ACE™

Advanced Core Engine (ACE) for Loading Pattern Optimization

The Westinghouse Solution

Advanced Core Engine (ACE) is a Westinghouse-developed AI and machine-learning tool for core loading pattern optimization that accelerates and improves nuclear fuel core design. Using a surrogate model trained on high-fidelity neutronic simulations, ACE rapidly evaluates large design spaces to deliver faster insight, improved margins and stronger economic performance.

ACE is designed to reduce engineering cycle time, expand the search space beyond traditional methods and support more efficient in-core fuel management across multiple reactor types.

The Challenge Addressed

Optimizing core loading patterns is a computationally intensive, high-dimensional problem with millions (or more) of possible configurations. Traditional approaches are:

- Time consuming due to repeated full-physics simulations
- Highly dependent on expert iteration
- Limited in the number of viable patterns that can be explored

These constraints can restrict optimization quality and lengthen reload design critical path, especially as plants pursue **longer cycles, higher discharge burnup and tighter design constraints.**

ACE Graphic User Interface (GUI)

How it Works

ACE replaces brute-force iteration with a machine-learning surrogate model that rapidly predicts key core design metrics, enabling fast and scalable optimization.

Core elements include:

- **ML-based surrogate model** trained on thousands of input/output cases from validated neutronic codes (e.g., ANC, POLCA)
- **Instant prediction** of key metrics (e.g., FdH, power distribution, boron) in milliseconds instead of minutes
- **Optimization engine** that searches extremely large loading-pattern spaces under user-defined constraints
- **Hybrid optimization approach**, combining advanced heuristics to efficiently converge on optimal solutions

This architecture allows ACE to explore design spaces that would be impractical using conventional workflows.

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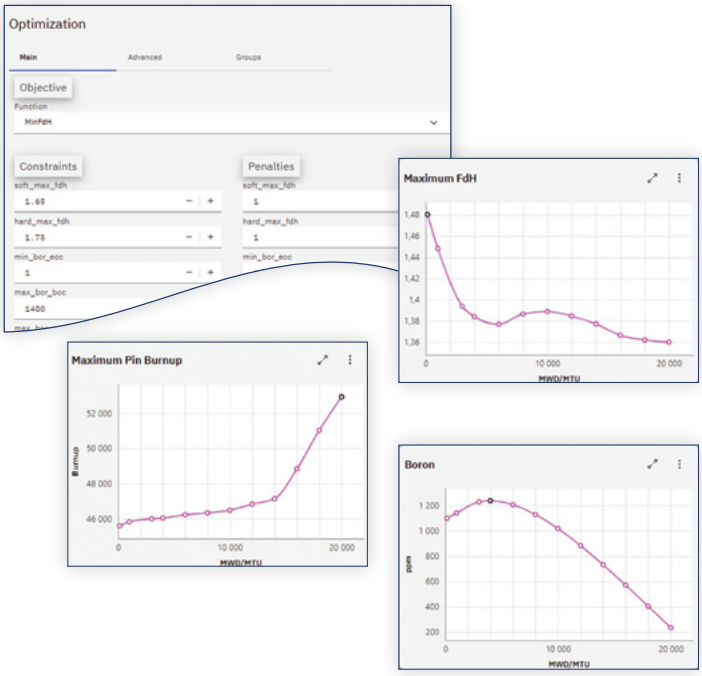
What ACE Optimizes

ACE is built to optimize loading patterns while satisfying all applicable safety, operational and energy constraints, including:

- Enthalpy rise (FdH)
- Peak pin power / burnup (Fq)
- Energy and cycle length requirements
- Core-specific design constraints

The result is better-balanced cores with improved margins and economic performance.



Performance and Speed

On widely accessible computing platforms — with scalable performance on higher-end systems — ACE enables orders-of-magnitude more exploration in a fraction of the time:

This speed allows engineers to:

- Evaluate significantly more candidate solutions
- Reduce the number of design iterations
- Identify solutions with lower peaking and improved safety margin

Supported Reactor Types

ACE currently supports, or is being extended to support, the following reactor technologies:

- PWR (square lattice)
- VVER (hexagonal lattice)
- BWR (under development)

Customer Benefits

With ACE, customers can expect:

- Faster core design and reduced engineering effort
- Improved fuel economics through optimized loading
- Enhanced safety margins via lower-peaking solutions
- Greater design insight by exploring broader solutions
- Reduced dependence on manual trial-and-error

ACE complements existing Westinghouse core design tools and expertise, acting as a force multiplier rather than a replacement.

Status and Development

- ACE is an in-house Westinghouse development with active deployment and continued capability expansion
- Ongoing enhancements include expanded reactor support and optimization to support transition to longer cycles, higher burnups and power uprates
- Future development focuses on deeper integration with digital fuel platforms and analytics workflows

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