Nuclear Services / Engineering Services

Subcritical Physics Testing with the RhoPRO® Reactivity Computer System

Background

Prior to beginning a new operating cycle after refueling, Low Power Physics Testing (LPPT) is the first series of tests to demonstrate consistency between the reconstructed core and its nuclear design model. The core design is validated by demonstrating measured-to-predicted agreement of key characteristics such as reactor shutdown capability, core reactivity balance and control, as well as by providing an initial core power distribution check. For over 40 years, Westinghouse has continuously developed new products and services to save critical path time during reload plant startups, all the while maintaining or enhancing safety and performance.

Subcritical Physics Testing (SPT) with the RhoPRO® reactivity computing system is the latest in that line of innovative startup test methods.

Description

SPT with RhoPRO is a revolutionary program for core design validation that achieves the same objectives as traditional LPPT through a unique and simplified approach. The process primarily consists of performing steady-state comparisons of inverse count rate ratio (ICRR) over a variety of subcritical core configurations and conditions.

SPT with RhoPRO data collection occurs during normal planned subcritical MODE 3 operations (e.g., in parallel with Rod Drop Time Measurement Testing) and again coupled with a rod withdrawal approach to criticality in MODE 2. In both cases, data collection is seamlessly integrated into pre-existing activities, thus significantly reducing critical-path testing time. Testing at critical conditions is therefore reduced to only an isothermal temperature coefficient (ITC) measurement, during which the plant can be pre-configured for power ascension to MODE 1.

SPT is deployed using Westinghouse's state-of-the-art RhoPRO reactivity computer to connect to isolated nuclear instrumentation and temperature signals. Service offerings include use of the RhoPRO system and 24-hour coverage by qualified Westinghouse test engineers.

RhoPRO Reactivity Computer System

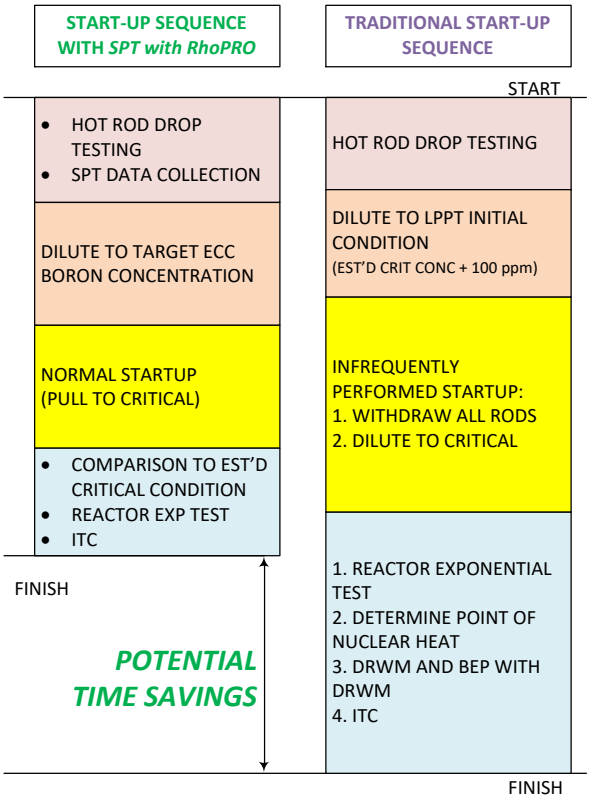
Benefits

- Integration of SPT with RhoPRO data collection into existing plant startup activities eliminates the critical path time associated with LPPT.
- Elimination of other associated LPPT activities (e.g., rod speed adjustments, nuclear heat determination).
- Minimal impact on outage critical path (less than one hour total) due to the ITC measurement being the lone dedicated physics test performed on critical path.
- Implementation of program is possible for any PWR design plant. Any given plant could save more than four critical path hours by substituting traditional ANSI/ANS-19.6.1-endorsed methods with SPT with RhoPRO.
- Distinct operational, human performance and reactivity management benefits as compared to traditional LPPT methods:
  - Nearly all data is collected at steady-state subcritical conditions, as compared to several hours of dynamic at-critical reactivity maneuvering during traditional LPPT.
  - No time-sensitive operator actions are required.
  - Enables a "pull-to-critical" startup rather than an infrequently performed dilution to criticality.

Westinghouse

- The RhoPRO system collects data from ex-core neutron detectors without their removal from service. As a result, all nuclear instrumentation channels and associated protection functions remain operable.

A comparison of the SPT with RhoPRO and typical LPPT evolutions is depicted in the following illustration.



Traditional LPPT is a direct barrier to MODE 1 entry. SPT with RhoPRO *simplifies and streamlines post-refueling startup activities between MODE 3 and MODE 1. As a result, core design verification is almost entirely removed from outage critical path, putting the customer back on the grid faster than ever before.*

Experience

The Spatially Corrected Inverse Count Rate (SCICR) methodology was originally approved by the U.S. Nuclear Regulatory Commission (NRC) in 2005, which paved the way for release of the Subcritical Rod Worth Measurement (SRWM™) application.

The new SPT with RhoPRO application maintains all fundamental benefits of the original SRWM product, while incorporating new features and changes in response to key lessons learned from 50 total SRWM applications at over 15 U.S. units.

- The new generation SPT / SCICR methodology eradicates masking effects by eliminating interaction between measurement and prediction. In doing so, SPT with RhoPRO offers a "pure" measured-to-predicted comparison.
- The SPT with RhoPRO program and results evaluation package enhance overall detectability of core anomalies.
- The data collection requirements have been significantly reduced as compared to those of the SRWM application. By reducing the necessary data sampling to 1-2 minutes per state point, which is generally within the normal hold time following a reactivity maneuver, a "net zero" critical path impact can be achieved.

The licensing basis of the SCICR methodology, topical report WCAP-16260, Rev. 2, has been accepted by the NRC as of April 2018. Commercial release of *SPT with RhoPRO* site services are scheduled for fall 2019.

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066

May 2019 / NS-ES-0303