

# Memorandum

- To: Dr. Angela Chambers, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-ESH
- Thru: Joetta Goda, LANL NCSP Task Manager
- From: Nick Whitman, NEN-2, MS B228 Kelsey Amundson, NEN-2, MS B228
- **Symbol:** NEN-2:23-016

Date: April 24, 2023

# Subject: Report on Foreign Travel to Paris, France for participation in the 2023 International Criticality Safety Benchmark Evaluation Project (ICSBEP) Technical Review Group (TRG)

## **Meeting Details**

## Attendees on behalf of NCSP from LANL

Kelsey Amundson, Jeff Favorite, George McKenzie, Alex McSpaden, Rene Sanchez, Nicholas Whitman, Robert Weldon. Noah Kleedtke and Wim Haeck also attended from LANL but were not funded by NCSP.

#### Meeting Title

2023 International Criticality Benchmark Evaluation Project (ICSBEP), International Reactor *Physics Evaluation Project* (IRPhEP), and *Shielding Integral Benchmark and Database* (SINBAD) Technical Review Group (TRG) Meetings

#### Meeting Location

OECD/NEA Headquarters, 92100 Boulogne-Billancourt, Paris, France

#### Meeting Dates

April 3-7, 2023

#### Meeting Objective

The meetings provided a forum for the review of ICSBEP, IRPhEP, and SINBAD evaluations by a Technical Review Group.

#### **Purpose of Travel**

Attendees from Los Alamos National Laboratory traveled from the US to France to attend the meetings in person at the OECD/NEA Headquarters in Boulogne-Billancourt, Paris, France.

Alex McSPADEN and Rene SANCHEZ presented as the evaluators for HEU-MET-FAST-104, MUSIC: Critical Experiments with Bare Highly-Enriched Uranium Shells. Geordie McKENZIE participated as the internal reviewer.

Kelsey AMUNDSON presented as the evaluator for HEU-MET-FAST-102, ZEUS: Fast Spectrum Critical Assemblies with a Pb-HEU Core Surrounded by a Copper Reflector. Jeff FAVORITE participated as the internal reviewer.

Jeff FAVORITE presented as the evaluator for 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.

Robert WELDON and Nicholas WHITMAN participated as TRG reviewers and future evaluators.

#### Meeting Benefits to the NCSP

Out of the six total critical benchmark evaluations presented at ICSBEP, five were supported either fully or in part by NCSP. Four were performed at the National Criticality Experiments Research Center (NCERC) and one was performed at the Sandia National Laboratories SPR/CX Facility.

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. The meeting also allows a forum that fosters collaboration between attendees.

#### **Meeting Summary**

#### Monday, April 3, 2023 (IRPhEP Meeting)

- In the IRPhEP session, the OECD/NEA chair Ian Hill presented on ongoing efforts and updates for the IRPhEP program.
- Patrick Blaise (CEA France) presented on the BERENICE R2 and ZONA2 experiments, which have recently gathered interest among the international community as a benchmark for IRPhE. CEA is hoping to have these benchmarks finalized soon. There is currently no funding from the Gen-IV program (CEA) in 2023, although discussions are underway.
- Luke Yaraskavitch (Canada) presented updates on the ZED-2 (Zero Energy Deuterium) reactor experiments at Chalk River Laboratories. Currently, there are 3 benchmarks in draft status, but are on hold pending resolution of intellectual property questions. Work on the benchmark is planned through 2024/25. Revisions to ZED2-HWR-EXP-001 were discussed. There was a question asked regarding interest in previous heavy water experiments performed as benchmarks among the community. Mike Zerkle (NNL) and David Heinrichs (LLNL) echoed interest in well characterized <sup>233</sup>U benchmarks. Mike Zerkle also expressed interest as well in benchmarks that could validate heavy water thermal scattering law (TSL).
- Marat Margulis (Bangor University, UK) presented on the SNEAK-12A/B experimental programs which are candidates for IRPhEP benchmark. SNEAK-12A was an experimental series that explored the effects of molten pool growth, sodium voiding. SNEAK-12B was similar to the 12A series but the sodium was replaced with graphite and MOX was loaded into the central core. Experimental results from SNEAK-12A/B simulations were shared.
- Dennis Mennerdahl (Studsvik Nuclear, Sweden) presented on candidates for IRPhEP; Zero Power Critical Reactor in Pressure Tank (KRITZ) critical experiments performed at



Studsvik, Sweden in the 1960-70s, which were UO2 and MOX fuel rod clusters and 8x8 assemblies at 20 - 250 C. Current status is that no funding from Sweden is available, so no internal reviewer is possible.

