NEA Nuclear Science Committee activities in connection with the NCSP

Julie-Fiona Martin (NEA)
1. The Nuclear Science Committee of the NEA
2. WPNCS  Working Party on Nuclear Criticality Safety
3. WPEC  ... on nuclear data Evaluation Cooperation
4. WPRS  ... on scientific issues and uncertainty analysis of Reactor Systems
5. NEA tools
1. The Nuclear Science Committee of the NEA
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NEA committees (as of 1 January 2022)

- **8** standing technical committees
- **1** management board
- **74** working parties and expert groups
Nuclear Science Committee (NSC)

Working Party on International Nuclear Data Evaluation Co-operation (WPEC)
- Expert Group on the High Priority Request List for Nuclear Data (EGHPRL)
- Expert Group on the Recommended Definition of a General Nuclear Database Structure (EGGNDS)

Task Force on Demonstration of Fuel Cycle Closure including Partitioning and Transmutation (P&T) for Industrial Readiness by 2050 (TF-FCPT)

Programme Review Group (PRG)

Working Party on Scientific Issues of the Fuel Cycle (WPFC)
- Expert Group on Reactor Coolants/Components Technology (EGCoCoT)
- Expert Group on Fuel Recycling and Waste Technology (EGFRW)
- Expert Group on Advanced Fuel Cycle Scenarios (EGAFCS)
- Expert Group on Innovative Fuel Elements (EGIFE)

Working Party on Nuclear Criticality Safety (WPNC)
- Technical Review Group for the International Criticality Safety Benchmarks Evaluation Project (ICSBEPTREG)
- Technical Review Group for the International Assay Data of Spent Nuclear Fuel Database (SFCOMPOTRG)

Working Party on Scientific Issues and Uncertainty Analysis of Reactor Systems (WPRS)
- International Reactor Physics Experiments Evaluation Project Technical Review Group (IRPhETRG)
- Expert Group on Reactor Fuel Performance (EGRFP)
- Expert Group on Reactor Core Thermal-hydraulics and Mechanics (EGTHM)
- Expert Group on Reactor Systems Multi-Physics (EGMUP)
- Expert Group on Physics of Reactor Systems (EGPRS)
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## Working Party on Nuclear Criticality Safety (WPNCS) – Highlights since last NCSP presentation (Feb. 2022)

### US leadership highlighted

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<th>Published</th>
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<td>IPD Information preservation and dissemination</td>
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<td>SFCOMPO Evaluations, databases and tools</td>
<td>Chair: G. Ilas (ORNL)</td>
<td>ICSBEP Handbooks, databases and tools</td>
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<td>IE Integral experiments</td>
<td>Experimental needs (SG5)</td>
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<td>Source convergence (SG6)</td>
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<td>Integral experiments uncertainty and covariance (SG1)</td>
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<td>ND Nuclear data</td>
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<td>ND uncertainty on spent fuel inventory calculations Part A (SG10)</td>
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<td>CSE Criticality Safety Evaluations</td>
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<td>CSE and BUC (SG13)</td>
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<td>DH Decay heat</td>
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<td>DH review (SG12)</td>
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Chair: A. Vasiliev (CH)  
Vice-chair: G. O’Connor (UK)  
Secretariat: J.-F. Martin
Data preservation and dissemination

**SFCOMPO TRG** Technical Review Group for the International Assay Data of Spent Nuclear Fuel Database

Chair G. Ilas (ORNL)

Nuclide inventory of used fuels experiments and decay heat measurements

24k measurements on 750 samples from 44 reactors, DH addition in progress

**Focus of the TRG**

**Collection** of experimental data incl. decay heat data

**Evaluation** of the experimental data and the development of benchmarks and benchmark models

Revision of **guidance** documents

**Maintenance** of the database & GUI

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**ICSBEP TRG** Technical Review Group for the International Criticality Safety Benchmarks Evaluation Project

Chair: C. Percher (LLNL); Vice Chair: B.J. Marshall (ORNL)

Critical, subcritical, alarm/shielding and fundamental physics experiments

587 experimental series from 19 countries, Handbook of ~70000 pages

**2022 Edition**

Annual meeting in Oct. + Dec ’21 (remote)
6 new evaluations approved + 1 update

**2023 Edition**

Meeting in April 2023 (NEA HQ)
7 new evaluations approved + 1 update

>> Joint 2022/2023 publication scheduled in ’24

**2024 Edition**

Meeting in April 2024 (LLNL)
5 candidate new evaluations

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[oe.cd/nea-sfcompo](http://oe.cd/nea-sfcompo)
[oe.cd/nea-icsbep](http://oe.cd/nea-icsbep)
IE Integral experiments

