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GARDEL BWR On-line Monitoring Experience at Cooper and Monticello

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INTRODUCTION

Cooper Nuclear Station and Monticello Nuclear Generating Plant are General Electric single unit Boiling Water Reactors (BWRs) of 2381 MWt and 1775 MWt respectively. Since February of 2005, these plants have relied on Studsvik's GARDEL system for core monitoring. Both plants have accumulated a full cycle (cycle 23 for both plants) of operating data and are in their second operating cycle using the GARDEL system.

STUDSVIK'S GARDEL SYSTEM

GARDEL is Studsvik's core monitoring and analysis system. GARDEL is currently being applied, or in the process of implementation, for 23 Light Water Reactors in five different countries. 1,2

Studsvik's state-of-the-art physics codes CASMO-4/Simulate-3/Simulate-3K perform all fuel simulation calculations within GARDEL without any additional simplifications. This also allows for compatibility and data exchange between GARDEL, analysis and design groups, and training simulator groups using Studsvik's S3R core model.

The system has a clear separation between physics codes, process control, database and graphics. For each particular plant system, GARDEL will activate different modules. GARDEL currently supports PWR reactors of Westinghouse and CE design, as well as BWR reactors of GE, KWU and ASEA design.

Users exclusively interact with the system through its Graphical User Interface, ensuring a high degree of data security. The interface supports detailed data presentation as well as intuitive input data generation for off-line support calculations.

IMPLEMENTATION

Both Cooper and Monticello have support organizations using Studsvik's physics codes for analysis, design, and operational support and use S3R for their training simulator. Thus GARDEL was a natural fit for integrating these related activities. The system is implemented on dual Windows servers with fully redundant hardware. Site acceptance testing was performed in 2004 followed by a period of parallel operation with the customers' previous core monitoring system prior to replacement in February 2005.

APPLICATIONS

GARDEL uses Simulate-3 for calculations of thermal margins adapted to TIP and Local Power Range Monitoring (LPRM) detector measurements, and for all other steady state applications. For monitoring of BWR stability, a full three dimensional, time domain model, based on Simulate-3K, is used to calculate global and regional decay ratios, both for current and for postulated double pump trip conditions.

In addition to thermal limits and stability monitoring, GARDEL provides an interface for performing common reactor engineering tasks such as critical estimates, maneuver planning, shutdown margin, notch worth calculations, and more. By integrating these functions with current plant data using design grade models, these calculations remove many approximations inherent in earlier manual procedures and thus reduce the uncertainties in the estimates. The detail available to the engineering staff for analyzing current and historical plant conditions, such as pin level power distributions, was hitherto inaccessible in such a timely and automated fashion.

Furthermore, GARDEL provides uninterrupted core monitoring functions, even while the reactor is shutdown and approaching criticality

RESULTS

GARDEL has successfully performed its core monitoring function while both empowering and simplifying engineering and operating activities. Figure 1 below (captured from user interface) illustrates the pin-wise Linear Heat Generation Rate (LHGR) in a bundle at a particular axial level.

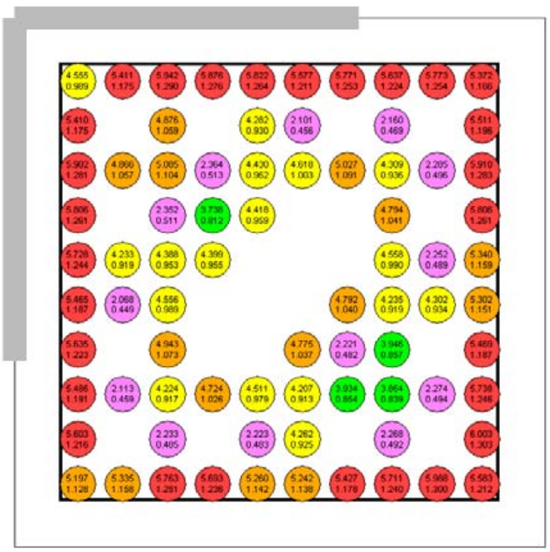

Figure 1 Pin-wise LHGR distribution within bundle.

Figure 2 below shows an example of GARDEL's automatic reporting functions for documenting the results of a TIP measurement. Measured and predicted TIP response axial traces and integrated differences are shown for each detector location along with the statistics for nodal, axial, and radial differences.

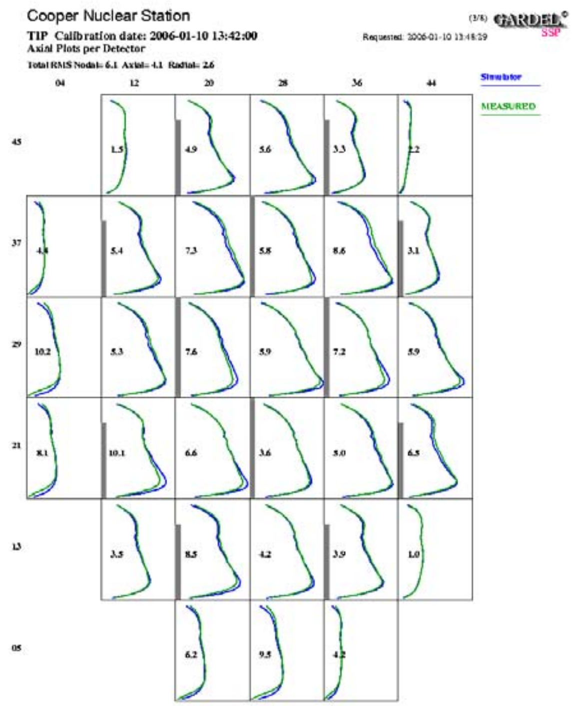

Figure 2 TIP comparison report example.

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