



U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

RIC 2007

**Evaluation of TRACE for
Advanced BWR LOCAs**

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Outline

- Background
- Advanced Passive BWRs
- Evaluation Model Concept
- TRACE Adequacy Evaluation
 - Element 1: Establish Requirements for Evaluation Model Capability
 - Element 2: Develop Assessment Base
 - Element 3: Develop Evaluation Model
 - Element 4: Assess Evaluation Model Adequacy
 - Adequacy Decision
- Summary
- Future Work

Background

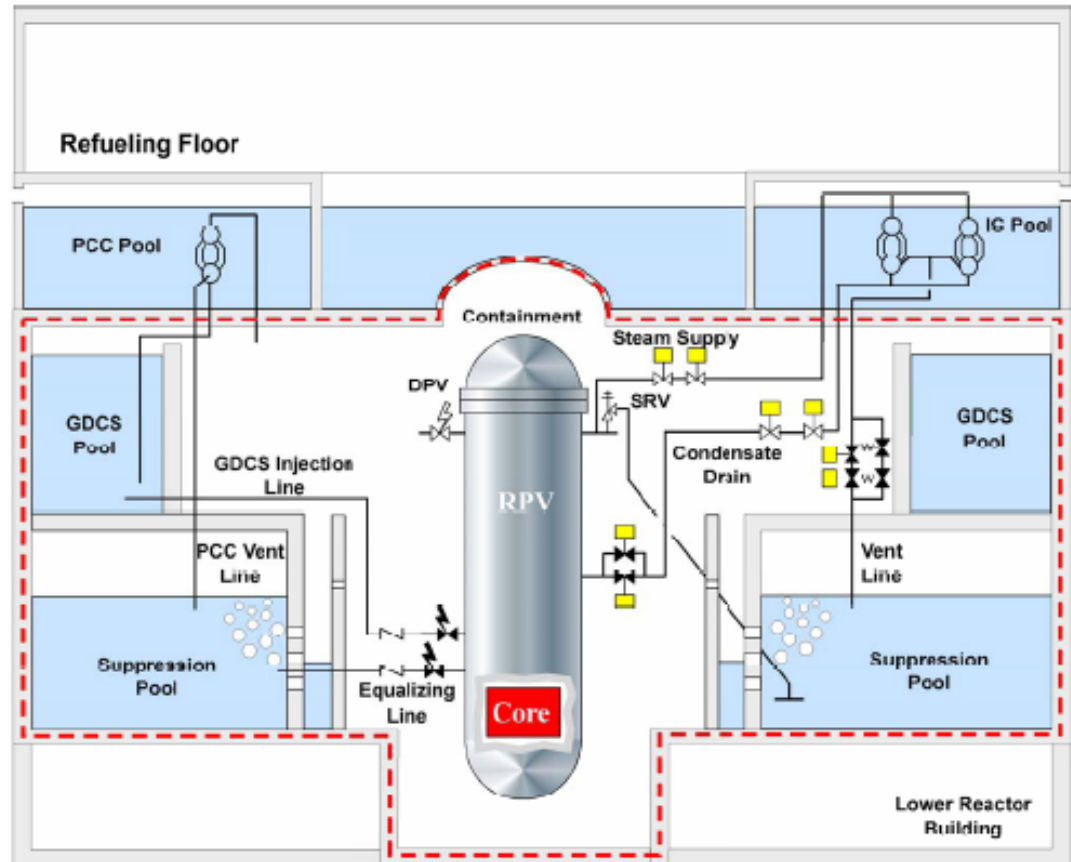
- TRAC/RELAP Advanced Computation Engine (TRACE)
 - Independent safety analysis computer code for analyzing nuclear power plant response to postulated accidents
 - Can be used for small- and large-break loss-of-coolant accidents (LOCAs) for standard PWRs, BWRs, and advanced passive BWRs
 - Version 5.0 was released in Dec 2006
 - Version 6.0 planned for release in Dec 2007

