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NRC/EPRI RIA Analytical Benchmark Activities

RIA Criteria Workshop
September 25, 2008
Washington, DC

Goals of Benchmark Study

- Compare results from the same sample problems to clarify differences in FALCON and FRAPTRAN calculated responses
  - SCANAIR results provided by IRSN
- Review cladding failure models used in FALCON and FRAPTRAN to evaluate PCMI failure during RIA loading conditions
- Clarification Working Meeting held in August
  - Attend by representatives of NRC, PNNL, EPRI and IRSN (by NRC)

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Acceptance of Key Scaling Factors in the NSRR/CABRI Data Base

- NRC and Industry have developed different factors to adjust NSRR data for temperature effects
  - Important to develop final failure threshold
- Test rods selected to clarify the differences in analysis approach and failure models being used to develop the adjustment factors
- Cases selected that were slightly above or below the PNNL failure threshold
  - Comparison between cases give a glimpse of the role of oxide thickness/hydrogen on the failure models
  - Oxide/clad thickness ratios near the transition points of the interim PWR failure line

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Sample Problems used in Benchmark

Test Case	Burnup	Oxide Thickness	Pulse Width	Injected Enthalpy	Failure Enthalpy
HBO-1	50 GWd/MTU	43 μm	~4 ms	73 cal/g	60 cal/g
HBO-5	44 GWd/MTU	60 μm	~4 ms	80 cal/g	77 cal/g
HBO-6	49 GWd/MTU	30 μm	~4 ms	85 cal/g	n/a
RepNa-3	64 GWd/MTU	40 μm	9.5 ms	120 cal/g	n/a

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FALCON Input Modified to Match FRAPTRAN

- Power pulse shapes modified to match FRAPTRAN input
  - Addition of delayed power deposition
- Initial pellet-cladding gap thickness increased to match FRAPTRAN input
  - Results in lower calculated SED
- Others (e.g. fast fluence, etc.)
- SCANAIR input may not be consistent with FRAPTRAN

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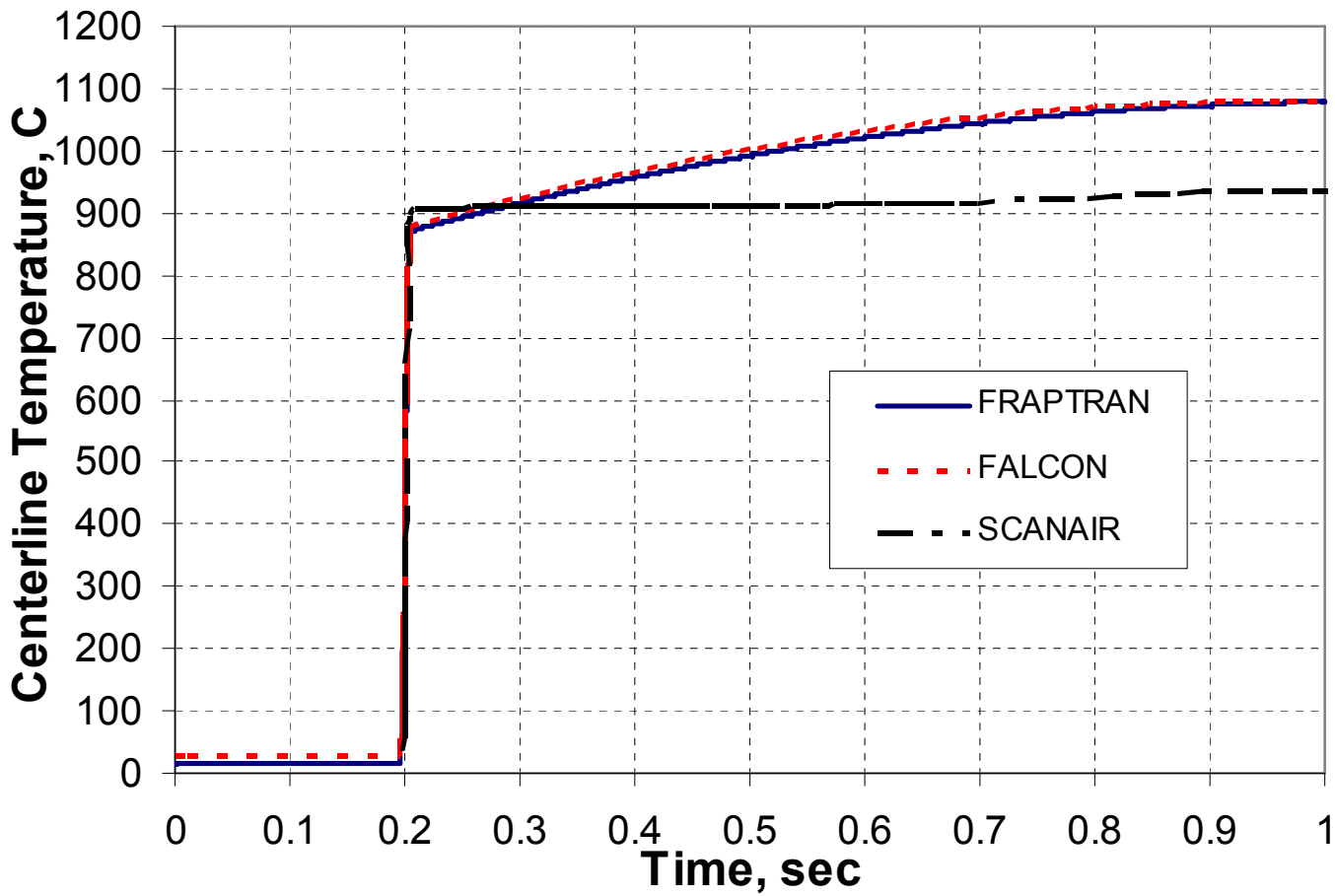
Example of Calculated Centerline Fuel Temperatures for HBO-1



