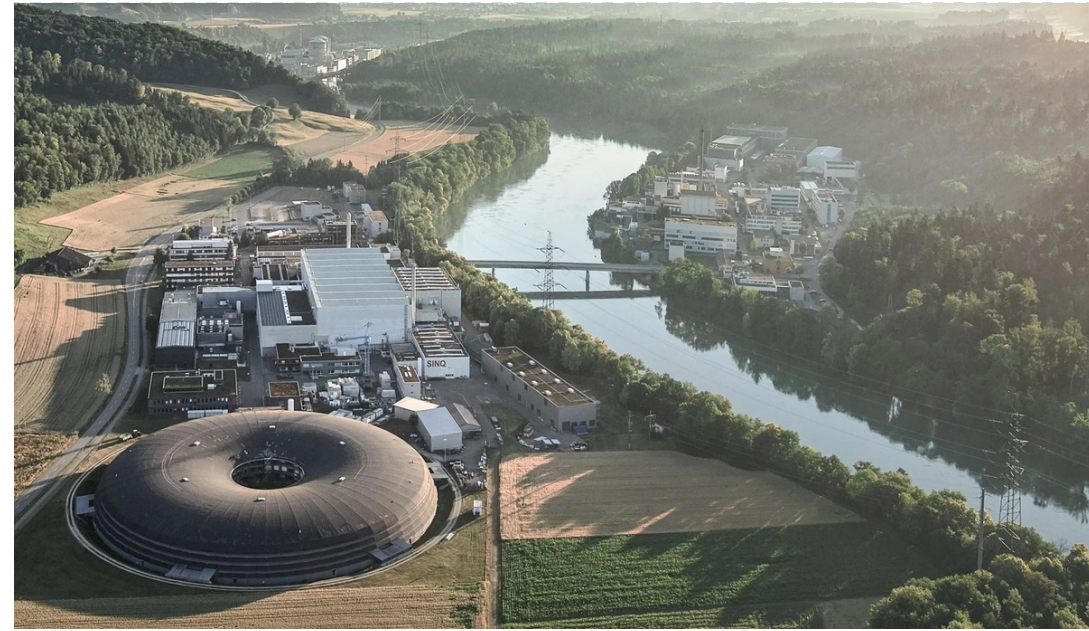


**PSI** Center for Nuclear Engineering  
and Sciences



# Reporting on the 1<sup>st</sup> meeting of SG16 on

***“Computational Spent Nuclear Fuel decay heat: the PWR 0E2 case”***

D. Rochman

WPNCS Meeting, September 27<sup>th</sup>, 2024,  
OECD-NEA, Boulogne Billancourt, France

- Feedback from SG12
  - On assessing our current knowledge regarding decay heat for current SNF
  - From January 2022 to December 2023
  - Gather actors from different horizons and exchange of knowledge
  - Find a consensus, presented in
    - Publication at the ICNC 2023 conference
    - Accepted review paper in EPJ/N
- Follow-up activity: this SG16, on “Computational Spent Nuclear Fuel decay heat: the PWR 0E2 case”
- Goals:
  - Defining a decay heat benchmark (done)
  - Perform required calculations (to be submitted 31/12/2024)
  - Analyze results (2025)
  - Report/publish results and discussions (2025)
  - Possibly extend the benchmark with new measurements & analysis (2025)

# SG16 decay heat benchmark



- Specifications: sent by email on August 29



NEA/NSC/WPNCs/WD(2024)1/REV1

For Official Use

English text only  
31 July 2024

NUCLEAR ENERGY AGENCY  
NUCLEAR SCIENCE COMMITTEE

Working Party on Nuclear Criticality Safety (WPNCs)

Decay heat computational comparison exercise: definition for a PWR UO<sub>2</sub> assembly and pincell

Specifications for the exercise of WPNCs SG16

Revision of June 25<sup>th</sup>, 2024: in table 4, He gap density was corrected to 1.3e-3 g/cm<sup>3</sup> (in lieu of 1.3e-4 g/cm<sup>3</sup>)

2 | NEA/NSC/WPNCs/WD(2024)1/REV1



**Decay heat computational benchmark:  
definition for a PWR UO<sub>2</sub> assembly and pincell**

**WPNCs SG16**

D. Rochman

Reactor Physics and Thermal hydraulic Laboratory, PSI, Switzerland

# SG16 decay heat benchmark



- Specifications: sent by email on August 29
- Benchmark description in the document
  - Pincell
  - Assembly
  - 6 measurements

10 | NEA/NSC/WPNCs/WD(2024)1/REV1

## 3 Decay heat measurements for assembly 0E2

A total of 6 measurements was performed for assembly 0E2. The first one is mentioned in Ref. [1], and the 5 later ones in Ref. [2]. They are listed in Table 4, with the cooling time relative to the shutdown date for cycle C5: July 7, 1988.

Table 5: Decay heat measurements for assembly 0E2.