**Experimental needs (SG5)**
- Coord. I. Duhamel (FR), then C. Percher (LLNL) & G. McKenzie (LANL)
- Report published in 2022
- Review of needs, proprietary experiments, experimental facilities
- Needs ranked by usage / level of knowledge

**Expert knowledge (SG8)**
- Coord. W. Wieselquist (ORNL)
- Brief conclusions in preparation
- Acknowledge variation in quality expectations of ICSBEP benchmarks with time
- Capture tacit knowledge on quality/reliability/suitability of ICSBEP cases
- Template to be used for robust and long-lasting repository of feedback
AM Analytical methods - calculations

Temperature effect (SG3)
- Coord. S. Gan, A. R. Wilson (UK)
- Report published in 2023
- Comparison exercise assessing impact of temperature on $k_{eff}$, notably integrating TSL of H in water & ice, at various BU
- Experiment to confirm findings needed!

Random geometries (SG9)
- Coord. A. Zoia (FR)
- Report pending publication
- Application cases: randomly arranged fuels (e.g. TRISO), severe accident recovery, dismantling, radwaste repositories
- Impact of randomization model on multiplication factor calculations

Neutron source convergence (SG6)
- Coord. F. Brown (LANL, UNM)
- Report published in 2023
- Recommended series of statistical tests to enhance reliability and robustness of source convergence assessments in MC calculations
- Checked against a series of problems

Left: Initial geometry, and randomized geometries. Right: Impact on randomization chord length on $k_{eff}$
Court. A. Zoia, CEA (FR), Nov. 2022
AM Analytical methods - uncertainties

Integral experiments uncertainty and covariance (SG1)
- Coord. M. Stuke (GER)
- Report published in 2023
- Derive covariance between benchmarks and assess impact on application case

Bias and correlated data (SG11)
- Coord. A. Hoefer (GER)
- Report in preparation
- Using pre-defined correlations between criticality benchmark experiments, assess role of methodology to derive impact on application case
- Families of methods provide consistent results

Error recovery and experimental coverage (SG14)
- Coord. U. Mertyurek (ORNL) & H. Abdel-Khalik (Purdue U.)
- Kick-off in Sept. 2024
- Explore modern data assimilation techniques and capabilities to spot (and correct for) embedded errors and to quantify experimental coverage

Figure court. U. Mertyurek
CSE Criticality Safety Evaluations

CSE + BUC, pseudo application case with user defined NCS criteria (SG13)
- Coord. A. Vasiliev & M. Wittel (CH)
- Started in 2023
- Simplified final disposal canister for used nuclear fuel
- Derive loading curve taking into account burn up credit with a user-defined nuclear criticality safety criteria (criticality aspects only – other metrics such as decay heat, radioprotection are not covered)
- Compare loading curves for various participants, covering variety of user-defined criticality safety criteria and methodologies

Reference values for criticality (SG17)
- Coord. G. Frontier (FR)
- Kick off scheduled Sept 2024
- Provide reference values for Nuclear Criticality Safety (NCS) using state-of-the-art codes, methods and nuclear data

Results court. PSI (CH)
LC = loading curve
USL = Upper Subcritical Limit

Blue = pre-defined USL
Green = with user-defined USL
Pink = with user-defined USL, relying on a larger validation base
ND Nuclear data

Nuclear data uncertainty for irradiated fuels inventory calculations (SG10 & 15)
- Coord. C. Carmouze & R. Ichou (FR)
- Part 1: Best estimate values (2020-2023)
- Part 2: Uncertainty propagation (2023-2026)
- ARIANE GU3 spent fuel nuclide inventory
- Nuclear data sensitivity/uncertainty analysis (cross-sections, decay data and fission yield) on fuel assembly depletion calculations
- ~35 nuclides important for criticality safety and decay heat
Assessing the confidence level in experimental and computational estimations (SG12)

- Coord. D. Rochman (CH)
- Journal article under review
- Review of experimental and simulation knowledge pertaining to DH assessments
- Incl. uncertainties, methods, standards.

