHAL	F OF NCSP:	Eric Aboud <sup>1</sup> , Kelsey Amundson <sup>2</sup> , Doug Bowen <sup>3</sup> , Cihangir Celik (remote) <sup>3</sup> , Mathieu Dupont (remote) <sup>3</sup> , Jeff Favorite <sup>2</sup> , Wim Haeck <sup>2</sup> , Gary Harms <sup>4</sup> , Dave Heinrichs <sup>1</sup> , Jesson Hutchinson (remote) <sup>2</sup> , Germina Ilas (remote) <sup>3</sup> , Noah Kleedtke <sup>2</sup> , B. J. Marshall <sup>3</sup> , Geordie McKenzie <sup>2</sup> , Alex McSpaden <sup>2</sup> , Ugur Mertyurek (remote) <sup>3</sup> , Jesse Norris <sup>1</sup> , Catherine Percher <sup>1</sup> , Rene Sanchez <sup>2</sup> , Aaron Tamashiro (remote) <sup>1</sup> , Nick Thompson <sup>2</sup> , Rob Weldon <sup>2</sup> , Nick Whitman <sup>2</sup> , Mike Zerkle <sup>5</sup>
			<sup>1</sup> LLNL (5), <sup>2</sup> LANL (11), <sup>3</sup> ORNL (6), <sup>4</sup> SNL (1), <sup>5</sup> NNL (1)

#### **MEETING PURPOSE:**

The Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD) coordinates benchmark activities including the Shielding Integral Benchmark Archive and Databae (SINBAD), the International Criticality Safety Benchmark Evaluation Project (ICSBEP) and the International Reactor Physics Experiment Evaluation Project (IRPhEP). The three benchmark activities met in person (with a virtual attendance option) in April 2023 for the first time since 2019 (before the pandemic) to discuss the projects and review benchmarks for inclusion in the various compendia. SINBAD and IRPhEP held parallel meetings on Monday, April 3. A joint meeting for all three projects to discuss administrative items was held on Tuesday, April 4. The technical meetings for ICSBEP were held from April 5-7. All agendas for these meetings are provided in the appendix of this report.

SINBAD is undergoing a transition process to assess and improve the quality of the shielding benchmarks. The project is different than the other two benchmark projects in that they have restructured the technical review group into small subgroups that work on improving benchmarks and

reviewing them for quality. The progress on a number of benchmarks was discussed at the in person meeting, including the NCSP-funded LLNL Pulsed Spheres evaluation.

IRPhEP did not have completed benchmarks to approve at this meeting, but a number of laboratories presented the status of in-process benchmarks. There were no NCSP benchmarks presented.

The ICSBEP Technical Review Group met to review nine evaluations (eight new evaluations and one major revision of an existing evaluation). Four new and one legacy NCSP evaluations were reviewed by members of the ICSBEP Technical Review Group (TRG) constituted from the meeting attendees:

- PU-MET-THERM-004: TEX-Pu Experiments for Thermal Scattering Law Validation of Polyethylene and Polymethyl-methacrylate (LLNL)
- PU-MET-THERM-005: Thermal spectrum plutonium metal configurations with C-PVC and PVC-Chlorine Worth Study (CWS) (LANL)
- HEU-MET-FAST-104: MUSIC: Critical Experiments with Bare Highly-Enriched Uranium Shells (LANL)
- LEU-COMP-THERM-111: Molybdenum Sleeve Experiments in Fully-Reflected Water-Moderated Triangular-Pitched U(6.90)O<sub>2</sub> Fuel Rod Lattices (1.55 cm Pitch) (SNL)
- ALARM-REAC-SST-SHIELD-001: Health Physics Research Reactor shieling benchmark (ORNL)

The four new evaluations from LLNL, LANL, and SNL were accepted pending resolution of the TRG review comments and approval of a subgroup of the TRG. During the reviw of PU-MET-THERM-005, there was a discussion about how to assess the composition of C-PVC and PVC due to difficulties encountered during the benchmarking phase, with the resolution deferred to the subgroup. The one legacy benchmark from the ORNL HPRR (ALARM-REAC-SST-SHIELD-001) was found to be unacceptable as a benchmark due to the quality of the historical data regarding the measured flux (the benchmark quantity). This benchmark was encouraged to be submitted to SINBAD.

