



**RIC 2012**  
**TH28: Thermal Hydraulic & Severe Accident**  
**Research**

**TRACE/PARCS Coupled Calculations**

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Office of Nuclear Regulatory Research  
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**Coupled Thermal-Hydraulic/  
Neutronic Analysis**

- NRC staff consider a specified set of transients when reviewing a licensing action
- Several require the modeling of thermal-hydraulic with neutronic phenomena during normal operations, Anticipated Operational Occurrences (AOOs), & proposed accidents
  - Transient over-cooling events, control rod bank withdrawal, rod drop, rod ejection, flow & boiling instabilities, & Anticipated Transients Without SCRAM (ATWS)

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**Coupled Thermal-Hydraulic/  
Neutronic Analysis**

- Understanding the effect of power distribution on thermal-hydraulic (TH) phenomena is necessary to predict:
  - Peak pin powers in relation to regulated fuel thermal limits, reactivity & power control, safe shutdown margin (SDM), spatial xenon oscillations, & slow xenon/samarium tracking
  - Nuclide composition in fuel bundle materials (uranium, clad, structure, etc.) at points in time during the fuel cycle
- The coupling is linked by the interpolation of averaged nuclear data (cross sections) at fluid property state points (temperature, density, etc.)

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## Regulatory Need

- Combined TH/neutronic capabilities are necessary for the NRC to perform audit calculations for new reactor designs, licensing actions for operating plants, evaluation of generic safety issues, support for rulemaking, & analyses of plant events
  - Reviews of operating Boiling Water Reactor (BWR) Extended Power Uprates (EPU) and MELLLA+ operations, stability, & ATWS events
- New & advanced reactor designs including ESBWR, EPR, & Small Modular Reactors

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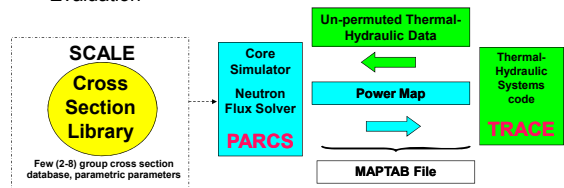
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## NRC Code Suite

- PARCS - Purdue Advanced Reactor Core Simulator
- TRACE - TRAC (*Transient Reactor Analysis Code*) RELAP (*Reactor Excursion and Leak Analysis Program*) Advanced Computational Engine
- SCALE – Standardized Computer Analysis for Licensing Evaluation



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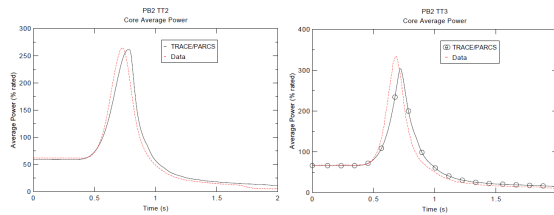
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## Peach Bottom Turbine Trips

- PBTT-2: Power Rise
- PBTT-3: Power Rise



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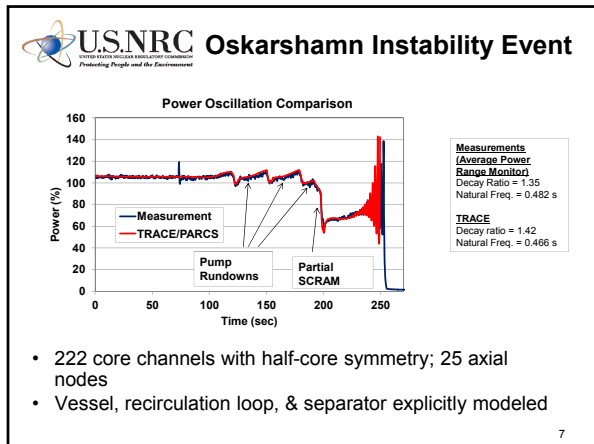
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- 222 core channels with half-core symmetry; 25 axial nodes
- Vessel, recirculation loop, & separator explicitly modeled

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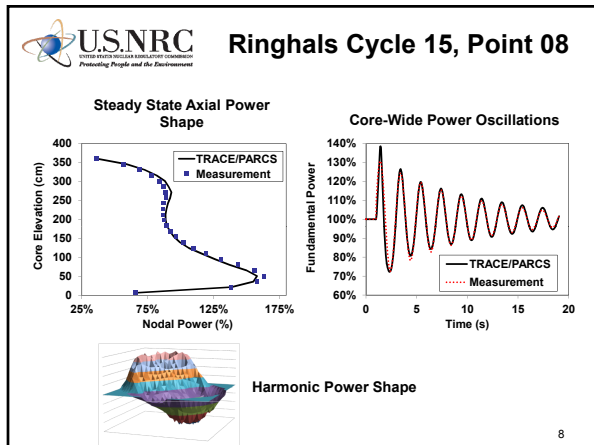
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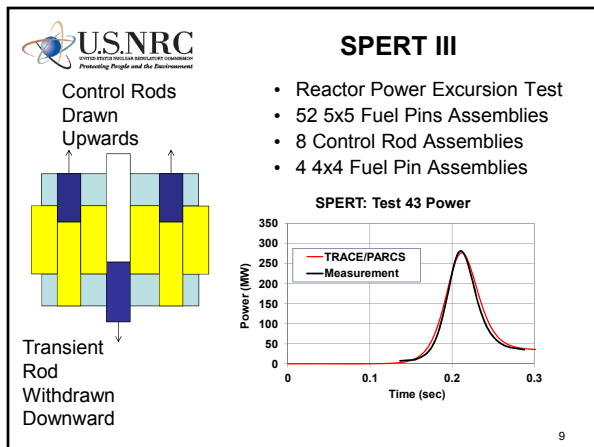
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## Conclusions

- Coupled thermal-hydraulic/neutronic analysis plays a role in confirmatory safety calculations at the NRC
- TRACE/PARCS is the NRC tool for core physics, steady-state, & transient neutronics problems
- Codes mature & get better with use. Recent heavy usage on complex and difficult plant simulations has led to several improvements
- NRC's goal is continuous improvement in capabilities, automation of routine tasks, & expansion of the assessment basis of TRACE/PARCS
- The results presented here were developed at Oak Ridge National Laboratory, the University of Michigan, & Pennsylvania State University

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