Cooling time (days)	Measurement date	Gamma escape (W)	Total decay heat (W)	Uncertainty (in W, 1 $\sigma$ )	Reference
5823	16/06/2004	15.5	587.9	7.0	[1], pages 19,34/253, [2], Table A.2
6389	03/01/2006		566.0	6.9	[2], Table A.2
6390	04/01/2006		567.7	6.9	[2], Table A.2
7826	10/12/2009		522.4	6.6	[2], Table A.2
7837	21/12/2009		525.6	6.6	[2], Table A.2
7970	03/05/2010		520.1	6.6	[2], Table A.2



NEA/NSC/WPNCs/WD(2024)1/REV1

For Official Use

English text only

NUCLEAR ENERGY AGENCY  
NUCLEAR SCIENCE COMMITTEE

31 July 2024

Working Party on Nuclear Criticality Safety (WPNCs)

Decay heat computational comparison exercise: definition for a PWR UO<sub>2</sub> assembly and pincell

Specifications for the exercise of WPNCs SG16

Revision of June 25<sup>th</sup>, 2024: in table 4, He gap density was corrected to 1.3e-3 g/cm<sup>3</sup> (in lieu of 1.3e-4 g/cm<sup>3</sup>)

- Required output: fill an Excel table about
  - Calculated decay heat at the measured times
  - Decay heat contributors
  - Neutron and gamma emission at the measured times (possibly with 7 groups gamma spectrum)
  - Number densities (during irradiation and at measured times)
  - $k_{\infty}$
  - Fission rates
  - Possibly input files after the submission of results
- Excel document distributed and available on the SG16 webpage
- At the date of the 1<sup>st</sup> meeting:
  - Results received from 5 institutes
  - Some institutes provided different scenarios (nuclear data, codes, options)
  - In total:
    - 15 calculations for the pincell and
    - 8 calculations for the assembly

WPNCs SG16 – Decay heat benchmark

FANC results

**FANC**  
FEDERAL AGENCY FOR NUCLEAR CONTROL

Kevin GOVER5  
BASE NUCLEAR FACILITIES  
FACILITIES & WASTE DEPARTMENT

**sck cen**  
Belgian Nuclear Research Centre

**SCK CEN preliminary results with ALEPH2 and Serpent2**

P. Romojaro and L. Fiorito  
INS/NSP

1st meeting of the WPNCs SG 16 | OECD/NEA (France) – September 25<sup>th</sup>, 2024

**VTT**

**VTT's first results on the decay heat computational comparison exercise**

Silja Häkkinen and Milko Mäkinen

18/09/2024 VTT – beyond the obvious

RÉPUBLIQUE FRANÇAISE  
Ministère de l'Énergie

**IRSN**  
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

**SCIENCES SORBONNE UNIVERSITÉ**

**FISSION YIELD UNCERTAINTY PROPAGATION TO DECAY HEAT IN THE VESTA CODE**

WPNCs SG16 meeting, 25/09/2024

IRSN  
PSN-RES/SNC  
Pôle Sûreté Nucléaire  
Service de Neutronique et des risques de Criticité  
Laboratoire de Neutronique

Amélie BRASSART, presented by Sébastien BONTHOUX  
Raphaëlle ICHOU, Fausto MALVAGI, Vivian SALINO

**BGZ**  
Gesellschaft für Zuercher  
Kernforschung

**BGZ Results for the Decay Heat Computational Benchmark**

Volker Hannstein, BGZ

WPNCs – SG16 Meeting  
OECD/NEA, September 25<sup>th</sup>, 2024

**Short code and ND comparison study for the DH benchmark CASE**

Gašper Žerovnik, Benjamin Ruprecht  
OECD/NEA WPNCs SG16  
25th September 2024

Bundesamt für die Sicherheit der nuklearen Entsorgung

**Decay heat computational benchmark: definition for a PWR UO<sub>2</sub> assembly and pincell. Contribution of CIEMAT**

*1st meeting of the WPNCs Subgroup 16 on a Computational Spent Nuclear Fuel decay heat benchmark: the PWR OE2 case*

F. Álvarez-Velarde

Unidad de Innovación Nuclear - CIEMAT

francisco.alvarez@ciemat.es

WPNCs/SG16 – The PWR OE2 case – 25/09/2024

**UPM contribution to WPNCs/SG16: “Decay heat computational benchmark: definition for a PWR UO<sub>2</sub> assembly and pincell”**

**... preliminary results**

**INDUSTRIALES**  
ETSII | UPM

O. Cabellos  
Universidad Politécnica de Madrid (UPM)  
E-mail: oscar.cabellos@upm.es

WPNCs/SG16 Meeting, September 25, 2024

**JSI Contribution to the WPNCs SG16 Decay Heat Computational Benchmark**

NEA  
OECD


Marjan Kromar  
“Jožef Stefan” Institute

31<sup>st</sup> meeting of the WPNCs Subgroup 16  
September 23-27, 2024  
Paris, France

**PSI** Center for Nuclear Engineering and Sciences

**PSI results – SG16**

D. Rochman  
WPNCs SG16 Meeting, September 25<sup>th</sup>, 2024,  
OECD-NEA, Boulogne Billancourt, France



- All required quantities (preliminary) presented
  - Decay heat, number densities,  $k_{inf}$ ,
  - Different nuclear data libraries
  - Different codes
  - Different modelling assumptions
- Additional quantities
  - Sensitivities
  - Uncertainties (from fission yields)
- Main comments
  - Pincell model: overestimation of the decay heat
  - Necessity to analyse differences
  - Discussion on relevance of C/E=1

- Some preliminary results at EOL ( $\Delta = 1$  standard deviation)

	<u>pincell</u>	assembly
• $\Delta k_{\infty}$ :	$\approx 1800$ <u>pcm</u>	$\approx 2700$ <u>pcm</u>
• $\Delta^{235}\text{U}$ :	$\approx 4 \%$	$\approx 2 \%$
• $\Delta^{239}\text{Pu}$ :	$\approx 3 \%$	$\approx 2 \%$
• $\Delta$ neutron emission:	$\approx 3 \%$	$\approx 9 \%$
• $\Delta$ gamma emission:	$\approx 29 \%$	$\approx 38 \%$

- Average pincell C/E decay heat:  $1.023 \pm 0.048$
- Average assembly C/E decay heat:  $0.982 \pm 0.056$



# Many thanks

---

- Questions ?