As members of the Technical Review Group, the NCSP and other attendees participated in review of non-NCSP evaluations including one new critical benchmark as part of a LANL/JAEA collaboration and two new shielding benchmarks from the Czech Republic:

- HEU-MET-FAST-102: ZEUS: Fast-Spectrum Critical Assemblies with a Pb-HEU Core Surrounded by a Copper Reflector (LANL)
- ALARM-CF-FE-SHIELD-002/ ALARM-CF-NI-SHIELD-001: Fast Neutron Leakage Spectra from an Iron or Nickel Sphere with <sup>252</sup>Cf Source in Center (Centrum Výzkumu Řež)
- ALARM-CF-SST-SHIELD-001: Fast Neutron Leakage Spectra from a Stainless Steel 321 Sphere with <sup>252</sup>Cf Source in Center (Centrum Výzkumu Řež)

All three evaluations were approved for publication in ICSBEP pending adequate resolution of TRG review comments. Extended discussion was had by the TRG regarding the measured benchmark quantity for the two ALARM benchmarks, with the resolution deferred to the subgroup.

Additionally, the meeting included a discussion of proposed major revision to one previously approved French plutonium solution experiment evaluation, evaluated by the Institut de Radioprotection et de Sûreté Nucléaire (IRSN):

• PU-SOL-THERM-028: Water-reflected Annular Cylinders (50/30 cm diam.) Containing Plutonium (3% <sup>240</sup>Pu) Nitrate Solutions

The revisions to PST-028 evaluation was undertaken to update the plutonium solution chemistry due to additional information being uncovered. LANL (Jennifer Alwin) provided the independent review. The major revision to the benchmark was approved contingent on resolution of review comments through a technical subgroup.

The 2020 editions of the ICSBEP and IRPhE Handbooks were published in December 2022. The next ICSBEP/IRPhE meetings will either be hosted by LLNL in Livermore, CA or by NEA at NEA Headquarters in March/April 2024.

## **MEETING BENEFITS TO THE NCSP:**

**ICSBEP:** The ICSBEP is the main and most trusted source of critical benchmarks used for NCS validation and nuclear data testing in the United States and the world. The US DOE Office of Defense Programs founded the Criticality Safety Evaluation Project (CSBEP) in 1992 to document and preserve criticality safety benchmark experiments. In 1994, the CSBEP welcomed international participants from France, Hungary, Japan, Russia, and the United Kingdom; and in 1995, the DOE allowed the CSBEP to become an official activity of the OECD NEA to further enhance international participation and changed the name to the ICSBEP. As described in the USDOE NCSP Mission and Vision, Five-Year Execution Plan, and CEdT Manual, the ICSBEP remains an important element of information preservation and dissemination.

**IRPhE:** The International Reactor Physics Experiment Evaluation (IRPhE) Project is a follow-on to the ICSBEP focused on the totality of experimental reactor physics data including, but not limited to, critical data. A subset of the critical data benefits NCSP. However, due to the physical complexity of real reactor systems, uncertainties in this critical data is often much too large (e.g., > 1%  $\Delta$ k) to benefit NCSP users or inform nuclear data evaluation.

**SINBAD:** SINBAD is a compilation of shielding experiments and benchmarks of varying quality which often have limited experimental description leading to very high model uncertainties. While shielding benchmarks can be used to inform nuclear data, only a subset of the SINBAD benchmarks are of high enough quality to provide informative tests. The project is currently undergoing a transition process to assess and improve the quality of the shielding benchmarks.

## PURPOSE OF TRAVEL:

The benchmark projects meet in person annually to review new benchmarks for inclusion in their respective handbooks. Meeting in person greatly facilitates the review and ensures a higher quality product due to the rigor of the technical review group's examination.

## SECONDARY MEETING:

Eric Aboud, Dave Heinrichs, and Catherine Percher held a secondary meeting during this trip with IRSN at their offices in Fontenay-aux-Roses, France on Friday, March 3. The travelers met with IRSN staff to discuss and plan continued NCSP work tasks, including the TEX experimental collaboration, slide rule calculations, benchmark intercomparison, and the nuclear accident dosimetry field characterization and Intercomparison. IRSN has been a very beneficial partner to the NCSP, providing technical expertise and excellent independent review for three TEX plutonium benchmarks.