- Dennis Mennerdahl (Studsvik Nuclear, Sweden) also presented on further candidates for IRPhEP; Fukushima Daini Unit 2 8x8 BWR burnup credit benchmark measurements involving non-destructive axial gamma-ray scanning and radiochemical analysis.
- Quentin (North Carolina State University) presented on the Multi-physics pellet cladding mechanical interaction validation benchmark (MPCMIV). The presentation provided a case for expanding IRPhEP to include benchmark with multi-physics benchmarks.
- T. Albagami (North Carolina State University) presented on the progress of the TVA Watts Bar 1 benchmark.
- Luke Labrie-Cleary (Copenhagen Atomics, Denmark) presented on Molten Salt Preliminary benchmarks. Copenhagen Atomics expressed interest in modeling the Air Force Reactor Experiment (ARE), and the Molten Salt Reactor Experiment (MSRE). The presentation emphasized using OpenMC and DAGMC tools.
- The next presentation updated the status of the pending benchmarks for the IRPhEP. Rene Sanchez was asked about the KRUSTY reactor physics experiment performed at NCERC. Rene stated that funding is needed to continue the benchmarking process for the experiment. The benchmark is of international interest. Can NCSP help fund this effort? [Note: The KRUSTY critical experiment benchmark evaluation was funded by NCSP and published in the ICSBEP Handbook, there is additional information available for a reactor physics benchmark evaluation.] The HEU/lead and Pu/lead reactor physics experiments, performed at NCERC, are indefinitely delayed due to shifting priorities from the Japanese. [Note: Three of the four U/Lead and Pu/Lead critical experiment benchmark evaluations have been published or submitted to the ICSBEP Handbook (one is still being evaluated), there is additional information available for a reactor physics benchmark evaluation.]
- The next presentation by Evgeny Ivanov (France) was related to a multi-physics handbook effort for IRPhEP.
- Ian Hill presented on the IDAT database, which allows users to search the handbook for experimental configurations that satisfy their input criteria and to trend results and identify suitable benchmark experiments for their application.

## Tuesday, April 4, 2023 (Joint IRPhEP, ICSBEP, SINBAD Task Force Administrative Meeting)

- The ISCBEP, IRPhEP, and SINBAD format, uncertainty, and planning guides were discussed. Differences between the guides was discussed. Desired changes between guides were also discussed. There will be a follow-on meeting to discuss these changes and updates further and determine a team who will lead those efforts.
- A draft form of: "Benchmark committee chair guidelines" was handed out for discussion.
- Discussion ensued on potential of ICSBEP meetings every 6 months, but ultimately was viewed unfavorably.
- SINBAD readiness levels, GitLab proposed changes to SINBAD workflow, and LaTeX templates for were discussed.
- The publication and copyright processes for ICSBEP, IRPhEP, and SINBAD were discussed.
- LaTeX templates and their applicability for the benchmark process was discussed. The general consensus was that LaTeX templates and submissions would be acceptable as





a favorable alternative to Word documents and dependent on the evaluation team (evaluators, internal reviewer(s), and independent reviewer(s))

- Discussion of Issue Board tracker on myNEA, and the email and Sharepoint lists, which requires myNEA access for licensees.
- Discussion of critical experiment correlations, which are needed for ND adjustments. The proposed paths forwards were discussed. Establishments of correlations is generally subjective and non-trivial, however.
- Discussion of NDaST (NEA nuclear data sensitivity tool), which is a GUI that connects ND with integral experiments. An update that includes a command line tool is coming soon.
- Discussion of NEA integrated services, which can be accessed through the NEA GitLab. There is also a MCNP to Serpent-2 deck conversion tool.
- Communication of the importance of benchmarks to funding agencies was discussed. Reactor physics (IRPhEP) needs funding, and ICSBEP is heavily funded through NCSP.

## Wednesday, April 5, 2023 (ICSBEP TRG Meeting)

- The first benchmark candidate for discussion was ALARM-CF-FE-SHIELD-002. This benchmark was accepted pending review by a subgroup. There was discussion about if a sufficient independent review was completed and it was determined that there was sufficient review. However, it appeared that the process for naming an independent reviewer needs to be clearer. There were significant concerns about experimental uncertainties being quantified in the report, but upon discussion with the evaluators those values are quantified and will be discussed as part of the subgroup.
- The next benchmark candidate for discussion was PU-SOL-THERM-028. The revision was due to new information on the solution used in the experiment; therefore, only some sections were revised. The benchmark was accepted pending review by the internal and independent reviewers.
- The next benchmark candidate was LEU-COMP-THERM-111, which was an experiment funded by NCSP and **performed at the SPR/CX** facility at Sandia National Laboratories using Molybdenum sleeves. The benchmark was accepted pending completion and subgroup review.

