Nuclear Fuel

FULL SPECTRUM™ LOCA Methodology

The latest evolution of Westinghouse's best-estimate loss-of-coolant accident analysis technology designed to fit your needs

Background

As its name implies, the state-of-the-art **FULL SPECTRUM**™ LOCA (**FSLOCA**™) evaluation model can analyze the full spectrum of LOCA break sizes with improved capability and analysis results compared to prior LOCA technologies.

The FSLOCA evaluation model is NRC-approved for application to Westinghouse 3-loop and 4-loop PWRs. Extensions of the methodology to Westinghouse 2-loop PWRs, plants equipped with direct vessel injection, and CE PWRs are ongoing such that the methodology will soon be NRC-approved for all Westinghouse and CE PWR designs.

The FSLOCA methodology is designed to address the draft 10 CFR 50.46c criteria and has the capabilities to support implementation of higher burnup, higher enrichment fuel as well as the Westinghouse **EnCore**® fuel products.

Description

For the FSLOCA methodology, Westinghouse created a new version of its best-estimate thermal-hydraulic code, which is named WCOBRA/TRAC-TF2 (WC/T-TF2). The code combines two-fluid, three-field, multidimensional fluid equations used in the vessel with an upgraded one-dimensional, two-fluid, six-equation formulation of the two-phase flow to model the loops, allowing for a complete and detailed simulation of a PWR. Additionally, a transport equation is included to model an explicit non-condensable field within the gas mixture.

WC/T-TF2 was subjected to a rigorous code assessment against a large number of separate and integral effect tests. The large test matrix provides validation of various models such as break flow, fuel rod behavior, core heat transfer, delivery and bypassing of the emergency core cooling (ECC), steam binding/entrainment, cold leg/downcomer condensation, non-condensable gases/ accumulator nitrogen, core void distribution (mixture level), horizontal flow regime in the loops, loop seal clearance, and steam generator thermal hydraulics. Four integral test facilities with varying scales were simulated to provide full coverage of LOCA break sizes and scenarios.

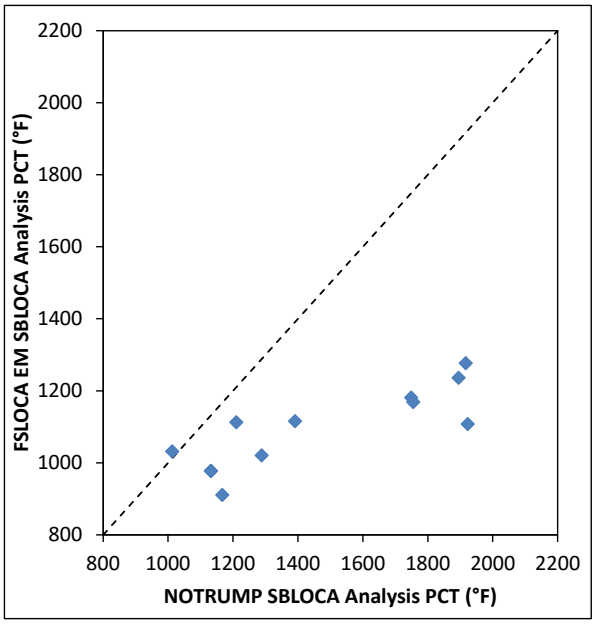
The FSLOCA evaluation model utilizes a patent-pending uncertainty treatment method based on a direct Monte Carlo sampling of the uncertainty attributes, but which allows for larger sample sizes that improve analytical margins from prior methods.

Benefits

Implementing the FSLOCA evaluation model enables numerous benefits compared to previous LOCA analysis technologies.

