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A potential future comparison exercise

WPNCS SG12 Meeting, June 27th, 2022, OECD Headquarters, Paris, France

Zertifiziertes Managementsystem STARS ISO 9001

Summary

- General goals
- Recommendations from previous discussions
- Proposal for input and output

General goals

- Goal 1: evaluate the decay heat (DH) for a specific assembly case
- Goal 2: provide users with informed recommendations for this case
- Publish results
- Example study for other cases

Recommendations from previous discussions

The following recommendations were supported by the group (meeting May 18):

1. Perform in parallel 2D calculations for an assembly and one of its pincell

2. Select a PWR assembly from the SKB 2006 campaign for comparison with measured decay heat

3. Provide to participants all relevant geometry/irradiation information (*e.g.* irradiation steps, cooling steps)

4. Ask participants the “maximum” information about their simulations: inputs (*e.g.* libraries, energy releases…)

Recommendations from previous discussions

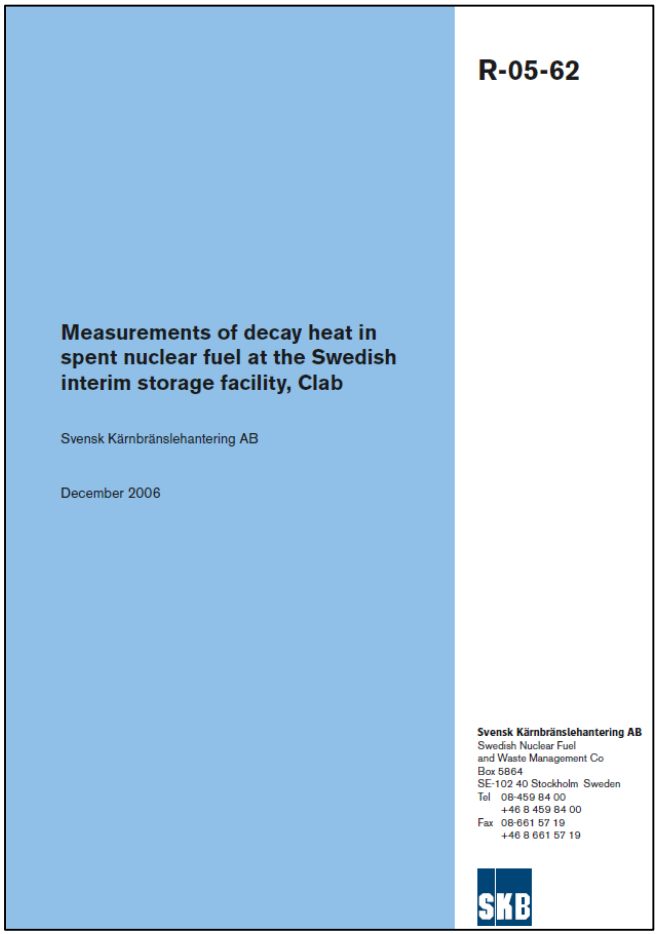
The following recommendations were supported by the group (meeting May 18):

5. Provide the following output
   - K_{inf}, nuclide concentrations, fission rates (separate between 4 main actinides)
   - Decay heat, neutron/gamma, activities (contributions from different isotopes)
   - Make a list of isotopes (+ provide top 20 for DH by different codes with %, as a function of cooling time)
   - Delayed fission
   - Possibly sensitivity analysis
6. Assessing gaps, for instance in nuclear data

Relevant case

- SKB 2006 report: https://www.skb.com/publication/1472024

- Assembly 0E2
- PWR 17x17, Ringhals-3
- Fuel UO_2, 3.10 wt%
- 1 measurement at 5823 days (≈16 years)
- Measured DH: 587.9 ± 6.1 W (1%)
- Average BU: 41.6 MWd/kgU
- 4 consecutive cycles
- 1 state point / cycle


R-05-62

Measurements of decay heat in spent nuclear fuel at the Swedish interim storage facility, Clab