**AUSPICES:** This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

**ATTACHMENT:** Agenda for SINBAD, ICSBEP, and IRPhE Technical Review Group Meetings, Hosted by OECD NEA, April 4-7 2023.

## **DISTRIBUTION:**

Angela Chambers, <u>angela.chambers@nnsa.doe.gov</u> Doug Bowen, <u>bowendg@ornl.gov</u> Marsha Henley, <u>henleym@ornl.gov</u> OECD/NEA Nuclear Science Committee

Working Party on Scientific Issues and Uncertainty Analysis of Reactor Systems (WPRS)

Expert Group on Physics of Reactor Systems (EGPRS)

# Meeting of the EGPRS Task Force on the Shielding Integral Benchmark Archive and Database (SINBAD)

## FINAL AGENDA

# 3<sup>rd</sup> April 2023, Hybrid meeting

## OECD/NEA - 46, quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, Paris France

# Room BB3

Agenda Item	Start Time (CET)	Торіс	Speaker	Duration
1	09:00	Welcome and Introduction of participants	Chair/ Secretariat	00:20
2	09:20	Adoption of the Agenda	Chair	00:10
3	09:30	Updates from the Secretariat	NEA Secretariat, All	00:20
4	09:50	Review of the new SINBAD process and discussion of related new proposals (LaTeX template, DB distribution via GitLab, access to development area, issue boards)	Chair/ Secretariat	00:40
5	10:30	COFFEE BREAK		00:20
6	10:50	Prioritization of benchmark maintenance efforts	Chair/All	00:40
7	11:30	Overview of ongoing maintenance tasks (20min per subgroup incl. discussion) - PART 1 - CERN CERF [3*20min]	Subgroup leads	01:00
8	12:30	LUNCH BREAK		01:00
9	13:30	Overview of ongoing maintenance tasks (20min per subgroup incl. discussion) - PART 2 - FNG HCLL - FNG Copper - Broomstick O16 - KFK n-gamma	Subgroup leads	01:20
10	14:50	COFFEE BREAK		00:20
11	15:10	Overview of ongoing maintenance tasks (20min per subgroup incl. discussion) - PART 3 - LLNL Pulsed Spheres - RPV Fluence	Subgroup leads	00:40
12	15:50	List of Actions	NEA Secretariat, All	00:15
13	16:05	Date and place of next meeting	All	00:05
14	16:10	Any other business	All	00:10
15	16:20	Closing	Chair	

## **OECD/NEA Nuclear Science Committee**

Working Party on Scientific Issues and Uncertainty Analysis of Reactor Systems (WPRS)

## International Reactor Physics Experiment Evaluation Project (IRPhEP)

## FINAL AGENDA

# 3<sup>rd</sup> April 2023

## Hybrid meeting

## OECD/NEA - 46, quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, Paris France Room BB2

Upon arrival, please report to the Reception Desk on the ground floor with a photo ID. A badge will be issued that will allow you to enter the premises at all times during the meeting.

Local information about hotels and transport, as well as an area map, can be found on the Web page: <u>http://www.oecd-nea.org/general/practical/</u>

Agenda Item	Start Time (Duration)	Торіс	Speaker	
1	9h00 (15 min)	Welcome & Introduction	NEA and Chair(s)	
2	9h15 (5 min)	Adoption of the Agenda	Chair	
3	9h20 (30 min)	<ul> <li>Update from the Secretariat</li> <li>Website</li> <li>Preservation of un-evaluated data</li> <li>Related NEA initiatives to IRPhEP</li> </ul>	NEA Secretariat	
4	9h50 (30 min)	SNEAK-12A, (if timing allows 12B)	M. Margulis	
	10h20 (15 min)	Coffee break		
5	10h35 (30 min)	ZED2-HWR-EXP-001	L. Yaraskavitch	
6	11h05 (30 min)	BERENICE Evaluation	P. Blaise	
7	11h35 (20 min)	KRITZ-2 critical measurements of 8X8 UO2 and MOX fuel rod clusters and assemblies between 20 °C and 250 °C	D. Mennerdahl	
8	11h55 (20 min)	Fukushima Daini Unit 2 8X8 BWR burnup credit benchmark measurements involving non-destructive axial gamma-ray scanning and radiochemical assay measurements using reactor utility data for the measurement model	D. Mennerdahl	
	12h15 (60 min)	Lunch break		