Decay heat comparison exercise (SG16)

- Coord. D. Rochman (CH)
- Kick off scheduled Sept 2024
- Pin-cell and assembly simulation with experimental data
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3. WPEC  ... on nuclear data Evaluation Cooperation (input from A. Holcomb)

4. WPRS  ... on scientific issues and uncertainty analysis of Reactor Systems

5. NEA tools
Working Party on international nuclear data Evaluation Cooperation (WPEC)

WPEC

EG HPRL
C. Mattoon (LLNL)

EG GNDS

Reproducibility
M. Herman (LANL)

Potential areas for new subgroups include gamma data, fission product yields, continuations of SG46 and SG48 work

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MCNP to Serpent-2
WPEC SG45 contributions from Steven van der Marck and Andrej Trkov

• ~2400 functional inputs, ~4500 inputs with at least a starting point
• Upon request through the NEA Data Bank
• Incentive to include in ICSBEP DVD
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4. WPRS  ... on scientific issues and uncertainty analysis of Reactor Systems  
   (input from O. Buss)

5. NEA tools
Working Party on scientific issues and uncertainty analysis of Reactor Systems (WPRS)

Chairs K. Ivanov (US NCSU) & H. Ferroukhi (CH),
Secretariat O. Buss

US leadership highlighted

Worldwide Participants

EG Physics of Reactor Systems (EGPRS)
H. Ferroukhi (CH), R. Grove (US ORNL)

EG Reactor System Multi Physics (EGMUP)
T. Valentine (US), E. Ivanov (FR)

EG Reactor Core Thermal Hydraulics and Mechanics (EGTHM)
M. Avramova (US NCSU), A. Petruzzi (IT)

EG Reactor Fuel Performance (EGRFP)*

International Reactor Physics Experiments Technical Review Group (IRPhE) **
M. DeHart (US INL), L. Buiron (FR)

Task force Zero Power Reactors (ZPR)

* Secretariat M. Bales
** Secretariat I. Hill

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www.oecd-nea.org
Task Force on Zero Power Reactors “The demise of ZPRs – From concern to action” [2022-...]

IE

Chair: Robert Jacqmin (FR)

– Objectives

• Assess the projected needs for new reactor physics validation data, and elaborate on the motivations
• Recommend a consensual course of action for acquiring such data, including minimal functional specifications of the needed facilities and expertise

– Deliverables

• NSC/WPRS Workshop on Zero Power Reactors “The demise of zero power reactors: From concern to action”
• “WPRS Zero Power Reactor Task Force - Interview Questionnaire”, including representatives from the criticality safety community

A dedicated activity under the WPNCS reported on “Experimental needs for criticality safety purposes” including needs for ZPR facilities (NEA/NSC/R(2022)6, Sept. 2023).

These criticality-oriented needs will be further conveyed by this ZPR TF. [oe.cd/wpnccsexpneeds]
SINBAD - Shielding Integral Benchmark Archive and Database, a task force

NEA & US RSICC, since 1992
Reactor (48), fusion neutronics (31), and accelerator (23) shielding experiments

TF: **Progressive**, well-defined **maintenance process**: subsequent updates to reach well-defined intermediate maturity levels

**Modular organization**: task force splits in several subgroups working on different entries/experiments

Q1 2024: Distributing SINBAD via NEA GitLab platform for SINBAD licensees

- Users can propose improvements to SINBAD via GitLab merge request workflows.
- Crowdsourcing, transparency and traceability

https://oe.cd/nea-sinbad

Chair: T. Miller (US)
1. The Nuclear Science Committee of the NEA
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5. NEA tools (input from I. Hill)
   
   Nuclear Data Sensitivity Tool, Testing New Nuclear Data Libraries ENDF/B-VIII.1 (beta) and JEFF-4 Test Libraries, I. Hill & N. Soppera, in M&C 2023
NDaST Nuclear Data Sensitivity Tool

NDaST combines collections of sensitivity coefficients, with nuclear data tools.

Independent of response function, code, nuclear data library

Computations take of the order of minutes. Direct methods take multiple months to provide similar feedback.

Checked against direct perturbations in other work, found to be reliable in most cases, but accuracy is limited like other first order methods.

NDaST provides quick feedback to questions like, if I change from ENDF/B-VIII.0 to ENDF/B-VIII.1β1 how will my design calculations be impacted? Do the nuclear data changes improve the consistency of various benchmarks? Can filter what needs additional checking.

**9Be elastic ratio e8.1beta1/e8.0**

<table>
<thead>
<tr>
<th>Energy</th>
<th>Impact (pcm) (many groups/few groups)</th>
</tr>
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<tbody>
<tr>
<td>9Be (elastic)</td>
<td>Over 100 keV</td>
</tr>
<tr>
<td></td>
<td>-512 / -512</td>
</tr>
<tr>
<td>9Be (n.g)</td>
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</tr>
<tr>
<td></td>
<td>-66 / -66</td>
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</table>
The NEA is grateful for the support of the NCSP for the US representation in NSC groups

Thank you for your attention

wpnncs@oecd-nea.org
julie-fiona.martin@oecd-nea.org