

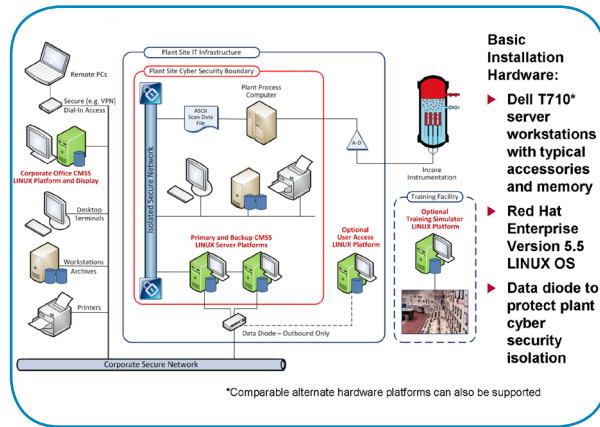
# POWERPLEX® XD BWR Core Monitoring Software

## Real-Time Fuel Performance Data

With more than 30 years of successful operation and experience in 19 BWRs (nearly 400 reactor-years), AREVA's POWERPLEX Core Monitoring Software System provides superior reliability and accuracy in core monitoring and enhances the operating efficiency of boiling water reactors (BWRs). POWERPLEX has evolved over the years from POWERPLEX to POWERPLEX-III and the latest evolution POWERPLEX-XD is installed at the three Browns Ferry Units. Currently POWERPLEX is the monitoring system of choice in 13 of the 39 BWRs in the United States and Far East. Use of POWERPLEX has proven to be an accurate tool for successful core monitoring and operation.

Nuclear power plants are under ever-increasing pressure to maximize their capacity factors. Faster maneuvering rates contribute to higher capacity factors. The rate at which a plant can increase power is governed, in part, by the plant maneuvering guidelines that warranty the fuel. These guidelines are developed to maintain the mechanical stresses from pellet-clad interaction (PCI) below levels of elevated risk for fuel rod failures. Empirical guidelines do not consider the specific core conditions at the time of the planned maneuver and can unnecessarily limit the rate of power increase.

POWERPLEX-XD replaces AREVA's empirically-based maneuvering guidelines with the patented XEDOR™ technology. As a subroutine that is implemented in AREVA's core monitoring software systems (CMSS), XEDOR™ provides reactor operators with the means to quantify the core-wide PCI margin available at any given time. XEDOR™ utilizes the essential modeling features for cladding and pellet dynamics from the RODEX thermo-mechanical code to calculate cladding stress in each 6-inch segment for each rod in the core. It has been demonstrated to produce comparable results to both the AREVA licensing basis thermo-mechanical fuel performance method (RODEX) and the reactor ramp test benchmark data. In addition, XEDOR™ has been compared with the industry



standard cladding stress method (EPRI's FALCON fuel performance code), and very close agreement was observed. Unlike these other codes, however, XEDOR™ performs these calculations fast enough to be used to monitor all fuel rods in a core in real time. It is incorporated into a core monitoring system to eliminate the need for a separate online system and provide results within existing and familiar core monitoring displays.

As an offline application executed from AREVA's core simulator codes, it allows reactor engineers to plan power maneuvers based on maintaining a defined PCI margin. In most cases, the lost capacity factor arising from "one size fits all" maneuvering rules can be recovered. It also enables reactor engineers to perform cycle design and engineering studies to quantify the effect of core loading on PCI margin or to assess the PCI impact of fuel design changes.

## Precision Accuracy

POWERPLEX-XD is built around our advanced 3-D nodal simulator code, MICROBURN-B2. This simulator code was specifically developed for the complex environment of the BWR reactor. State-of-the-art microscopic isotopic depletion techniques and two-phase hydraulic models provide accurate calculated results across a broad range of operating conditions. That means operators can confidently predict both short-term power maneuvers and long-term cycle operating projections.

## Reliability You Can Count On

POWERPLEX-XD helps keep a plant operating when unforeseen events arise. The software includes capabilities to accurately model the core with a significant number of Local Power Range Monitors (LPRM) or one or more Traveling Incore Probe (TIP) machines out of service – with little or no impact on power uncertainty. Additional features allow predefined multiple operating limits to support a rapid response should the plant shift to single-loop operations, or if scram speed measurements do not meet expectations, or if other such atypical operating conditions arise.

## Independent Operation Works with Fuel from Other Vendors

Prior to the introduction of the POWERPLEX-III system, plant operators considering a change in fuel vendors also had to plan for a change in the core monitoring system. This change poses broad implications for plant operations, operator training, and modifications to the plant computer systems, making fuel vendor transitions more complex than necessary. From the very first installation, POWERPLEX-III broke through this barrier. POWERPLEX-III explicitly models each fuel assembly (in a mixed-vendor core) in accordance with its unique characteristics and associated operating limits. Additionally, software features allow interaction with “black box” proprietary critical power correlations and fuel conditioning criteria to accurately calculate conditions for non-AREVA fuel.

Partnering with TVA at Browns Ferry Unit 1, POWERPLEX-XD has also been extended to monitor the PCI risk for non-AREVA fuel.

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## More Than Three Decades of Field-Proven Experience

After 30 years of successful operations, POWERPLEX-XD is capable of modeling a wide variety of 8x8, 9x9, 10x10, and 11x11 fuel configurations supplied by all three BWR fuel vendors. Operators with alternative fuel can also use the highly-effective software with confidence. POWERPLEX-III has even been installed in plants without our fuel to upgrade plant monitoring capabilities independent of fuel supply.

## Features and Benefits

- POWERPLEX-XD is the only core monitoring system that produces real-time PCI margin information for every 6-inch node of every rod in the core
- We continue applying our extensive global resources to deliver new technology, such as POWERPLEX-XD
- The accuracy of the software allows direct comparison of design and monitoring system results throughout the cycle to ensure compliance with the licensing basis
- POWERPLEX-XD keeps a plant operating when unforeseen events arise
- POWERPLEX-XD can explicitly model each fuel assembly in a mixed-vendor core
- POWERPLEX-XD is currently installed at all three Browns Ferry Units
- Off-line calculations allow customers to optimize the way in which the fuel is utilized (e.g., maneuvering operations and reload patterns) while maintaining a robust PCI program

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