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D. Rochman

# Proposal for a new subgroup on Spent Nuclear Fuel decay heat

OECD/NEA/NCS, 25th meeting of WPNCS, July 9th, 2021

Zertifiziertes Managementsystem
STARS
ISO 9001

# Summary

- Background
- Goal and context
- Proposed activities
- Participants
- Related questions
- Conclusion

# Background

- Spent Nuclear Fuel decay heat (SNF-DH) is a key quantity for SNF characterization:
  - Wet storage
  - Transport casks
  - Reprocessing facilities
  - Storage canisters
  - (Severe accident)

- Linked to criticality, dose, nuclide inventory

- No systematic SNF-DH measurements planned worldwide: reliance on calculated DH

→ **<u>Calculated DH</u> estimation and confidence intervals are a necessity**

- High interest from different actors of the nuclear industry

# Background

- The SNF-DH depends on many factors
  - Irradiation history
  - Assemblies types, enrichments, burnup
  - Cooling time
  - Nuclear data
  - Modeling assumptions

- Recent “Blind decay heat benchmark” from SKB tends to indicate different C/Es than expected

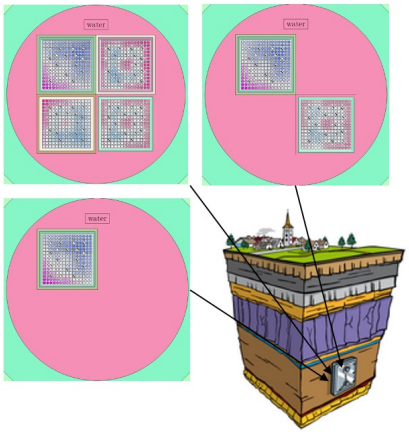
- What are the associated uncertainties, biases ?

- How applicable are the DIN, ISO, NRC standards to recent SNF (high burnup, MOX ?)

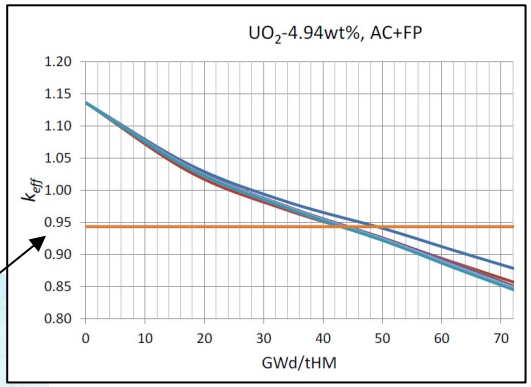
- Can we provide *evaluated* DH for specific cases ?

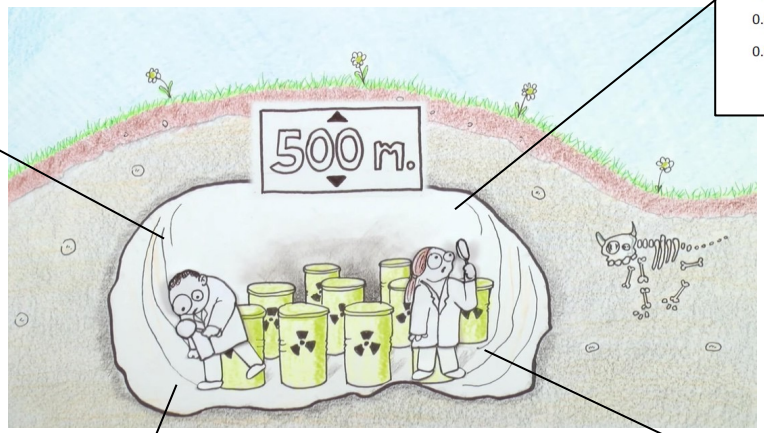
# Example: SNF decay heat for deep repository

