National Organization of Test, Research, and Training Reactors

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United States Nuclear Regulatory Commission
Protecting People and the Environment

Thermal Hydraulic Analysis Update

2015 TRTR Conference

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Relevance to Operations

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- Existing inventory of fuel is much more varied than when General Atomics started supplying TRIGA reactors
- Department of Energy is looking for additional sources of replacement fuel including utilization of “lightly” burned fuel currently on inventory
- Fuel management for improved shuffle without peak channel penalty
- General Atomics was not able to provide a threshold power per element for safe operations
- HEU to LEU conversion experience
- Over power event at a facility with a highly tilted flux profile following addition of a fresh element
- Desire to use modern tools for research reactors

Code Enhancements

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- TRACE – Update
  - Revision (minor release) coming soon (end of CY2015)
  - Updated Groeneveld correlation table
  - Corrected Groeneveld calculation

- TRACE Code availability
  - Must have non-disclosure agreement (agreement to not redistribute) on file with NRC office of Nuclear Regulatory Research
  - Free to Universities

Code Enhancements

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- RELAP5 – Update
  - Updated Groeneveld correlation tables (2006 version)
  - Code is available
  - Must have non-disclosure agreement (agreement to not redistribute) on file with NRC office of Nuclear Regulatory Research
  - Free to Universities

Code Enhancements

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- Interfacial drag (bundle) model versus PIPE model in TRACE and RELAP5
  - Classical pipe slug flow does not occur in rod bundles
  - Rod bundle interfacial drag model does not have the bubbly to slug flow transition that the pipe interfacial drag model has

Common Issues

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- Conflicting information for grid plate and fuel dimensions
  - Inconsistent inlet and outlet flow loss coefficients
  - Inconsistent channel flow area and hydraulic diameter determination
- Need to search for limiting sub-channel
  - Limiting channel may not be highest power rod, need to consider all parameters
  - Limiting channel based on power and flow, especially with circular lattice (irregular pin pitch)

Result Challenges

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- Using technical specification (TS) values for input parameters can create artificial conditions that may never exist
- Bounding core designs may result in limitations to bulk pool (core inlet) temperature, power level, or fuel placement constraints
- Code results show density wave oscillations
  - Driven by power to flow area ratio
  - Stability limit may be more restrictive than CHF

Potential Items Under Consideration

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- Measurement of actual inlet temperatures instead of assuming bulk limit
- Determination of cross-flow and utilization of core models that can apply appropriate cross-flow values
  - More accurate representation of physical phenomena
  - Increased margin to critical heat flux (reduced DNBR) and flow stability boundary

Potential Items Under Consideration

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- Increased range in test series in sub-cooled boiling models
  - Model improvements needed to address irregular quality of predicting void fractions at low pressure and low flow
  - Validate against existing data
  - Expect to update both codes

Future Plans

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- Consideration for more testing to further assess and enhance the models
  - Understand flow stability limits in TRIGA lattice geometries
  - Plate fuel creates unique power distribution issues (edge peaked) that complicates 1D flow modeling. The existing plate fuel CHF and flow stability thermal hydraulic data has uniform power distributions

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Questions