

Nuclear Fuel and Components Manufacturing / Fuel Engineering and Safety Analysis

BEACON™ Core Monitoring System for VVER

Background

The BEACON™ Core Monitoring System is an advanced core monitoring and support package that uses current instrumentation in conjunction with a three-dimensional (3-D), nodal analytical methodology for online measurement and analysis of 3-D power distributions. The system performs core monitoring, measurement data reduction, analysis, core follow and prediction.

Description

The BEACON system can obtain core power distribution measurements without waiting for equilibrium Xe conditions. This capability enhances accuracy during the initial ascent to full power, shortening it by up to 24 hours. This feature is also invaluable if a tilt in the core power distribution is detected on the initial ascent to power, because it allows the plant to ascend without waiting for equilibrium conditions to take core power distribution measurements at reduced power.

The BEACON system can also be very accurate (less than 100 pcm) in predicting expected critical positions (ECPs) and shutdown margin (SDM) on the initial ascent to power or after a trip/forced outage. Its improved accuracy in predicting ECP can save a utility substantial time. Accurate knowledge of SDM can help a utility from over-borating the reactor coolant system, resulting in less dilution occurring for the return to power after an outage, thereby reducing replacement power costs.

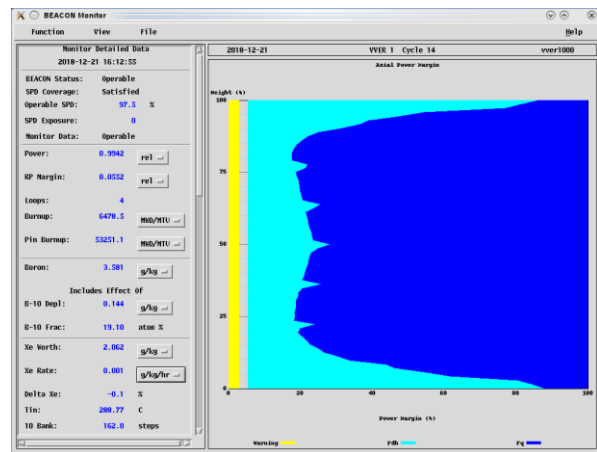
The BEACON system provides continuous core Xe distribution information, thus enhancing operator understanding and planning of control rod insertion withdrawal movements necessary to dampen oscillations during load follow or load change.

BEACON has several different levels of functionality for hexagonal fuel reactors as follows:

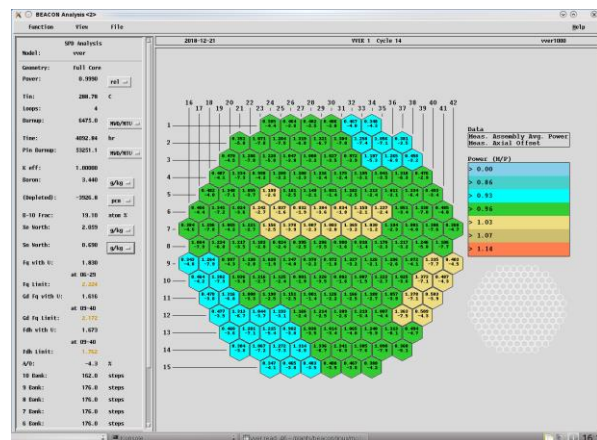
- **BEACON-OLM:** Performs In-core detector flux map analysis. Calculates estimated

critical condition, shutdown margin, load swing and other reactor engineering support functions. In addition it provides on-line monitoring of core power distribution using in-core instrumentation with no calculation of online uncertainties.

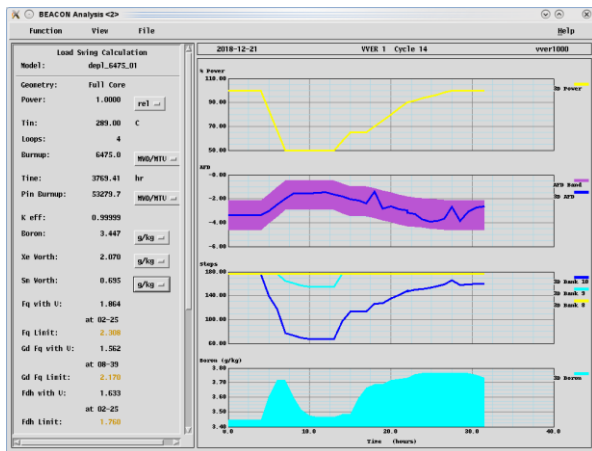
- **BEACON-TSM:** All the functions of OLM plus Tech Spec monitoring. Calculates online dynamic uncertainties to measured results allowing BEACON to be used for technical specification monitoring via a predefined surveillance report.



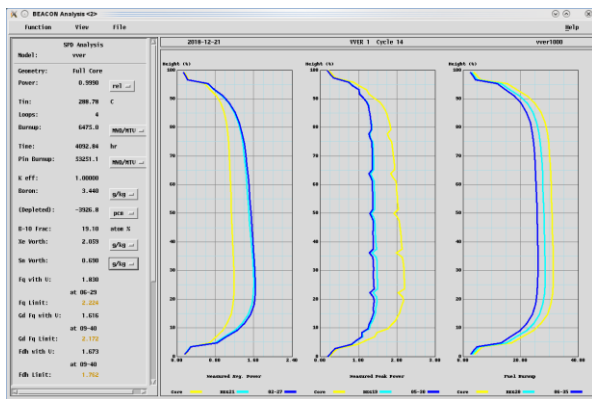
Graphic Axial Power Distribution Analysis



Radial Power Distribution Analysis



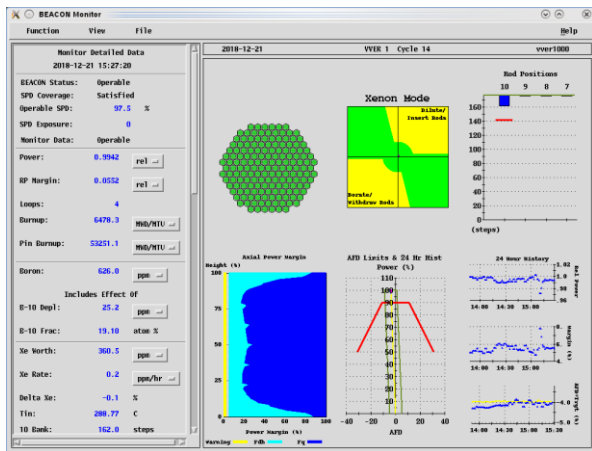
Load Swing Data Trend Showing Power History



Axial View Display

Benefits

- Can increase capacity factors by saving time on initial ascent to power.



BEACON Main Core Monitor Window

- Can save many days of delay in the ascent to power in the event of a tilt in core power distribution.
- Helps reduce operation and maintenance costs by more accurately predicting critical positions and by not delaying return to power after an outage due to excessive boration.

Experience

In February 1994, Westinghouse received U.S. Nuclear Regulatory Commission (NRC) approval of the BEACON system. The NRC concluded that the BEACON system provides the capability for accurate, continuous core monitoring in existing pressurized water reactors using currently available instrumentation.

The BEACON system has been in operation since 1990 and is currently being used in over 50 nuclear power plants in eight countries including VVER units at Temelin and South Ukraine. It has well over 400 reactor years of operational experience.

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