Optimization

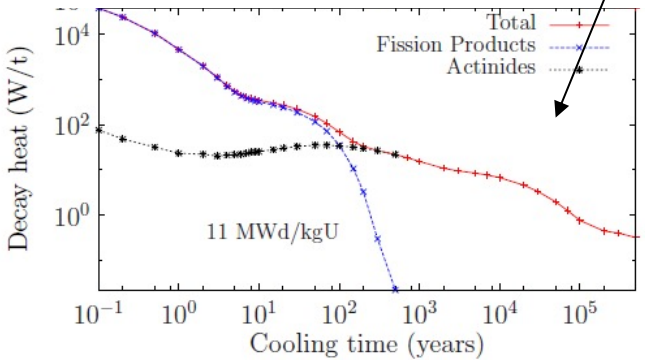


Criticality

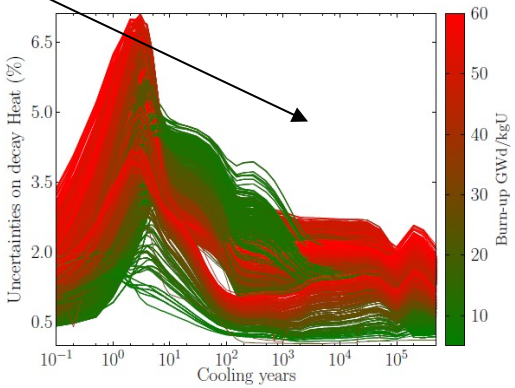



Decay heat




Uncertainties



# Goal and context

- Goal: Provide users with reliable estimations of SNF-DH

- Underlying:
  - guidance, specific studies, estimates, validity regions
  - Analysis of experiments/calculations

- Proposed studies:
  - Spent fuel from existing power plants
  - Decay heat for specific cooling time (to be determined (*e.g.* < 3days, >months, years, decades, more)
  - Activities to be planned within 2-year activities to fit the WPNCS requirements

- Link to Working Party activities:
  - WPNCS (after irradiation, validation),
  - WPRS (reactor parameters/irradiation history)
  - WPEC (nuclear data evaluation)

# Activities

- Specific activities will be discussed during dedicated “ad-hoc meeting(s)”, but should be around the following areas:
  - Experiments
  - Calculations
  - Nuclide contributions
  - Biases and Uncertainties
  - (New) standards
  - ML modelling
  - Evaluations for specific cases (*i.e*. $UO_2$, MOX, PWR, BWR)
  - New DH benchmark

# Activity example

Example of a dedicated study:

- Select an assembly type (*e.g.* PWR 17x17, $UO_2$, 4.0%)
- Select experiments (do they exist ?)
  - Analysis of data, uncertainties

- Perform modelling and simulations
  - Modelling effect
  - Biases (to DH and PIE ?)
  - Model/input uncertainties

- Provide estimated (evaluated) DH and uncertainties/correlations
  - For specific cooling times
  - Nuclide contributors
  - Comparison with standards
  - Reporting/publication

# Participants

- Expressions of interest from 10 member countries, IAEA and EU (in alphabetic order), 09/07/2021:

1. P. Àlvarez, D. Cano (CIEMAT, Spain)
2. A. Bardeley, R. Ichou (IRSN, France)
3. O. Cabellos (UPM, Spain)
4. C. Carmouze and V. Vallet (CEA SPRC, France)
5. S. Caruso (KKG, Switzerland)
6. R. Dagan (KIT, Germany)
7. L. Fiorito (SCK, Belgium)
8. S. Häkkinen, P. Juutilainen, J. Leppanen (VTT, Finland)
9. V. Hannstein, F. Sommer (GRS, Germany)
10. G. Ilas, W. Wieselquist (ORNL, USA)
11. P. Jansson (UU, Sweden)
12. A. Koning (IAEA, Austria)
13. J. Lam (Rolls-Royce, UK)
14. A. Launay, V. Leger (ORANO, France)
15. L. MacManniman (IAEA, Austria)
16. F. Minato (JAEA, Japan)
17. Y. Nauchi, S. Sato (CRIEPI, Japan)
18. D. Rochman (PSI, Switzerland)
19. P. Schillebeeckx, S. Kopecky (JRC, Geel Belgium)
20. T. Simeonov (Studsvik, USA)
21. A. Sjöland (SKB, Sweden)
22. S. Tittelbach (WTI, Germany)
23. T. Watanabe (JAEA, Japan)

# Related question: WPNCS or WPRS ?

- The estimation of SNF Decay heat is overlapping with studies performed at WPNCS and WPRS
- It is affected by reactor cycles, and goes beyond it
- WPRS can bring core knowledge, core physics and multiphysics,
- WPNCS is experienced in criticality-safety (ICSBEP), PIE data (SFCOMPO)
  - SNF decay heat time periods overlap more with WPNCS
  - SNF decay heat is linked to criticality (source term)
  - SNF decay heat evaluations can be based on SFCOMPO decay heat experimental data.
- Conclusion: the WPNSC seems more adapted, with strong feedback from WPRS

# Conclusion

- SNF-DH is of high importance for many actors of the nuclear industry
- There is a need for a better understanding of our modelling capabilities
- Middle-term goal:
  - This working group proposes to gather specialists to produce recommended (evaluated) decay heat for well-defined cases
- Longer-term goal:
  - Help to update standards
- WPNCS seems to be the right environment, including strong links with WPRS, WPEC and RWMC (Radioactive Waste Management Committee)

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# Wir schaffen Wissen – heute für morgen