## Monday, 3rd April 2023 (IRPhEP)

9	13h15 (30 min)	MPCMIV Benchmark	M. Avramova	
10	13h45 (30 min)	TVA Watts Bar 1 Benchmark	K. Ivanov	
11	14h15 (20 min)	MSR Additional Benchmarks	L. Cleary	
12	14h35 (30 min)	Prioritisation and advancement of evaluations	Chair	
13	14h55 (30 min)	Potential for a multi-physics handbook	E. Ivanov	
14	15h35 (10 min)	Update on the IRPhEP Database and Analysis Tool	NEA Secretariat	
15	15h45 (15 min)	Upcoming meeting/events	Chair	
16	16h00 (5 min)	Next Meeting	NEA Secretariat	
Close of Meeting				

## **OECD/NEA Nuclear Science Committee**

Joint Administrative Meetings of

International Reactor Physics Experiment Evaluation Project (IRPhEP)

International Criticality Safety Benchmark Evaluation Project (ICSBEP)

SINBAD Task Force (SINBAD-TF)

## FINAL AGENDA

4<sup>th</sup> April 2023

Hybrid meeting

OECD/NEA - 46, quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, Paris France Room BB2

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Tuesday, 4th April 2023 (Joint IRPhEP, SINBAD-TF, ICSBEP)					
Agenda Item	Start Time (Duration)	Торіс	Speaker		
1	9h30 (15 min)	Welcome & Introduction	Chair(s)/Secretariat		
2	9h45 (5 min)	Adoption of the Agenda	Secretariat		
3	9h50 (30 min)	Guidance Documents – Format Guides Updates	TRG Chairs		
	10h20 (15 min)	Coffee break			
4	10h35 (25 min)	Guidance Documents – Uncertainty Guides Updates	TRG Chairs		
5	11h00 (30 min)	Guidance Documents – Planning Guide	TRG Chairs		
6	11h30 (30min)	Process—New SINBAD process and maturity levels	T. Miller		
7	12h00 (30 min)	Distribution – Options of releasing evaluation prior to full Handbook Release, + SINBAD distribution via GitLab	TRG Chairs		

	12h30 (60	Lunch break			
	min)				
8	13h30 (20	Publication –LaTeX templates	TRG Chairs		
	min)				
9	13h50 (30	Issue boards, licenses, handling compatibility of legacy	O. Buss/TRG Chairs		
	min)	inputs			
10	14h20 (40	Experimental Correlations Discussion	TRG Chairs		
	min)				
11	15h00 (30	Nuclear Data Sensitivity Tool (NDaST)	I. Hill		
	min)				
	15h30 (20	Coffee break			
	min)				
12	15h50 (30	Integrated, Automated, Reproducible, Verified, and	A. Holcomb		
	min)	Validated Nuclear Data Services			
13	16h20 (30	Discussion how to stress the importance of benchmarks for	TRG Chairs		
	min)	benchmark funding			
	Buffer				
14	17h15	Next Meeting	Secretariat		
15	17h20 (10	Actions	Secretariat		
	min)				
16		Closing Remarks			
	17h30	Cocktail			
Close of Meeting					

