Advanced Loading Pattern Search

Engineering Services

Background

The Advanced Loading Pattern Search (ALPS) rapidly generates loading patterns that meet design constraints using a unique, powerful methodology. XALPS provides a graphical user interface (GUI) for ALPS with point-and-click shuffling capability and visual loading pattern comparisons.

Loading pattern development is a complex process balancing a utility's operational and economic requirements against the constraints imposed by Technical Specifications and safety limits. ALPS provides the core designer with sophisticated tools to efficiently sort through hundreds of thousands of possible loading patterns in a matter of a few hours to select those most likely to meet design constraints.

Westinghouse

ALPS

ADVANCED LOADING PATTERN SEARCH

Benefits

The unique, powerful, and sophisticated methodology in ALPS, combined with numerous convenience features, can significantly reduce the time to develop loading patterns. ALPS has a built-in master library of cross-sections for Westinghouse fuel assembly and burnable absorber design. ALPS can read core geometry, thermal-hydraulic conditions, and shuffle assembly parameters from user input or from ALPS databanks, as well as from ANC databanks. ALPS incorporates a three-dimensional effects model to include product features such as axial blankets and reduced-length burnable absorbers into its two-dimensional calculations. ALPS generates its own databanks to allow multiple cycles to be created and depleted for long-term analyses.

The loading pattern generation techniques in ALPS scan rapidly through thousands of candidate loading patterns, spatially analyzing and depleting each one. The method generates interesting and innovative loading patterns that would not be considered in a manual search or by a code that searches with a single heuristic function. The final results contain a variety of loading patterns that have been evaluated economically with varying degrees of design constraint compliance.

The XALPS GUI enhances the usability and flexibility of ALPS execution by providing a point-and-click input capability and a visualization of the process and results.

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Description

ALPS is the advanced fuel management code used by Westinghouse nuclear designers and utility analysts to determine core loading patterns and fuel enrichment requirements. ALPS is a dimensional tool that obtains candidate loading patterns compatible with the available fuel inventory, which satisfies power peaking and moderator temperature coefficient constraints. ALPS evaluates and ranks the most successful loading patterns with respect to fuel cycle costs.

With fuel management trends evolving towards longer operating cycles, higher discharge burnups, increased burnable absorber inventories, reduced radial leakage, and multiple-batch feed fuel regions, obtaining economical loading patterns that meet all design criteria is a difficult and time-consuming task to perform manually. The ALPS search methodology produces a wide spectrum of loading patterns, including many that would not typically be discovered in manual searches or by codes that use a single search heuristic.

XALPS is the GUI that allows the user to execute ALPS in the automated search mode, or in the manual search mode with point-and-click shuffling. XALPS displays candidate loading patterns in a color-coded quarter-core window and displays the summary tables graphically, or as a scrollable window.

ALPS has been benchmarked to PHOENIX-P/ANC design predictions to confirm the following performance criteria:

Critical boron at end of cycle	±30 ppm (2-sigma difference)
Average assembly power (assembly powers > 1.0)	<2% (Radiation Monitoring System [RMS] difference)
Peak pin power (pin power > 1.3)	<3% (RMS difference)

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