#### Thursday, April 6, 2023 (ICSBEP TRG Meeting)

- The first evaluations up for discussion was ALARM-CF-SST-SHIELD-001, it was delayed to Thursday due to scheduling conflicts of other evaluations presented on Wednesday. It received similar comments to ALARM-CF-FE-SHIELD-002 and were evaluated by the same team. The benchmark was accepted pending subgroup review.
- PU-SOL-THERM-028 was pulled from the addenda by the evaluator since it was not complete and was not discussed by the TRG.
- The next benchmark discussed was HEU-MET-FAST-104, which was the MUSIC experiment using Rocky Flats HEU hemi-shells **performed at NCERC**. The benchmark was accepted pending subgroup review. There were minimal comments regarding this evaluation but discussions regarding impurities in the HEU, location of the pry holes, and the sphericity of the hemi-shells occurred.
- The next benchmark discussed was ALARM-REAC-LUC-SHIELD-001. The benchmark was ultimately rejected due to unquantifiable experimental uncertainties. The conclusion was for the evaluation to be submitted to SINBAD as a historical benchmark and since



SINBAD has a grading matrix (compared to ICSBEP that is either accepted or rejected) users could be more informed about the application of this evaluation.

The final benchmark discussion of the day was HEU-MET-FAST-102, which is the evaluation of ZEUS Pb/HEU experiment that was **performed at NCERC** and was a collaboration between LANL and the Japan Atomic Energy Agency. Review was not completed by the end of the day (made it most of the way through Section 2). Discussions regarding this evaluation include: the uncertainty of gaps within the core since stack height measurements were not performed as well as why a particular data set of measurements were chosen and how those values changed over the experiment series due to different weights reported on the Comet load cell.

## Friday, April 7, 2023 (ICSBEP TRG Meeting)

- The day started by continuing the reviews of HEU-MET-FAST-102 (mostly Section 3). The benchmark was accepted pending subgroup review. An independent model still needs to be made, which should resolve any concerns about the model description being sufficient.
- The next discussion was a review of PU-MET-THERM-005, which is the evaluation of the Chlorine Worth Study (CWS) that was **performed at NCERC** using Pu ZPPR plates. An in-depth discussion of the PVC and C-PVC composition uncertainties and following concern was entailed. The benchmark was approved pending subgroup approval related to uncertainties of the composition of PVC/C-PVC.
- The final discussion was a review of PU-MET-THERM-004, which is the evaluation of TeX-Lucite and Poly that was **performed at NCERC**. The benchmark was approved pending subgroup review. There were minimal comments regarding this evaluation.

Attachment(s): Meeting agendas for each day

Copy: Doug Bowen, ORNL, <u>bowendg@ornl.gov</u> John Miller, SNL, <u>millerj@sandia.gov</u> Marsha Henley, ORNL, <u>henleym@ornl.gov</u> Johnna Marlow, LANL, <u>jmarlow@lanl.gov</u>



Monday, 3rd April 2023 (IRPhEP)			
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)	Update from the Secretariat	NEA Secretariat
		Website	
		Preservation of un-evaluated data	
	01 50 (00	Related NEA initiatives to IRPhEP	
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	
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			



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



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>25</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 202Cf Source in Center		
			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 Phytonium (3% 2000) Nitrate Solutions		
		Fidelindin (576 Tu) Annaic 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- Moderated Triangular-Pitched U(6.90)O <sub>2</sub> Fuel Rod Lattices (1.55 cm Pitch)	Gary Harms	
16:30 – 18:00		Additional Time if Needed		



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.% 2000; 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	Mathieu Dupont	
		of the OKINL Health Physics Research Reactor		
12:15 – 13:15	LUNCH			
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	Kelsey Amundson	
		Surrounded by a Copper Reflector		
14:45 - 15:00	BREAK			
15:00 – 18:00	SESSION 3:	APPROVAL OF NEW EVALUATIONS (Continued)		
	HEU-MET-FAST-104:	MUSIC: Critical Experiments with Bare Highly-Enriched Uranium Shells	Alex McSpaden	
			Rene Sanchez	

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	Jeff Favorite	
		Alloy Core surrounded by a Polyethylene Reflector		
10:30 - 10:45	BREAK		Everyone	
10:45 – 12:15	SESSION 5: PU-MET-THERM-004	DISCUSSION TEX Plutonium Thermal Assemblies: Plutonium-Aluminum Metal Alloy Plates with Thick Polyethylene and Polymethyl Methylacrylate (Lucite) Moderators	Catherine Percher	