Background

- TRACE calculations to support:
 - Power uprates
 - License renewals
 - Design certification reviews (e.g., EPR, ESBWR)
 - Rule changes (e.g., 50.46, Pressurized Thermal Shock)
 - Other research activities (e.g., scoping studies)

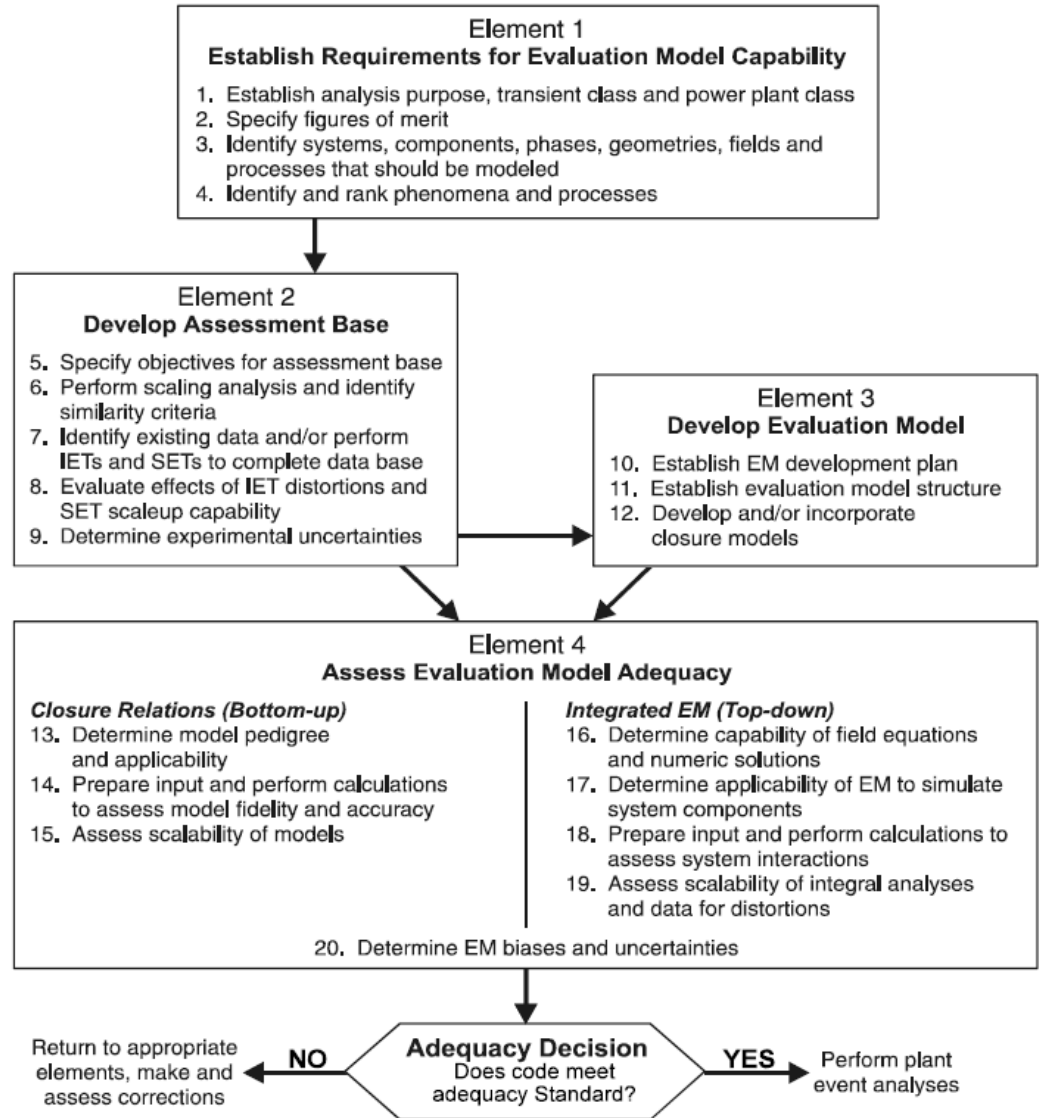
Advanced Passive BWRs

- SBWR, ESBWR, etc...
 - Passive safety systems such as heat exchangers and gravity driven injection to provide core makeup and containment cooling