#### Working Party on Nuclear Criticality Safety (WPNCS)

## Annual International Criticality Safety Benchmark Evaluation Project (ICSBEP)

## **Technical Review Group Meeting**

## **FINAL AGENDA**

## 5-7 April 2023

## Hybrid meeting

#### OECD/NEA - 46, quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, Paris France Room BB2

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Wednesday, 5 April 2023 (ICSBEP)					
8:45 – 9:00	SESSION 1:	WELCOME AND INTRODUCTION			
		Welcome and Introduction			
		Administrative Items: Sign-In, List of Experiment for Next Year			
9:00 – 10:30	SESSION 2:	APPROVAL OF NEW EVALUATIONS			
	ALARM-CF-FE-SHIELD-002	Fast Neutron Leakage Spectra from an Iron or Nickel Sphere with <sup>252</sup> Cf Source in Center	Tomas Czakoj		
10:30 – 10:45	BREAK				
10:45 – 12:15	SESSION 3:	APPROVAL OF NEW EVALUATIONS			
	ALARM-CF-SST-SHIELD-001	Fast Neutron Leakage and Spatial Distribution of Activation of a Stainless Steel 321 Sphere with <sup>232</sup> Cf Source in Center	<b>T C 1</b> ·		
			Tomas Czakoj		
12:15 – 13:15	LUNCH				
13:15 – 14:45	SESSION 4:	APPROVAL OF REVISED EVALUATION			
	PU-SOL-THERM-028	Water-reflected Annular Cylinders (50/30 cm diam.) Containing			
		Flutonium (5% ** ru) Nittate Solutions	Nicolas Leclaire		
14:45 – 15:00	BREAK	GROUP PHOTO	Everyone		
15:00 – 16:30	SESSION 5:	APPROVAL OF NEW EVALUATIONS (Continued)			
	LEU-COMP-THERM-111	Molybdenum Sleeve Experiments in Fully-Reflected Water-	Course Hormon		
		moderated mangular-Friend 0(0.90)02 ruer Kod Lattices (1.55 cm Pitch)	Gary namis		
16:30 – 18:00		Additional Time if Needed			

# Annual International Criticality Safety Benchmark Evaluation Project (ICSBEP) Technical Review Group Meeting

## FINAL AGENDA

## 5-7 April 2023

# Hybrid meeting

#### OECD/NEA - 46, quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, Paris France

Room BB2

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Thursday, 6 April 2023 (ICSBEP)					
8:45 – 9:00	SESSION 1:	WELCOME AND INTRODUCTION			
		Welcome and Introduction			
		Administrative Items: Sign-In, List of Experiment for Next Year			
9:00 – 10:30	SESSION 2:	APPROVAL OF NEW EVALUATIONS			
	LEU-COMP-THERM-109	Criticality Experiments in Hexagonal Lattices (1.275 cm Pitch) of VVER-1000 Low Enriched U(3.3 wt.% <sup>235</sup> U)O <sub>2</sub> Fuel Assemblies in	Tomas Czakoj		
		Light Water with Seven Void, Silicon Dioxide or Graphite Modules in Center	·		
10:30 – 10:45	BREAK				
10:45 – 12:15	SESSION 3:	APPROVAL OF NEW EVALUATIONS			
	ALARM-REAC-PE-001	Neutron Fluence Response to a Bare and to a Lucite-Reflected Pulse of the ORNL Health Physics Research Reactor	Mathieu Dupont		
12.15 - 13.15	LUNCH	•			
12.10 10.10	Lonon				
13:15 – 14:45	SESSION 4:	APPROVAL OF NEW EVALUATIONS (Continued)			
	HEU-MET-FAST-102	ZEUS: Fast Spectrum Critical Assemblies with a Pb-HEU Core Surrounded by a Copper Reflector	Kelsey Amundson		
14:45 – 15:00	BREAK				
15:00 – 18:00	SESSION 3:	APPROVAL OF NEW EVALUATIONS (Continued)			
	HEU-MET-FAST-104:	Shells	Alex McSpaden		
			Rene Sanchez		

Annual International Criticality Safety Benchmark Evaluation Project (ICSBEP)

**Technical Review Group Meeting** 

## FINAL AGENDA

## 5-7 April 2023

## Hybrid meeting

#### OECD/NEA - 46, quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, Paris France

Room BB2

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Friday, 7 April 2023 (ICSBEP)					
8:50 – 9:00		WELCOME BACK			
9:00 – 10:30	SESSION 4:	APPROVAL OF NEW EVALUATIONS (Continued)			
	PU-MET-THERM-005	Thermal Spectrum Critical Assemblies with a Polyvinyl Chloride and Chlorinated Polyvinyl Chloride-Plutonium-Aluminum Metal Alloy Core surrounded by a Polyethylene Reflector	Jeff Favorite		
10:30 – 10:45	BREAK		Everyone		
10:45 – 12:15	SESSION 5:	DISCUSSION TEX Plutonium Thermal Assemblies: Plutonium-Aluminum Metal Alloy Plates with Thick Polyethylene and			
	PU-MET-THERM-004	Polymethyl Methylacrylate (Lucite) Moderators	Catherine Percher		