SCANAIR results provided by IRSN

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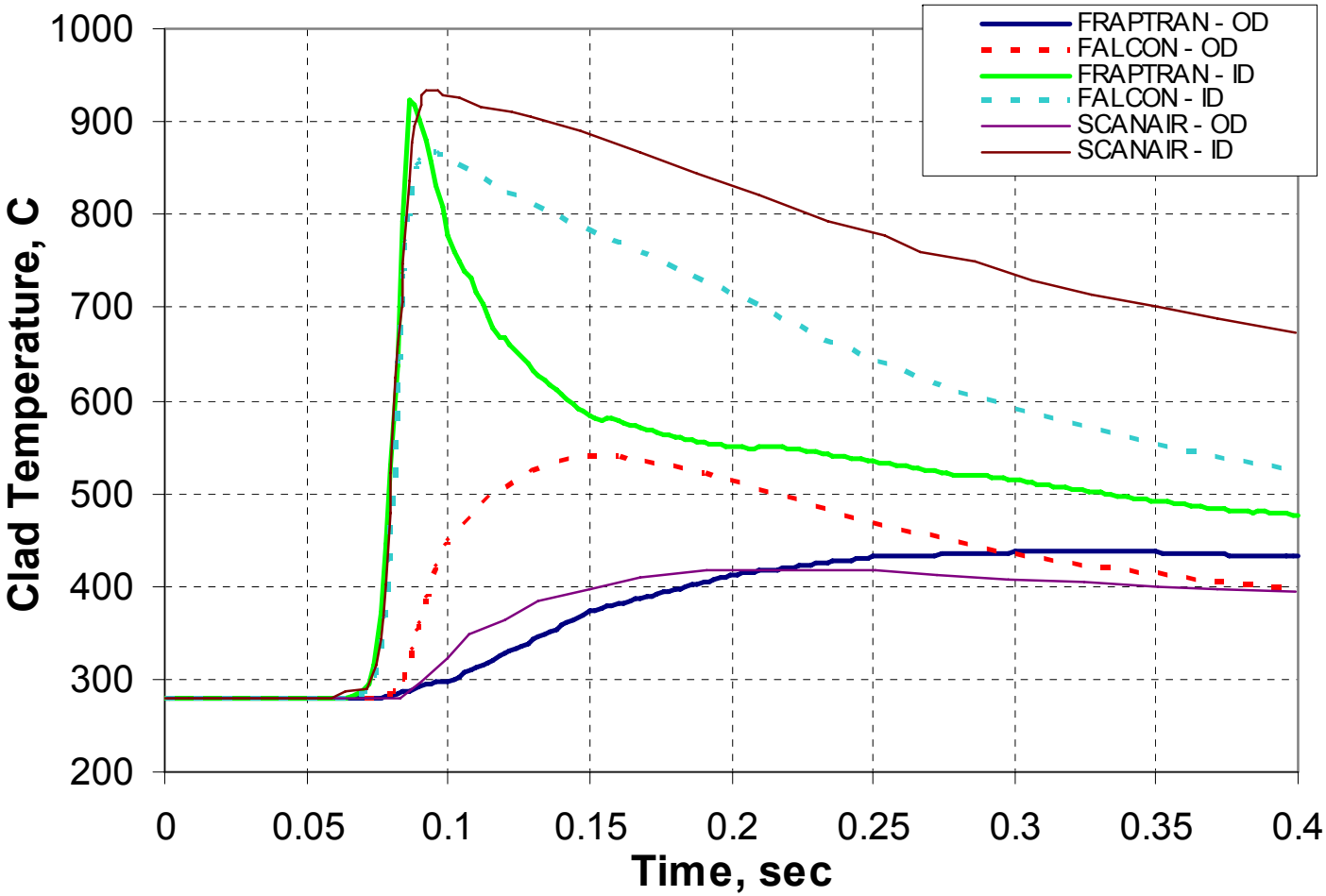
Example of Calculated Cladding Temperature for RepNa3