Evaluation Model Concept

- Regulatory Guide (RG) 1.203, "Transient and Accident Analysis Methods," provides the description of a process that is acceptable to the NRC staff for the development and assessment of evaluation models that may be used to analyze transient and accident behavior that are within the design basis of the plant.



TRACE Adequacy Evaluation

- Element 1: Establish Requirements for Evaluation Model Capability
 - Figures of Merit
 - Reactor vessel collapsed liquid level
 - Some Key Phenomena
 - Distribution of noncondensables in drywell
 - Core void distribution
 - Natural circulation flow
 - Break flow
 - Presence of noncondensables in passive heat removal systems
 - Suppression pool temperature stratification

TRACE Adequacy Evaluation

- Element 2: Develop Assessment Base
 - Conduct scaling analyses and identify similarity criteria
 - Utilize well-scaled integral and separate effects test (IET and SET) data:
 - IET Facilities: PUMA (MSLB, BDLB, & GDLB), PANDA (ISP-42 & M9), and GIRAFFE (GS2 & GS3)
 - SET Facilities: Ontario Hydro, Wilson Bubble Rise, PUMA (PCCS and Suppression Pool SETs), PANDA PCCS SETs, PANTHERS (PCCS and ICS SETs)
 - Evaluate experimental scaling distortions (RIC 2007, Thermal-Hydraulics Session, Marcos Ortiz of ISL, Inc.)
 - Determine experimental uncertainties

TRACE Adequacy Evaluation

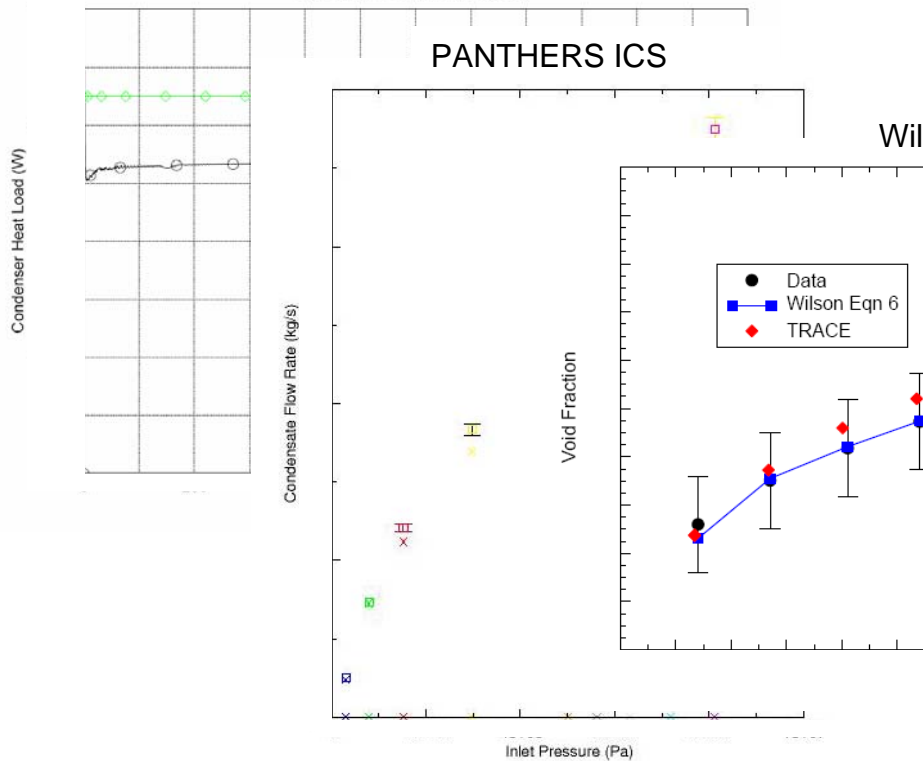
- Element 3: Develop Evaluation Model
 - TRACE Version 5.0
 - Two-phase, two-fluid model for flow in 1- and 3-D
 - Can select SETS or semi-implicit method to solve two-fluid model
 - Can simulate all high-ranked advanced passive BWR PIRT phenomena based on a review of governing and closure equations as implemented
 - Numerical considerations
 - Non-physical circulatory flows in large pools
 - Numerical diffusion (Eulerian formulation)
 - Level tracking model