Svensk Kärnbränslehantering AB

December 2006

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SKB

Relevant case: 0E2

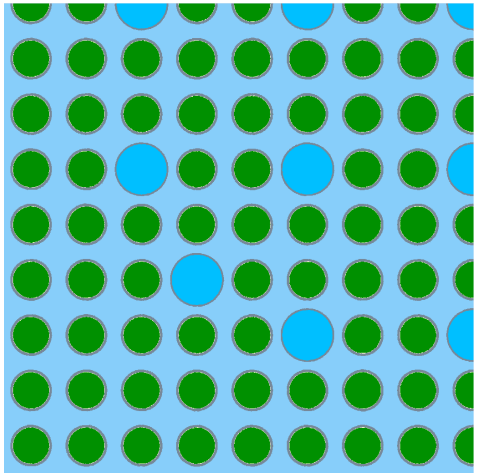
Fuel data	0E2
Fuel type	W17×17
No of fuel rods	264
Rod pitch (mm)	12.6
Rod diameter (mm)	9.5
Clad thickness (mm)	0.572
Pelletdiameter (mm)	8.191
Cladding material	Zr4
Active length (mm)	3,658
Density UO2 (g/cc)	10.45
Density incl. porsity,dishing etc	10.35
No of guide tubes	24
Material in guide tubes	Zr4
Outer diameter guide tube (mm)	12.24
Cladding thickness guide tube	0.406
No of instrument tubes	1
Material in instrument tubes	Zr4
Outerdiameter instrument tubes (mm)	12.24
Cladding thickness instrument tubes (mm)	0.406
Burnable poison rods?	No
No of spacers	8
Spacer material	Inc 718
Mass of spacer (g)	753

Initialdata	0E2
Initial mass Utot (g)	463,598
Initial mass U238 (g)	449,111
Initial mass U235 (g)	14,487
Avg.enrichment% U238	96.897
Avg.enrichment% U235	3.103

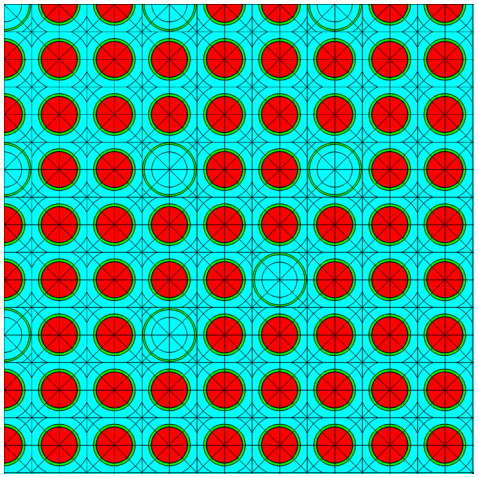
Cycle history burnup/cycle, MWd/tU	
C1A	
C1B	
C2	7,496
C3	13,034
C4	11,308
C5	9,790
C6	
C7	
C8	
C9	

Relevant case: 0E2

- 17x17: quarter symmetry



CASMO5 plot



SCALE plot

- Also adequate for a single pincell calculation
- 2 separate calculations: (1) full assembly, (2) single pincell

Required input/output

- Input details provided by the SG12

- Irradiation steps and cooling steps for the pincell and assembly
- Code, important methods, libraries

- Calculated DH + standard DH values
- Calculated neutron/gamma emission, activity
- k_{inf} during irradiation
- Nuclide concentrations during irradiation + cooling time:
  - U-234,235,236,238, Pu238-242, Am241-243, Cm242-244
  - Nd146-148, Rh103,106, Cs133,134,137, Ba137m, Sr90, Y90, Pr144,
- fission rates (separate between 4 main actinides)
- Delayed fission

- Sensitivity ?
- Gaps ?

Open general questions

- Interest ?
- Time scale ?

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Wir schaffen Wissen – heute für morgen