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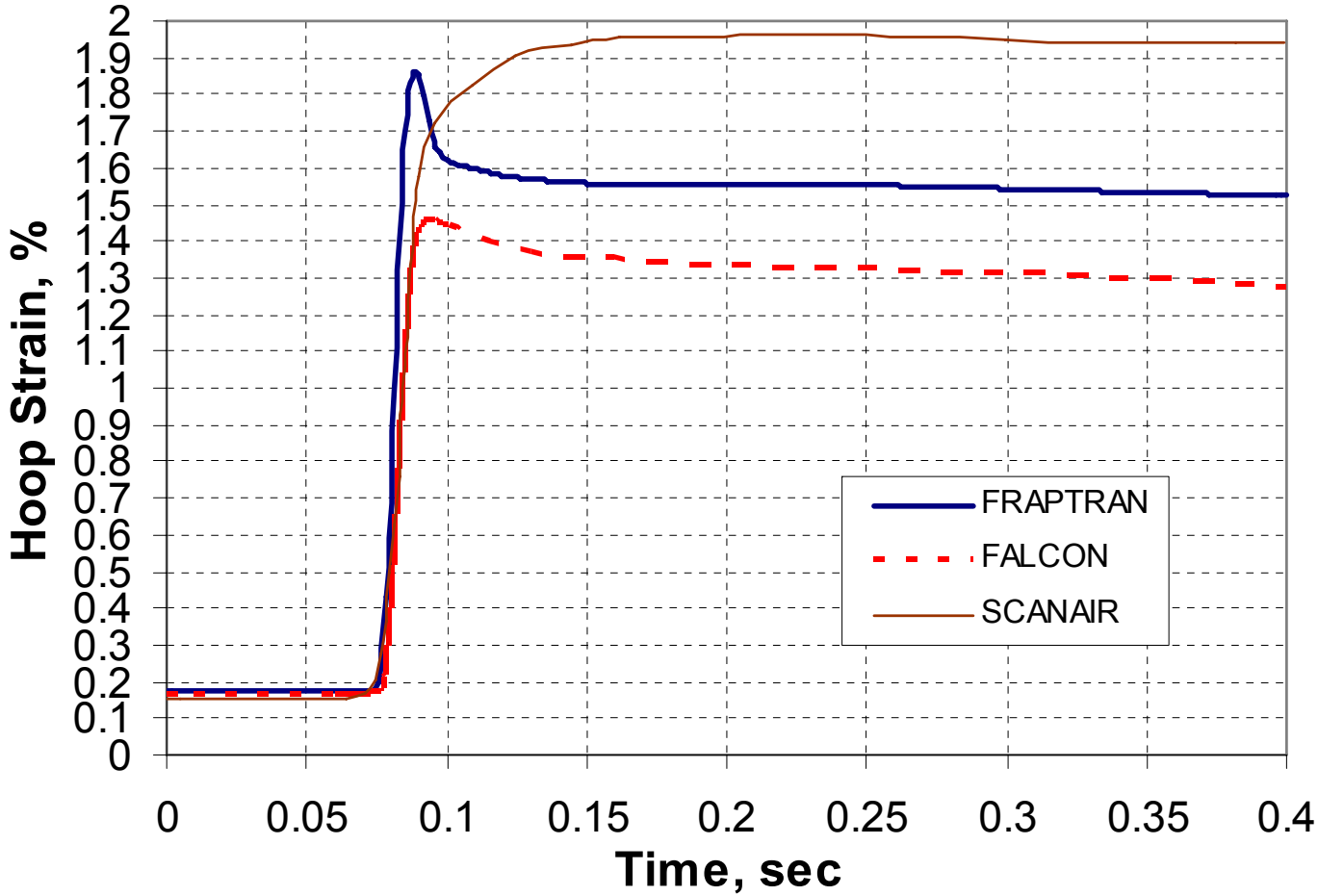
Example of Calculated Hoop Stress for RepNa3



