Modeling of Boiling Water Reactors

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Organization

BWR Modeling and Model Assessment Session Agenda

1. Model Overview
2. Determining Key Analysis Parameters
3. Important BWR Phenomena
4. BWR Specific Components
5. Steady State Model
6. LBLOCA Simulation

Key Analysis Parameters

Determining whether a model is good depends directly on what the model is designed to tell you. Whenever you build or assess a model, it is useful to ask the following questions:

- What issue or concern motivates this analysis?
- What key model parameters directly address this concern?
- What do these parameters tell me relative to the issue?
- What important thresholds or events I am looking for?

Key Analysis Parameters

Figures of merit are values, derived from key parameters, that can be compared against important thresholds or events for decision making purposes.

Once you know the key analysis parameters and important thresholds or events, evaluate the **key phenomena** that impact the figures of merit and should be captured in the model to give a realistic prediction.

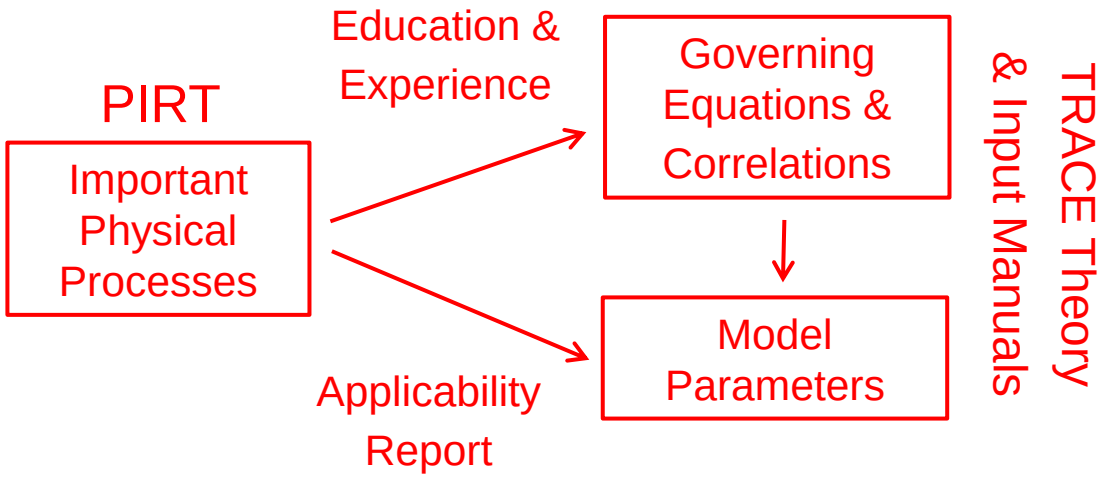
A model that neglects or fails to adequately capture important phenomena is less likely to produce a realistic prediction of figures of merit. An understanding of the key parameters and phenomenological dependencies plays an important role in model development and review.

The PIRT – a Valuable Resource

A **Phenomena Identification and Ranking Table (PIRT)** can be valuable resource in identifying:

- The key parameters/figures of merit for the specific accident type
- The dominant processes involved by phase
- Phenomena ranked by the anticipated impact to key parameters by phase

Resources for Mapping from Physical Phenomena to Model Parameters



- PIRT focuses on key physical phenomena, NOT model parameters
- Applicability Reports assess TRACE ability to model important phenomena, and provides modeling recommendations for capturing phenomena (refer to the TRACE users guide)
- Education and Experience help relate phenomena to equations and correlations or model parameters
- The TRACE theory manual explains the governing equations and correlations used in TRACE. This is important for **understanding dependencies**. The TRACE input manual helps connect eqns to inputs.

Figures of Merit

Peak Cladding Temperature (PCT) and **core mixture level** are often identified as **Figures of Merit** for LOCA events in power plants.

- Phenomena can be grouped by impact on Power Generation, Delivery of Coolant to the Core Region, or Heat Transfer Processes.
- There are two primary factors that influence PCT:
  - **local generated power** and
  - **local heat transfer processes** which remove power.
- The fuel clad temperature response is determined by the imbalance between power generated and power dissipated.
- The majority of important phenomena are related to delivery of water to the core region for cooling purposes or to heat transfer processes

Figures of Merit

The PIRT provides some justification of why particular phenomena are ranked as having High impact on PCT for LOCAs. It may also be worth examining each phenomenon to determine how it impacts each of the following:

- Power Generation
- Delivery of Coolant to the Core Region
- Heat Transfer Properties in the Core

Capturing Important Phenomena

The PIRT identifies physical phenomena that are expected to be important in specific safety related events. How do you verify that important physical phenomena are modeled reasonably?

- Set the parameters that can be mapped directly to phenomena (power distribution, decay heat, etc.)
- Verify steady state targets related to important phenomena are achieved (channel bypass leakage, core pressure drop, etc.)
- Compare transient against data or independent analysis when available. Consistent behavior increases confidence.
- For some phenomena, there is no direct data for comparison, so it is necessary to rely on code assessments, and seek to make model parameters that affect a particular phenomenon agree with available plant information.