Improved Analytical Margins

- First model in the industry to eliminate small-break LOCA as a design constraint
- More robust uncertainty treatment along with improved nuclear design and fuel rod design interfaces result in large-break LOCA margin



Westinghouse

Aligned with Regulator-Driven Initiatives

- Utilizes Westinghouse's advanced fuel performance data and explicitly accounts for thermal conductivity degradation (TCD)
- Demonstrates compliance with draft 10 CFR 50.46c acceptance criteria for post-processing of analysis results

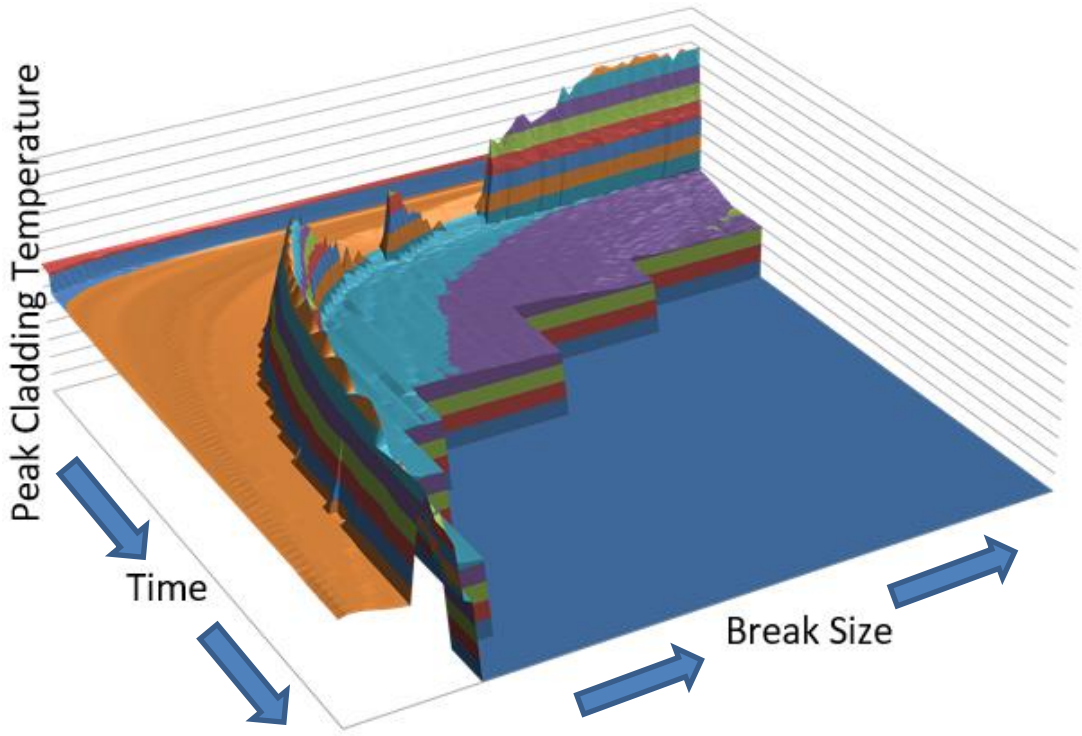
Improved Economics / Operational Flexibility

- Enables increases in rated power and improved fuel cycle economics (e.g., relaxed core operating limits, increased peaking factors and increased fuel cycle length)
- Improved operational flexibility and relaxed operational restrictions (e.g., emergency core cooling system performance, extended emergency diesel generator start times, and broader accumulator operating ranges)

The FSLOCA methodology and code suite can also be used to perform non-standard thermal-hydraulic analyses, such as a novel application to predict tritium-producing burnable absorber rod (TPBAR) structural integrity during a LOCA, which is NRC-approved.

Experience

To date, Westinghouse has successfully applied its best estimate LOCA methodologies to more than 40 PWR units across seven countries. The FSLOCA evaluation model has built on this success while expanding its offering to better support customer needs. Analyses with the FSLOCA EM have been completed to support 20+ PWR units, with NRC-approval for 10+ of those units to date. 10+ additional PWR units are contracted for analyses with the FSLOCA evaluation model, including sites in Brazil and Sweden.



Peak Cladding Temperature Response for a Typical 3-Loop PWR Predicted with the FSLOCA Methodology

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