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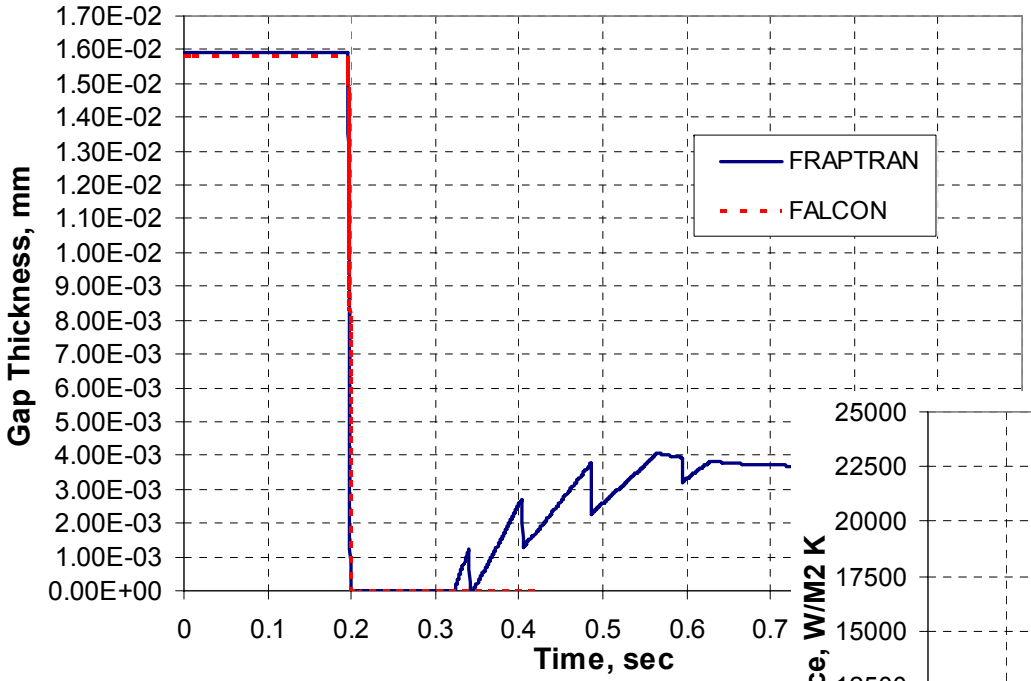
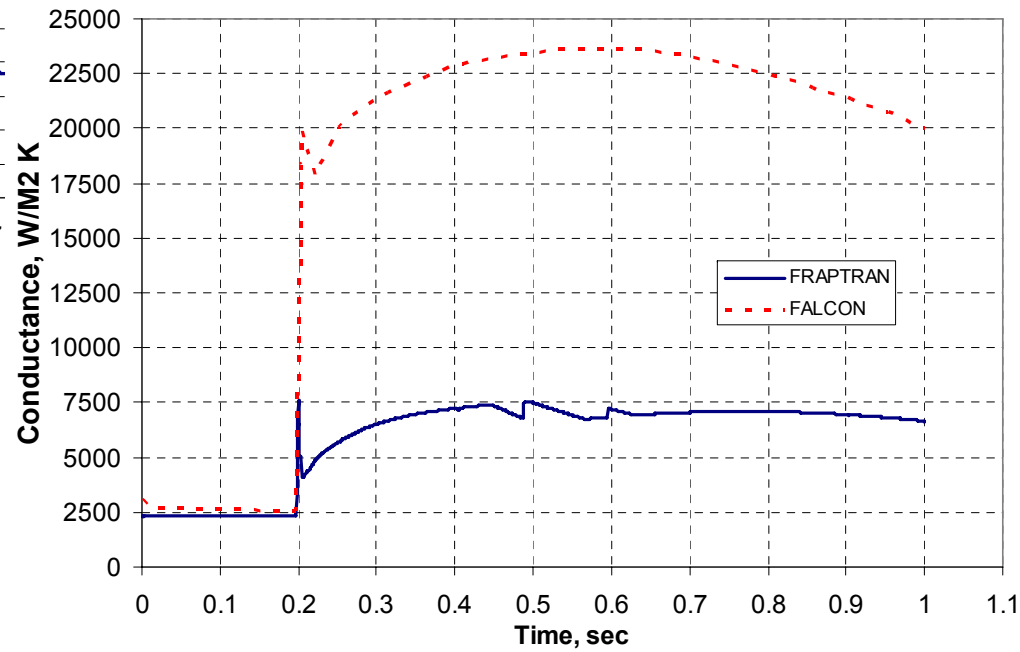
HBO-1 Comparison: Fuel-Clad Gap Behavior





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Action Items from Meeting

- Evaluate CSED based on total elongation versus uniform elongation
- Investigation of fuel-cladding gap behavior differences
  - Gap reopening in FRAPTRAN
  - Gap conductivity values
- Investigation of fuel pellet thermal expansion differences
- Clad to coolant heat transfer coefficients differences
- Other issues
  - Review initial yield stress differences
  - Propose an analysis to evaluate pulse width effects

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