TRACE Adequacy Evaluation

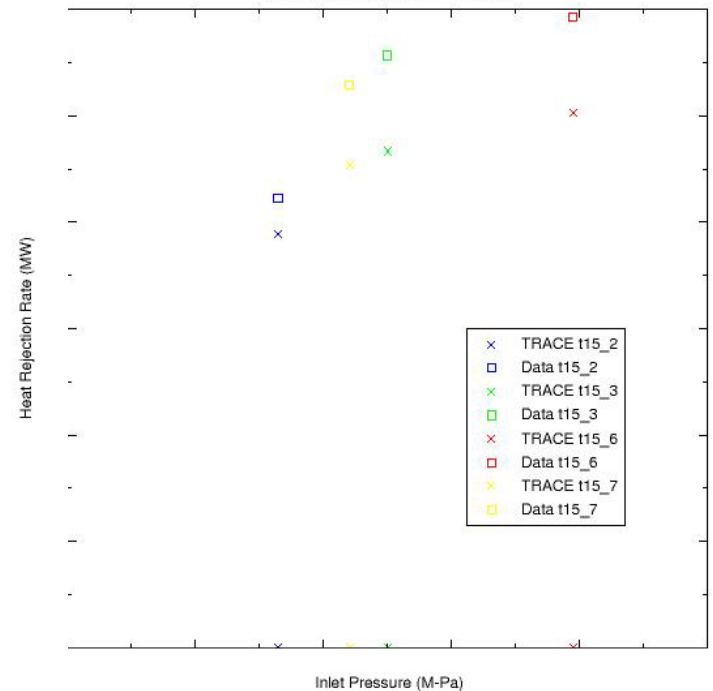
- Element 4: Assess Evaluation Model Adequacy
 - Closure relations (bottom-up)
 - Integrated EM (top-down)

