

BEACON™ Core Monitoring Software

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, and follow and prediction.

Description

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

The BEACON system incorporates the Westinghouse single-point incore/excore calibration technique. Quarterly incore/excore calibrations can be done without spending 12 hours 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 helps the utility keep from over-borating the reactor coolant system, so that less dilution has to occur 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 as follows:

BEACON-INCORE: In-core detector flux map analysis capability.

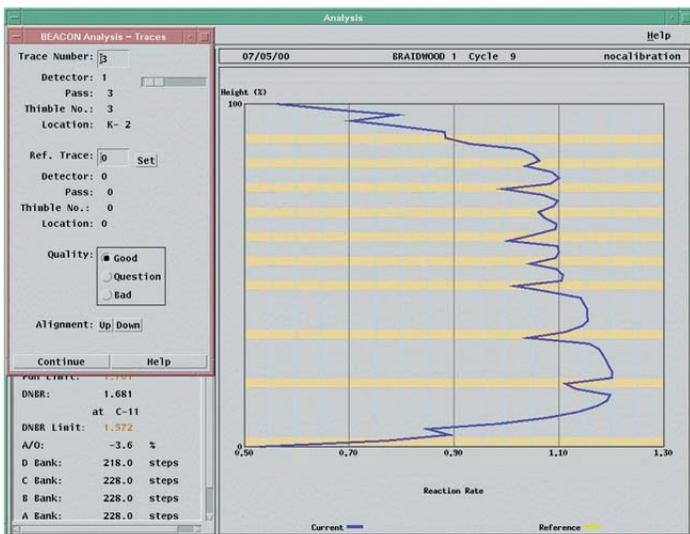
BEACON-Predictor: Adds capability to calculate estimated critical condition, shutdown margin, load swing and other reactor engineering support functions.

BEACON-OLM: All the functions of Predictor plus on-line monitoring of core power distribution using core exit thermocouple data with no calculation of online uncertainties.

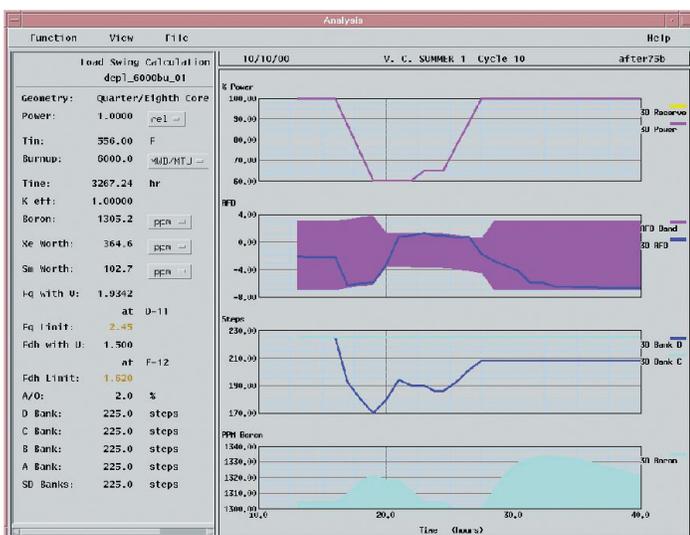
BEACON-TSM: All the functions of OLM plus Tech Spec monitoring. Calculates online dynamic uncertainties based on instrumentation characteristics and time since the last flux map, plus allows the user to perform power distribution surveillances without taking a flux map using only the available instrumentation.

BEACON-DMM: All the functions of TSM plus direct margin monitoring. Calculates departure from nucleate boiling margin continuously and can set alarms on control room annunciators if limits are approached or violated.

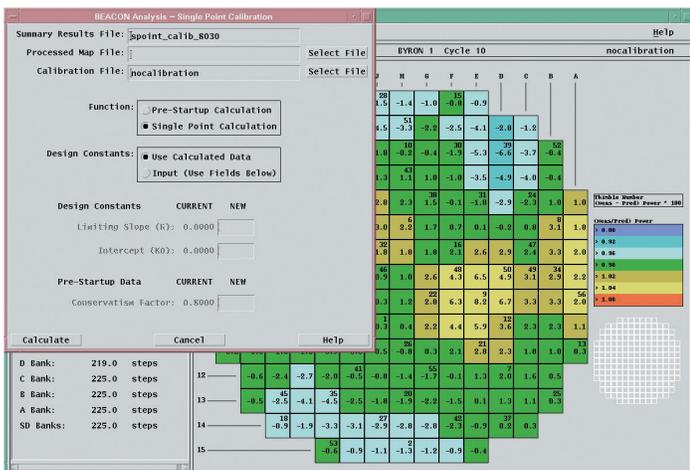
BEACON-DMM/AP1000: An integral part of the AP1000® plant design. Does what BEACON-DMM does using vanadium fixed in-core detectors instead of core exit thermocouples for online input. Also manages the MSHIM™ plant operation to account for rod shadowing to prevent unnecessary cycling of the gray rods and control banks.



Support graphic analysis of measured power distributions



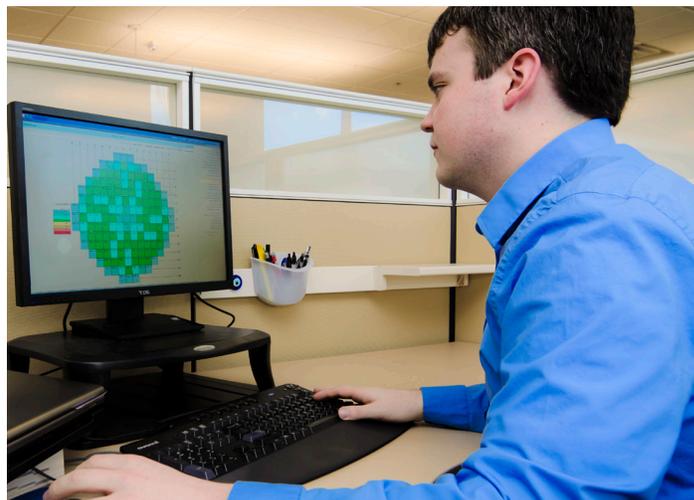
Review detailed history of critical parameters versus limits



Integrated single-point excure calibration

Benefits

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



BEACON system

- Helps reduce the time at reduced power by 24 hours through the single-point excure calibration feature.
- 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. It has well over 400 reactor years of operational experience.

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