from Joe Staudenmeier.

for 1:00 pm mtg w/ John H + Joe S in John's office

Options for Spent Fuel Pool Heatup Analysis

Spent fuel pool heatup calculations are to be performed in support of the decommissioning rulemaking and interim acceptance criteria for license exemptions. The approach taken for the calculations must be able to support the overall rulemaking or exemption strategy. The overall strategy will determine what we want the calculations to tell us. This should be guided by insights from the PRA. The PRA would also provide the allowable uncertainties (or required precision) in the calculation Some possible calculation options are presented below:

Identify uncertainties

Zirconium Fire Progression Calculations
Perform calculations to gain understanding about the onset and progression of a zirconium fire including the source term.
advantage: provides the most information about the progression and consequences of a zirconium fire.
disadvantage: This would be a long term, expensive research project that would involve code development and experimental data.

Modified Cobra
Experiments – Yes (Gary)

Bounding Calculations
Use Near Bounding Pool Configuration to provide estimate of critical decay times.
advantage: Less calculations are needed. (1 PWR, 1 BWR?)
disadvantage: The bounding critical decay time may not be useful for many plants. Bounding parameters such as burnup may not be bounding when the criteria are applied to plants undergoing decommissioning in the future.

Cobra

Configuration Bin Calculations
spectrum of bounding calculations
Cobra
Perform calculations to provide critical decay time estimates for a matrix of possible (likely?) spent fuel pool configurations.
advantage: better estimate of critical decay time for spent fuel pools that are not near the bounding configuration.
disadvantage: requires more calculations (money) and time.
Note: The incremental costs of additional calculations is less than the first calculation since a substantial part of the effort is in setting up the geometry of the original model.

Dry cask

Develop simplified heatup code and methodology for critical decay time calculations
Perform detailed calculations in support of developing a simplified heatup code that will give a realistic estimate of the critical decay time for actual plant configurations.
advantage: Plant specific estimates for critical decay times that may be better than the bin method.
disadvantage: Will require many detailed code calculations and the

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development of a simplified calculation methodology and/or code to perform the plant specific calculations.

Physical Modeling Issues

Uncertainties in the bundle flow resistance, the oxidation models and the decay heat models will set a lower limit on the uncertainties attainable in the critical decay time estimates.

Peak temperatures in the calculations are very sensitive to bundle flow resistance because of the small driving heads that are available. We do not have grid spacer loss coefficient data for the Reynolds numbers that are typical of the calculations (Re ~ 100-200) .

The oxidation model has an uncertainty of about a factor of 4 in the rate equation. The parabolic rate equation oxidation model may also underestimate oxidation. The parabolic rate equation assumes that there is a well defined oxide layer that grows in time. The transport of oxygen to the reacting surface is limited by diffusion through the oxide layer. Some data for long exposure times indicates that the oxide layer may flake off and expose fresh zircaloy which would increase the oxidation reaction rate.

We do not currently have decay heat calculations for high burnup fuel. These will be needed for future
calculations

Computer Code Issues

COBRA-SFS does not currently have an oxidation model. Adding a verified and validated oxidation model will probably take 2 months or longer. Alternatively, a temperature below 600 C could be used as the success criteria. The calculations anticipated to be run with COBRA will be the largest calculations ever run with the code. Some unanticipated code problems may arise.

Conclusion

Present funding may allow the bounding option with an ~ 565 C success criteria. The source of decay heat inputs for high burnups has not yet been determined. No funding has been identified for this.