TRACE Adequacy Evaluation

PANDA Steady State Test S4
 0.1942 kg/s steam, 0.016 kg/s air

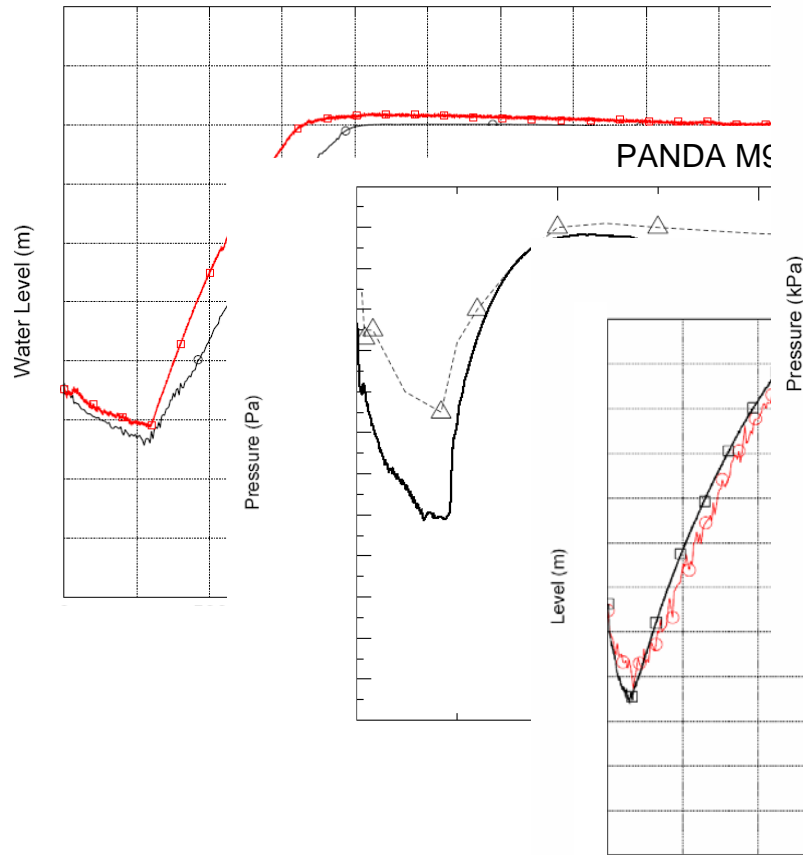


PANTHERS-PCC Saturated steam-air tests
 Air mass fraction = 0.032

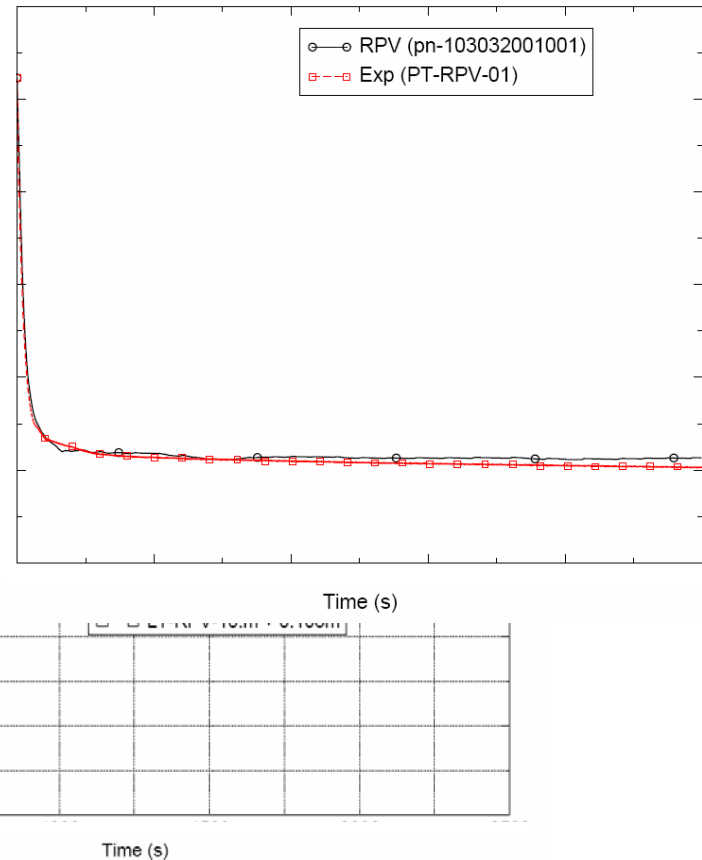


TRACE Adequacy Evaluation

PUMA: MSLB (May '98)



PUMA: BDLB (Feb-27 '98)



Summary

- TRACE Version 5.0 has been released
- Evaluation Model Concept (RG 1.203, “Transient and Accident Analysis Methods”)
- TRACE Adequacy Evaluation for Advanced Passive BWR LOCAs
 - Four interrelated elements including scaling analyses, experimental data, computer code models, etc.

Future Work

- Complete IET and SET experimental data reviews
- Finalize scaling distortion analysis for integral test facility data
- Perform sensitivity analysis
- Document adequacy decision